PRELIMINARY DATA SHEET

MOS INTEGRATED CIRCUIT

μPD178016GC-051

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

The μPD178016GC-051 is an 8-bit CMOS microcontroller for use in digital tuners designed to receive the European FM, MW, and LW bands. It incorporates a prescaler, PLL frequency synthesizer, and IF counter.

The device supports European RDS (Radio Data System), and offers many RDS functions. Thus, it enables the configuration of a high-performance, multi-function FM/MW/LW tuner, such as an automotive stereo system, using a single chip.

Because the device implements the RDS decoder as a software library, an RDS system can be configured by combining the device with an RDS data demodulation IC μPC2539.

FEATURES

- Preset memory
  Stores six stations in each of the FM1, FM2, FM3, and AM bands (the AM band is shared between the MW and LW bands), giving a total of 24 stations
- Last channel memory
  One station per band, totaling four stations
- Tuning functions
  - Manual seek/auto-seek
  - Auto-storage
  - Preset scan
  - Auto-retuning
- A μPD16431A is used as the LCD controller/driver
- Single power supply (V_{DD} = 5 V ± 10 %)
- RDS functions
  - Built-in RDS decoder function
  - Station name display (PS)
  - AF function
  - Traffic information standby function (TP and TA)
  - EON function
  - CT function (automatic time adjustment)
  - Alarm function (PTY = 31)
  - PTY seek function (program identification information)
- CD changer and logic tape deck control
- Electronic volume control
- Remote-controller signal reception function (a μPD6121G-002 is used for sending the remote-controller signal)

ORDERING INFORMATION

Part number	Package
μPD178016GC-051-3B9	80-pin plastic QFP (14 × 14 mm), 0.65-mm pitch

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

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FUNCTION OVERVIEW

Tunable Frequencies, Channel Separation, Reference Frequency, and Intermediate Frequency

Region	Band	Tunable frequency	Channel separation	Reference frequency	Intermediate frequency
Europe	FM	87.50 to 108.0 MHz	50 kHz	50 kHz	10.7 MHz
	MW	522 to 1 620 kHz	9 kHz	9 kHz	450 kHz/459 kHz/10.71 MHz
	LW	144 to 288 kHz	9 kHz	9 kHz	450 kHz/459 kHz/10.71 MHz
USA	FM	87.50 to 108.0 MHz	50 kHz	50 kHz	10.7 MHz
	MW	530 to 1 720 kHz	10 kHz	10 kHz	450 kHz

TUNING FUNCTIONS

(1) Manual tuning

Function	Description
Manual up Manual down	Each time one of these keys is pressed, the frequency is increased or reduced by one step, respectively. If either of the keys is held down, the frequency is increased or reduced in high-speed 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.

(3) Preset memory

Stores six stations in each band (FM1/FM2/FM3/AM), giving a total of 24 stations.

(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, FM3, and AM bands.

(5) Auto-storage

Searches through the entire frequency range of the received bands and stores the frequencies of the detected stations in the preset memory.

(6) Last channel memory

Stores the frequency of the most-recently received station in each of the FM1, FM2, FM3, and AM bands, totaling four stations.

(7) Auto-retuning

Automatically starts auto-tuning if the SD signal is not detected for about 30 seconds during broadcast reception. Also starts seek up if traffic information is not received for four seconds in TP/SK mode.

RDS FUNCTIONS

(1) Station name display

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

(2) AF function

If reception of the received RDS station deteriorates, searches for and tunes to an RDS station having the same broadcast contents.

Supports METHOD A and METHOD B, and stores an AF list of up to 40 stations. Using EON, the device can also store an AF list of other stations.

(3) Traffic information station switching

Selects radio mode when traffic information broadcasting starts.

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) RDS station seek

- RDS seek
  Searches for RDS stations only.
- PTY seek
  Searches for an RDS station broadcasting a specific type of program.
- TP/SK seek
  Searches for an RDS station broadcasting traffic information.
- TP auto-storage
  Writes only an RDS station broadcasting traffic information to the preset memory.

(6) Program identification information

Displays the name of the program currently being received by using a PTY code.

The device is also capable of performing search based on the displayed program name.

TAPE FUNCTIONS

(1) FF/REW: Fast-forwards or rewinds the tape.
(2) TAPE: Switches the tape side between A and B.
(3) AMS: Searches for the beginning of a track.

CD CHANGER CONTROL FUNCTIONS

(1) Disc selection
Selects a specified CD.

(2) Track up/down
Moves up or down by one track.

(3) Search up/down
Fast-forward and rewind.

(4) REPEAT
Repeats the playback of a track.

(5) DISC REPEAT
Repeats the playback of an entire disc.

(6) RANDOM
Selects and plays back the tracks of a single CD at random.

(7) DISK RANDOM
Selects and plays back the tracks of all the CDs at random.

(8) INTRO
Sequentially plays back the first ten seconds of each track, starting from the first track.

(9) DISK INTRO
Sequentially plays back the first ten seconds of the first track of each CD.

CLOCK FUNCTIONS

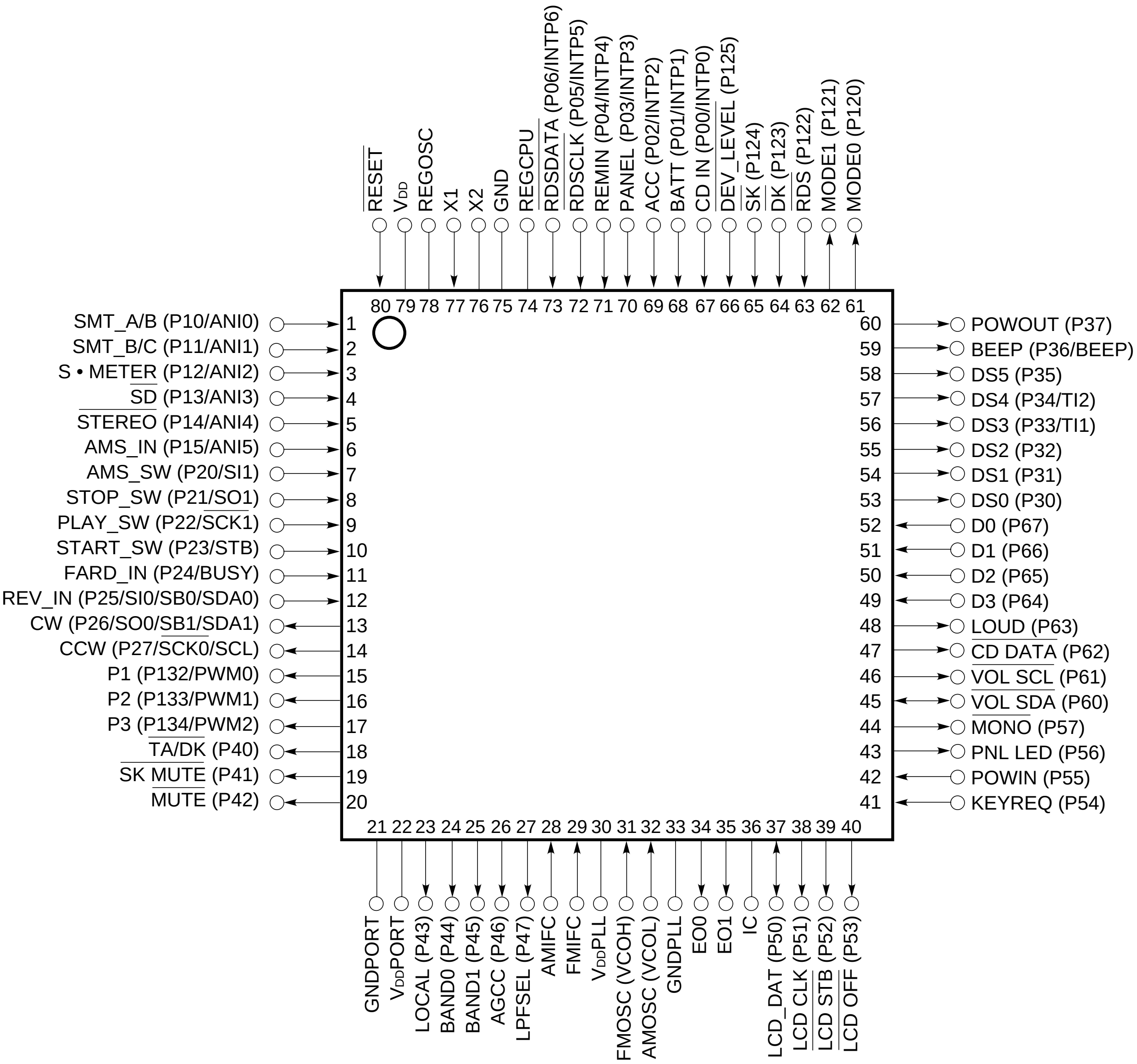
(1) 12-hour clock display (with “AM” and “PM” indication) or 24-hour clock display
(2) Selectable colon (“:”) flashing (1 Hz)
(3) Back up (with low power consumption) in no-clock mode

ELECTRONIC VOLUME CONTROL FUNCTIONS

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

PIN CONFIGURATION (TOP VIEW)

80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)
μPD178016GC-051-3B9



Remarks 1. ( ): μPD178016GC-×××-3B9

2. IC: 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
2</td><td>SMT_A/B
SMT_B/C</td><td>Signal meter reading range input</td><td>Pins used for setting the signal meter voltage ranges used to determine the condition for starting an AF operation. Input analog voltages according to the characteristics of the tuner being used (See (1) in Section 3.1.5).</td><td>Analog input</td></tr>
<tr><td>3</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 signal strength. This pin is used to monitor the conditions controlling AF switching.</td><td>Analog input</td></tr>
<tr><td>4</td><td>$\overline{\text{SD}}$</td><td>SD signal input</td><td>Input pin for the station detection signal.
Input the signal as indicated in the table below.
<table>
<tr><th>$\overline{\text{SD}}$ pin</th><th>Description</th></tr>
<tr><td>0</td><td>Station detected</td></tr>
<tr><td>1</td><td>Station not detected</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>5</td><td>$\overline{\text{STEREO}}$</td><td>Stereo signal input</td><td>Input pin for the stereo broadcast signal.
This pin is valid for the FM band only.
Input the signal as indicated in the table below.
<table>
<tr><th>$\overline{\text{STEREO}}$ pin</th><th>Description</th></tr>
<tr><td>0</td><td>Stereo broadcast</td></tr>
<tr><td>1</td><td>Mono broadcast</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>6</td><td>AMS_IN</td><td>Audio signal input</td><td>Pin indicating input of the audio signal from the logic tape deck.
Input the signal as indicated in the table below.
<table>
<tr><th>AMS_IN pin</th><th>Description</th></tr>
<tr><td>0</td><td>Audio signal not input</td></tr>
<tr><td>1</td><td>Audio signal input</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>7</td><td>AMS_SW</td><td>AMS switch signal input</td><td>Input pin for logic tape deck state.
Input the signal as indicated in the table below.
<table>
<tr><th>AMS_SW pin</th><th>Description</th></tr>
<tr><td>0</td><td>AMS mode</td></tr>
<tr><td>1</td><td>Other than AMS mode</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>8</td><td>STOP_SW</td><td>STOP switch signal input</td><td>Input pin of logic tape deck state.
Input the signal as indicated in the table below.
<table>
<tr><th>STOP_SW pin</th><th>Description</th></tr>
<tr><td>0</td><td>FF/REW</td></tr>
<tr><td>1</td><td>PLAY</td></tr>
</table>
(0: Low, 1: High)</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>9</td><td>PLAY_SW</td><td>PLAY switch signal input</td><td>Input pin for logic tape deck state.
Input the signal as indicated in the table below.
<table>
<tr><th>PLAY_SW pin</th><th>Description</th></tr>
<tr><td>0</td><td>PLAY</td></tr>
<tr><td>1</td><td>FF/REW</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>10</td><td>START_SW</td><td>START switch signal input</td><td>Input pin for logic tape deck state.
Input the signal as indicated in the table below.
<table>
<tr><th>START_SW pin</th><th>Description</th></tr>
<tr><td>0</td><td>EJECT</td></tr>
<tr><td>1</td><td>LOADING-EJECT</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>11</td><td>FARD_IN</td><td>Side A pulse signal input</td><td>Input pin for pulse of side A of logic tape deck.</td><td>Input</td></tr>
<tr><td>12</td><td>REV_IN</td><td>Side B pulse signal input</td><td>Input pin for pulse of side B of logic tape deck.</td><td>Input</td></tr>
<tr><td>13
14</td><td>CW
CCW</td><td>Power motor control signal output</td><td>Output pins controlling the power motor of the logic tape deck.
The signals are output as indicated in the table below.
<table>
<tr><th>CW pin</th><th>CCW pin</th><th>Description</th></tr>
<tr><td>0</td><td>1</td><td>LOADING</td></tr>
<tr><td>1</td><td>0</td><td>EJECT</td></tr>
<tr><td>0</td><td>0</td><td>STOP</td></tr>
<tr><td>1</td><td>1</td><td>BRAKE</td></tr>
</table>
(0: Low, 1: High)</td><td>CMOS push-pull output</td></tr>
<tr><td>15
to
17</td><td>P1
to
P3</td><td>Main motor control signal output</td><td>Output pins controlling the main motor of the logic tape deck.
The signals are output as indicated in the table below.
<table>
<tr><th>P1 pin</th><th>P2 pin</th><th>P3 pin</th><th>Description</th></tr>
<tr><td>1</td><td>0</td><td>0</td><td>PLAY, side A</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>PLAY, side B</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>FF, side A</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>FF, side B</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>STOP</td></tr>
</table>
(0: Low, 1: High)</td><td>N-ch open-drain output</td></tr>
<tr><td>18</td><td>$\overline{\text{TA/DK}}$</td><td>Traffic information station signal output</td><td>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
• A traffic information alarm is output.</td><td>CMOS push-pull output</td></tr>
<tr><td>19</td><td>$\overline{\text{SK MUTE}}$</td><td>SK mute signal output</td><td>Traffic information mute output pin.
The SK mute output pin is used when a traffic information station identification signal is not being received in TP/SK mode.</td><td>CMOS push-pull output</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>20</td><td>$\overline{\text{MUTE}}$</td><td>Mute signal output</td><td>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.</td><td>CMOS push-pull output</td></tr>
<tr><td>21</td><td>GNDPORT</td><td>Ground pin for port</td><td>Ground pin for port. Connect this pin to GND.</td><td>—</td></tr>
<tr><td>22</td><td>V_{DD} PORT</td><td>Positive power supply pin for port</td><td>Positive power supply pin for port.
Connect this pin to V_{DD}.</td><td>—</td></tr>
<tr><td>23</td><td>LOCAL</td><td>Local signal output</td><td>Output pin for the tuner LOCAL/DX switching output.
The output of this pin is high while the device is in LOCAL mode.</td><td>CMOS push-pull output</td></tr>
<tr><td>24
25</td><td>BAND0
BAND1</td><td>Band switching signal output</td><td>Band switching signal output pins.
These pins output the following signals in each band.
<table>
<tr><th>Band</th><th>BAND0 pin</th><th>BAND1 pin</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>0</td></tr>
</table>
(0: Low, 1: High)
The FM band is output when power is first applied.</td><td>CMOS push-pull output</td></tr>
<tr><td>26</td><td>AGCC</td><td>AGCC signal output</td><td>Output pin for the auto gain control cut signal.
The signal is output during auto-tuning.</td><td>CMOS push-pull output</td></tr>
<tr><td>27</td><td>LPFSEL</td><td>LPF time constant switching signal output</td><td>Output pin for the signal for switching the time constant of the LPF of the tuner during AF operation.
The output level of this pin goes high during AF operation.</td><td>CMOS push-pull output</td></tr>
<tr><td>28</td><td>AMIFC</td><td>AM intermediate frequency input</td><td>Input pin for intermediate frequency (IF) in the AM (MW, LW) band.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current.
When the AM SD/IF switch of the initial setting diode matrix is set to 1 (the diode is jumpered), this pin is used to detect a station during auto-tuning.
When the input frequency range and the 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>MW</td><td>450 kHz ± 3 kHz</td></tr>
<tr><td></td><td>459 kHz ± 3 kHz</td></tr>
<tr><td>LW</td><td>450 kHz ± 3 kHz</td></tr>
<tr><td></td><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>
</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>29</td><td>FMIFC</td><td>FM intermediate frequency input</td><td>Input pin for intermediate frequency (IF) in FM band.
To protect the built-in AC amplifier, use a capacitor to prevent the flow of direct current.
When the FM SD/IF switch of the initial setting diode matrix is set to 1 (the diode is jumpered), 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 ± 25.0 kHz</td></tr>
</table>
A frequency within the input frequency range must be input within 20 ms of the PLL being locked. However, input the frequency within 5 ms during AF operation, best station, or EON operation.</td><td>Input</td></tr>
<tr><td>30</td><td>V_{DD}PLL</td><td>Positive power supply pin for PLL</td><td>Positive power supply pin for PLL.
Connect this pin to V_{DD}.</td><td>—</td></tr>
<tr><td>31</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 enters the high-impedance state.
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>32</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 enters the high-impedance state.
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>33</td><td>GNDPLL</td><td>PLL ground pin</td><td>Ground pin for PLL.
Connect this pin to GND.
Insert a 100-pF capacitor between the V_{DD}PLL pin and GNDPLL pin.</td><td>—</td></tr>
<tr><td>34
35</td><td>EO0
EO1</td><td>Error output</td><td>Output pins for the PLL 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).</td><td>CMOS 3-state output</td></tr>
<tr><td>36</td><td>IC</td><td>Internally connected</td><td>Connect this pin to GND.</td><td>—</td></tr>
<tr><td>37</td><td>LCD_DAT</td><td>LCD driver data signal input/output</td><td>Input/output pin for exchanging serial data with the LCD controller/driver (μPD16431A).</td><td>Input
CMOS push-pull output</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>38</td><td>LCD CLK</td><td>LCD driver clock output</td><td>Output pin for sending the serial clock to the LCD controller/driver (μPD16431A).
Reads data at a rising edge and outputs data at a falling edge.
The serial interface with the LCD controller/driver is of 2-wire serial type.</td><td>CMOS push-pull output</td></tr>
<tr><td>39</td><td>$\overline{\text{LCD STB}}$</td><td>LCD driver strobe signal output</td><td>Output pin for the strobe signal to the LCD controller/driver (μPD16431A).
Outputs data while low.
Processes data at a rising edge.</td><td>CMOS push-pull output</td></tr>
<tr><td>40</td><td>$\overline{\text{LCD OFF}}$</td><td>LCD driver display OFF signal output</td><td>Output pin for sending the display OFF signal to the LCD controller/driver (μPD16431A).</td><td>CMOS push-pull output</td></tr>
<tr><td>41</td><td>KEYREQ</td><td>LCD driver key request signal input</td><td>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.</td><td>Input</td></tr>
<tr><td>42</td><td>POWIN</td><td>Power key signal input</td><td>Signal input pin used to detect power key input.</td><td>Input</td></tr>
<tr><td>43</td><td>PNL LED</td><td>Panel detachment detection LED signal output</td><td>Output pin for the LED signal indicating that the front panel has been detached. In this state, the pin outputs a 1-Hz signal.
The active level is high.</td><td>CMOS push-pull output</td></tr>
<tr><td>44</td><td>$\overline{\text{MONO}}$</td><td>MONO signal output</td><td>Control signal output pin of forced MONO.
The signal is output as follows:
<table>
<tr><th>$\overline{\text{MONO}}$ pin</th><th>Description</th></tr>
<tr><td>0</td><td>Forced MONO ON</td></tr>
<tr><td>1</td><td>Forced MONO OFF</td></tr>
</table>
(0: Low, 1: High)
This pin outputs a high level when the power is first applied.</td><td>CMOS push-pull output</td></tr>
<tr><td>45</td><td>$\overline{\text{VOL SDA}}$</td><td>Electronic volume control data input/output</td><td>Input/output pin for the serial data that is fed to the electronic volume control (TDA7313, TEA6320).</td><td>Input
N-ch open-drain output</td></tr>
<tr><td>46</td><td>$\overline{\text{VOL SCL}}$</td><td>Electronic volume control clock output</td><td>Output pin for the serial clock that is fed to the electronic volume control (TDA7313, TEA6320).
Data is read at a rising edge and data is output at a falling edge.
The interface with the electronic volume control is of I^2C bus type.</td><td>N-ch open-drain output</td></tr>
<tr><td>47</td><td>$\overline{\text{CD DATA}}$</td><td>CD changer data output</td><td>Output pin for the data to the CD changer.</td><td>N-ch open-drain output</td></tr>
<tr><td>48</td><td>LOUD</td><td>Loudness signal output</td><td>Output pin for the loudness control signal.
The signal is output as indicated in the table below.
<table>
<tr><th>LOUD pin</th><th>Description</th></tr>
<tr><td>0</td><td>Loudness OFF</td></tr>
<tr><td>1</td><td>Loudness ON</td></tr>
</table>
(0: Low, 1: High)
This pin outputs a low level when the power is first applied.</td><td>N-ch open-drain output</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>49
to
52</td><td>D3
to
D0</td><td>Initial setting diode return signal input</td><td>Input pins for the return signals of the initial setting diode matrix.
These pins, together with DS0 (pin 53) to DS5 (pin 58), constitute a diode matrix.
Connect a pull-down resistor to these pins.</td><td>Input</td></tr>
<tr><td>53
to
58</td><td>DS0
to
DS5</td><td>Initial setting diode source signal output</td><td>Output pins for the source signals of the initial setting diode matrix.
These pins, together with D3 (pin 49) to D0 (pin 52), constitute a diode matrix.</td><td>CMOS push-pull output</td></tr>
<tr><td>59</td><td>BEEP</td><td>Beep signal output</td><td>Beep output pin.
A square wave with a frequency of 1.5 kHz and a duty cycle of 50 % is output for 50 ms.
A beep is output when:
• The beep is validated by pressing a key.
• The next preset memory is selected during preset memory scan operation.</td><td>CMOS push-pull output</td></tr>
<tr><td>60</td><td>POWOUT</td><td>Power state output</td><td>Output pin indicating the power state of the system.</td><td>CMOS push-pull output</td></tr>
<tr><td>61
62</td><td>MODE0
MODE1</td><td>Mode signal output</td><td>Output pins indicating the operating mode.
See the table below.
<table>
<tr><th>MODE0</th><th>MODE1</th><th>Mode</th></tr>
<tr><td>0</td><td>0</td><td>Radio</td></tr>
<tr><td>1</td><td>0</td><td>Tape</td></tr>
<tr><td>1</td><td>1</td><td>CD</td></tr>
</table>
(0: Low, 1: High)
Radio output mode is set when the power is first applied.</td><td>CMOS push-pull output</td></tr>
<tr><td>63</td><td>$\overline{\text{RDS}}$</td><td>RDS indicator signal input</td><td>Input pin used to detect the RDS signal of an RDS station.
Prevents the device from erroneously locking onto 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 $\overline{\text{RDSDATA}}$ and $\overline{\text{RDSCLK}}$ during auto-tuning.</td><td>Input</td></tr>
<tr><td>64</td><td>$\overline{\text{DK}}$</td><td>DK signal input</td><td>Input pin used to detect the DK signal of a VF station.
If both the $\overline{\text{SK}}$ and $\overline{\text{DK}}$ pins go low in standby mode, the device judges that traffic information is being broadcast and the device switches to standby radio mode.
If the level of the $\overline{\text{DK}}$ pin goes from low to high, the device returns to standby mode. Pull up this pin when ARI is not to be used.</td><td>Input</td></tr>
<tr><td>65</td><td>$\overline{\text{SK}}$</td><td>SK signal input</td><td>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.</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>66</td><td>$\overline{\text{DEV\_LEVEL}}$</td><td>Modulation signal input</td><td>Input pin for the modulation signal.
Input the signal as indicated in the table below.
<table>
<tr><th>$\overline{\text{DEV\_LEVEL}}$ pin</th><th>Description</th></tr>
<tr><td>0</td><td>Mute</td></tr>
<tr><td>1</td><td>Sound</td></tr>
</table>
(0: Low, 1: High)</td><td>Input</td></tr>
<tr><td>67</td><td>CD IN</td><td>CD changer data input</td><td>Input pin for the CD changer data.</td><td>Input</td></tr>
<tr><td>68</td><td>BATT</td><td>BATT signal input</td><td>Input pin for the BATT signal.
Input the signal as indicated in the table below.
<table>
<tr><th>BATT pin</th><th>Description</th></tr>
<tr><td>0</td><td>Power OFF</td></tr>
<tr><td>1</td><td>Power ON</td></tr>
</table>
(0: Low, 1: High)
In no-clock mode (initial setting diode NOCLK = 1) or a mode in which the clock is not counted during power off (initial setting diode CTOFF = 1), the power consumption is reduced during power off.</td><td>Input</td></tr>
<tr><td>69</td><td>ACC</td><td>ACC signal input</td><td>Input pin for the ACC signal.
Input the signal as indicated in the table below.
<table>
<tr><th>ACC pin</th><th>Description</th></tr>
<tr><td>0</td><td>Power OFF</td></tr>
<tr><td>1</td><td>Power ON</td></tr>
</table>
(0: Low, 1: High)
In no-clock mode (initial setting diode NOCLK = 1) or a mode in which the clock is not counted during power off (initial setting diode CTOFF = 1), the power consumption is reduced during power off.</td><td>Input</td></tr>
<tr><td>70</td><td>PANEL</td><td>Panel detachment detection input</td><td>Input pin used to detect whether the front panel has been detached. The input of a high-level signal indicates that the front panel has been detached.</td><td>Input</td></tr>
<tr><td>71</td><td>REMIN</td><td>Remote-controller signal input</td><td>Remote-controller signal input pin.</td><td>Input</td></tr>
<tr><td>72</td><td>$\overline{\text{RDSCLK}}$</td><td>RDS clock input</td><td>RDS clock input pin. To this pin, input the clock signal from the RDS signal detector section.
Because the μPD178016GC-051 does not detect bit synchronization based on the width of a clock signal, the input clock signal must be as accurate as possible.</td><td>Input</td></tr>
<tr><td>73</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>
<tr><td>74</td><td>REGCPU</td><td>CPU power supply regulator</td><td>Regulator pin for CPU power supply.
Connect this pin to ground via a 0.1-μF capacitor.</td><td>—</td></tr>
<tr><td>75</td><td>GND</td><td>Ground</td><td>Device ground</td><td>—</td></tr>
</table>

Pin No.	Symbol	Pin name	Description	I/O type
76 77	X2 X1	Crystal resonator	Pin for connecting a 4.5-MHz crystal resonator.	—
78	REGOSC	Oscillation circuit regulator	Regulator pin for oscillation circuit. Connect this pin to ground via a 0.1-μF capacitor.	—
79	V_{DD}	Power supply	Power supply pins for the device. To this pin, supply 5 V ± 10 % while the device is operating.	—
80	$\overline{\text{RESET}}$	Reset input	Reset input pin.	Input

2. KEY MATRIX STRUCTURE

2.1 Configuration of Initial Setting Diode Matrix and Transistor Switch

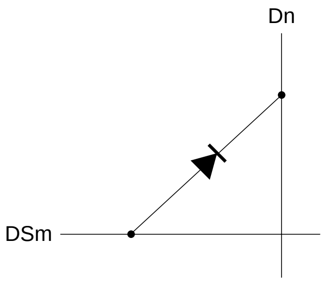
Input pin / Output pin	D0 (52)	D1 (51)	D2 (50)	D3 (49)
DS0 (53)	AM SD/IF	FM SD/IF	AMIF1	AMIF2
DS1 (54)	NOCLK	CTADJ	CTOFF	FLASH
DS2 (55)	RETUNE	NO_PIM	BEEP	DEV_SEL
DS3 (56)	CLK24	REGION	VOLSEL	FAD
DS4 (57)	ERR_COR3	ERR_COR2	ERR_COR1	AFALL
DS5 (58)	POWER1	POWER2	AMERICA	METAL

Remarks 1. Numbers in ( ) are pin numbers.

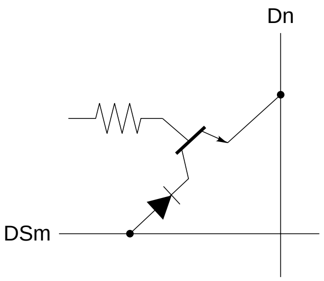
2. ▭ : Initial setting diode, ▣ : Transistor switch

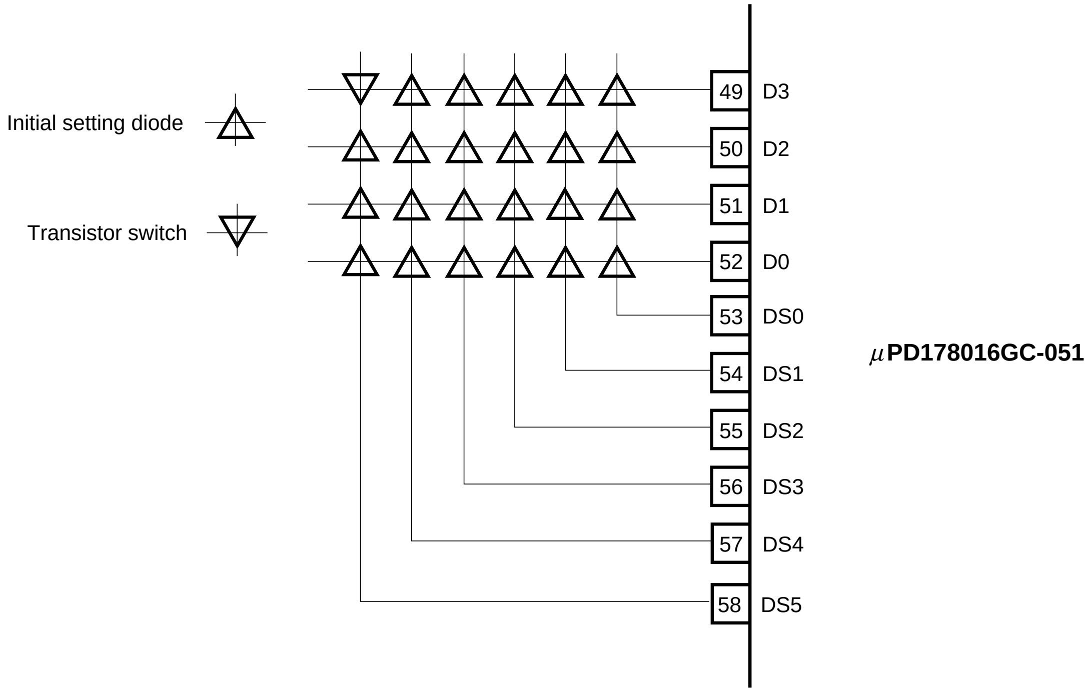
2.2 Connection between Initial Setting Diode Matrix and Transistor Switch

Initial setting diode



Transistor switch





2.3 Momentary Key Matrix Configuration

Input pin Output pin	KEY1 (2)	KEY2 (3)	KEY3 (4)	KEY4 (5)
KS1 (25)	M1	M2	M3	M4
	—	—	—	—
	M1	M2	M3	M4
KS2 (26)	M5	M6	DOWN	UP
	—	—	DOWN	UP
	M5	M6	DOWN	UP
KS3 (27)	PSCAM/ASM	RDS/REGION	TP/SK	PTY
	—	—	TP/SK	—
	—	—	TP/SK	—
KS4 (28)	BAND	CDC	TAPE	DISP/ADJ
	BAND	CDC	TAPE	DISP/ADJ
	BAND	CDC	TAPE	DISP/ADJ
KS5 (29)	MONO/LOC	VOL DOWN	VOL UP	SEL/LOUD
	—	VOL DOWN	VOL UP	SEL/LOUD
	—	VOL DOWN	VOL UP	SEL/LOUD
KS6 (30)	AUTO	—	—	—
	—	—	—	RANDOM/AMS
	—	INTRO	REPEAT	RANDOM/AMS
KS7 (31)	—	—	—	—
	—	—	—	—
	—	—	—	—
KS8 (32)	POWER	—	—	—
	POWER	—	—	EJECT
	POWER	—	—	—

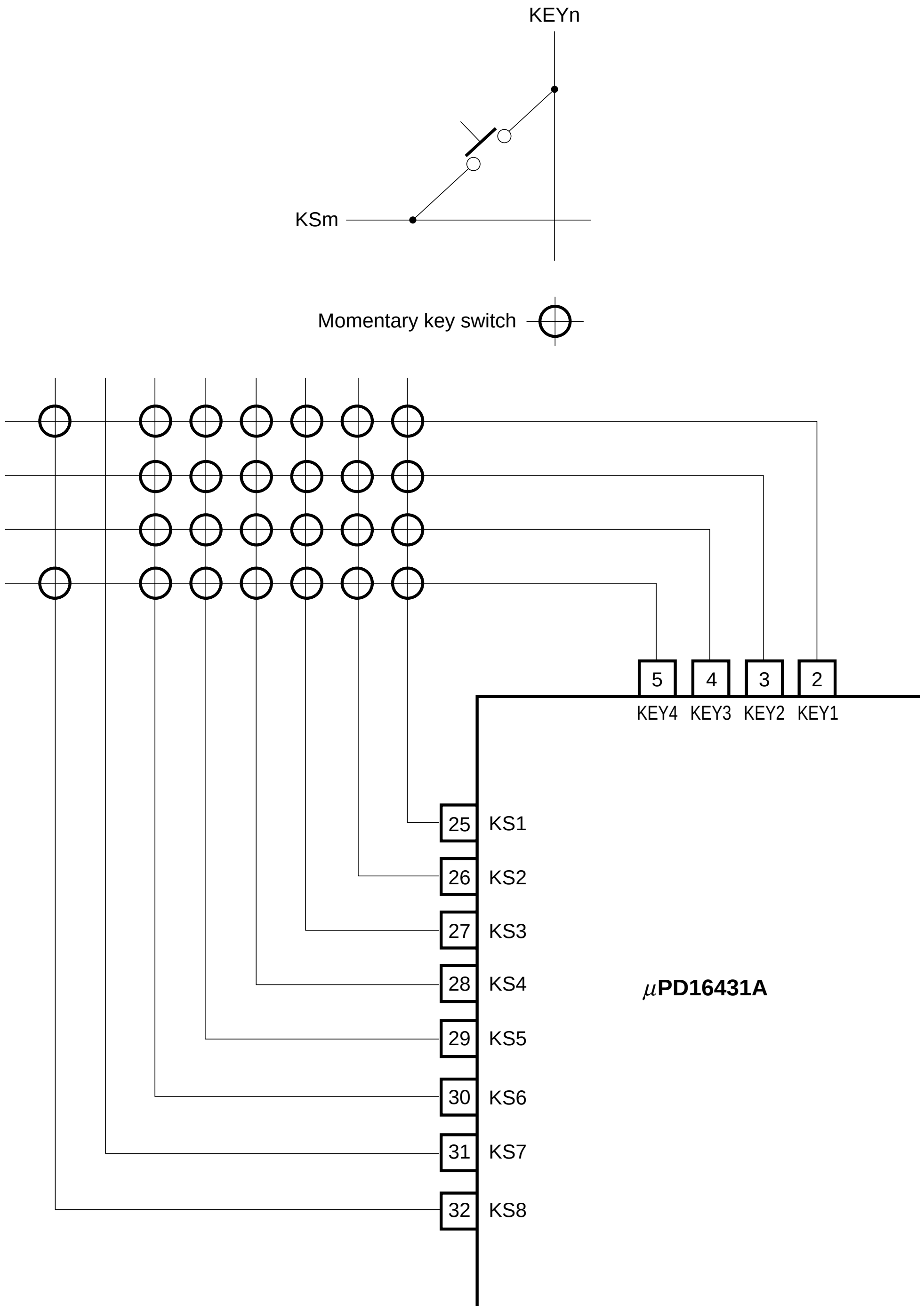
Remarks 1. The top line in each row indicates the momentary key that is valid in radio mode, the middle line indicates the key valid in tape mode, and the bottom line indicates the key valid in CD changer mode.

Top	Radio mode
Middle	Tape mode
Bottom	CD changer mode

2. Numbers in ( ) indicate the pin numbers of the μPD16431A.

2.4 Momentary Key Matrix Connection

Momentary key switch



2.5 Description of the Key Matrixes

2.5.1 Initial setting diode matrix

The initial setting diode matrix is used to determine the function of the μPD178016GC-051. This matrix must be set.

The initial setting diode matrix is read only when the microcontroller is reset by means of power-ON clear. It is ignored at all other times.

(1) Switches used to specify the method for detecting a station during auto-tuning

AM SD/IF, FM SD/IF

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

AMIF1, AMIF2

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

RETUNE

(4) Switches related to the clock functions

CLK24, CTADJ, CTOFF, FLASH, NOCLK

(5) Switches used to specify the electronic volume control function

FAD, VOLSEL

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

BEEP

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

AMERICA

(8) Switch used to validate the use of the REGION key function

REGION

(9) Switch used to specify whether the mute function is used during PI check of AF

NO_PIM

(10) Switches used to specify the AF function

AFALL, DEV_SEL

(11) Switches used to select the number of error correction bits when RDS data is decoded

ERR_COR1, ERR_COR2, ERR_COR3

(12) Switch used to select the method for inputting the POWER key

POWER1

(13) Switch used to select display during power off

POWER2

To set these switches, the respective matrix diodes are either jumpered (1) or left open (0).

The functions of the switches in the initial setting diode matrix are summarized below (in alphabetical order).

<table>
<tr><th>Initial setting diode</th><th>Description</th></tr>
<tr><td>AFALL</td><td>This switch is used to specify the AF function.
Set the switch as indicated in the following table.
<table>
<tr><th>AFALL</th><th>AF function</th></tr>
<tr><td>0</td><td>Performs only one-station AF.</td></tr>
<tr><td>1</td><td>Performs broadcasting AF.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>AMERICA</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>AMERICA</th><th>Europe/USA</th></tr>
<tr><td>0</td><td>Europe</td></tr>
<tr><td>1</td><td>USA</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>AMIF1
AMIF2</td><td>These switches are used to specify the intermediate frequency in the AM band for the European market.
The setting of these switches is invalid when the USA market is selected (initial setting diode AMERICA = 1).
Set the switch as indicated in the following table.
<table>
<tr><th>AMIF1</th><th>AMIF2</th><th>Intermediate frequency</th></tr>
<tr><td>0</td><td>0</td><td>450 kHz</td></tr>
<tr><td>0</td><td>1</td><td>459 kHz</td></tr>
<tr><td>1</td><td>×</td><td>10.71 MHz</td></tr>
</table>
(0: Open, 1: Jumpered, ×: Don’t care)</td></tr>
<tr><td>AM SD/IF
FM SD/IF</td><td>This switch is used to specify the method used to detect a station during auto-tuning.
AM SD/IF specifies the method of detecting the AM band, while FM SD/IF specifies the method of detecting the FM band.
Set these switches as indicated in the following table.
<table>
<tr><th>AM SD/IF
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>
(0: Open, 1: Jumpered)</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>
(0: Open, 1: Jumpered)</td></tr>
</table>

<table>
<tr><th>Initial setting diode</th><th>Description</th></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>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>CTADJ</td><td>This switch is used to select whether the clock is adjusted according to RDS data.
The clock is not adjusted during power off.
When no-clock mode is selected (initial setting diode NOCLK = 1), this setting is invalid.
Set this switch as indicated in the following table.
<table>
<tr><th>CTADJ</th><th>Adjusting clock with RDS data</th></tr>
<tr><td>0</td><td>Does not adjust the clock with RDS data.
The clock must be adjusted by the user.</td></tr>
<tr><td>1</td><td>Adjusts the clock according to the RDS data.
The clock cannot be adjusted by the user.
The clock does not operate until the RDS data is input.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>CTOFF</td><td>This switch is used to select how the clock operates in power-off mode.
When no-clock mode is selected (initial setting diode NOCLK = 1), this setting is invalid.
Set this switch as indicated in the following table.
<table>
<tr><th>CTOFF</th><th>Clock operation</th></tr>
<tr><td>0</td><td>Operates normally.</td></tr>
<tr><td>1</td><td>Stops operation.
Initializes the clock.
The clock can be backed (with low current consumption) when a low level signal is input to the ACC or BATT pin.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>DEV_SEL</td><td>This switch is used to select whether the $\overline{\text{DEV\_LEVEL}}$ pin (pin 66) is referenced during AF operation.
Set this switch as indicated in the following table.
<table>
<tr><th>DEV_SEL</th><th>$\overline{\text{DEV\_LEVEL}}$ pin</th></tr>
<tr><td>0</td><td>Not referenced.</td></tr>
<tr><td>1</td><td>Referenced.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
</table>

<table>
<tr><th>Initial setting diode</th><th>Description</th></tr>
<tr><td>ERR_COR1
ERR_COR2
ERR_COR3</td><td>These switches are used to select the number of error correction bits when RDS data is decoded.
Set these switches as indicated in the following table.
<table>
<tr><th>ERR_COR1</th><th>ERR_COR2</th><th>ERR_COR3</th><th>Error correction</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>Error is not corrected.</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1-bit correction</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2-bit correction</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>3-bit correction</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>4-bit correction</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>5-bit correction</td></tr>
<tr><td>1</td><td>1</td><td>×</td><td>Error is not corrected.</td></tr>
</table>
(0: Open, 1: Jumpered, ×: Don’t care)</td></tr>
<tr><td>FAD</td><td>This switch is used to select whether the fader of the electronic volume control is adjusted.
Set this switch as indicated in the following table.
<table>
<tr><th>FAD</th><th>Fader function</th></tr>
<tr><td>0</td><td>Adjusted.</td></tr>
<tr><td>1</td><td>Not adjusted.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>FLASH</td><td>This switch is used to select the method of displaying “:” (colon).
The setting of this switch is invalid in no-clock mode (initial setting diode NOCLK = 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>Blinks at 1 Hz (duty factor: 60 %).
However, extinguished in power-off mode.</td></tr>
<tr><td>1</td><td>Lights.</td></tr>
</table>
(0: Open, 1: Jumpered)</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.
The clock can be backed up (with low current consumption) when a low level signal is input to the ACC or BATT pin.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>NO_PIM</td><td>This switch is used to select whether PI check of AF is muted.
Set this switch as indicated in the following table.
<table>
<tr><th>NO_PIM</th><th>Muting of PI check of AF</th></tr>
<tr><td>0</td><td>Muted.</td></tr>
<tr><td>1</td><td>Not muted.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
</table>

<table>
<tr><th>Initial setting diode</th><th>Description</th></tr>
<tr><td>POWER1</td><td>This switch is used to select the method of inputting the POWER key.
Set this switch as indicated in the table below.
<table>
<tr><th>POWER1</th><th>Input of POWER key</th></tr>
<tr><td>0</td><td>Input port (pin 42)</td></tr>
<tr><td>1</td><td>LCD driver</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>POWER2</td><td>This switch is used to select the display in power-off mode.
The setting of this switch is invalid in no-clock mode (initial setting diode NOCLK = 1) or when the power-off clock operation is stopped (initial setting diode CTOFF = 1).
Set this switch as indicated in the table below.
<table>
<tr><th>POWER2</th><th>Display in power-off mode</th></tr>
<tr><td>0</td><td>No display</td></tr>
<tr><td>1</td><td>Clock display
The clock cannot, however, be adjusted in power-off mode.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>REGION</td><td>This switch is used to validate the use of the REGION key.
Set this switch as indicated in the following table.
<table>
<tr><th>REGION</th><th>Use of REGION key</th></tr>
<tr><td>0</td><td>Invalid (REGION mode is always on.)</td></tr>
<tr><td>1</td><td>Valid</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>RETUNE</td><td>This switch is used to specify whether to turn auto-retuning on or off.
Auto-retuning is performed only when RDS mode is not set.
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>
(0: Open, 1: Jumpered)</td></tr>
<tr><td>VOLSEL</td><td>This switch is used to select between two types of electronic volume ICs.
Set this switch as indicated in the following table.
<table>
<tr><th>VOLSEL</th><th>Description</th></tr>
<tr><td>0</td><td>Electronic volume IC (SGS-TDA7313) is used.</td></tr>
<tr><td>1</td><td>Electronic volume IC (PHILIPS TEA6320) is used.</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
</table>

2.5.2 Transistor switch

The following transistor switch is used:

METAL

Unlike the initial setting diodes, the transistor switch can always be switched.

The setting of the switch is recognized when the setting coincides two times during 1-ms scanning.

<table>
<tr><th>Transistor switch</th><th>Description</th></tr>
<tr><td>METAL</td><td>This switch is used to change the state of METAL between on and off each time it is pressed.
<table>
<tr><th>METAL</th><th>METAL state</th></tr>
<tr><td>0</td><td>Off</td></tr>
<tr><td>1</td><td>On</td></tr>
</table>
(0: Open, 1: Jumpered)</td></tr>
</table>

2.5.3 Momentary keys

The **POWER** key is effective even when pressed together with another momentary key. Pressing any other two keys together is invalid, and it is assumed that no key has been pressed.

A BEEP sound (BEEP pin, pin 59) is output for 50 ms when a valid combination is pressed.

The functions of the momentary keys are described below (in alphabetical order).

<table>
<tr><th>Momentary key</th><th>Description</th></tr>
<tr><td>AUTO</td><td>This key is used to select the auto or manual mode.
This key is valid in radio mode.
Each time it is pressed, auto or manual mode is selected alternately.
In auto mode, the LCD indicator “AUTO” lights.
Manual mode is set in the initial state when the power is first applied.
The functions of the UP and DOWN keys differ depending on the selected mode.
• Auto mode
The UP / DOWN keys are used to start auto seek up/down operation.
• Manual mode
The UP / DOWN keys are used to start manual seek up/down operation.</td></tr>
<tr><td>BAND</td><td>This key is used to switch a band or to select radio mode.

(1) In radio mode
This key is used to select a band. The frequency of the selected band will be displayed. The LCD indicator corresponding to the selected band (“FM1”/“FM2”/“FM3”/“MW”/”LW”) lights.
Each time this key is pressed, the band is changed as follows:

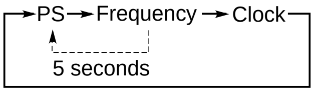
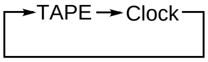
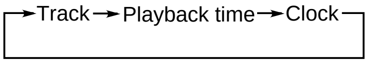
→FM1→FM2→FM3→MW/LW

The FM1 band is selected in the initial state when the power is first applied.
The outputs of the BAND0 and BAND1 pins are changed depending on the selected band, as indicated in the following table.
<table>
<tr><th>Band</th><th>BAND0 pin (pin 24)</th><th>BAND1 pin (pin 25)</th></tr>
<tr><td>FM</td><td>1</td><td>0</td></tr>
<tr><td>MW</td><td>0</td><td>0</td></tr>
<tr><td>LW</td><td>0</td><td>1</td></tr>
</table>
(0: Low, 1: High)

(2) In CD changer/tape mode
This key is used to select radio mode.
The frequency is displayed for two seconds then PS is displayed for three seconds (if there is no PS, the frequency is displayed for five seconds). Subsequently, the display returns to normal.
The LCD indicator indicating the most-recently selected band (“FM1”/“FM2”/“FM3”/“MW”/“LW”) lights.</td></tr>
<tr><td>CDC</td><td>This key is used to select CD changer mode in radio or tape mode, and is used to play back or pause the CD changer in CD changer mode.

(1) In radio/tape mode
Selects CD changer mode.

(2) In CD changer mode
Plays back or pauses the CD changer.</td></tr>
</table>

Momentary key	Description
DISP/ADJ	When this key is held down for two seconds, clock adjustment display mode is set. When the key is held down for less than two seconds, the LCD panel display is changed. Clock adjustment display mode is not selected when initial setting diode NOCLK = 1 or when initial setting diode CTADJ = 1. Clock display is not performed when initial setting diode NOCLK = 1. **(1) When used as LCD panel display select key** Each time this key is pressed, the display is changed as follows: • **When traffic information is received in radio mode, or CD changer/tape mode**  PS display is performed if RDS PS data has been input (for details, see **Section 5.3**). • **In tape mode**  • **In CD changer mode**  **(2) Clock adjustment display mode** The clock display blinks, and LCD indicator ":" lights. For details of clock adjustment, refer to the description of the **UP** and **DOWN** keys. The second digits are cleared (to 0 seconds) upon the completion of time adjustment using the **DISP/ADJ** key during clock adjustment display. The clock adjustment display is cleared when the system is started by pressing the **POWER** key.
EJECT	This key is used to eject the tape in power-on mode. It is used to select radio mode in tape mode.
INTRO	This key turns on/off disc introduction scan mode when it is held down for more than two seconds. It turns on/off introduction scan mode when pressed for less than two seconds. This key is valid in CD changer mode. • **Introduction scan** When introduction scan mode is selected, the first ten seconds of each track of the disc currently being played back are scanned. During introduction scanning, the track number blinks. • **Disc introduction scan** When disc introduction scan mode is selected, the first ten seconds of each track of all the discs in the magazine of the CD changer are scanned. During disc introduction scanning, the disc number blinks, and LCD indicator "ALL" lights. When system is started by pressing the **POWER** key, both introduction scan mode and disc introduction scan mode are turned off.

Momentary key	Description
M1 **M2** **M3** **M4** **M5** **M6**	These keys are used to call and write to the preset memory in radio mode. In CD changer mode, they are used to directly select a disc.

(1) In radio mode

The procedures for calling and writing to the preset memory are described below.

Operation	Description
Call	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 the frequency display.
Write	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 the frequency display or to the preset display when the frequency is written.

The frequency is displayed for two seconds then PS is displayed for three seconds (if there is no PS, the frequency is displayed for five seconds), after which the display returns to normal. When a frequency is displayed, the preset number corresponding to the pressed key is displayed, and LCD indicator “CH” lights.
One station in each of the FM1, FM2, FM3, and AM bands can be stored to one key; therefore, a total of 24 stations can be stored.
The PI code, PS code, and AF list are also written to the preset memory.
In the initial state after the power is first applied, the following frequencies are written to the preset memory.

(Region: Europe)

Band	M1	M2	M3	M4	M5	M6
FM1 (MHz)	87.50	89.90	97.90	105.90	107.90	87.50
FM2 (MHz)	87.50	87.50	87.50	87.50	87.50	87.50
FM3 (MHz)	87.50	87.50	87.50	87.50	87.50	87.50
AM (kHz)	144	153	522	603	1 404	144

(Region: USA)

Band	M1	M2	M3	M4	M5	M6
FM1 (MHz)	87.50	89.90	97.90	105.90	107.90	87.50
FM2 (MHz)	87.50	87.50	87.50	87.50	87.50	87.50
FM3 (MHz)	87.50	87.50	87.50	87.50	87.50	87.50
AM (kHz)	530	820	1 120	1 420	1 720	530

(2) In CD changer mode

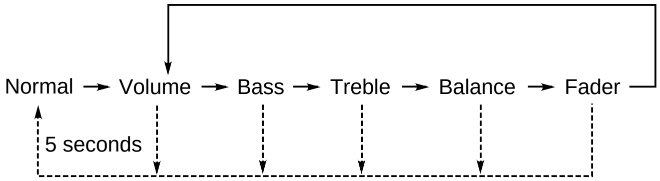
These keys are used to directly select discs in CD changer mode.

Key	Description
M1	Plays disk 1.
M2	Plays disk 2.
M3	Plays disk 3.
M4	Plays disk 4.
M5	Plays disk 5.
M6	Plays disk 6.

Momentary key	Description
MONO/LOC	This key acts as a LOCAL/DX setting key when held down for at least two seconds. When released within two seconds, it acts as a forced MONO ON/OFF key. • **Forced MONO ON/OFF** When an FM band is selected in radio mode, pressing this key switches forced MONO mode on or off. In forced MONO mode, LCD indicator "MONO" appears. The "STEREO" indicator is forcibly turned off. In forced MONO mode, $\overline{\text{MONO}}$ pin (pin 44) outputs a low level signal. • **LOCAL/DX setting** In radio mode, pressing this key switches the setting of LOCAL/DX. In LOCAL mode, LCD indicator "LOC" appears, and the LOCAL pin (pin 23) outputs a high level signal. The LOCAL pin outputs a high level signal, regardless of the setting, in auto-storage mode. Forced MONO mode and DX setting are turned off in the initial state after the power is first applied.
POWER	This key turns the power to the system on/off.
PSCAN/ASM	This key is used to perform auto-storage when it is held down for two seconds. When it is released within two seconds, preset memory scan is performed. This key is valid in radio mode. • **For preset memory scan** If a station other than a preset station is currently being received, the preset memory contents are sequentially called for five seconds each, starting from M1, as shown below. If a preset station is currently being received, the preset memory contents are sequentially called for five seconds each, starting from the next station (for example, if M3 is currently being received, calling starts from M4).  When the next preset memory contents are called, a beep is issued for 50 ms. During preset memory scanning, LCD indicator "PSCAN" appears. If there is a PS code, the PS code blinks for three seconds after the frequency has been displayed, blinking, for two seconds. If there is no PS code, the frequency is displayed, blinking, for five seconds. • **For auto-storage operation** During auto-storage, LCD indicator "ASM" appears. At this time, the LCD panel switches to the frequency display. Stations are searched from the lowest toward the highest frequency of the band currently being received. The frequencies are written to the preset memory. Searched stations are set to LOCAL in the first round of searching by the output signal of the LOCAL pin (pin 23), and to DX in the second round. If six or more stations cannot be searched in the first round, the second round of search is performed. If a detected station is an RDS station, the PI code is also written to the preset memory. If stations having the same PI code are detected during auto-storage, the signal meter values input from S • METER (pin 3) are compared, and only that having the highest frequency is written. Upon the completion of auto-storage, six of the detected stations are selected starting from that having the highest signal meter value (RDS stations take precedence), and are written into preset memory, starting from the station having the lowest frequency and starting from M1. If the number of detected stations is less than six, the remaining preset memory locations remain as is, retaining the contents they had before auto-storage was started. If search is aborted, all the preset memory locations retain the contents they had before the start of auto-storage. When **TP/SK** is on, only those stations broadcasting traffic information (stations with TP or SK) are written.

Momentary key	Description
PTY	This key is used to display and search for a program based on a PTY (program type) from among the RDS data. This key is valid while an FM band station is being received in radio mode and when the **TP/SK** key is off. While a program type is being displayed, or while a search is being made for a program type, LCD indicator "PTY" appears. 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, symbol "NONE" appears in the LCD indicator, indicating that the program does not have a program type. A program type is displayed for five seconds after the key has been pressed. Within those five seconds, each time the key is pressed, the program type is switched. The displayed program type changes as follows each time this key is pressed. If the key is pressed for 0.5 seconds or longer while a PTY is displayed, the display changes every 300 ms. When the desired program type is displayed, pressing either the **UP** or **DOWN** 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. When a corresponding station is detected, the PTY display is automatically cleared. →PTY code 0 → PTY code 1 → PTY code 2 → ···· → PTY code 16 "NONE" "NEWS" "AFFAIRES" "OTHER M" If the **UP**, **DOWN**, or **PTY** key is not pressed within five seconds while a program type is displayed, the PTY display is automatically cleared, the "PTY" indicator is turned off, and PS display (or frequency display) is performed. The PTY display is cleared when the system is started by pressing the **POWER** key.
RANDOM/AMS	This key is used as an AMS ON/OFF setting key in tape mode. If this key is held down for at least two seconds in CD changer mode, it can be used as a disc random mode ON/OFF setting key. If the key is released within two seconds, it is used as a random mode ON/OFF setting key. **(1) AMS ON/OFF setting** This key is used as an AMS (Auto Music Search) control key. Each time this key is pressed, AMS is alternately turned ON/OFF. While AMS is ON, LCD indicator "AMS" appears. **(2) Disc random mode ON/OFF setting** Each time this key is pressed, the disc random mode is turned ON/OFF. During disk random mode operation, LCD indicators "RANDOM" and "ALL" appear. **(3) Random mode ON/OFF setting** Each time this key is pressed, the random mode is alternately turned ON/OFF. During random mode operation, LCD indicator "RANDOM" appears. In the initial state after the power is first applied, random mode and disc random mode are turned OFF.

Momentary key	Description
RDS/REGION	This key acts as a REGION mode ON/OFF key when held down for two seconds. When it is released within two seconds, this key acts as an RDS mode ON/OFF key. **(1) RDS mode ON/OFF setting** This key is valid while an FM band is being received in radio mode. When RDS mode is ON, LCD indicator “RDS” appears. While RDS mode is selected, the following processing is performed. • AF operation and best station are performed. • PI seek is performed if best station has failed. • RDS seek is performed for seek and auto-retuning. **(2) REGION mode ON/OFF setting** 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 while an FM band is being received in radio mode. If initial setting diode REGION is open, however, turning ON/OFF REGION mode is invalid, and RDS mode ON/OFF setting becomes valid as soon as this key is pressed. When REGION mode is ON, LCD indicator “REGION” appears. When PI codes are compared in REGION mode, 12 bits of the PI codes, except the area cover codes of the PI codes, are compared. If the area cover code is 0 to 2, however, 16 bits of a PI code are compared. When REGION mode is OFF, 16 bits are compared when PI codes are compared. RDS mode and REGION mode are OFF in the initial state after the power is first applied.
REPEAT	This key acts as the disc repeat mode ON/OFF key when it is held down for two seconds. When it is released within two seconds, this key acts as the repeat mode ON/OFF key. This key is valid in CD changer mode. ● **Repeat mode ON/OFF setting** When repeat mode is ON, only the track currently being played is repeated. In repeat mode, LCD indicator “REPEAT” appears. ● **Disc repeat mode ON/OFF setting** When disc repeat mode is ON, all the tracks of the disc currently being played are repeated. In disc repeat mode, LCD indicators “REPEAT” and “ALL” appear. Both repeat mode and disc repeat mode are OFF in the initial state after the power is first applied.

Momentary key	Description
SEL/LOUD	This key acts as the loudness ON/OFF key when it is held down for two seconds. When it is released within two seconds, this key selects the electronic volume control function. **(1) Selecting the electronic volume control function** Each time this key is pressed to select the electronic volume control function, the mode changes as illustrated below. If initial setting diode FAD is jumpered, fader mode cannot be used.  Each time the key is pressed, one of the above modes is set for five seconds. In each electronic volume control mode, adjustment can be made by using the **VOL UP** or **VOL DOWN** key. For details, refer to the description of the **VOL UP** and **VOL DOWN** keys. The volume can be adjusted in normal display mode. In each of the above modes, “VOL”, “BAS”, “TRE”, “BAL”, or “FAD” and the set value are displayed. After five seconds, normal display mode is restored. **(2) Loudness ON/OFF setting** When loudness mode is ON, LCD indicator “LOUD” appears. At this time, the LOUD pin (pin 48) outputs a high level signal. The volume control display is cleared when the system is started by pressing the **POWER** key. Loudness mode is off in the initial state when the power is first applied.
TAPE	**(1) In radio/CD changer mode** This key is used to select tape mode. **(2) In tape mode** This key switches the tape side between A and B.
TP/SK	This key is used to turn ON/OFF traffic information interrupt enable mode (TP/SK mode). This key is valid in power-on mode. While an AM band is being received, however, presing this key causes the FM1 band to be selected. TP/SK mode is turned ON/OFF for each band (FM1, FM2, and FM3). ● **TP/SK mode ON/OFF setting** If the device is tuned to an FM band station, this key is valid even in CD changer/tape mode. When TP/SK mode is selected, LCD indicator “TP/SK” appears. In TP/SK mode, auto-seek detects traffic information stations only. While TP/SK mode is ON, the operations performed are as follows. • **While traffic information is being received** In radio mode, the $\overline{\text{SK MUTE}}$ pin (pin 19) outputs a high level signal. The $\overline{\text{TA/DK}}$ pin (pin 18) outputs a low level signal. In CD changer/tape mode, radio mode is selected, and traffic information is output. • **While traffic information is not being received** In radio mode, the $\overline{\text{SK MUTE}}$ pin (pin 19) outputs a low level signal. The $\overline{\text{TA/DK}}$ pin (pin 18) outputs a high level signal. TP/SK mode is OFF in the initial state after power is first applied.

Momentary key	Description
UP DOWN	These keys act as auto-seek and manual seek keys in radio mode. In CD changer mode, they act as up and down keys for track/search. In tape mode, they act as FF and REW keys. While the clock is displayed, these keys are used to adjust the clock. **(1) In radio mode** ● **When used for auto-seek** While the "AUTO" indicator is lit in radio mode, these keys are used to perform auto-seek. Pressing a key instigates a search for a station. Once a station has been detected, the device receives that station. In RDS mode, RDS seek is performed. In TP/SK mode, TP/SK seek is performed. In PTY display mode, PTY seek is performed. ● **When used for manual seek** While the "AUTO" indicator is not lit in radio mode, these keys are used for manual seek. Each time the key is pressed, the frequency is increased or decreased by 1 step (1 channel separation), respectively. When either key is pressed and held down for about 0.5 seconds, the frequency is continuously increased or decreased at a rate of about one step every 50 ms, respectively, until the key is released. In PTY display mode, PTY seek is performed. **(2) In tape mode** Pressing the UP key fast-forwards the tape. Pressing the DOWN key rewinds the tape. While AMS is ON, AMS FF/REW is performed. A search is made for the beginning of a track, then that track is played. While AMS is OFF, FF/REW is performed. During FF/REW operation, LCD indicator "▶" or "◀" blinks. **(3) In CD changer mode** If either of these keys is held down for about 0.5 seconds, search up/down is performed for as long as the key is held down. If the key is released within 0.5 seconds, 1-track up/down operation is performed. During track up/down operation, the LCD panel switches to the display of the track number. During search up/down operation, the panel switches to the time display. **(4) When used to adjust the clock** By pressing the UP or DOWN key in clock adjustment mode, the hour and minute digits of the clock can be adjusted. • **Adjustment of the hour digits** Each time the UP key is pressed, the hour digits of the clock are incremented by one. When the key is held down for about 0.5 seconds, the digits increment continuously every 0.2 seconds until the key is released. While the hour digits are being adjusted, the minute digits and second count value are not affected. • **Adjustment of the minute digits** Each time the DOWN key is pressed, the minute digits of the clock are incremented by one. When the key is held down for about 0.5 seconds, the digits increment continuously every 0.1 seconds until the key is released. There is no carry-over to the hour digits. When clock adjustment is completed by pressing the DISP/ADJ key, the second digits are cleared to 0.

<table>
<tr><th>Momentary key</th><th>Description</th></tr>
<tr><td>VOL UP
VOL DOWN</td><td>
<p>These keys are used to adjust each electronic volume control function (volume, bass, treble, balance, fader) in electronic volume control mode.
Either of the following two types of electronic volume controls can be selected.</p>
<p>(1) TDA7313 (initial setting diode VOLSEL = 0)
(2) TEA6320 (initial setting diode VOLSEL = 1)</p>
<p>(1) TDA7313
TDA7313 can be used when initial setting diode VOLSEL = 0.</p>
<p>(a) Volume
These keys are valid during normal/volume display.
The electronic volume control function becomes valid when the key is pressed, and the volume is incremented or decremented in units of 1.25 [dB]. When the key is held down for about 0.5 seconds, the volume is successively incremented or decremented by 1.25 [dB] every 0.1 seconds, until the key is released.
The initial value when the power is first applied is VOLUME 38 (-31.25 [dB]).</p>
<table>
<tr><td>Display (64 steps)</td><td>VOL 0</td><td>VOL 1</td><td>VOL 2</td><td>...</td><td>VOL 62</td><td>VOL 63</td></tr>
<tr><td>Attenuation [dB]</td><td>-78.75</td><td>-77.50</td><td>-76.25</td><td>...</td><td>-1.25</td><td>0</td></tr>
</table>
<p>(b) Bass
The bass control function is valid only in bass display mode.
This function becomes valid as soon as either of these keys is pressed, and the bass is incremented or decremented in units of 2 [dB].
When the key is held down for about 0.5 seconds, the bass is successively incremented or decremented at a rate of 2 [dB] every 0.3 seconds, until the key is released.
The initial value when the power is first applied is BASS 0 (0 [dB]).</p>
<table>
<tr><td>Display (15 steps)</td><td>BAS - 7</td><td>BAS - 6</td><td>...</td><td>BAS 0</td><td>...</td><td>BAS + 6</td><td>BAS + 7</td></tr>
<tr><td>Attenuation [dB]</td><td>-14</td><td>-12</td><td>...</td><td>0</td><td>...</td><td>12</td><td>14</td></tr>
</table>
<p>(c) Treble
The treble control function is valid only in treble display mode.
This function becomes valid as soon as either of these keys is pressed, and the treble is incremented or decremented in units of 2 [dB].
When the key is held down for about 0.5 seconds, the treble is successively incremented or decremented every 0.3 seconds in units of 2 [dB], until the key is released.
The initial value when the power is first applied is TRE 0 (0 [dB]).</p>
<table>
<tr><td>Display (15 steps)</td><td>TRE - 7</td><td>TRE - 6</td><td>...</td><td>TRE 0</td><td>...</td><td>TRE + 6</td><td>TRE + 7</td></tr>
<tr><td>Attenuation [dB]</td><td>-14</td><td>-12</td><td>...</td><td>0</td><td>...</td><td>12</td><td>14</td></tr>
</table>
</td></tr>
</table>

Momentary key	Description
VOL UP **VOL DOWN**	**(d) Balance**

The balance control function is valid only in balance display mode.

This function becomes valid as soon as either of these keys is pressed. Pressing a key increments or decrements the balance by one step, respectively.

When the key is held down for about 0.5 seconds, the balance is successively incremented or decremented at a rate of one step every 0.3 seconds. Incrementing or decrementing stops when BAL CNT is reached.

The initial value when the power is first applied is BAL CNT (0 [dB]) for both the left and right.

Display (15 steps)		BAL CNT	BAL L1	BAL L2	BAL L3	BAL L4	BAL L5	BAL L6	BAL L7
Attenuation [dB]	Right	0	-1.25	-2.5	-5.0	-10.0	-17.5	-37.5	MUTE
	Left	0	0	0	0	0	0	0	0

Display (15 steps)		BAL R7	BAL R6	BAL R5	BAL R4	BAL R3	BAL R2	BAL R1	BAL CNT
Attenuation [dB]	Right	0	0	0	0	0	0	0	0
	Left	MUTE	-37.5	-17.5	-10.0	-5.0	-2.5	-1.25	0

(e) Fader

The fader can be adjusted when initial setting diode FAD = 0.

This function is valid in fader display mode.

This function becomes valid as soon as either of these keys is pressed, and the fader is incremented or decremented by one step.

When the key is held down for about 0.5 seconds, the fader is successively incremented or decremented at a rate of one step every 0.3 seconds. Incrementing or decrementing stops when FAD CNT is reached.

The initial value when the power is first applied is FAD CNT (0 [dB]) for both the front and rear.

Display (15 steps)		FAD CNT	FAD F1	FAD F2	FAD F3	FAD F4	FAD F5	FAD F6	FAD F7
Attenuation [dB]	Front	0	0	0	0	0	0	0	0
	Rear	0	-1.25	-2.5	-5.0	-10.0	-17.5	-37.5	MUTE

Display (15 steps)		FAD R7	FAD R6	FAD R5	FAD R4	FAD R3	FAD R2	FAD R1	FAD CNT
Attenuation [dB]	Front	MUTE	-37.5	-17.5	-10.0	-5.0	-2.5	-1.25	0
	Rear	0	0	0	0	0	0	0	0

Momentary key	Description
VOL UP **VOL DOWN**	**(2) TEA6320**

TEA6320 can be used when initial setting diode VOLSEL = 1.

(a) Volume

These keys are valid during normal/volume display.

The electronic volume control function becomes valid when the key is pressed, and the volume is incremented or decremented in units of 2 [dB]. When the key is held down for about 0.5 seconds, the volume is successively incremented or decremented at a rate of 2 [dB] every 0.1 seconds, until the key is released.

The initial value when the power is first applied is VOL 22 (-24 [dB]).

Display (41 steps)	VOL 0	VOL 1	VOL 2	...	VOL 39	VOL 40
Attenuation [dB]	MUTE	-66	-64	...	8	10

(b) Bass

The bass control function is valid only in bass display mode.

This function becomes valid as soon as either of these keys is pressed, and the bass is incremented or decremented in units of 3 [dB].

When the key is held down for about 0.5 seconds, the bass is successively incremented or decremented at a rate of 3 [dB] every 0.3 seconds, until the key is released.

The initial value when the power is first applied is BAS 0 (0 [dB]).

Display (9 steps)	BAS - 4	BAS - 3	...	BAS 0	...	BAS + 3	BAS + 4
Attenuation [dB]	-12	-9	...	0	...	9	12

(c) Treble

The treble control function is valid only in treble display mode.

This function becomes valid as soon as either of these keys is pressed, and the treble is incremented or decremented in units of 3 [dB].

When either key is held down for about 0.5 seconds, the treble is successively incremented or decremented at a rate of 3 [dB] every 0.3 seconds, until the key is released.

The initial value when the power is first applied is TRE 0 (0 [dB]).

Display (9 steps)	TRE - 4	TRE - 3	...	TRE 0	...	TRE + 3	TRE + 4
Attenuation [dB]	-12	-9	...	0	...	9	12

<table>
<tr><th>Momentary key</th><th>Description</th></tr>
<tr><td>VOL UP
VOL DOWN</td><td>
(d) Balance
The balance control function is valid only in balance display mode.
This function becomes valid as soon as either of these keys is pressed, and the balance is incremented or decremented by one step.
When a key is held down for about 0.5 seconds, the balance is successively incremented or decremented at a rate of one step every 0.3 seconds.
The initial value when the power is first applied is BAL CNT (0 [dB]) for both the left and right.
<table>
<tr><th colspan="2">Display (15 steps)</th><th>BAL CNT</th><th>BAL L1</th><th>BAL L2</th><th>BAL L3</th><th>BAL L4</th><th>BAL L5</th><th>BAL L6</th><th>BAL L7</th></tr>
<tr><td rowspan="2">Attenuation [dB]</td><td>Right</td><td>0</td><td>-2</td><td>-4</td><td>-8</td><td>-16</td><td>-35</td><td>-55</td><td>MUTE</td></tr>
<tr><td>Left</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
<table>
<tr><th colspan="2">Display (15 steps)</th><th>BAL R7</th><th>BAL R6</th><th>BAL R5</th><th>BAL R4</th><th>BAL R3</th><th>BAL R2</th><th>BAL R1</th><th>BAL CNT</th></tr>
<tr><td rowspan="2">Attenuation [dB]</td><td>Right</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Left</td><td>MUTE</td><td>-55</td><td>-35</td><td>-16</td><td>-8</td><td>-4</td><td>-2</td><td>0</td></tr>
</table>
(e) Fader
The fader can be adjusted when initial setting diode FAD = 0.
This function is valid in fader display mode.
This function becomes valid as soon as either of these keys is pressed, and the fader is incremented or decremented by one step.
When either key is held down for about 0.5 seconds, the fader is successively incremented or decremented at a rate of one step every 0.3 seconds.
The initial value when the power is first applied is FAD CNT (0 [dB]) for both the front and rear.
<table>
<tr><th colspan="2">Display (15 steps)</th><th>FAD CNT</th><th>FAD F1</th><th>FAD F2</th><th>FAD F3</th><th>FAD F4</th><th>FAD F5</th><th>FAD F6</th><th>FAD F7</th></tr>
<tr><td rowspan="2">Attenuation [dB]</td><td>Front</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Rear</td><td>0</td><td>-2</td><td>-4</td><td>-8</td><td>-16</td><td>-35</td><td>-55</td><td>MUTE</td></tr>
</table>
<table>
<tr><th colspan="2">Display (15 steps)</th><th>FAD R7</th><th>FAD R6</th><th>FAD R5</th><th>FAD R4</th><th>FAD R3</th><th>FAD R2</th><th>FAD R1</th><th>FAD CNT</th></tr>
<tr><td rowspan="2">Attenuation [dB]</td><td>Front</td><td>MUTE</td><td>-55</td><td>-35</td><td>-16</td><td>-8</td><td>-4</td><td>-2</td><td>0</td></tr>
<tr><td>Rear</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
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3. RDS (RADIO DATA SYSTEM) FUNCTIONS

3.1 Processing RDS Data

The μPD178016GC-051 incorporates an RDS data decoder section. Whether error correction is performed can be selected. If error correction is performed, the number of correction bits can be set to 1 to 5.

The μPD178016GC-051 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)

3.1.1 PI (Program Identification)

PI is used to identify the program being received.

3.1.2 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 five seconds after the completion of tuning, the LCD panel changes to the PS display.

If PS data cannot be read within about five 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-recently read PS data will be displayed about five seconds later, even if no other PS data is subsequently read.

3.1.3 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 18) goes low.

By pressing the **PTY** key, the program type can be displayed or a search for a given program type can be performed. (See **Section 2.5.3**.)

Program types are allocated as follows.

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

No.	Program type	
0, 16 to 30	No program type	(NONE)
1	News	(NEWS)
2	Current affairs	(AFFAIRES)
3	Information	(INFO)
4	Sports	(SPORT)
5	Education	(EDUCATE)
6	Drama	(DRAMA)
7	Culture	(CULTURE)
8	Science	(SCIENCE)
9	Variety	(VARIED)
10	Pop music	(POP M)
11	Rock music	(ROCK M)
12	M.O.R music	(M_O_R_M)
13	Light classic music	(LIGHT M)
14	Serious classic	(CLASSICS)
15	Other music	(OTHER M)
31	Alarm	(ALARM)

3.1.4 RDS memory

The RDS memory of the μPD178016GC-051 consists of the following:

- **AF list**
  PS codes, PI codes, and AF codes for 25 stations can be stored in each preset memory and each last channel. The AF list of the station currently being received can store the AF codes for 15 stations, in addition to the AF codes for the 25 stations mentioned above (giving a total of 40 stations). If, however, an AF operation, best station, or tuning operation other than an EON operation is performed, the AF codes for the 15 stations are cleared.

- **Pool memory**
  PI codes for 15 stations can be stored. AF codes for 25 stations can be stored for each PI code.

3.1.5 AF (Alternative Frequency)

The same contents as those of the RDS station currently being received are used as the code of the frequency broadcast.

The read AF code is stored into RDS memory.

METHOD A and METHOD B are supported.

If the reception of the RDS station currently being received deteriorates in RDS mode, a search is made for a station having the same PI code and the frequency is changed (AF operation).

(1) Judging the start of AF operation

(a) AF operation start condition

The AF operation start conditions are listed below.

Signal meter reading / Decode state	Range pending	Range A	Range B	Range C
Number pending	o	o	o	×
40 or greater	o	o	o	×
35 or greater and less than 40	o	o	o	×
30 or greater and less than 35	o	Δ	o	×
15 or greater and less than 30	o	Δ	Δ	×
Less than 15	o	Δ	Δ	×

o: AF operation does not start.

Δ: Single-station/All-station AF operation starts.Note

×: All-station AF operation starts.

Note Select single-station or all-station AF operation by using initial setting diode AFALL.

(b) Determining the signal meter reading range

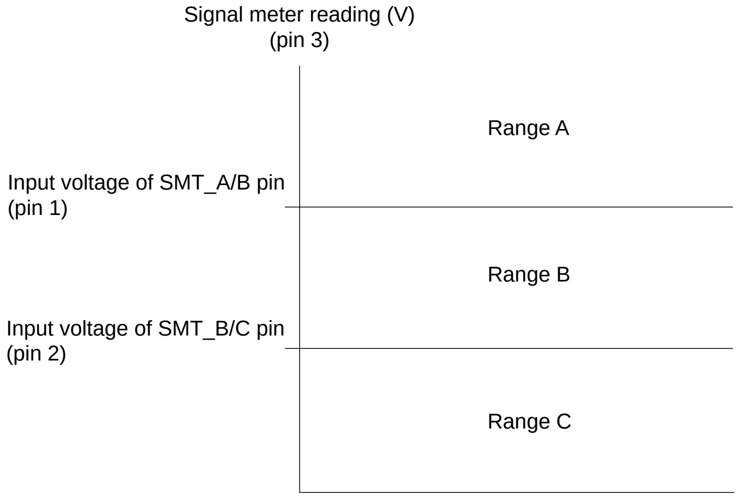
Determine the ranges (ranges A, B, and C, and range pending) of the signal meter readings by means of the following procedure:

<1> Read the signal meter reading from the S • METER pin (pin 3) every 100 ms and calculate the average of the last five signal meter readings.

<2> After the frequency has been changed, processing **<3>** below is not performed. The range remains pending until five signal meter readings have been obtained.

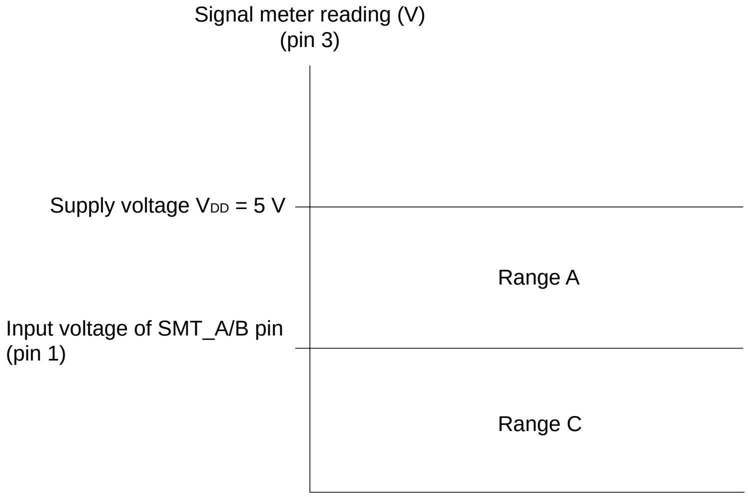
<3> Determine the signal meter reading ranges illustrated below, based on the calculated average of the signal meter readings.

Figure 3-1. Signal Meter Reading Ranges (where SMT_A/B voltage > SMT_B/C voltage)



The boundary voltages between the adjacent ranges are those voltages input to the SMT_A/B pin and SMT_B/C pin when the power is first applied.
These voltages must be input so that SMT_A/B voltage > SMT_B/C voltage.
If SMT_A/B voltage ≤ SMT_B/C voltage, the SMT_B/C voltage is invalid, so that the SMT_A/B voltage is used as the boundary voltage.
In this case, two ranges, A and C, are used, as shown below.

Figure 3-2. Signal Meter Reading Ranges (where SMT_A/B voltage ≤ SMT_B/C voltage)



(c) Determining the decode state

<1> Calculate the average of ten blocks, decoded in one second, and use this average as the decode state (number/number pending).

<2> The number of blocks remains pending until ten items of data have been read after the frequency has been changed.

<3> If the $\overline{\text{RDS}}$ pin is high when the number of blocks is read, the number of blocks at that time will be 0.

(2) AF operation disable time/AF reception disable time

(a) AF operation disable time

This is the period during which AF operation is disabled.

While the referenced disable timer is set, AF operation is not started.

(b) Setting of AF operation disable time

(i) When AF operation fails

The following AF operation disable time is set depending on the signal meter reading (S • M reading) ranges when the AF operation was started.

S • M reading range	Disable time
Range A	5 seconds
Range B	60 to 5 seconds[Note]
Range C	60 seconds

Note The AF operation disable time for range B is set as follows:

Range B is divided into 32 steps. The range into which the S • M reading falls is judged.

$$\text{Range} = \frac{(\text{S • M reading - Input value of SMT\_B/C pin}) \times 32}{(\text{Input value of SMT\_A/B pin - Input value of SMT\_B/C pin})}$$

Division is performed with the result truncated below the decimal point.

The disable time is set for each range as follows:

Range	Disable time (seconds)
31	60
30	58
29	56
⋮	Change of 2 seconds/range
10	18
9	16
8	14
7	12
6	11
5	10
4	9
3	8
2	7
1	6
0	5

(ii) When changing the tunable frequency

AF operation is disabled after the frequency has been changed until the reception state is stabilized.

Disable time
3 seconds

(iii) When power is first applied

AF operation is disabled until reception stabilizes.

Disable time
5 seconds

(iv) If AF operation fails repeatedly in a tunnel

If the S • M reading range changes from A to C, and if the AF operation has failed in range C, the system judges that the vehicle is currerntly in a tunnel.

If this judgment is made, AF operation is disabled depending on the number of times the operation has failed, so that AF operation is not retried frequently.

Disable time
(Number of successive failures - 1) × 60 seconds (9 minutes MAX.)

The number of successive failures is cleared in the following cases:

- When the tunable frequency is changed (except during AF operation/B.S./EON operation)
- If S • M reading range is not in range C
- If AF operation/B.S./EON operation is successful

(v) If AF operation is repeatedly successful in the same region

<1> If the AF operation (where S • M reading range is A) is successful in the decode state, the frequency at which the operation succeeded is recorded.

<2> If the number of stations for which the AF operation succeeded is three or less within one hour when **<1>** is repeatedly successful, it is judged that all the stations are suffering from reception abnormalities such as multipath.

However, this judgment is not made until **<1>** succeeds six times in a row.

<3> If a fault such as multipath occurs, the AF operation is immediately started even if the AF operation has been successful; therefore, the AF operation is disabled.

Disable time
10 seconds

<4> The frequency recorded in **<1>** is cleared in the following cases:

- When the tunable frequency is changed (except during AF operation/B.S./EON operation)
- When the AF operation succeeds in the S • M reading range (where the S • M reading range is B or C)

(c) AF reception disable time

This is the period during which the checking of a specific frequency during AF operation is disabled. While the timer to be referenced is set, the frequency is not checked by the AF operation.
When the tunable frequency is changed (except during AF operation/B.S./EON operation), the AF reception disable time for all frequencies is cleared.

(d) Setting AF reception disable time

(i) The disable time is set, as shown below, for that frequency at which the AF operation has failed for the cause of the failure of the operation.

Cause	Disable time
S • M reading	2 minutes
IF	4 minutes
PI once	7 minutes
PI two times	4 minutes
PI non-coincidence	12 minutes

(ii) When the AF operation has been successful, the disable time is set as follows so that the original station is not restored to the received frequency immediately after the AF operation has been successful.

Disable time
1 minute

(3) AF operation

- **Flow of AF operation**

<1> All signal meter readings for those frequencies having the same priority are measured.
<2> The measured signal meter readings are sorted starting from the greatest reading.
<3> IF and PI are checked, in this order, starting from the greatest signal meter reading.
When PI coincides, the AF operation is stopped.
<4> If an AF station is not found in **<1>** through **<3>**, **<1>** through **<3>** are repeated for a lower priority. Where the priority is 1, however, when a frequency having priority 1 has been received, the signal meter reading, IF, and PI are successively checked, in this order.
If it is judged that no station is detected, the next frequency is measured.

(a) Single-station AF operation

One station is received and checked by turning on/off mute once, to check the original station.
After the original station has been received for one second, mute is detected (five seconds after if mute is not detected), and the next station is received and checked.

Example Where two stations have priority 1, three stations have priority 2, and two stations have priority 3 (see **Figure 3-3**)

<1> A station with priority 1 is received at I, and its signal meter reading, IF, and PI are checked, in this order.
<2> If an RDS station cannot be received in **<1>** above, the second station having priority 1 is received at II, and its signal meter reading, IF, and PI are checked, in this order.

<3> If an RDS station with priority 1 cannot be received in **<1>** and **<2>** above, stations with priority 2 are received at III, IV, and V, and the signal meter reading of each station is measured.

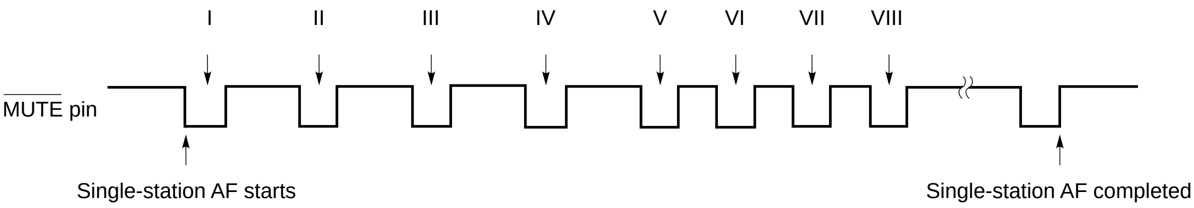
<4> The measured signal meter readings are sorted, starting from the greatest reading.

<5> IF and PI are checked in the order of the sorted signal meter readings, at IV, VII, and VIII.
If no station having priority 2 is found, and if the signal meter reading unacceptable in **<3>**, **<6>** is performed. If the signal meter reading is acceptable in **<3>**, the operation is completed when the AF operation next fails. Subsequently, **<6>** is performed by the next AF operation.

<6> A station having priority 3 is checked in the same manner as a station having priority 2.

<7> It is assumed that the AF operation has been successful when PI is judged as being acceptable, after which the AF operation is completed.

Figure 3-3. Single-Station AF Operation



(b) All-station AF operation

Stations are sequentially received by turning mute on/off once, until a station for which reception is satisfactory is found.

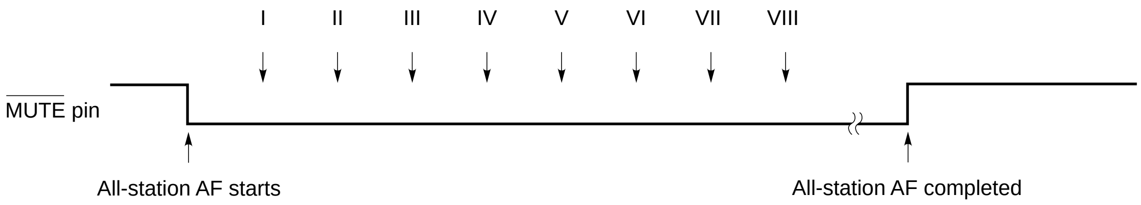
All the frequencies in the AF list are checked. If a station for which reception is satisfactory cannot be found, it is assumed that AF operation has failed, and the AF operation is completed.

Example Where one station has priority 1, three stations have priority 2, and two stations have priority 3 (see **Figure 3-4**)

(a) **<1>** through **<6>** in the example of single-station AF operation are successively performed.

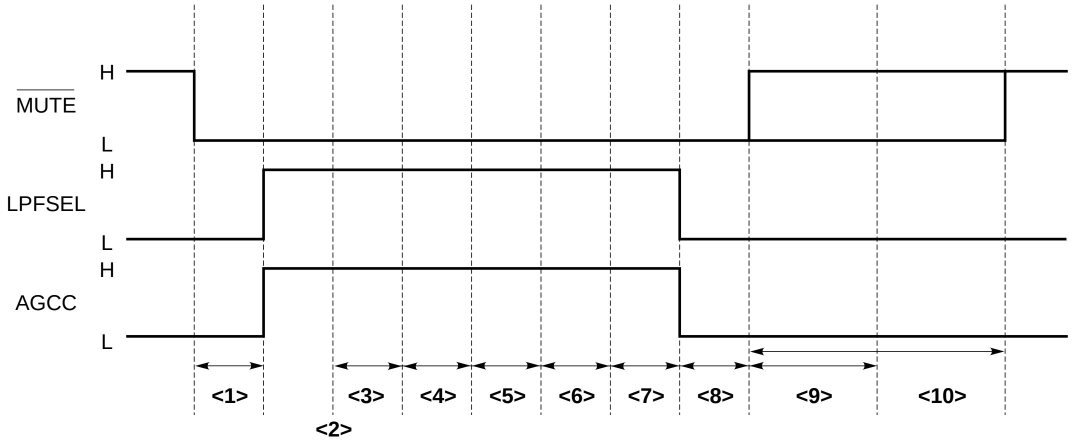
<7> It is assumed that the AF operation has been successful, and the AF operation is completed when PI is judged as being acceptable.

Figure 3-4. All-Station AF Operation



(c) AF timing

The frequencies in the AF list are received at the following timings.



<1> Preceding mute time (3 ms)
<2> PLL set time
<3> Lock wait time (40 ms MAX.)
<4> $\overline{\text{SD}}$ stabilization wait time (1 ms)
<5> Signal meter reading measurement time
<6> IF stabilization wait time (5 ms)
<7> IF measurement time (4 ms, 40 ms MAX.)
<8> Following mute time (3 ms) (Mute is cleared if initial setting diode NO_PIM is jumpered.)
<9> PI decode once wait time (400 ms MAX.)
<10> PI decode two times wait time (800 ms MAX.)

(4) Judgment of PI code

(a) Judgment of PI code when REGION mode is off

When 16 bits coincide, the station is judged as being the same.

(b) Judgment of PI code when REGION mode is on

When 12 bits of the PI code, except the area cover code, coincide, the station is judged as being the same. If, however, the area cover code is 0 to 2, the station is judged as being the same when 16 bits coincide. For the UK market, however, 8 bits are used for judgment (the area cover code and the last 4 bits are not used).

(c) AF operation for station in different REGION

The following processing is performed so that a station in a different REGION is not easily selected during AF operation.

<1> The signal meter reading at which the existence of a station is judged is changed between a station whose REGION coincides (or is unknown) and a station whose REGION is different, where the signal meter reading of the AF operation is judged.

<2> The value at which the signal meter for a station in a different REGION is judged is set to 5 V (0FFH) when the tunable frequency is changed.

<3> Each time the AF operation fails, the value at which the signal meter for a station in a different REGION is judged is decreased by 0.3125 V (10H). The minimum value is the voltage input to the SMT_B/C pin, or +0.3125 V.

(5) Identification of priority of METHOD

(a) Identification of method

METHOD A is identified if the AF code in that portion for the AF list where the number of stations and AF codes are paired is the same three times in a row. METHOD B is identified if this AF code differs even once. This identification is made each time the tunable frequency has been changed.

(b) Setting of priority by METHOD

Each of the recorded AF codes is assigned a priority. The procedure for updating or searching the AF list is determined according to the priority.
The AF code is read with priority 5 until METHOD is identified.
All the AF codes are read with priority 2 with METHOD A.

METHOD B is set as follows:

Number of stations	AF1
AF1	AF2

AF1, AF2, TF condition		Priority	Priority
AF1 = TF	AF1 < AF2	2	High
AF1 ≠ TF		3	↕
AF1 = TF	AF1 > AF2	4	
AF1 ≠ TF		5	Low

Priority 1 is set to the frequency at which a station is actually received.

(c) Updating AF list

- **Processing when AF code to be read is not in RDS memory**
  An AF code is added to the beginning of the priority that is the same as that of the AF code to be read. If, as a result, the RDS memory capacity exceeds the rated value, the AF code having the lowest priority is deleted.

- **Processing when the AF code to be read is already in RDS memory**
  If the priority of a previously read AF code is higher than that of the AF code to be read, the AF code is not read.
  If the priority of the AF code to be read is higher than that of a previously read AF code, the previously read AF code is deleted and a new code is added.

3.1.6 Best station

The reception state is checked when an RDS station is received. If the reception is poor, a search is made for a station having the same PI code, and the frequency is changed. This operation is performed in RDS mode.

(1) Best station start condition

If the reception of the newly received frequency remains poor even after the following operations have been performed, best station is started (when signal meter reading < SMT_B/C input voltage: +0.3125 V).
However, best station is not started when the FM tuner is turned on.
If a station for which the reception is good cannot be found as a result of best station, PI seek is started.

- Radio mode selection
- Band switching
- Preset memory calling

(2) Operation of best station

(a) One station is received at a time in steps **<1>** through **<5>**, below, starting from the beginning of the AF list, and the signal meter reading for each station is measured.

<1> Mute is turned on, and the LPFSEL pin (pin 27) is driven high after the completion of the preceding mute time (3 ms).

<2> A channel on the AF list is received.

<3> The signal meter reading is measured using the S • METER pin (pin 3), 1 ms after the station has been locked.

If the station is not locked after 40 ms, and if the signal meter reading is less than that when best station was started, or if it is less than the best station start condition, **<5>** is performed.

<4> The input signal meter reading is stored into RAM.

<5> The above operation is repeated starting from **<2>** if there is another station to be checked.

(b) PI check is sequentially performed starting from the greatest of the signal meter readings measured in (a).

<1> A channel on the AF list is received.

<2> The signal meter reading is measured by using the S • METER pin, 1 ms after the station has been locked.

If the station is not locked after 40 ms, and if the signal meter reading is less than that when best station was started, or less than the best station start condition, **<8>** is performed.

<3> IF is measured 5 ms after if initial setting diode FM SD/IF is jumpered.

If IF is not within the permissible range, **<8>** is performed.

<4> The LPFSEL pin is driven low.

<5> Reading PI is awaited.

If decoding is not performed once within 400 ms, **<8>** is performed.

If decoding is not performed two times within 800 ms, **<8>** is performed.

<6> The read PI code is checked for coincidence.

For an explanation of how to check the PI code, see **(4)** in **Section 3.1.5**.

<7> If the PI code coincides, that station is received, and best station is completed.

<8> If there is another station to be checked, the above operation is repeated starting from **<1>**.

<9> If no station is found after all the frequencies on the AF list have been searched, best station is terminated, and PI seek is performed.

3.1.7 Automatic station selection

A search is made for a station by using the RDS data during seek.

The following four types of seek operations can be performed.

(1) RDS seek
(2) PI seek
(3) PTY seek
(4) TP/SK seek

(1) RDS seek

- RDS seek is performed if seek is performed in RDS mode.
- Only an RDS station is selected from the stations that are judged to have a station.
- RDS seek is terminated if the following condition is satisfied.
  (a) If a PI code is read within 650 ms after the existence of a station has been judged.

(2) PI seek

- PI seek is performed if best station has failed in RDS mode.
- Only an RDS station having the same PI code as that of the RDS station being received before best station operation is started is selected from the stations that are judged to have a station.
- PI seek is terminated if all the following conditions are satisfied.
  - **(a)** If a PI code is read within 650 ms after the existence of a station has been judged.
  - **(b)** If the PI code is compared and coincides.
- If an RDS station having the same PI code is not found after the band has been subject to one round of searching, the frequency to which the system was tuned before the operation was started is received.

(3) PTY seek

- PTY seek is performed when seek is performed in PTY mode.
- Only an RDS station from which the same PTY code as PTY displayed before the start of PTY seek is selected from the stations that are judged to have a station.
- PTY seek is completed if all the following conditions are satisfied.
  - **(a)** If a PTY code is read within 650 ms after the existence of a station has been judged.
  - **(b)** If the PTY code is compared and coincides.
- If an RDS station having the same PI code is not found after the band has been subject to one round of searching, the frequency to which the system was tuned before the operation was started is received.

(4) TP/SK seek

- TP/SK seek is performed if seek is performed in TP/SK mode.
- Only an RDS station from which TP = 1 is read is selected from all the stations that are judged to have a station.
- TP/SK seek is terminated if all the following conditions are satisfied.
  - **(a)** If TP code is read within 650 ms after existence of a station has been judged.
  - **(b)** TP code = 1
- If RDS mode is off, however, the station for which the $\overline{\text{SK}}$ pin (pin 65) is low is also selected.
  If the TP code is read within 1 150 ms of the existence of a station having been judged, TP/SK seek is terminated.

3.1.8 Emergency broadcasting reception

When emergency broadcasting is started, radio mode is selected, and the emergency broadcast is received. This section explains how emergency broadcasting is received.

(1) If TP/SK mode is off in CD changer/tape mode

<1> The frequencies of the most-recently selected band, from the minimum frequency to the maximum frequency, are searched, and that RDS station for which reception is strongest is selected. When the AM band was selected last, FM1 is received.

<2> Search is performed again if the state in which the PTY code cannot be decoded persists for 30 seconds when **<1>** is being received.

<3> If the PTY code indicates emergency broadcasting (PTY = 31) in the state in which the PTY code can be decoded, radio mode is selected, and the “ALARM” indicator blinks.

<4> Upon the completion of emergency broadcasting, the original sound is restored (when the PTY code has been changed, or 30 seconds after the PTY code can no longer be read).

(2) If TP/SK mode is on

<1> The most-recently selected channel of the most-recently selected band is received. When the AM band was selected last, FM1 is received.

<2> If the PTY code indicates emergency broadcasting (PTY = 31) in the state in which the PTY code can be decoded, radio mode is selected, and the “ALARM” indicator blinks.

- **<3>** Upon the completion of emergency broadcasting, the original sound is restored (when the PTY code has been changed, or 30 seconds after the PTY code can no longer be read).

3.1.9 EON (Enhanced Other Network)

This data is used as the code for the information of an RDS station other than the network of the received RDS station.

The EON operation is explained next.

(1) When TA of group 14B = 1 (ON), and when the same list as PI (ON) exists in the pool memory, the EON operation is performed.

- **<1>** Mute is turned on, the LPFSEL pin (pin 27) is driven high after the preceding mute time (3 ms), and the channel of the pool memory is received.
- **<2>** The signal meter reading is measured by using the S • METER pin 1 ms after the station has been locked. If the station is not locked after 40 ms, and if the signal meter reading is less than the voltage being input to the SMT_B/C pin (+0.3125 V), **<4>** is performed.
- **<3>** The measured signal meter reading is stored into RAM.
- **<4>** The above operation is repeated, starting from **<1>**, if there is another station to be checked.

(2) PI is checked sequentially, starting from the greatest of the measured signal meter readings.

- **<1>** The channel of the pool memory is received.
- **<2>** After a station has been locked, IF is measured after 5 ms if initial setting diode FM IF/SD is jumpered. If IF is not within the permissible range, **<6>** is performed.
- **<3>** The reading of PI is awaited.
  If decoding is not performed once within 400 ms, **<6>** is performed.
  If decoding is not performed two times within 800 ms, **<6>** is performed.
- **<4>** The read PI code is checked for the coincidence of 16 bits.
- **<5>** If the PI code coincides, the receiving of a station is awaited for four seconds until both TP and TA are set to 1. If a station can be received, that station is received, and the EON operation is completed.
- **<6>** The above operation is repeated, starting from **<1>**, if there is another station to be checked.
- **<7>** The EON operation is completed if no station is found after all the frequencies of the pool memory have been searched.

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

TP and TA are used to identify the broadcasting state of traffic information.

Traffic information is received in TP/SK mode.

If the state, in which TP or TA of the RDS station being received is not 1, lasts for four seconds, TP/SK seek up is started (when initial setting diode RETUNE = 1).

If RDS mode is off, however, TP/SK seek up is started if the state, in which the $\overline{\text{SK}}$ pin (pin 65) is not low, lasts for four seconds.

(1) Traffic information standby → traffic information reception

The state is changed from traffic information standby to traffic information reception when EON is received with TP = TA = 1 or TA = 1 (ON).

If RDS mode is off, however, the state is also changed when the $\overline{\text{SK}}$ and $\overline{\text{DK}}$ pins (pin 65 and 64) go low.

- **Operation when TP = TA = 1 (or when both the $\overline{\text{SK}}$ and $\overline{\text{DK}}$ pins are low)**

  - In radio mode
    The $\overline{\text{SK MUTE}}$ pin (pin 19) is driven high.
    The $\overline{\text{TA/DK}}$ pin (pin 18) is driven low.
  - In CD changer/tape mode
    Radio mode is selected.
  - Common
    If the volume is less than the initial value, it is automatically changed to the initial value.

- **Operation when TA = 1 (ON)**
  The RDS station having the PI (ON) code is searched in RDS memory and received.
  If TP = TA = 1 cannot be read within four seconds of the station being received, the original station is restored and received.
  Operation when TP = TA = 1 is read from an RDS station with PI (ON)

  - In radio mode
    The $\overline{\text{SK MUTE}}$ pin is driven high.
    The $\overline{\text{TA/DK}}$ pin is driven low.
  - In CD changer/tape mode
    Radio mode is selected.
  - Common
    If the volume is less than the initial value, it is automatically changed to the initial value.

(2) Traffic information reception → traffic information standby

The state is changed from traffic information reception to traffic information standby if both TP and TA are not 1, or if TP and TA cannot be decoded for 30 seconds.
The original station is received if the traffic information reception state is set with TA = 1 (ON).

- In radio mode
  The $\overline{\text{SK MUTE}}$ pin is driven low.
  The $\overline{\text{TA/DK}}$ pin is driven high.
- In CD changer/tape mode
  The original sound is restored.
- Common
  If the volume was automatically changed when the traffic information was received, it is restored to its original level.
  If the volume was changed manually, however, it is not restored to its original level.

3.1.11 CT (Clock Time and Data)

CT is used to adjust the clock.

The time transmitted by a broadcast is the Coordinated Universal Time (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 μPD178016GC-051 is corrected using the broadcast time information.

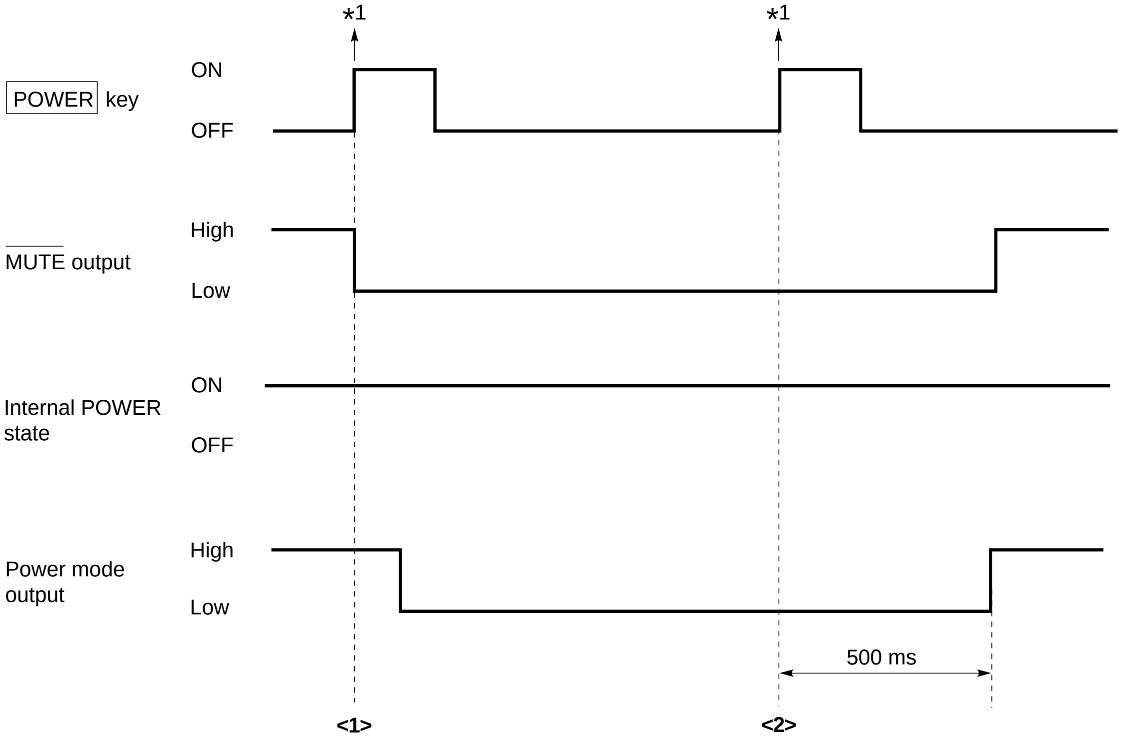
When initial setting diode CTADJ is set to 1, the clock is constantly being corrected by the input of broadcast time information. Whenever the clock is corrected, the seconds are reset to zero.

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

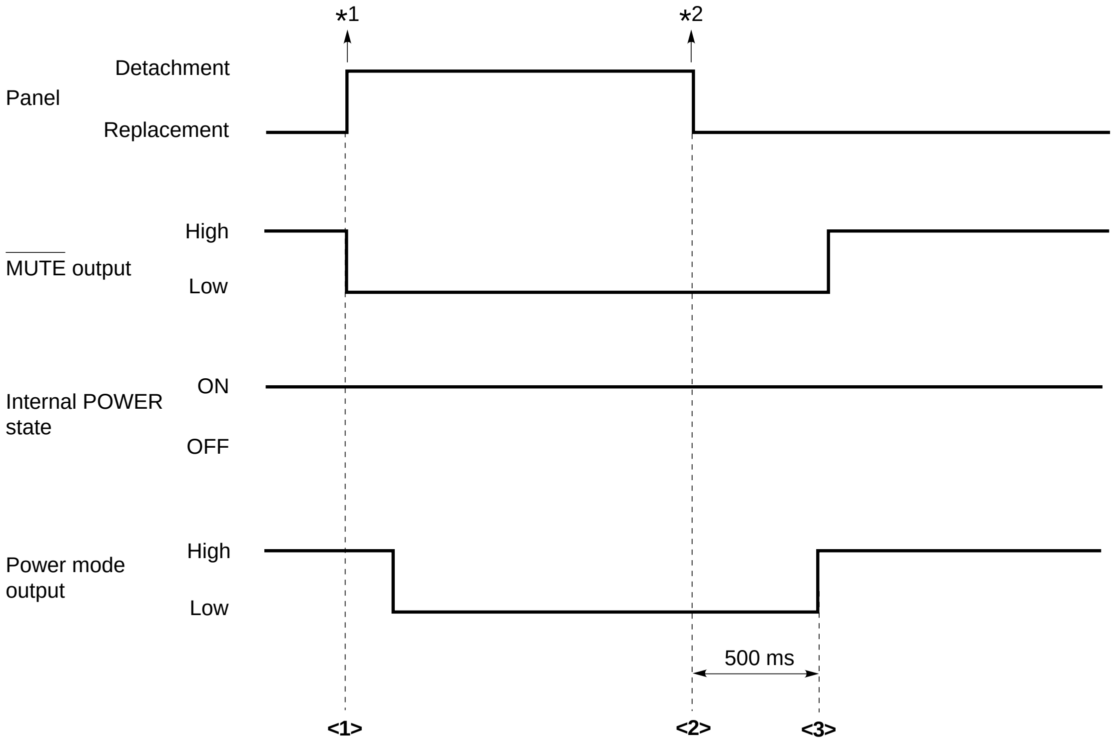


<1> Port setting, radio OFF, and serial communication interruption at POWER OFF

<2> Radio ON

***1** Timing 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, radio OFF, and serial communication interruption at POWER OFF

<2> Radio ON

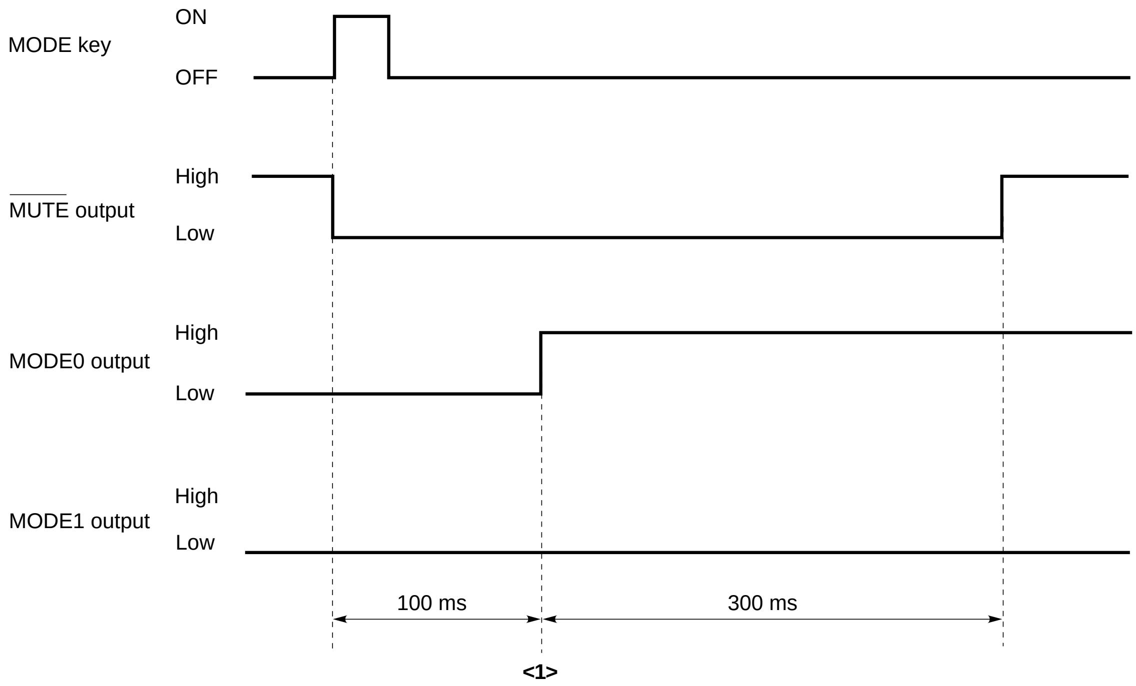
<3> Start of audio source mode and start of serial communication

***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)

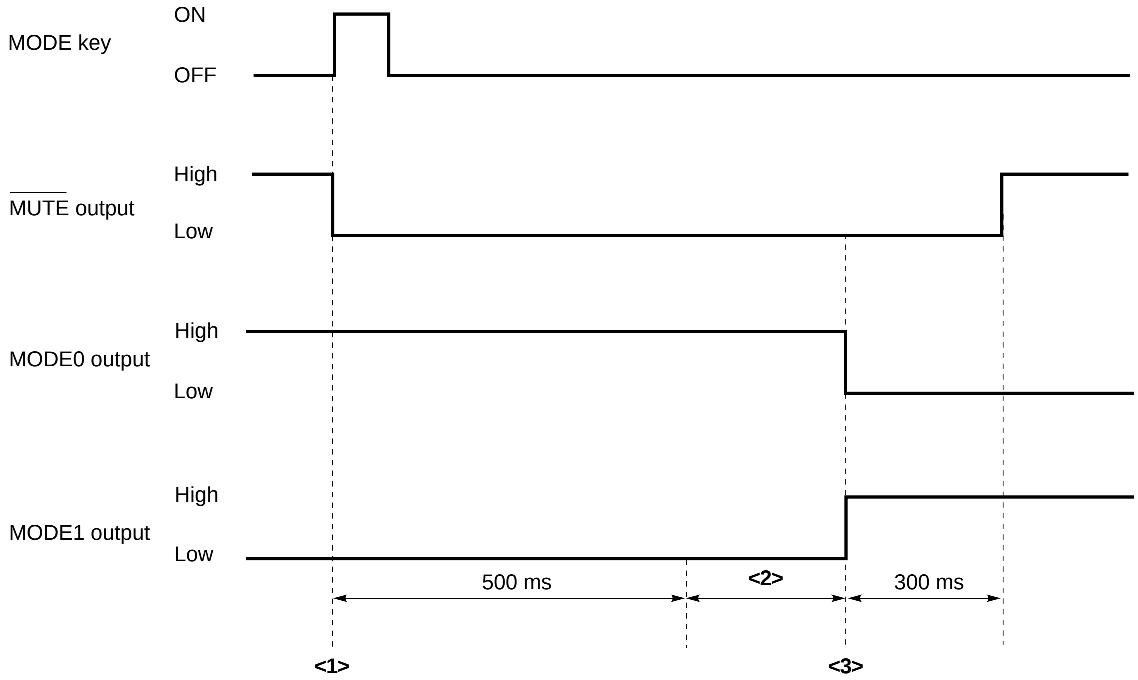
4.3 Timing of Audio Mode Switching

Example Radio to TAPE



<1> Display switching

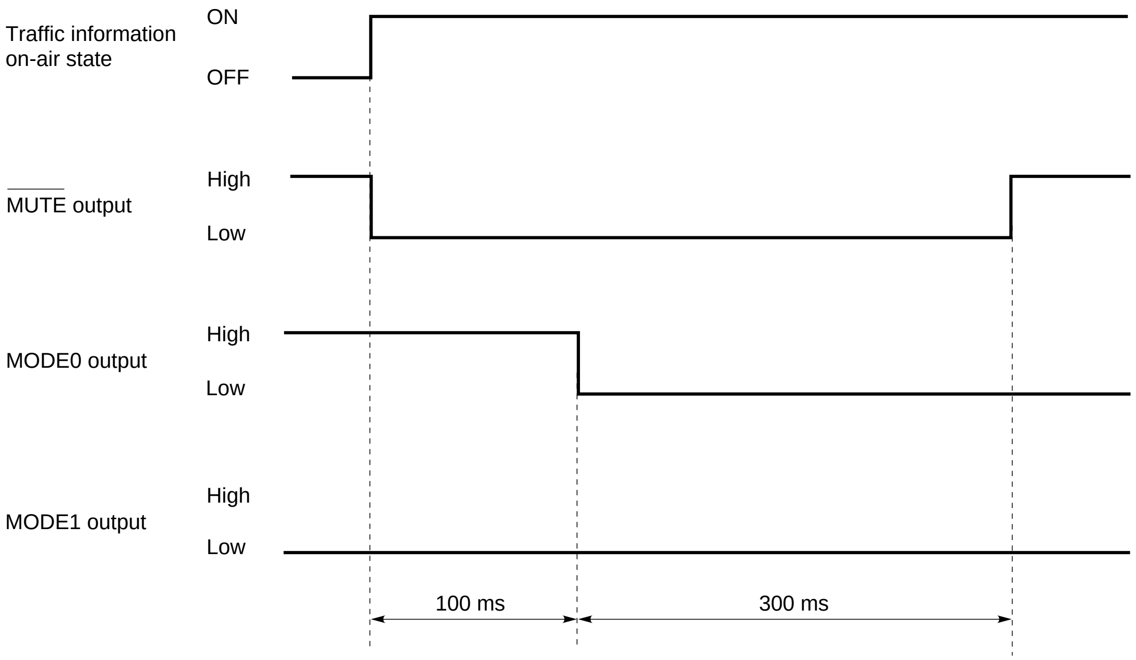
Example TAPE to CD changer



- **<1>** CD changer ON
- **<2>** One second to confirm that the CD changer is connected (the radio will be connected when a CD changer is not installed).
- **<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



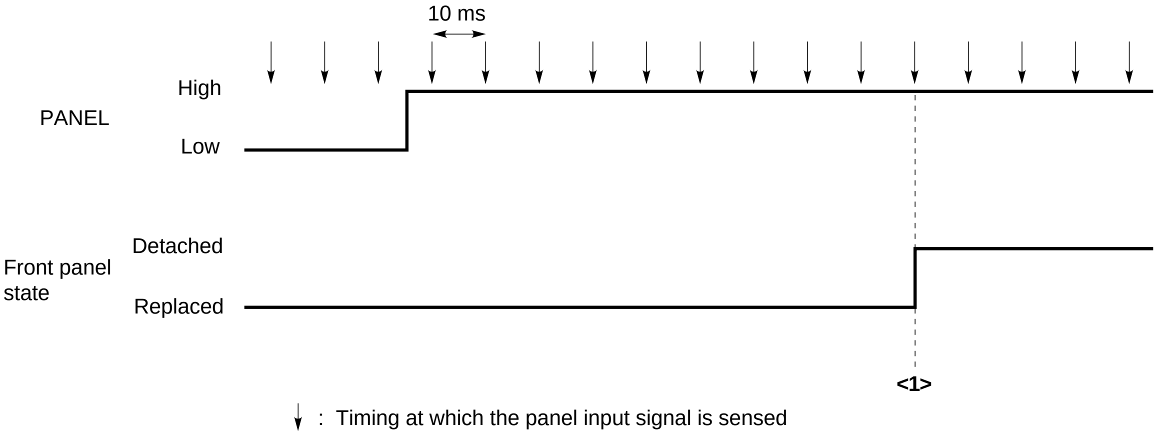
Caution If traffic information is being broadcast in radio mode, $\overline{\text{MUTE}}$ output is not performed (because the audio mode does not change).

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 has been 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.



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

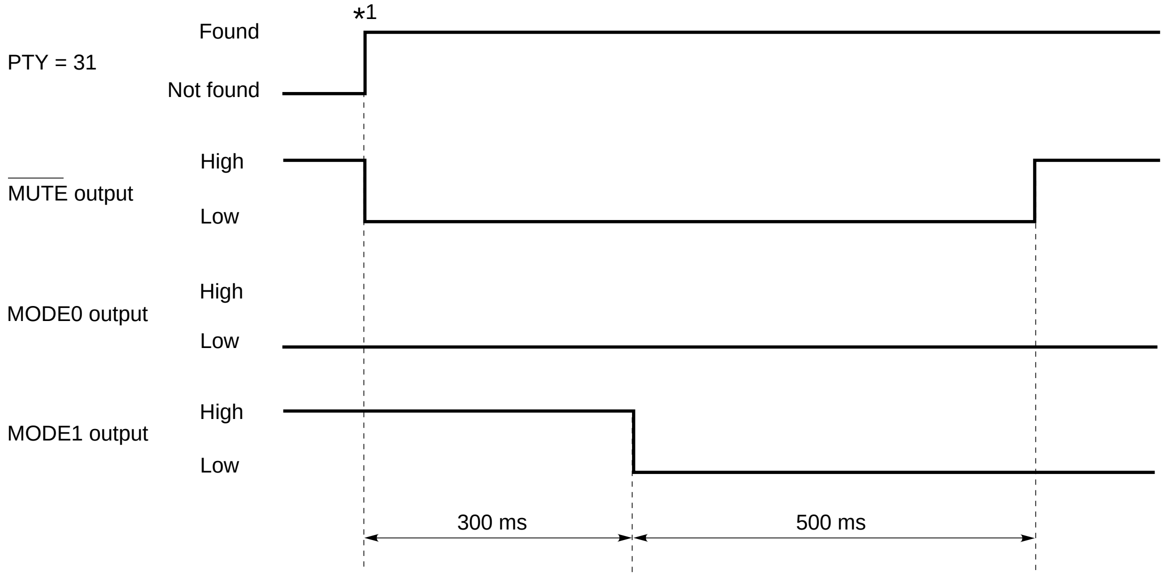
When the front panel is judged to have been detached, the power is turned off irrespective of the setting of the **POWER** key.

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



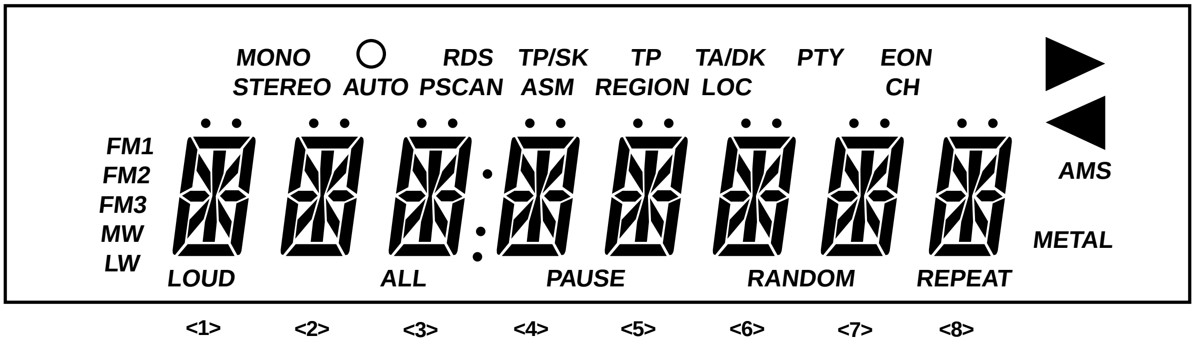
***1** Timing at which PTY = 31 is detected (not including the time required to confirm two matches)

Caution If a PTY alarm is generated in radio mode, MUTE output is not performed because the 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 the column positions in the 14-segment display area. “a” through “n” indicate the following 14 segments.

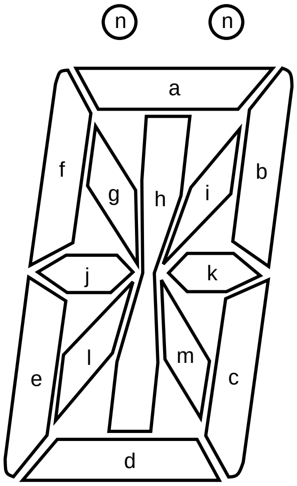


Table 5-1. Assignment of LCD Pins (1/2)

Common Segment	COM0 (21)	COM1 (22)	COM2 (23)	COM3 (24)
SEG1 (25)	FM3	MW	LW	
SEG2 (26)				
SEG3 (27)	FM2	**<1>** f	**<1>** e	FM1
SEG4 (28)	**<1>** g	**<1>** j	**<1>** l	
SEG5 (29)	**<1>** a	**<1>** h	**<1>** d	LOUD
SEG6 (30)	**<1>** i	**<1>** k	**<1>** m	
SEG7 (31)	**<1>** n	**<1>** b	**<1>** c	
SEG8 (32)				
SEG9 (33)	STEREO	**<2>** f	**<2>** e	MONO
SEG10 (34)	**<2>** g	**<2>** j	**<2>** l	
SEG11 (35)	**<2>** a	**<2>** h	**<2>** d	ALL
SEG12 (36)	**<2>** i	**<2>** k	**<2>** m	
SEG13 (37)	**<2>** n	**<2>** b	**<2>** c	○
SEG14 (38)				
SEG15 (39)	AUTO	**<3>** f	**<3>** e	RDS
SEG16 (40)	**<3>** g	**<3>** j	**<3>** l	
SEG17 (41)	**<3>** a	**<3>** h	**<3>** d	PAUSE
SEG18 (42)	**<3>** i	**<3>** k	**<3>** m	
SEG19 (43)	**<3>** n	**<3>** b	**<3>** c	.
SEG20 (44)				
SEG21 (45)	PSCAN	**<4>** f	**<4>** e	:
SEG22 (46)	**<4>** g	**<4>** j	**<4>** l	
SEG23 (47)	**<4>** a	**<4>** h	**<4>** d	RANDOM
SEG24 (48)	**<4>** i	**<4>** k	**<4>** m	
SEG25 (49)	**<4>** n	**<4>** b	**<4>** c	
SEG26 (50)				

Remarks 1. The digit in parentheses indicates a pin number of the μPD16431A.

2. Blank: Not used

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

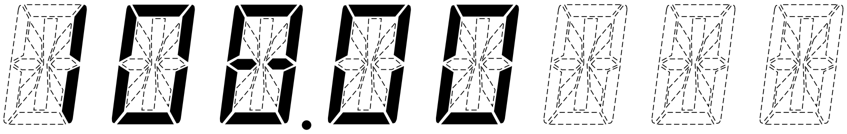
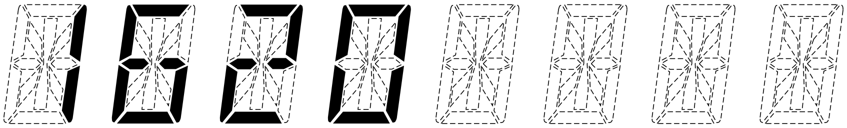
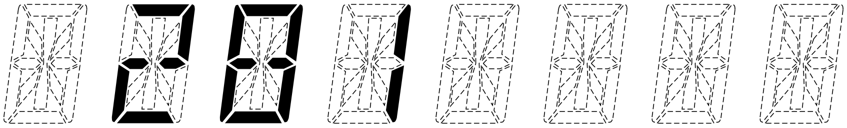
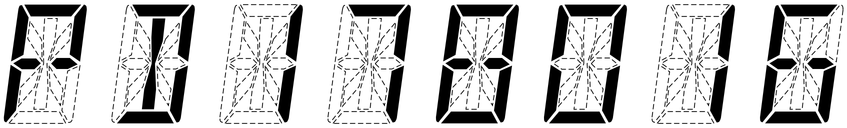
Common / Segment	COM0 (21)	COM1 (22)	COM2 (23)	COM3 (24)
SEG27 (51)	ASM	**<5>** f	**<5>** e	TP/SK
SEG28 (52)	**<5>** g	**<5>** j	**<5>** l	
SEG29 (53)	**<5>** a	**<5>** h	**<5>** d	
SEG30 (54)	**<5>** i	**<5>** k	**<5>** m	
SEG31 (55)	**<5>** n	**<5>** b	**<5>** c	TP
SEG32 (56)				
SEG33 (57)	REGION	**<6>** f	**<6>** e	◀
SEG34 (58)	**<6>** g	**<6>** j	**<6>** l	
SEG35 (59)	**<6>** a	**<6>** h	**<6>** d	
SEG36 (60)	**<6>** i	**<6>** k	**<6>** m	
SEG37 (61)	**<6>** n	**<6>** b	**<6>** c	TA/DK
SEG38 (62)				
SEG39 (63)	LOC	**<7>** f	**<7>** e	▶
SEG40 (64)	**<7>** g	**<7>** j	**<7>** l	
SEG41 (65)	**<7>** a	**<7>** h	**<7>** d	REPEAT
SEG42 (66)	**<7>** i	**<7>** k	**<7>** m	
SEG43 (67)	**<7>** n	**<7>** b	**<7>** c	PTY
SEG44 (68)				
SEG45 (69)		**<8>** f	**<8>** e	EON
SEG46 (70)	**<8>** g	**<8>** j	**<8>** l	
SEG47 (71)	**<8>** a	**<8>** h	**<8>** d	
SEG48 (72)	**<8>** i	**<8>** k	**<8>** m	
SEG49 (73)	**<8>** n	**<8>** b	**<8>** c	CH
SEG50 (74)				
SEG51 (75)			METAL	AMS

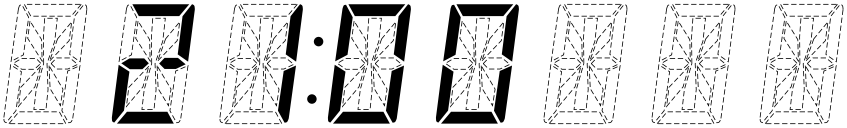
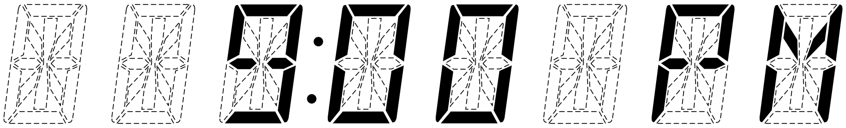
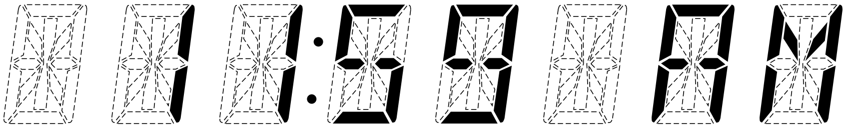
Remarks **1.** The digit in parentheses indicates a pin number of the μPD16431A.

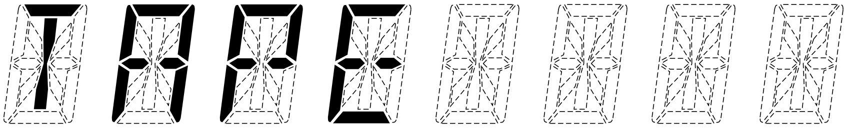
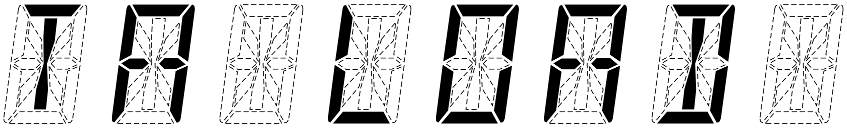
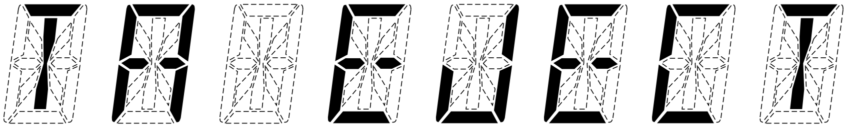
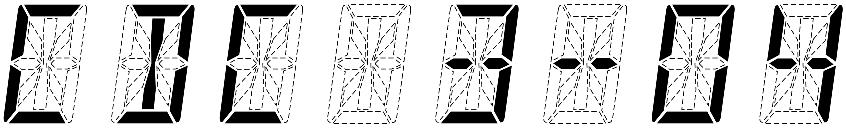
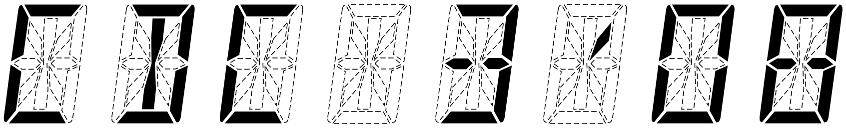
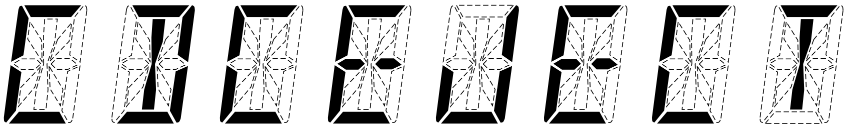
2. Blank: Not used

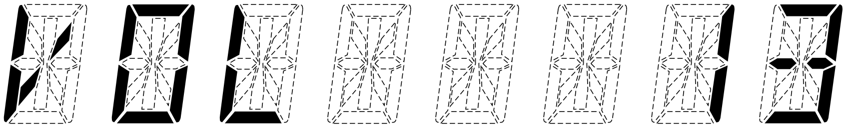
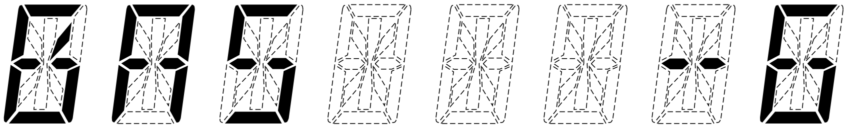
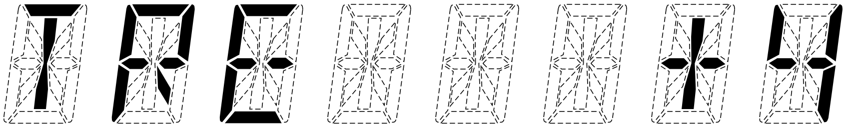
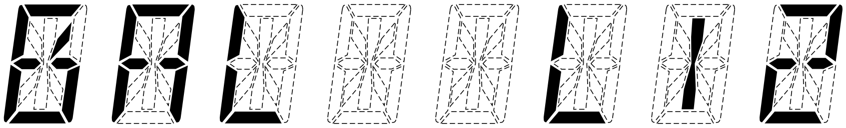
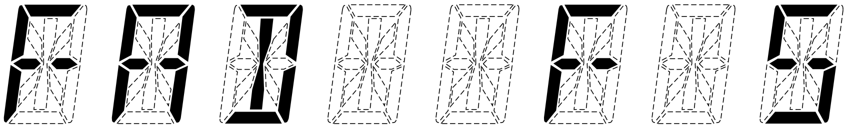
5.3 LCD Panel Displays

Display	Description
ALL	This indication appears during disc introduction scan, disc repeat, and disc random operations in CD changer mode.
AMS	Indicates that the system is in auto music search mode.
ASM	This indication appears during auto-storage operation in radio mode.
AUTO	This indication appears in radio mode and auto mode.
CH	This indicator indicates the channel of a preset memory number. The display turns on when a channel number is displayed in the 14-segment display area.
EON	Indicates that the station currently being received broadcasts traffic information. The display turns on when a TA signal is detected with other RDS stations received while an RDS station is being received.
FM1 FM2 FM3 LW MW	Indicates the radio band being received.
LOC	This indication appears in radio mode with LOCAL set.
LOUD	This indication appears in loudness mode.
METAL	The display turns on when METAL tape is inserted in tape mode.
MONO	The display turns on when the FM band is received in radio mode and forced MONO mode.
PAUSE	This indication appears during pause in CD changer mode.
PSCAN	This indication appears during preset memory scan operation in radio mode.
PTY	This indication appears during PTY search from PTY display while an FM band is being received in radio mode.
RANDOM	This indication appears in disc random mode and random mode in CD changer mode.
RDS	This indication appears in RDS mode when an FM band is being received in radio mode.
REGION	This indication appears in REGION mode in radio mode.
REPEAT	This indication appears in repeat mode and disc repeat mode in CD changer mode.
STEREO	The display turns on when $\overline{\text{STEREO}}$ pin goes low while an FM band is being received in radio mode. However, always turns off if forced MONO mode is on.
TA/DK	Indicates that the station currently being received 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.
TP	Indicates that the station currently being received broadcasts traffic information. The display turns on when the TP signal of an RDS station or the SK signal of a VF station is detected.
TP/SK	The display turns on when an FM band is being received in TP/SK mode.
○	Indicates that the station currently being received is an RDS station. The display turns on when the PI signal of an RDS station is read while an FM band is being received.
▶◀	Indicates the tape running direction.

Display	Description
14-segment display area	Displays the following: (1) Received frequency (2) PS (Program Service Name) (3) Clock (4) Tape (5) CD changer (6) Electronic volume control **(1) Received frequency display** **<1> In the FM band (108.00 MHz)**  **<2> In the MW band (1 620 kHz)**  **<3> In the LW band (281 kHz)**  **(2) PS display (if PS data is μPD178016)** 

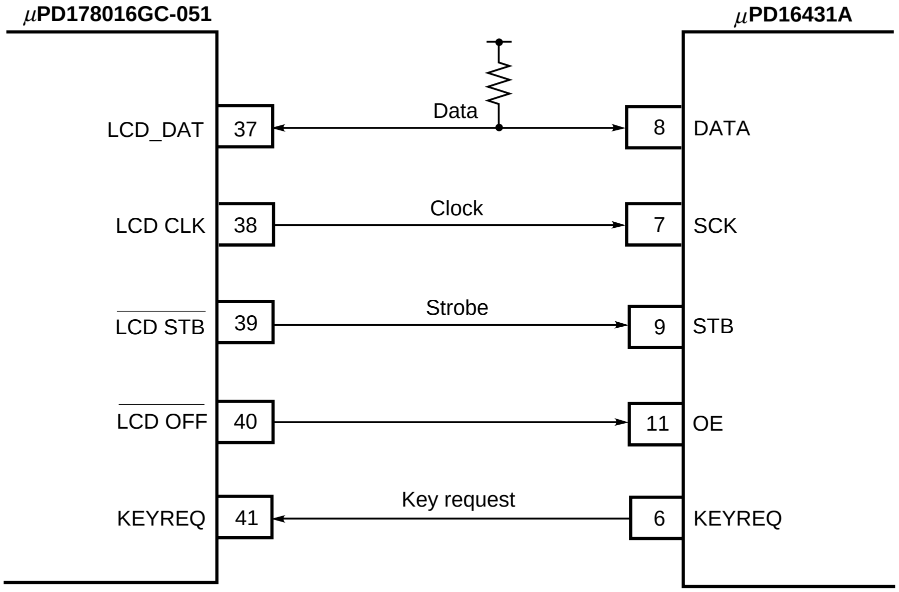
Display	Description
14-segment display area	**(3) Clock display** **<1> 24-hour display (21:00)**  **<2> 12-hour display (9:00 p.m.)**  **<3> 12-hour display (11:59 a.m.)** 

Display	Description
14-segment display area	**(4) Tape display** **<1> PLAY**  **<2> LOAD**  **<3> EJECT** 
14-segment display area	**(5) CD changer display** **<1> Track display (disc 3, track 4)**  **<2> Display of elapsed time (3 minutes 8 seconds)**  **<3> EJECT display** 

Display	Description
14-segment display area	**(6) Electronic volume control display** **<1> Volume display (VOLUME 13)**  **<2> BASS display (BASS -6)**  **<3> TREBLE display (TREBLE 4)**  **<4> BALANCE display (BALANCE L 12)**  **<5> FADER display (FADER F 5)** 

6. DESCRIPTION OF μPD16431A CONTROL

The μPD178016GC-051 uses the μPD16431A to control the LCD display.
The connection of the μPD178016GC-051 to the μPD16431A is illustrated below.



6.1 Key Scan

Key scan using the μPD16431A is performed as follows:

(1) Detecting a pressed key

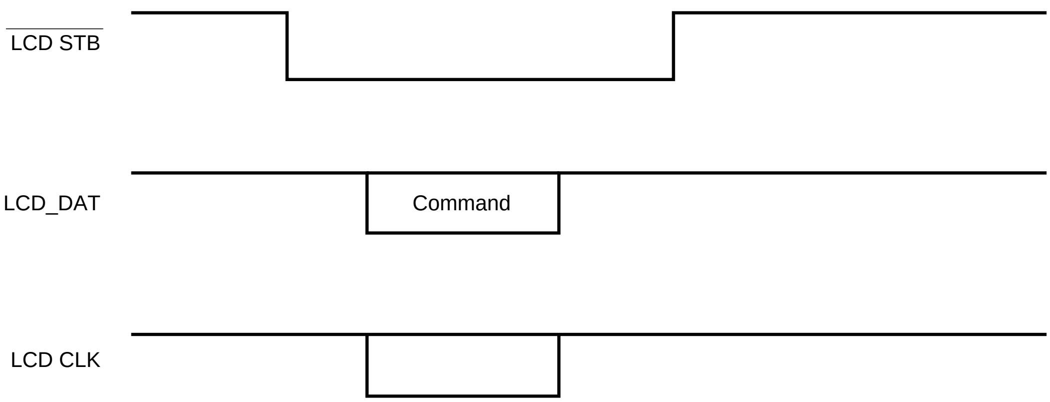
The controller judges the state of the KEYREQ pin (pin 6) of the μPD16431A every 20 ms.
When the KEYREQ pin is high, it is assumed that a key is being pressed. Noise elimination (chattering elimination) based on three consecutive matches is applied.
When noise elimination is performed correctly, the 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 Initial Data Output

The µPD178016GC-051 transfers the next initialization data to the µPD16431A about 500 ms after the level of $\overline{\text{LCD OFF}}$ (pin 40) changes from low to high.

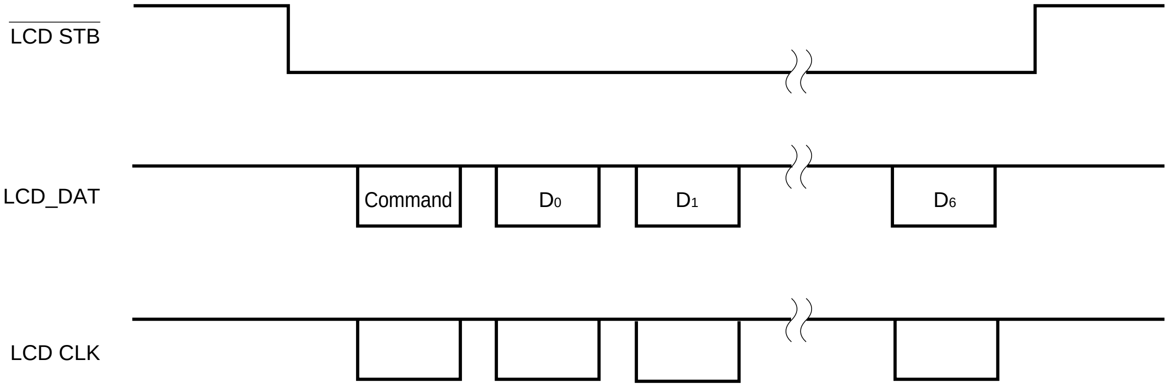


Command : 00001000 (initialization command)

1/4 duty, (f_{OSC}/512) /4, 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.

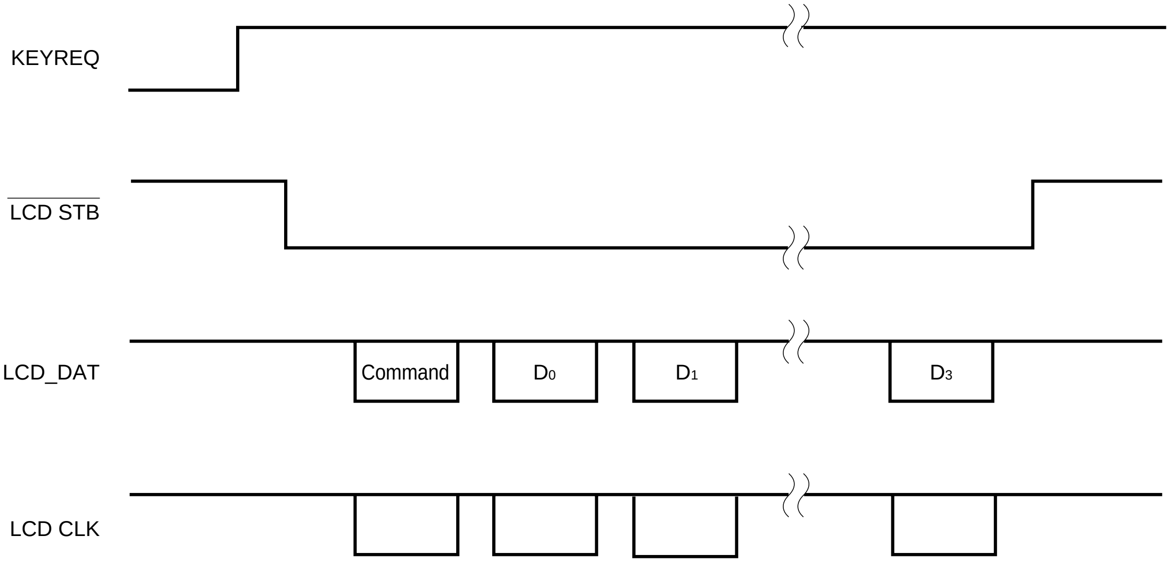


Command : 10000100 (status command (at COM1 output))
: 10001100 (status command (at COM2 output))
: 10010100 (status command (at COM3 output))
: 10011100 (status command (at COM4 output))
D$_0$ to D$_6$: 00000000 (display data)
|
11111111

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_3 : 00000000 (display data)
|
11111111

After the status command is send, key data is read from the LCD_DAT pin.

7. REMOTE CONTROL

The μPD6121G IC is used for sending a remote-controller signal. This IC uses a custom code, which must be set correctly to enable the control of the μPD178016GC-051 using a remote-controller signal.

The μPD178016GC-051 is operated with custom code 8604H. To set this code, connect diodes and pull-up resistors on the key matrix of the transmitter IC (μPD6121G). (See **Section 7.4**.)

7.1 Remote Control Key Configuration (When the μPD6121G Is Used)

Input pin (pin number) Output pin (pin number)	KI$_0$ (1)	KI$_1$ (2)	KI$_2$ (3)	KI$_3$ (4)
KI/O$_0$ (19)	M1	M2	M3	M4
KI/O$_1$ (18)	M5	M6	DOWN	UP
KI/O$_2$ (17)	PSCAN/ASM	RDS/REGION	TP/SK	PTY
KI/O$_3$ (16)	BAND	CDC	TAPE	DISP/ADJ
KI/O$_4$ (15)	MONO/LOC	VOL DOWN	VOL UP	SEL/LOUD
KI/O$_5$ (14)	AUTO	INTRO	REPEAT	RANDOM/AMS
KI/O$_6$ (13)	—	—	—	—
KI/O$_7$ (12)	POWER	—	—	EJECT

—: Undefined

7.2 Description of the Remote Control Keys

The functions of the remote control keys are the same as those of the μPD178016GC-051 momentary keys.

7.3 Remote Control Data Codes

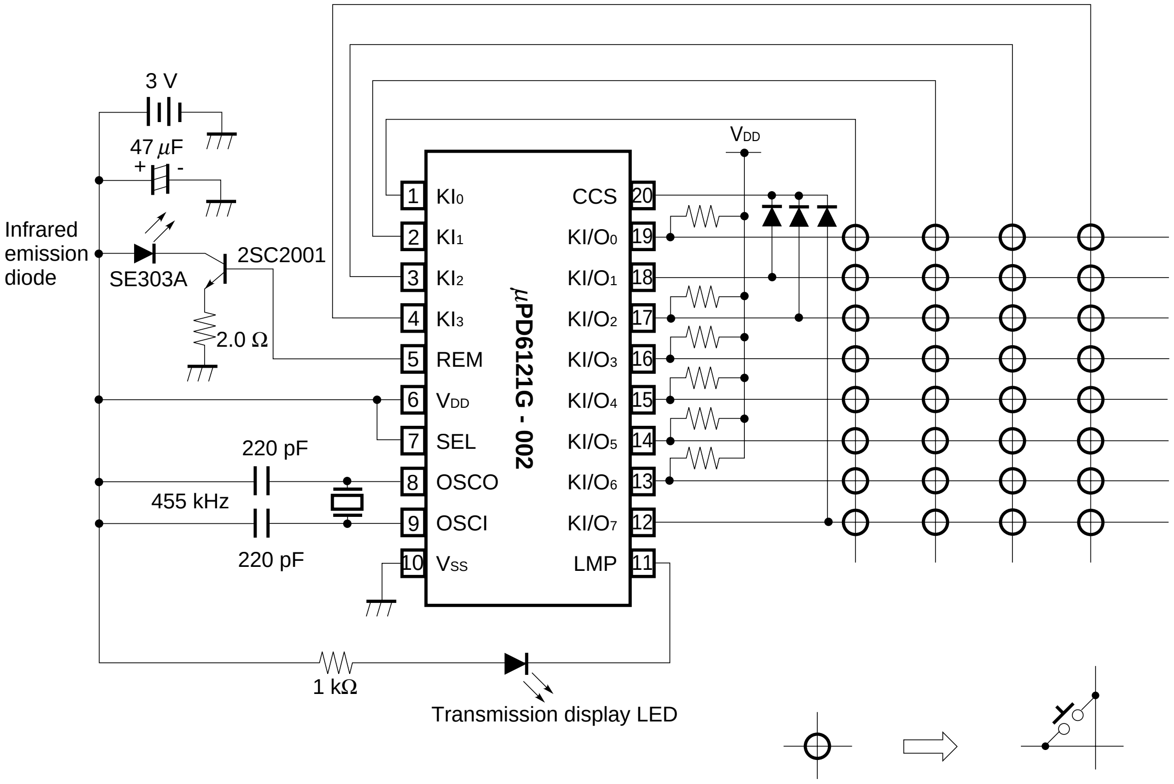
- **When a single key is pressed**

Remote control key	Data code							
	D0	D1	D2	D3	D4	D5	D6	D7
M1	0	0	0	0	0	0	0	0
M2	1	0	0	0	0	0	0	0
M3	0	1	0	0	0	0	0	0
M4	1	1	0	0	0	0	0	0
M5	0	0	1	0	0	0	0	0
M6	1	0	1	0	0	0	0	0
DOWN	0	1	1	0	0	0	0	0
UP	1	1	1	0	0	0	0	0
PSCAN/ASM	0	0	0	1	0	0	0	0
RDS/REGION	1	0	0	1	0	0	0	0
TP/SK	0	1	0	1	0	0	0	0
PTY	1	1	0	1	0	0	0	0
BAND	0	0	1	1	0	0	0	0
CDC	1	0	1	1	0	0	0	0
TAPE	0	1	1	1	0	0	0	0
DISP/ADJ	1	1	1	1	0	0	0	0

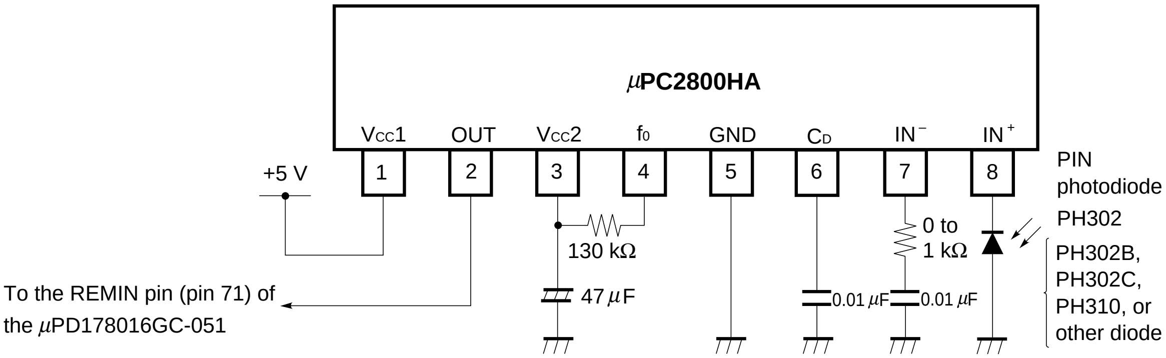
Remote control key	Data code							
	D0	D1	D2	D3	D4	D5	D6	D7
MONO/LOC	0	0	0	0	1	0	0	0
VOL DOWN	1	0	0	0	1	0	0	0
VOL UP	0	1	0	0	1	0	0	0
SEL/LOUD	1	1	0	0	1	0	0	0
AUTO	0	0	1	0	1	0	0	0
INTRO	1	0	1	0	1	0	0	0
REPEAT	0	1	1	0	1	0	0	0
RANDOM/AMS	1	1	1	0	1	0	0	0
—	0	0	0	1	1	0	0	0
—	1	0	0	1	1	0	0	0
—	0	1	0	1	1	0	0	0
—	1	1	0	1	1	0	0	0
POWER	0	0	1	1	1	0	0	0
—	1	0	1	1	1	0	0	0
—	0	1	1	1	1	0	0	0
EJECT	1	1	1	1	1	0	0	0

—: Undefined

7.4 Sample Remote Control Circuit Using the μPD6121G-002



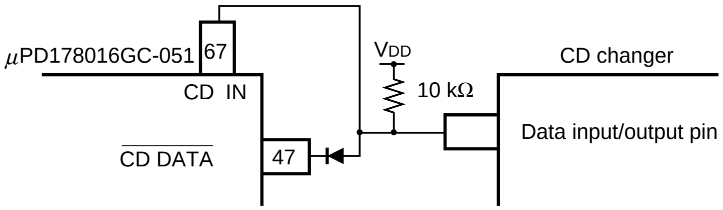
7.5 Sample Remote Control Preamplifier Using the μPC2800HA



8. DESCRIPTION OF CD CHANGER CONTROL

The μPD178016GC-051 is provided with CD changer control functions.

The pin connection between the μPD178016GC-051 and CD changer is illustrated below.



To transmit data between the μPD178016GC-051 and CD changer, use the CD changer data input pin (pin 67) and the CD changer data output pin (pin 47).

The following CD changer control functions are supported:

- Power-on
- Power-off
- Disc selection
- Play/pause
- Track up/down
- Search up/down
- Repeat
- Introduction scan
- Random

For details of each control function, see **Chapter 2**.

9. ELECTRONIC VOLUME CONTROLS

9.1 Electronic Volume Controls

The μPD178016GC-051 uses an electronic volume control IC for audio control and selection. It supports two types of electronic volume control ICs, the TDA7313 and TEA6320. Initial setting diode VOLSEL is set depending on which electronic volume control IC is being used.

The following electronic volume controls are supported:

Function	Electronic volume control IC	
	TDA7313	TEA6320
Volume	0 to 63 steps	0 to 40 steps
Bass	-7 to +7 steps	-4 to +4 steps
Treble	-7 to +7 steps	-4 to +4 steps
Balance	L7 to R7 steps	L7 to R7 steps
Fader	R7 to F7 steps	R7 to F7 steps
Loudness	On/off	On/off

See the description of the **VOL UP** and **VOL DOWN** keys for an explanation of how each adjustment is made.

9.2 Initial Values of Electronic Volume Controls

When power is first applied to the μPD178016GC-051, the initial values of the electronic volume controls are as listed below.

Function	Initial value	
	TDA7313	TEA6320
Volume	38 steps	22 steps
Bass	0 step	
Treble	0 step	
Balance	0 step (CNT)	
Fader	0 step (CNT)	
Loudness	Off	

10. MUTE OUTPUT TIMING CHART

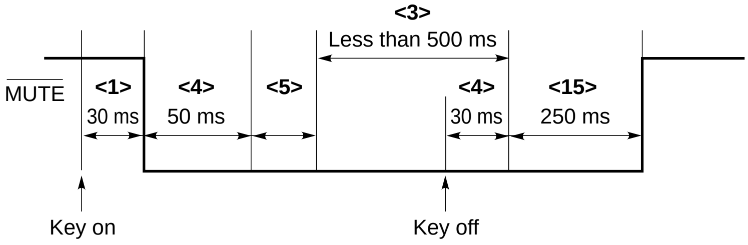
This chapter shows the mute output timings.

<1> through **<17>** in the timing charts on the following pages indicate the time required for each processing, as follows:

<1> Key on chattering wait time
<2> Key off chattering wait time
<3> Key valid wait time
<4> Preceding mute time
<5> Division ratio setting time
<6> PLL lock wait time
<7> SD stabilization wait time
<8> IF measurement time
<9> RDS data decode wait time (150 ms)
<10> PI code read wait time
<11> TP code read wait time
<12> PI/TP code read wait time
<13> SK read wait time
<14> PTY read wait time
<15> Following mute time
<16> Scan wait time
<17> Power-on processing time

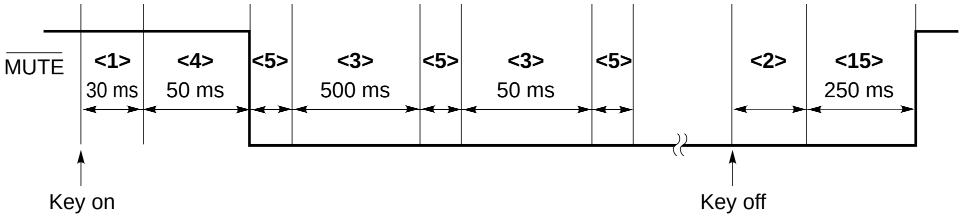
10.1 Manual Up/Down

10.1.1 1-channel up/down



Time **<15>** is 550 ms at band edge.

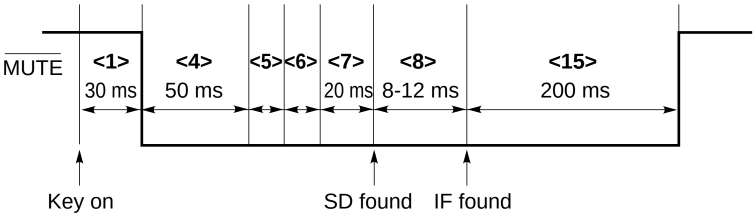
10.1.2 Successive up/down



Time **<3>** is 600 ms and time **<15>** is 550 ms at band edge.

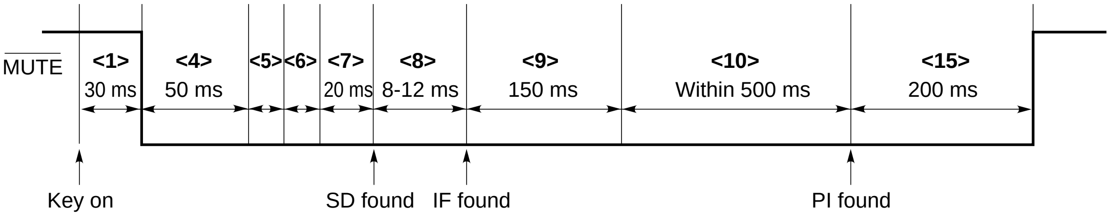
10.2 Auto Up/Down

10.2.1 Normal seek



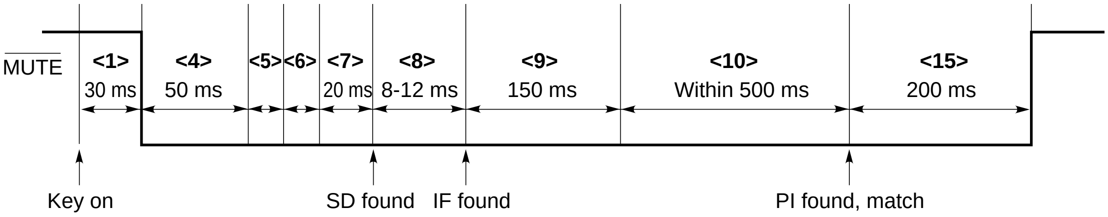
However, time **<7>** is 600 ms and time **<15>** is 500 ms if a band edge is detected in the middle.
Time **<8>** is 16 to 24 ms in the AM band.
If an error occurs in **<7>** or **<8>**, the next frequency is received (**<5>**).

10.2.2 RDS seek



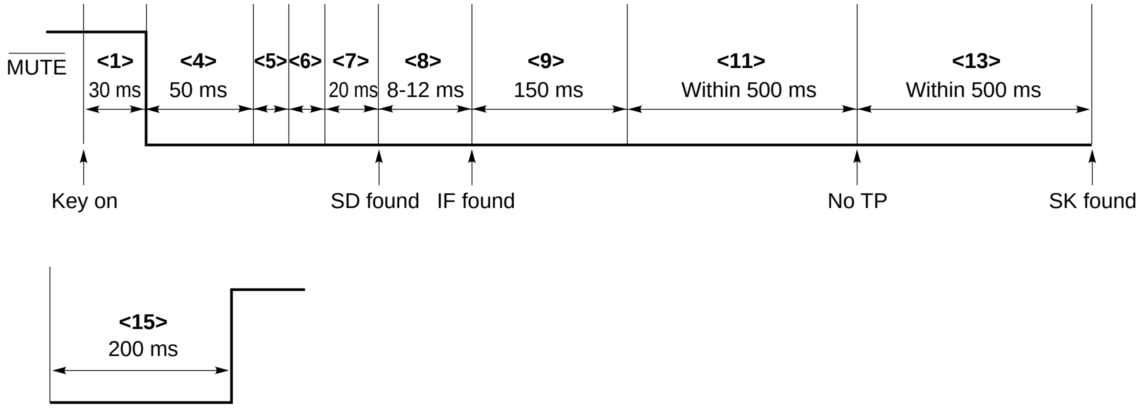
However, time **<7>** is 600 ms and time **<15>** is 500 ms if a band edge is detected in the middle.
If an error occurs in **<7>**, **<8>**, or **<10>**, the next frequency is received (**<5>**).

10.2.3 PI seek



However, time **<7>** is 600 ms and time **<15>** is 500 ms if a band edge is detected in the middle.
If an error occurs in **<7>**, **<8>**, or **<10>**, the next frequency is received (**<5>**).

10.2.4 TP seek



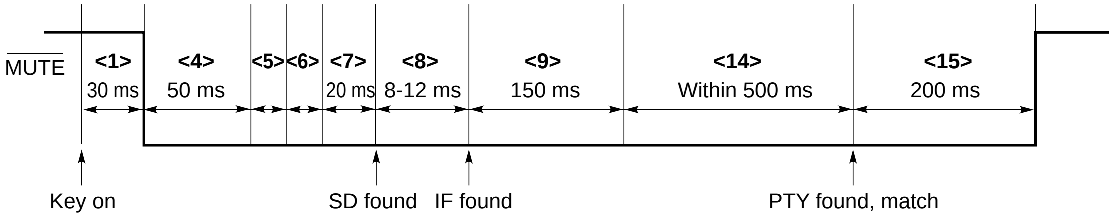
However, time **<7>** is 600 ms and time **<15>** is 500 ms if a band edge is detected in the middle.

If an error occurs in **<7>**, **<8>**, or **<13>**, the next frequency is received (**<5>**).

If PI/TP is found in **<11>**, **<15>** is performed.

<13> is not performed in RDS mode. If an error occurs in **<11>**, the next frequency is received. If no error occurs, **<15>** is performed.

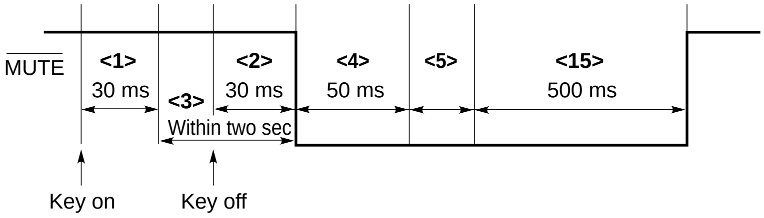
10.2.5 PTY seek



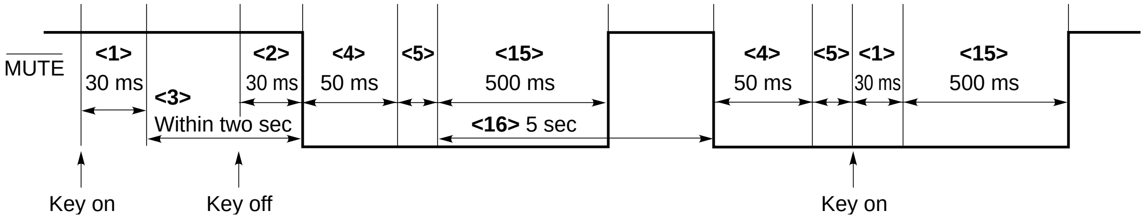
However, time **<7>** is 600 ms and time **<15>** is 500 ms if a band edge is detected in the middle.

If an error occurs in **<7>**, **<8>**, or **<14>**, the next frequency is received (**<5>**).

10.3 Preset Memory Calling

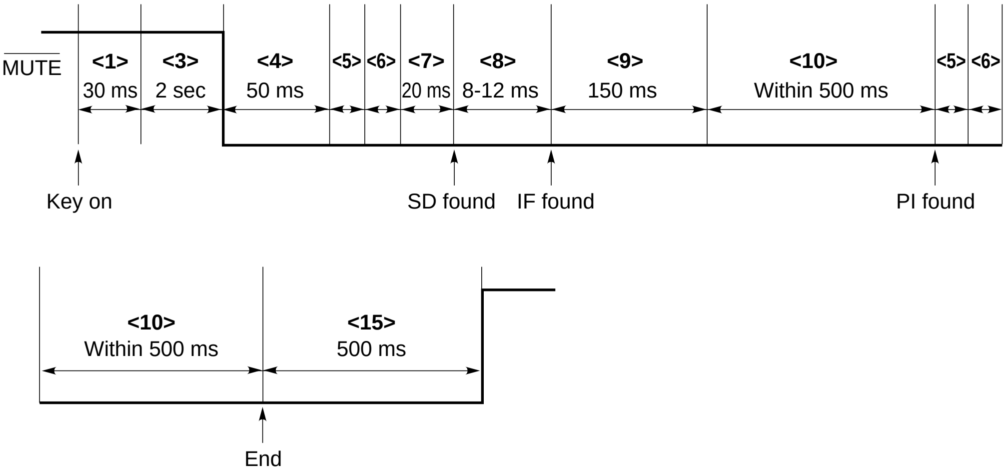


10.4 Preset Memory Scan



10.5 Auto-Storage

10.5.1 Auto-storage

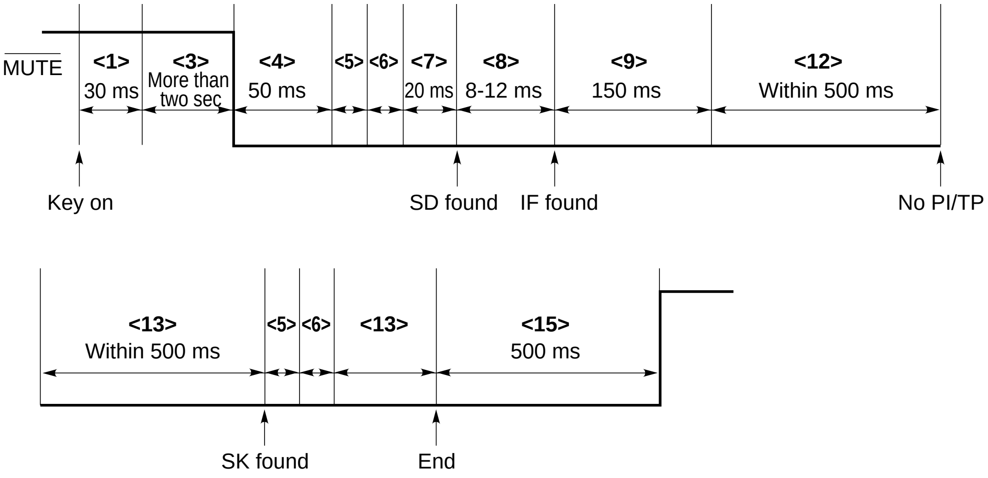


However, time **<7>** is 600 ms if a band edge is detected in the middle.

Time **<8>** is 16 to 24 ms in the AM band.

If an error occurs in **<7>** or **<8>**, the next frequency is received (**<5>**).

10.5.2 TP auto-storage



However, time **<7>** is 600 ms if a band edge is detected in the middle.

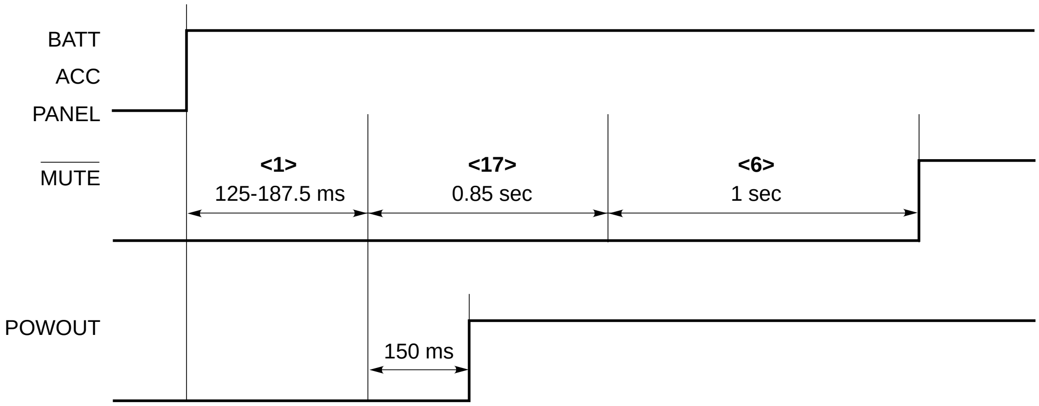
If an error occurs in **<7>**, **<8>**, or **<13>**, the next frequency is received (**<5>**).

If PI/TP is found in **<12>**, the next frequency is received (**<5>**).

10.6 POWER On/Off

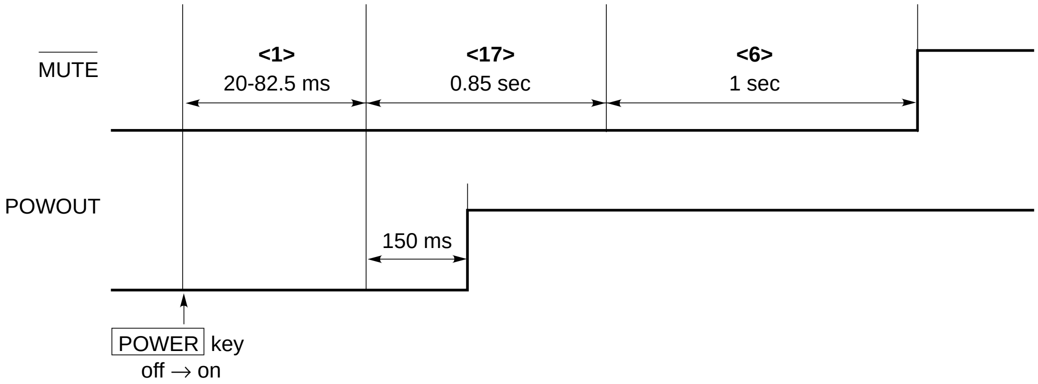
10.6.1 Power on

(1) ACC, BATT, and PANEL pins



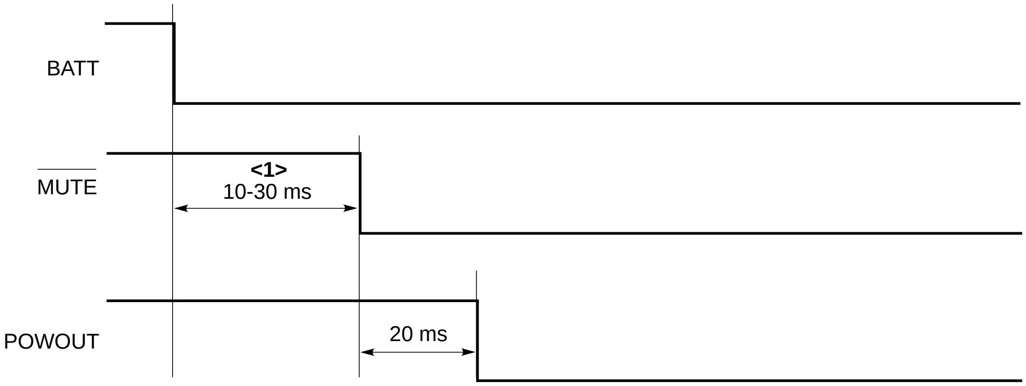
An oscillation stabilization time (31.3 ms) must elapse before **<1>** in the low current consumption state.

(2) POWER key

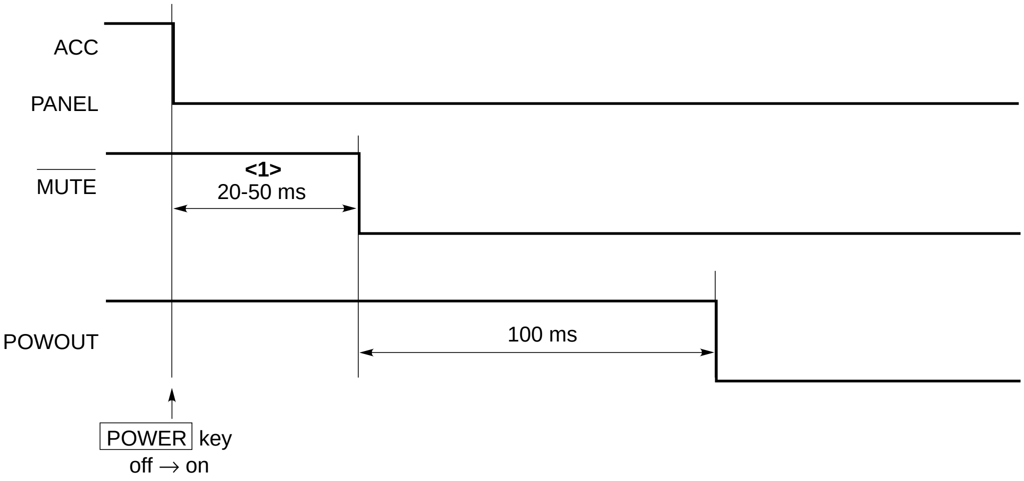


10.6.2 Power off

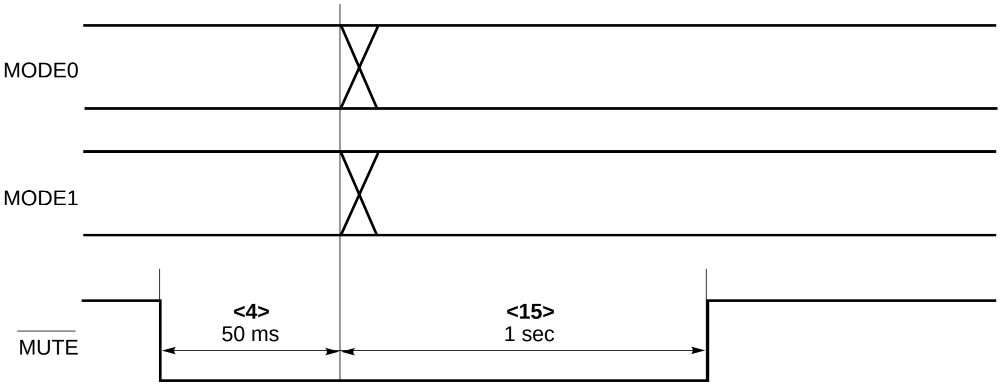
(1) BATT pin



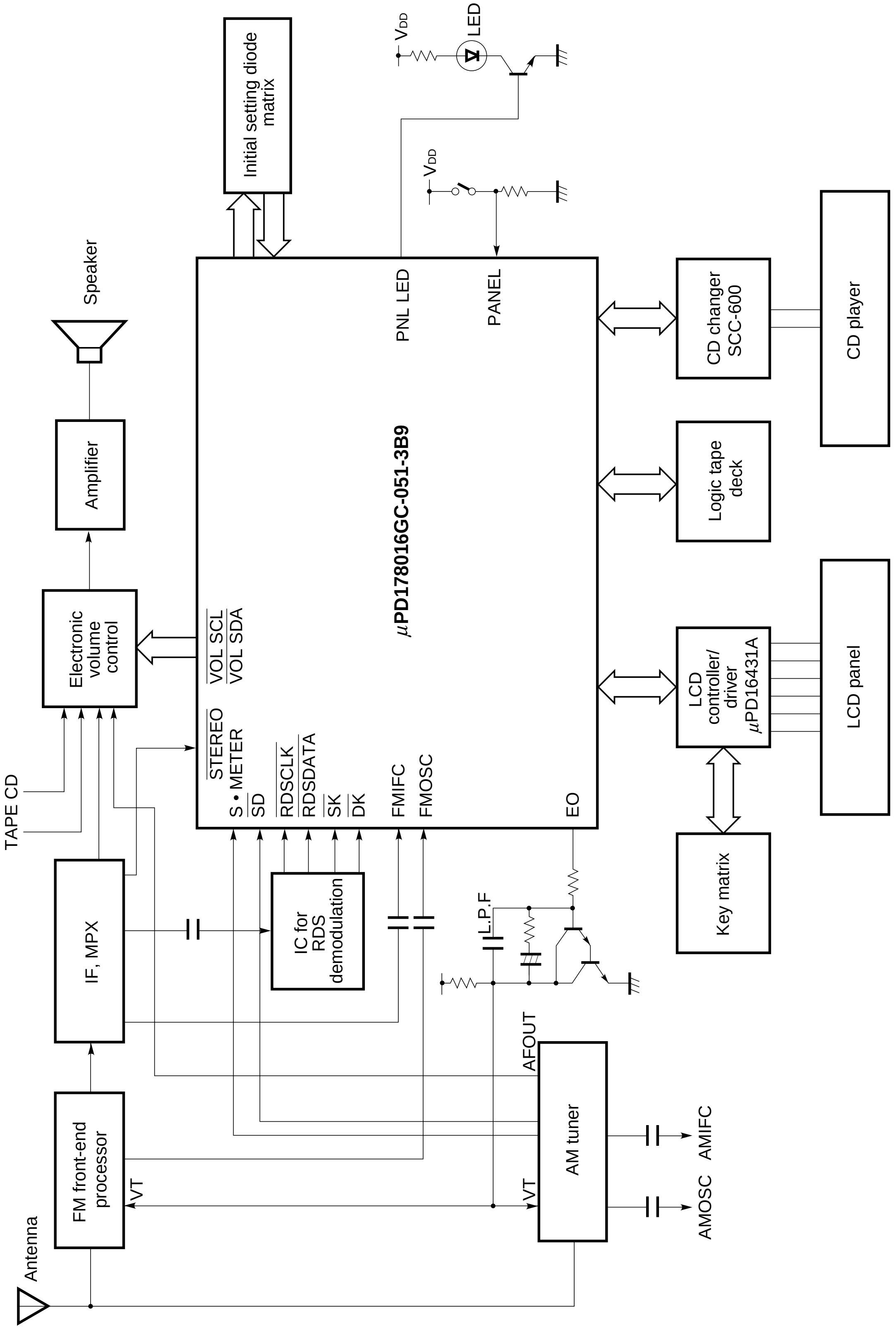
(2) ACC and $\overline{\text{PANEL}}$ pins, and POWER key



10.7 Mode Switching



11. SAMPLE APPLICATION CIRCUIT



12. ELECTRICAL CHARACTERISTICS (PRELIMINARY)

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C)

Parameter	Symbol	Conditions		Rating	Unit
Power supply voltage	V_{DD}			-0.3 to +7.0	V
Input voltage	V_{I1}	At other than P60-P63		-0.3 to V_{DD} + 0.3	V
	V_{I2}	P60-P63	N-ch open-drain	-0.3 to +16	V
Output voltage	V_O			-0.3 to V_{DD} + 0.3	V
Output withstand voltage	V_{BDS}	P132-P134	N-ch open-drain	16	V
Analog input voltage	V_{AN}	P10-P15	Analog input pin	-0.3 to V_{DD} + 0.3	V
High-level output current	I_{OH}	At one pin		-10	mA
		Total for P01-P06, P30-P37, P56, P57, P60-P67, and P120-P125		-15	mA
		Total for P10-P15, P20-P27, P40-P47, P50-P55, and P132-P134		-5	mA
Low-level output current	I_{OL} **Note**	At one pin	Peak value	15	mA
			rms	7.5	mA
Operating ambient temperature	T_A			-40 to +85	°C
Storage temperature	T_{stg}			-65 to +150	°C

Note Calculate a root-mean-square value as follows: [rms value] = [peak value] × $\sqrt{\text{duty cycle}}$.

Caution Absolute maximum ratings are rated values beyond which physical damage will be caused to the product; if the rated value of any of the parameters in the above table is exceeded, even momentarily, the quality of the product may deteriorate. Always use the product within its rated values.

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

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage	V_{DD1}	While the CPU and PLL are operating	4.5		5.5	V
	V_{DD2}	While the CPU is operating but the PLL is halted Cycle time: $T_{CY} \geq 0.89\ \mu s$	3.5		5.5	V
	V_{DD3}	While the CPU is operating but the PLL is halted Cycle time: $T_{CY} = 0.44\ \mu s$	4.5		5.5	V

Remark T_{CY}: Cycle time (minimum instruction execution time)

DC CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 3.5 to 5.5 V) (1/3)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
High-level input voltage	V_{IH1}	P10-P15, P21, P23, P30-P32, P35-P37, P40-P47, P50-P57, P64-P67, P120-P125		0.7V_{DD}		V_{DD}	V
	V_{IH2}	P00-P06, P20, P22, P24-P27, P33, P34, $\overline{\text{RESET}}$		0.85V_{DD}		V_{DD}	V
	V_{IH3}	P60-P63 (N-ch open-drain)		0.7V_{DD}		15	V
Low-level input voltage	V_{IL1}	P10-P15, P21, P23, P30-P32, P35-P37, P40-P47, P50-P57, P64-P67, P120-P125		0		0.3V_{DD}	V
	V_{IL2}	P00-P06, P20, P22, P24-P27, P33, P34, $\overline{\text{RESET}}$		0		0.15V_{DD}	V
	V_{IL3}	P60-P63 (N-ch open-drain)	4.5 V ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			3.5 V ≤ V_{DD} < 4.5 V	0		0.2V_{DD}	V
High-level output voltage	V_{OH1}		4.5 V ≤ V_{DD} ≤ 5.5 V, I_{OH} = -1 mA	V_{DD} - 1.0			V
			3.5 V ≤ V_{DD} < 4.5 V, I_{OH} = -100 μA	V_{DD} - 0.5			V
Low-level output voltage	V_{OL1}	P50-P57, P60-P63	V_{DD} = 4.5 to 5.5 V, I_{OL} = 15 mA		0.4	2.0	V
		P01-P06, P10-P15, P20-P27, P30-P37, P40-P47, P64-P67, P120-P125, P132-P134	V_{DD} = 4.5 to 5.5 V, I_{OL} = 1.6 mA			0.4	V
	V_{OL2}	SB0, SB1, $\overline{\text{SCK0}}$	V_{DD} = 4.5 to 5.5 V, When N-ch open-drain is pulled up (R = 1 kΩ)			0.2V_{DD}	V

Remark Unless otherwise specified, the characteristics of dual-function pins are as same as those of port pins.

DC CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 3.5 to 5.5 V) (2/3)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
High-level input leakage current	I_{LH1}	P00-P06, P10-P15, P20-P27, P30-P37, P40-P47, P50-P57, P64-P67, P120-P125, $\overline{\text{RESET}}$	$V_{IN} = V_{DD}$			3	μA
	I_{LH2}	P60-P63	V_{IN} = 15 V			80	μA
Low-level input leakage current	I_{LIL1}	P00-P06, P10-P15, P20-P27, P30-P37, P40-P47, P50-P57, P64-P67, P120-P125, $\overline{\text{RESET}}$	V_{IN} = 0 V			-3	μA
	I_{LIL2}	P60-P63				-3**Note**	μA
High-level output leakage current	I_{LOH}	P132-P134	V_{OUT} = 15 V			3	μA
Low-level output leakage current	I_{LOL}	P132-P134	V_{OUT} = 0 V			-3	μA
Output-off leakage current	I_{LOF}	EO0, EO1	$V_{OUT} = V_{DD}$, V_{OUT} = 0 V			±1	μA

Note A low-level input leakage current of -200 μA (MAX.) flows between P60 and P63 only for one clock when an input instruction is executed. During the period other than the one clock, a low-level input leakage current of -3 μA (MAX.) flows.

Remark Unless otherwise specified, the characteristic of dual-function pins are as same as those of port pins.

REFERENCE CHARACTERISTICS (T_A = 25 °C, V_{DD} = 5 V) (1/2)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
High-level output current	I_{OH1}	EO0	$V_{OUT} = V_{DD}$ - 1 V		-4		mA
		EO1 (EOCON0 = 1)			-6		mA
		EO1 (EOCON0 = 0)			-2		mA
Low-level output current	I_{OL1}	EO0	V_{OUT} = 1 V		6		mA
		EO1 (EOCON0 = 1)			8		mA
		EO1 (EOCON0 = 0)			3		mA

DC CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 3.5 to 5.5 V) (3/3)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply current[Note 1]	I_{DD1}	While the CPU is operating but the PLL is halted At f_X = 4.5 MHz	T_{CY} = 0.89 μs[Note 2]		2.5	15	mA
	I_{DD2}		T_{CY} = 0.44 μs[Note 3] V_{DD} = 4.5 to 5.5 V		4.0	27	mA
	I_{DD3}	While the CPU is operating but the PLL is halted HALT mode A sinusoidal wave is applied to the X1 pin (V_{IN} = V_{DD}). At f_X = 4.5 MHz	T_{CY} = 0.89 μs[Note 2]		0.7	1.5	mA
	I_{DD4}		T_{CY} = 0.44 μs[Note 3] V_{DD} = 4.5 to 5.5 V		1.0	2.0	mA
Data hold supply voltage	V_{DDR1}	While the crystal oscillator is operating	T_{CY} = 0.44 μs	4.5		5.5	V
	V_{DDR2}		T_{CY} = 0.89 μs	3.5		5.5	V
	V_{DDR3}	While the crystal oscillator is halted When the power failure is detected by power-on clear		2.6		5.5	V
Data hold supply current	I_{DDR1}	While the crystal oscillator is halted	T_A = 25 °C V_{DD} = 5 V		2	4	μA
	I_{DDR2}				2	30	μA

Notes 1. The port current is not included.

2. When both the processor clock control register (PCC) and the oscillation mode selection register (OSMS) are set to 00H

3. When the PCC is set to 00H, and the OSMS is set to 01H

Remarks 1. T_{CY}: Cycle time (minimum instruction execution time)

2. f_X: System clock oscillator frequency

REFERENCE CHARACTERISTICS (T_A = 25 °C, V_{DD} = 5 V) (2/2)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply current	I_{DD5}	While the CPU and PLL are operating A sinusoidal wave is applied to the VCOH pin. f_{IN} = 130 MHz, V_{IN} = 0.15 V_{P-P}	T_{CY} = 0.44 μs[Note]		7		mA

Note When the processor clock control register (PCC) is set to 00H and the oscillation mode selection register (OSMS) is set to 01H

Remark T_{CY}: Cycle time (minimum instruction execution time)

AC CHARACTERISTICS

Basic Operations (T_A = -40 to +85 °C, V_{DD} = 3.5 to 5.5 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Cycle time (minimum instruction execution time)	T_{CY}	At $f_{XX} = f_X/2^{\text{Note 1}}$ and f_X = 4.5 MHz		0.89		14.22	μs
		At $f_{XX} = f_X^{\text{Note 2}}$ and f_X = 4.5 MHz	4.5 V ≤ V_{DD} ≤ 5.5 V	0.44		7.11	μs
			3.5 V ≤ V_{DD} < 4.5 V	0.89		7.11	μs
$\overline{\text{RESET}}$ low-level width	t_{RSL}			10			μs

Notes 1. When the oscillation mode selection register (OSMS) is set to 00H

2. When the OSMS is set to 01H

Remarks 1. f_{XX}: System clock frequency (f_X or $f_X/2$)

2. f_X: System clock oscillator frequency

A/D CONVERTER CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Resolution			8	8	8	bit
Total error in conversion					±3.0	LSB
Conversion time	t_{CONV}		22.2		44.4	μs
Sampling time	t_{SAMP}		15/f_{XX}			μs
Analog input voltage	V_{IAN}		0		V_{DD}	V

Remarks 1. f_{XX}: System clock frequency (f_X/2)

2. f_X: System clock oscillator frequency

PLL CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating frequency	f_{IN1}	VCOL pin in MF mode, with a sinusoidal wave applied to the V_{IN} pin = 0.1 V_{P-P}	0.5		3	MHz
	f_{IN2}	VCOL pin in HF mode, with a sinusoidal wave applied to the V_{IN} pin = 0.2 V_{P-P}	9		55	MHz
	f_{IN3}	VCOH pin in VMF mode, with a sinusoidal wave applied to the V_{IN} pin = 0.15 V_{P-P}	60		160	MHz

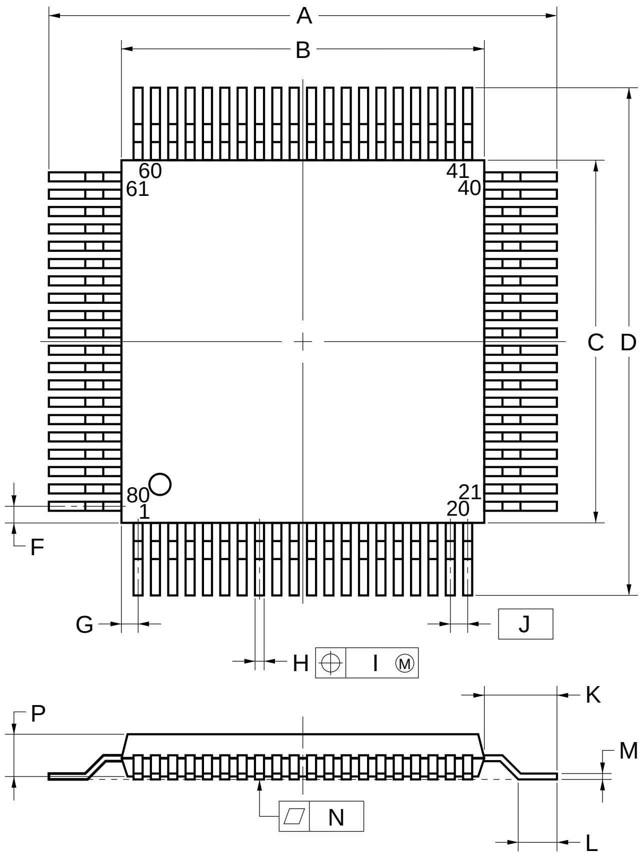
IFC CHARACTERISTICS (T_A = -40 to +85 °C, V_{DD} = 4.5 to 5.5 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Operating frequency	f_{IN4}	AMIFC pin in AMIF count mode, with a sinusoidal wave applied to the V_{IN} pin = 0.1 V_{P-P} **Note**	0.4		0.5	MHz
	f_{IN5}	FMIFC pin in FMIF count mode, with a sinusoidal wave applied to the V_{IN} pin = 0.1 V_{P-P} **Note**	10		11	MHz
	f_{IN6}	FMIFC pin in AMIF count mode, with a sinusoidal wave applied to the V_{IN} pin = 0.1 V_{P-P} **Note**	0.4		0.5	MHz

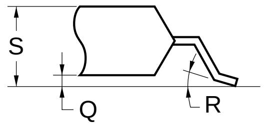
Note The condition of sinusoidal wave input V_{IN} = 0.1 V_{P-P} is the rated value when the μPD178016GC-051 alone is operating. Where influence of noise must be taken into consideration, operation under input amplitude condition of V_{IN} = 0.15 V_{P-P} is recommended.

13. PACKAGE DRAWING

80 PIN PLASTIC QFP (14×14)



detail of lead end



NOTE

Each lead centerline is located within 0.13 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	17.2±0.4	0.677±0.016
B	14.0±0.2	$0.551^{+0.009}_{-0.008}$
C	14.0±0.2	$0.551^{+0.009}_{-0.008}$
D	17.2±0.4	0.677±0.016
F	0.825	0.032
G	0.825	0.032
H	0.30±0.10	$0.012^{+0.004}_{-0.005}$
I	0.13	0.005
J	0.65 (T.P.)	0.026 (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	0.1±0.1	0.004±0.004
R	5°±5°	5°±5°
S	3.0 MAX.	0.119 MAX.

S80GC-65-3B9-4

14. RECOMMENDED SOLDERING CONDITIONS

The conditions listed below shall be met when soldering the μPD178016GC-051.

For details of the recommended soldering conditions, refer to our document **SMD Surface Mount Technology Manual (C10535E)**.

Please consult with our sales offices in case any other soldering process is used, or in case soldering is done under different conditions.

Table 14-1. Soldering Conditions for Surface-Mount Devices

μPD178016GC-051-3B9: 80-pin plastic QFP (14 × 14 mm, 0.65-mm pitch)

Soldering process	Soldering conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 235 °C Reflow time: 30 seconds or less (at 210 °C or more) Maximum allowable number of reflow processes: 3	IR35-00-3
VPS	Peak package's surface temperature: 215 °C Reflow time: 40 seconds or less (at 200 °C or more) Maximum allowable number of reflow processes: 3	VP15-00-3
Wave soldering	Solder temperature: 260 °C or less Flow time: 10 seconds or less Number of flow processes: 1 Preheating temperature: 120 °C max. (measured on the package surface)	WS60-00-1
Partial heating method	Terminal temperature: 300 °C or less Heat time: 3 seconds or less (for one side of a device)	—

Caution Do not apply more than a single process at once, except for "Partial heating method."

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

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

② HANDLING OF UNUSED INPUT PINS FOR CMOS

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

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

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

[MEMO]

Caution This product contains an I^{2}C bus interface circuit.
When using the I^{2}C 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^{2}C components conveys a license under the Philips I^{2}C Patent Rights to use these components in an I^{2}C system, provided that the system conforms to the I^{2}C 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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[MEMO]

The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

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