μPD1703C-014

PLL FREQUENCY SYNTHESIZER AND CONTROLLER
FOR FM AND AM TUNER

The μPD1703C-014 is a CMOS LSI with built-in PLL and controller capable of receiving FM/AM in U.S.A. and Japan. The μPD1703C-014 is provided in a shape of 28-pin DIP (Dual In-Line Package) with less substrate occupying area. In combination with a dedicated prescalar (μPB553AC), the μPD1703C-014 can be used to construct high fidelity FM/AM digital synthesizer tuners for home-stereo systems.

FEATURES

- FIP (Fluorescent Indicator Panel) direct drive (segments only)
- Built-in PLL frequency synthesizer, swallow counter, and controller
- Simple preset memory back-up (10 μA or less: CE pin = low)
- Preset station display (LED dot display)
- FM reference frequency is as high as 25 kHz (pulse swallowing method used)
- U.S.A. and Japanese FM and AM bands selectable by initializing switch
- Independent 7-station preset memories for FM and AM
- Use of momentary or alternate switch for preset and band selector keys
- Separate last channel memories for FM and AM bands
- Automatic and manual UP/DOWN tuning (triangle wave tuning)
- Dynamic or LCD static display by initializing switch (serial data output for static display mode)
- Built-in EXTERNAL DATA PRESET function useful for mass production operations
- Built-in REC. CALL function (333.3 Hz pulse output from MUTE pin)
- FM IF offset capacity (4 ways by 25 kHz steps)
- Small 28-pin plastic DIP package (400 mil type) which occupies little circuit board space
- 5 V ±10 % single power supply

FUNCTION

Receiving frequency, channel spacing, reference frequency, intermediate frequency

		FREQUENCY RANGE	CHANNEL SPACE	REFERENCE FREQUENCY	INTERMEDIATE FREQUENCY
U.S.A.	AM1	530 to 1 620 kHz	10 kHz	10 kHz	450 kHz
	AM2	531 to 1 602 kHz	9 kHz	9 kHz	
	FM1	87.9 to 107.9 MHz	200 kHz	25 kHz	10.650, 10.675, 10.700, 10.725 MHz
	FM2	87.9 to 107.9 MHz	100 kHz	25 kHz	
Japan	AM	531 to 1 602 kHz	9 kHz	9 kHz	450 kHz
	FM	76.0 to 90.0 MHz	100 kHz	25 kHz	10.675, 10.700, 10.725, 10.750 MHz

Tuning functions

(1) Auto UP/DOWN tuning (sawtooth wave mode)

Auto tuning is stopped when a high level input is applied to the SD pin. The freuquency at that time remains tuned. The auto tuning direction is reversed when a band edge (the lowest or highest frequency in that band) is reached (that is, UP reversed to DOWN, and DOWN reversed to UP) and the auto tuning operation is continued.

(2) Manual UP/DOWN tuning (sawtooth wave mode)

Stepwise tuning by momentary switch. If pressed for more than 0.5 sec, tuned frequency is changed continuously until switch is released. Note that the tuning operation is stopped when a band edge is reached.
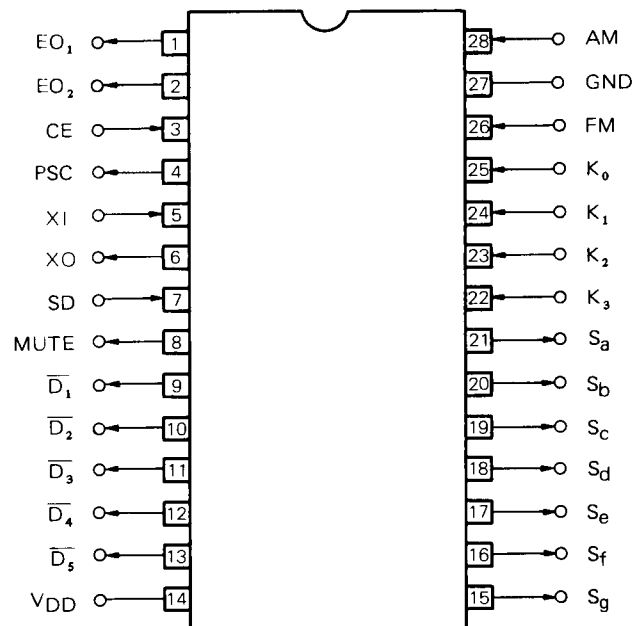
(3) Preset station memory call

AM .... Seven stations (M1 to M7)

FM .... Seven stations (M1 to M7)

Independent preset memories are used for AM and FM.

PIN CONFIGURATION (Top View)

PIN DESCRIPTION

PIN NO.	PIN SYMBOL	PIN NAME	DESCRIPTION
1 2	EO_1 EO_2	Error out	PLL phase detector charge pump outputs. High level outputs are obtained from these pins if the frequency obtained by dividing the oscillator frequency is higher than the reference frequency, and low level outputs are obtained if the divided oscillator frequency is lower. The outputs are switched to floating status if the divided frequency is the same as the reference frequency. Since the same output signal is obtained from both EO_1 and EO_2, either pin may be connected to the L.P.F.
3	CE	Chip enable	Device selector signal input pin. The CE pin is set to high level for normal device operation, and to low level if the device is not used. 　　　High level · · · · · · · · · ·Normal operation 　　　Low level · · · · · · · · · ·Memory hold status (display OFF, PLL operation 　　　　　　　　　　　　　　　　halted, and internal clock operation stopped) Preset memory back-up is enabled at low power consumption current (below 10 µA) by switching this pin to low level. Note that neither high nor low level pulses of less than 134 µs are accepted. Also note that the rising edge of a high level pules applied to the CE pin must come after V_{DD} has reached high level (4.5 V min.), and a low level falling edge must be applied before V_{DD} reaches 4.5 V.
4	PSC	Pulse swallow-ing control	Output of signal for switching the prescalar frequency division factor for FM reception where pulse swallowing is used as the frequency division method. Connect to PSC pin of the µPB553AC dedicated prescalar. The switchable µPB553AC frequency division factors are 1/16 and 1/17.
5 6	XI XO	X'tal	Crystal resonator connector pins. Connect to a 4.5 MHz resonator.
7	SD	Station detector	Input pin used to determine when a broadcasting station is received during auto tuning (auto UP/DOWN). Apply a high level input signal within 75 msec after locking the PLL.
8	MUTE	MUTE	Active high output pin used to eliminate shock noise if the PLL comes un-locked. The MUTE pin is switched unconditionally to low level if the CE pin is at low level (back-up status). 　　　During AM/FM switching . . . . .800 msec. (approx.) 　　　During manual UP/DOWN tuning . . . .200 msec. (approx.) 　　　　　　　　　　　　　　　　　　　(Single step operation) 　　　During auto UP/DOWN tuning . . . . . .200 msec. (approx.) 　　　　　　　after high level input is applied to the SD pin 　　　During preset memory calls . . . . . . .450 msec. (approx.) These muting periods refer to the output periods after a change in PLL data. In actual circuits, approximately 50 msec. of "first out" (preceeding the PLL data change) is added to these values. See the MUTE output timing chart on page 27 for details.
9 to 13	$\overline{D_1}$ to $\overline{D_5}$	Digit outputs	Display digits signal output pins (active low). (See the display description on page 20 for details.)
14	V_{DD}	V_{DD}	Device power supply pin A voltage of +5 V ±10 % is supplied during device operation, and this can be reduced to 2.5 V for back-up mode. The V_{DD} rise time must be less than 500 msec. The device may not be correctly initialized if the rise time is very long.

| PIN NO.	PIN SYMBOL	PIN NAME	DESCRIPTION
15 to 21	S_a to S_g	Segment outputs	Display segment signal output and key return signal source pins (active high). (See page 6 for details on the key matrix.) Since this pin has a voltage endurance of 30 V, it may be connected directly to the FIP (fluorescent indicator panel) segment pins. (See the display section on page 20 for details.)
22 to 25	K_0 to K_3	Key return signal inputs	Input pins for key return signals from an external key matrix. (See section on key matrix configuration on page 6 for details.)
26	FM	FM local oscillator signal inputs	The output obtained by dividing the FM local oscillator output by 16 or 17 (in the μPB553AC prescalar) is applied to this pin. Because of the built-in AC amplifier, eliminate the DC components of the input by capacitor.
27	GND	GND	Connect to system ground.
28	AM	AM local oscillator signal inputs	The AM local oscillator output is applied to this input pin. Because of the built-in AC amplifier, eliminate the DC components of the input by capacitor.

CONTENTS

1. KEY MATRIX

1.1 CONFIGURATION OF KEY MATRIX

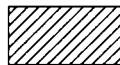| Input / Output	K_0 (25)	K_1 (24)	K_2 (23)	K_3 (22)
S_a (21)	DOWN	UP	MEMORY	EXT. DATA PRESET
S_b (20)	M4	M3	M2	M1
S_c (19)		M7	M6	M5
S_d (18)			FM	AM
S_e (17)				
S_f (16)	100 k/200 k	STATIC/DYNA	AUTO/MANUAL	REC. CALL
S_g (15)	USA/JPN(FM)	10 kHz/9 kHz(AM)	IF1	IF0

( ): Pin number
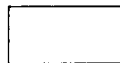
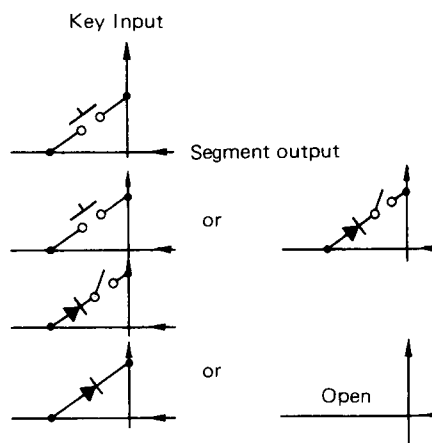☐ : Momentary switch
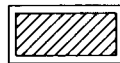
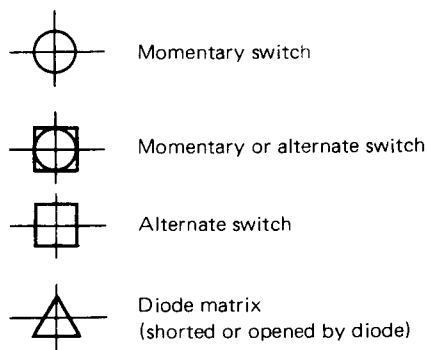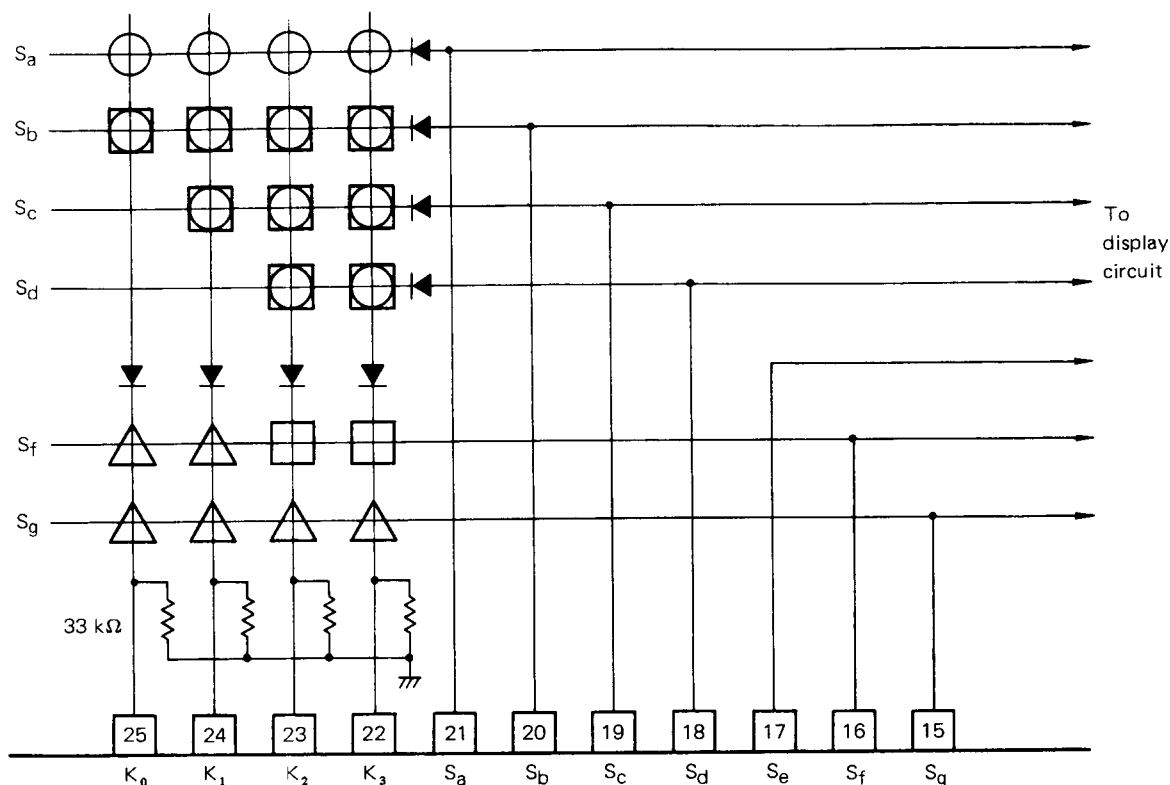▨ (boxed) : Momentary or alternate switch

▨ : Alternate switch

▩ : Diode matrix (shorted or opened by diode)

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1.2 KEY MATRIX CONNECTIONS AND SWITCH FORMATS

The preset keys (M1 to M7) and the band selector keys (AM, FM) may be either momentary or alternate switches. Note, however, that the insertion positions of the diodes (used to prevent the key return signals from taking roundabout routes) differ according on the type of switch used. A number of examples are given below.

Example 1. When momentary switches are used as preset keys and band selecter keys.
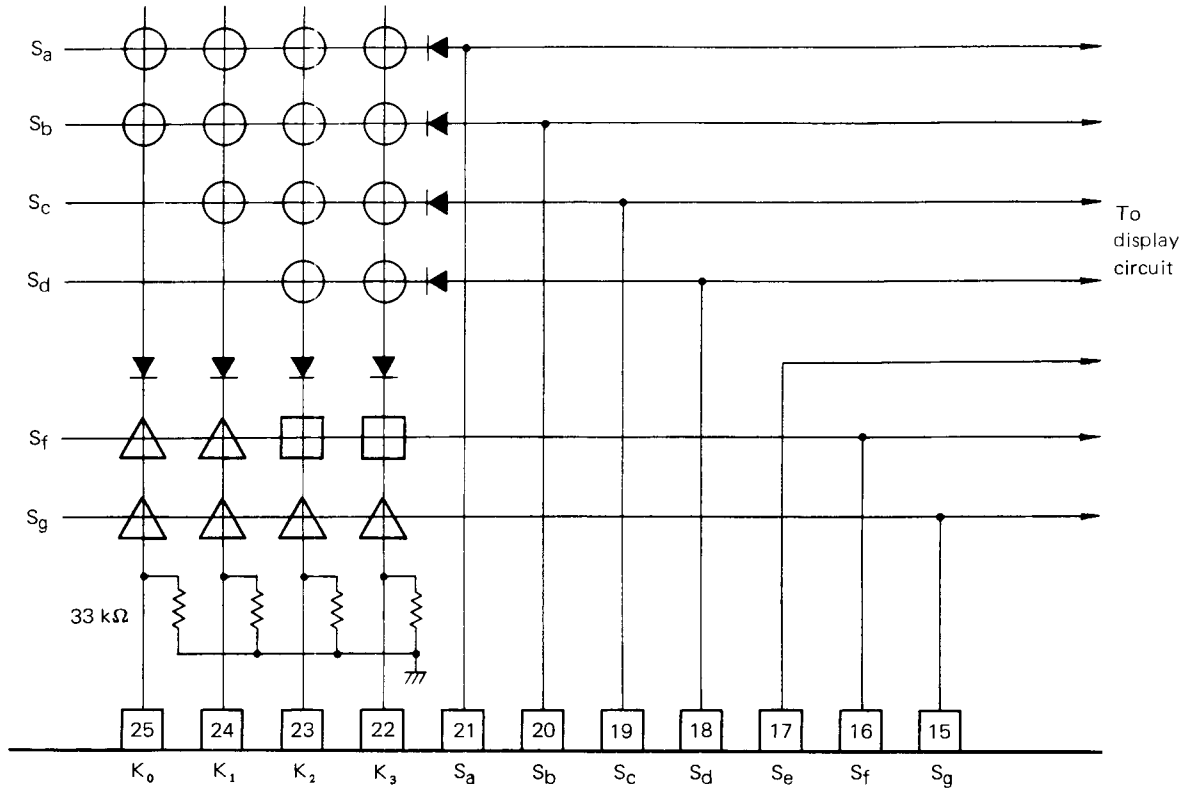
Example 2. When alternate switches are used as band selector keys.

8
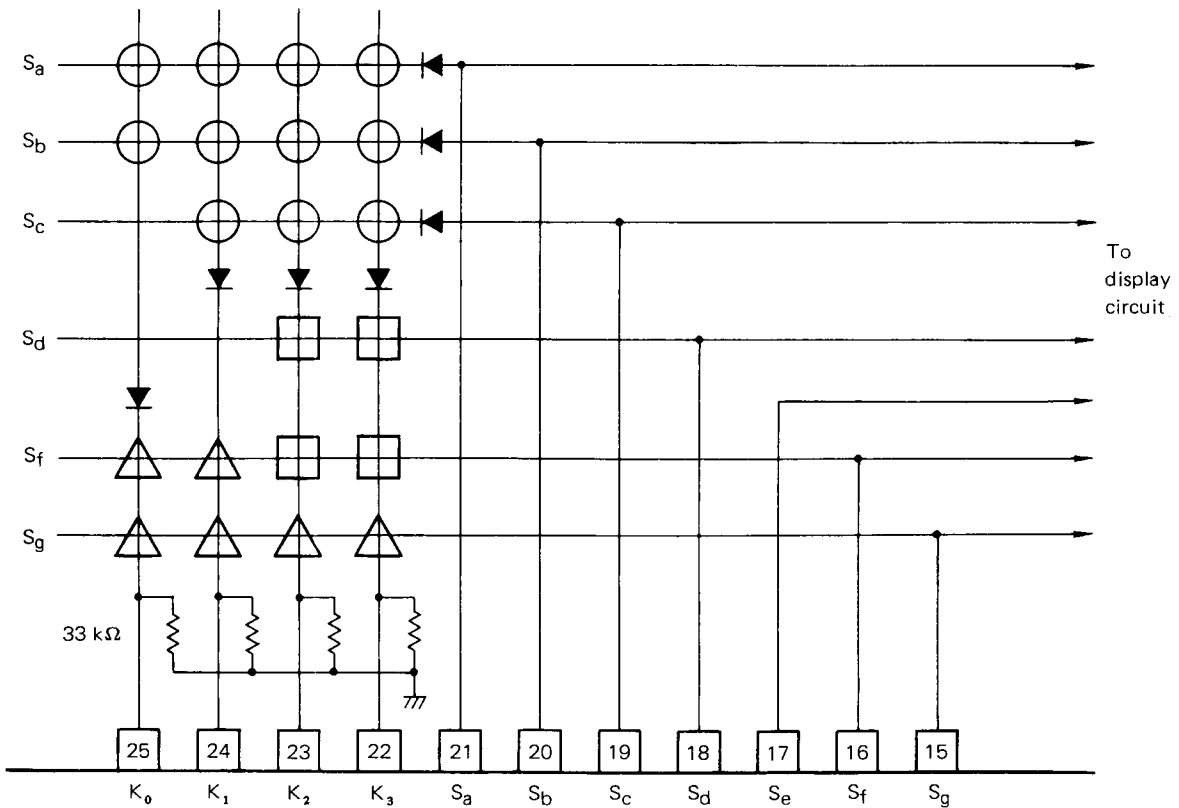
Example 3.   When alternate switches are used as preset keys and band keys.

1.3 DESCRIPTION OF KEY MATRIX

1.3.1 Initialization Diode Matrix

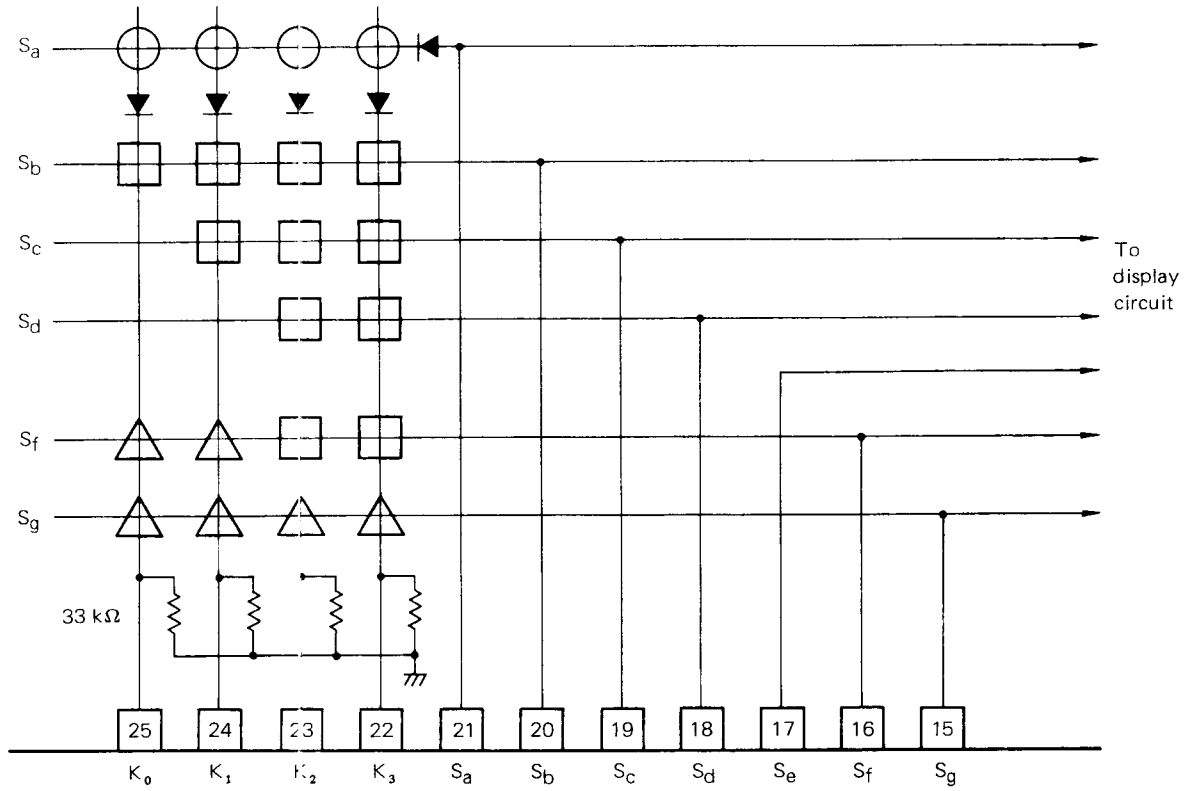The five types of initialization diode matrix are outlined below. The status of this diode matrix is read when the power is applied to the V_{DD} pin (initialization) and when the CE pin status is changed from low to high level. And although the status of 100 k/200 k and STATIC/DYNAMIC switches is read constantly, the PLL data and display are changed only when a momentary switch (UP, DOWN, M1 to M7) is pressed.

(1) FM IF offset setting switch

IF1, IF0

(2) AM band channel space and reference frequency setting switch

9 kHz/10 kHz (AM)

(3) FM band country (U.S.A./Japan) setting switch

USA/JPN

(4) U.S.A. FM band channel space setting switch

100 kHz/200 kHz

(5) Static and dynamic display setting switch

STATIC/DYNA

These settings are made by either shorting or opening the intersections in the matrix. (In the following tables, 1 denotes "shorted by diode" and 0 denotes "opened by diode".)

SYMBOL	FUNCTION
IF1 IF0	FM IF offset setting switches. The intermediate frequency can be set to the following four values in 25 kHz steps without changing the display frequency. | IF1	IF0	U.S.A. band	Japanese band
---	---	---	---
0	0	10.700 MHz	10.700 MHz
0	1	10.725 MHz	10.675 MHz
1	0	10.650 MHz	10.750 MHz
1	1	10.675 MHz	10.725 MHz	
10 kHz/9 kHz	Switch for setting AM band channel spacing, reference frequency, and frequency range. This setting is made independent of the FM band country (U.S.A./JPN). | 10 kHz/9 kHz	Frequency range	Channel spacing	Reference frequency
---	---	---	---
0	531 to 1 602 kHz	9 kHz	9 kHz
1	530 to 1 620 kHz	10 kHz	10 kHz	
USA/JPN	Selector switch for country setting. The FM band for either the USA or Japan can be set. | USA/JPN	Band area	Frequency range	Channel spacing
---	---	---	---
0	Japanese band	76.0 to 90.0 MHz	100 kHz
1	U.S.A. band	87.9 to 107.9 MHz	200/100 kHz	 Channel space can be selected by the 100 k/200 k switch when the U.S.A. band is selected.
100 k/200 k	FM band channel space selector switch when used in the U.S.A. This switch can only be used when the country selector switch is set to U.S.A. 	100 k/200 k	Channel spacing	Frequency range
---	---	---
0	200 kHz	87.9 to 107.9 MHz
1	100 kHz		
STATIC/ DYNA	Switch for setting the display to static or dynamic mode. 0 . . . . Dynamic display 1 . . . . Static display When set to static display, the DATA signal is obtained from the segment Sc pin, the CLOCK signal from the $\overline{D_1}$ pin, and the LOAD signal from the $\overline{D_2}$ pin. (See the display description on page 20 for details.)

1.3.2 Alternate Switches

The following two types of alternate switches available can be switched at any time.

(1) Recording level check oscillator output selector switch

REC CALL

(2) Auto/manual tuning selector switch

AUTO/MANUAL

SYMBOL	FUNCTION

REC CALL	Recording level check oscillator output selector switch.
	
	A 333.3 Hz pulse putout is obtained from the MUTE pin when REC CALL is switched ON.
	
	    ON (1) . . . . 333.3 Hz pulse output (display OFF)
	
	    OFF (0) . . . Normal operation
	
	No other switch can be used during REC CALL operations.
	
	This oscillator output is also used in adjustment of the crystal resonator oscillating frequency (4.5 MHz) where an oscillating frequency adjuster capacitor is adjusted to obtain a frequency of 333.333 . . . . Hz.

AUTO/ MANUAL	Auto/manual tuning selector switch
	
	    ON (1) . . . . Auto tuning
	
	    OFF (0) . . . Manual tuning
	
	Auto and manual tuning is activated pressing the UP or DOWN momentary switch after this AUTO/MANUAL switch has been set. (See the section on momentary and alternate/ switches on page 13 for details.)
	
	Note 1. No change occurs if the AUTO/MANUAL switch is switched to the MANUAL position after auto tuning has been commenced. To halt auto tuning when switching to manual mode, a high level input signal must be applied constantly to the SD pin during manual mode.
	
	Note 2. Since the PLL lock status is detected during auto tuning, a defective PLL system may result in tuning failure or unsteady operation (such as different scanning speeds for each channel). If the tuning operation fails to start, apply a low level signal to the CE pin temporarily before returning to high level.

1.3.3 Momentary and Alternate Switches

The preset keys ($\boxed{\text{M1}}$ to $\boxed{\text{M7}}$) and the band selector keys (AM, FM) may be either momentary or alternate switches. However, if alternate switches are used for the preset keys, the $\boxed{\text{UP}}$ and $\boxed{\text{DOWN}}$ keys must be interlinked with the preset key operations.

| SYMBOL	FUNCTION
$\boxed{\begin{array}{c}\text{EXTERNAL}\\\text{DATA}\\\text{PRESET}\end{array}}$	Writing of adjustment frequency data from an external microprocessor (such as TK-80) into the AM and FM preset memories ($\boxed{\text{M1}}$ to $\boxed{\text{M7}}$) during mass production of tuners is activated by this switch. The following six pins are used in the transfer of data. K_0 to K_3 . . . Frequency data input pins (4-bit parallel inputs) MUTE . . . . Data request signal output pin SD . . . . Data acknowledge signal input pin (See the EXTERNAL DATA PRESET description on page 16 for details.)
$\boxed{\text{MEMORY}}$	Memory switch is used to write fresh frequency data into preset memories. If one of the preset memory keys ($\boxed{\text{M1}}$ to $\boxed{\text{M7}}$) is pressed within five seconds after pressing the MEMORY key, the displayed frequency is stored in the memory corresponding to that key. To release the memory write-enable state, push UP/DOWN Key or AM/FM Band switch.
$\boxed{\text{UP}}$ $\boxed{\text{DOWN}}$	Auto and manual tuning keys. The operations outlined below are activated by pressing these keys. (1) When AUTO/MANUAL switch is set to the AUTO position ○ Frequency is increased continuously at a rate of 80 msec./step when the $\boxed{\text{UP}}$ key is pressed. The frequency is likewise decreased continuously after the band edge is reached. (Sawtooth wave mode) If a high level input is applied to the SD pin when the band edge is reached, auto tuning is stopped. And if the $\boxed{\text{DOWN}}$ key is pressed while the frequency is being increased, the frequency change is immediately reversed. ○ Frequency is decreased continuously at a rate of 80 msec./step when the $\boxed{\text{DOWN}}$ key is pressed. The frequency is likewise increased continuously after the band edge is reached. (Sawtooth wave mode) If a high level input is applied to the SD pin when the band edge is reached, auto tuning is stopped. And if the $\boxed{\text{UP}}$ key is pressed while the frequency is being decreased, the frequency change is immediately reversed. * The auto tuning operation continues unchanged if the $\boxed{\text{UP}}$ key is pressed during frequency increase, or if the $\boxed{\text{DOWN}}$ key is pressed during frequency decrease. Also note that auto tuning is not stopped if the $\boxed{\text{UP}}$ or $\boxed{\text{DOWN}}$ key remains depressed when a high level input is applied to the SD pin. (2) When AUTO/MANUAL switch is set to the AUTO position ○ The frequency is increased or decreased in single steps (channel space) each time the $\boxed{\text{UP}}$ or $\boxed{\text{DOWN}}$ key is pressed. ○ If the $\boxed{\text{UP}}$ or $\boxed{\text{DOWN}}$ key is pressed for more than 0.5 seconds, the frequency is increased or decreased at a rate of 80 msec./step until the key is released.

SYMBOL	FUNCTION
UP DOWN	* Manual tuning is stopped when the band edge (the lowest or highest frequency in that band) is reached. Note: Auto tuning is not stopped if the AUTO/MANUAL switch is switched to the MANUAL position during auto tuning. To halt auto tuning when switching to manual mode, a high level input signal must be applied constantly to the SD pin during manual mode.
M1 to M7	Preset memory write and call keys Each key is linked to independent memories for AM and FM. (1) Memory write If one of the Preset memory keys (M1 to M7) is pressed within five seconds after pressing the MEMORY key, a new frequency is stored in the memory corresponding to that key. (2) Memory call Memory contents (frequency data) can be retrieved by pressing the Preset memory key (M1 to M7) corresponding to that memory. Pressing one of the preset keys at this time results in output of a muting signal of about 450 msec. duration. (See the mute timing chart on page 27 for details.) * The lowest FM frequency is called when V_{DD} is first activated. If preset memory calling is performed at this stage, the lowest frequencies in each band (AM and FM) are called.
AM FM	AM/FM band selector switches. These switches may be a momentary or alternate switch. A muting signal of approximately 850 msec. duration is generated when switching bands.

2. FM/AM POWER SWITCHING CIRCUIT EXAMPLE

If a momentary switch is used for AM/FM band switching, the tuner power supply can be switched on and off by using the following circuit.

In this diagram, character display ("FM" and "AM") signals are used as the input signals, and an active high signal obtained from the μPD1703C-014 digit pin $\overline{D_5}$ via a buffer stage (PNP transistor etc.) is used as the CLOCK signal ($\overline{D_5}$).
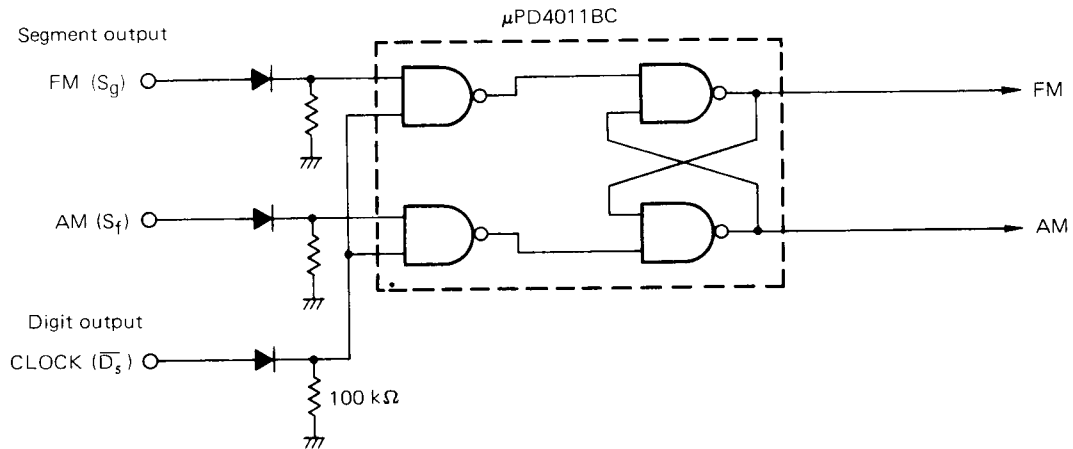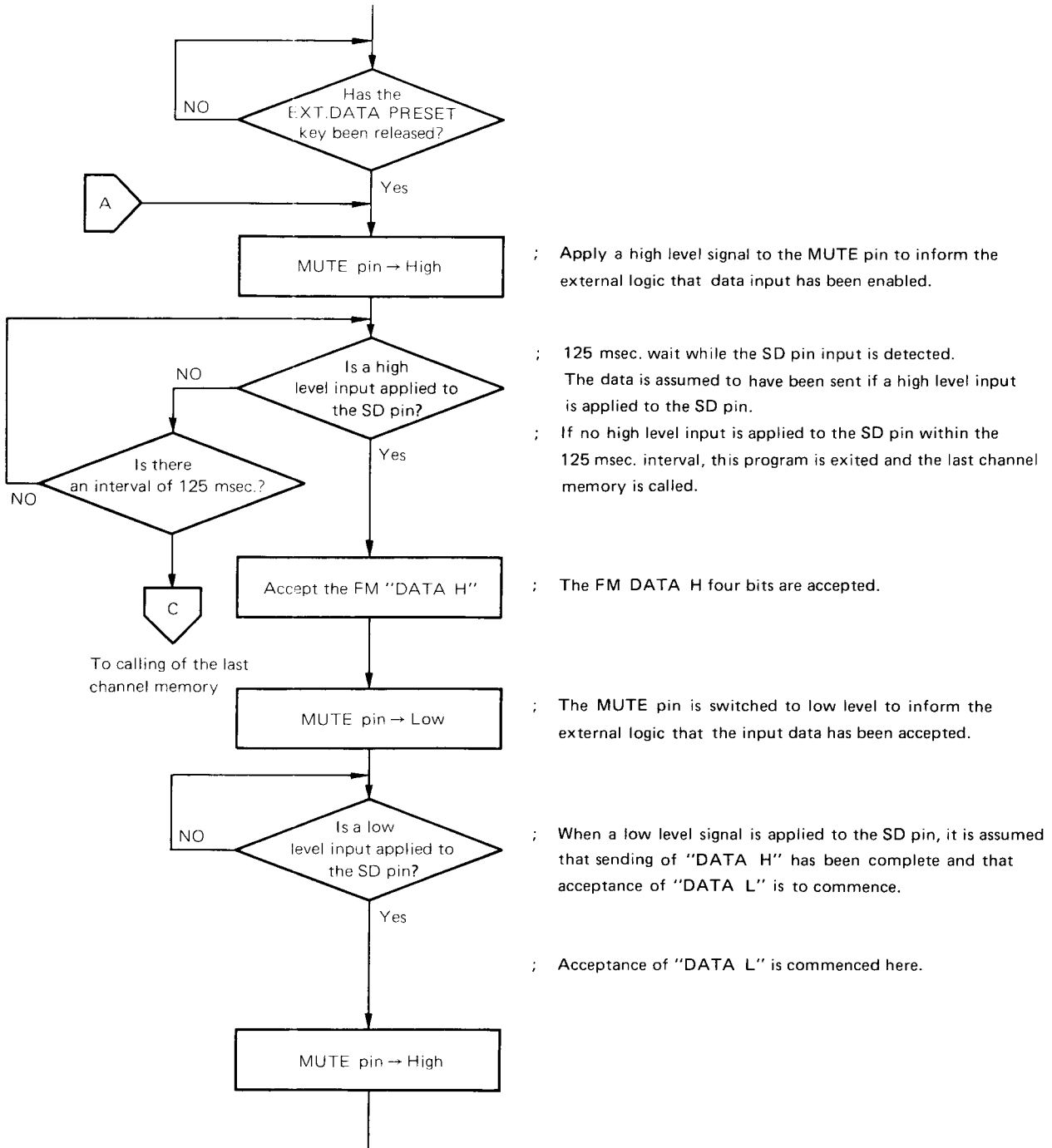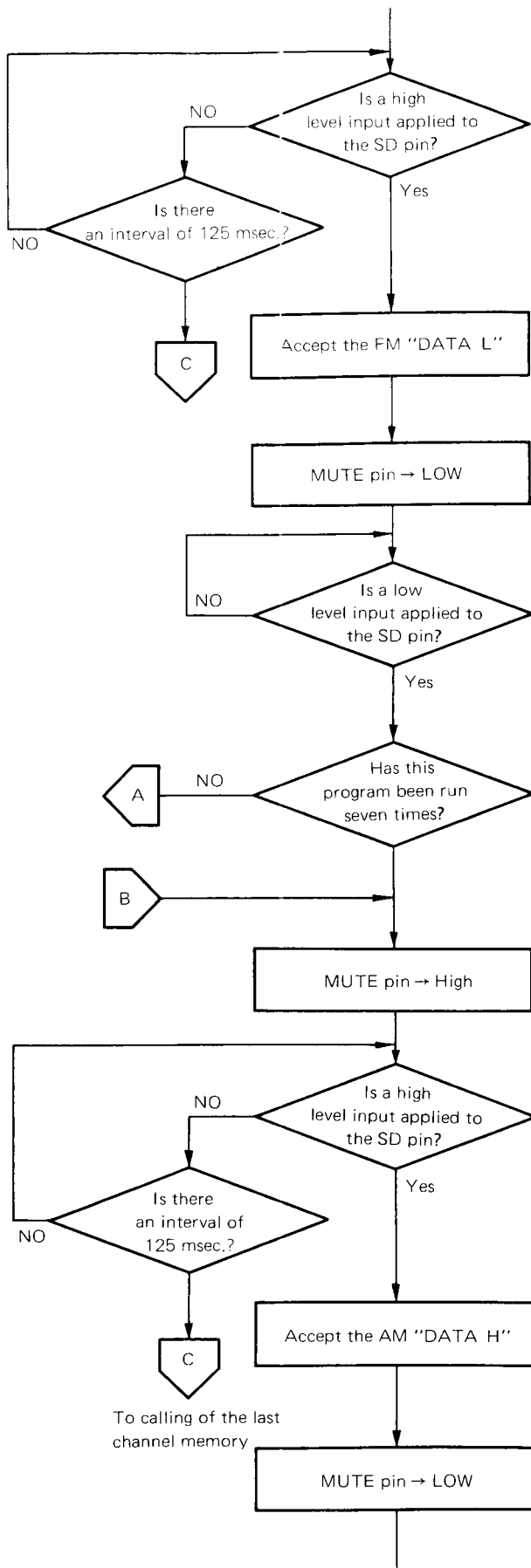
3. DESCRIPTION OF EXTERNAL DATA PRESET

The external data preset function is used to transfer frequency data (8 bits) from an external personal computer to the μPD1703C-014 key inputs (K_0 to K_3) and subsequently write that data into FM or AM preset memory (M1 to M7).

Input of this frequency data is achieved by applying the eight bits of channel no. (see Table 1) corresponding to the frequency in two groups of four bits each (DATA H and DATA L). Any frequency value within the specified frequency ranges (87.9 to 107.9 MHz for FM and 530 to 1 620 kHz for AM in the U.S.A.) can be stored.

The μPD1703C-014 flow chart is given in Figure 1 below.


```
                    ┌──────────────────────┐
                    │   Has the            │
         NO ────────│  EXT.DATA PRESET     │
                    │  key been released?  │
                    └──────────┬───────────┘
                              Yes
     ┌───┐                     │
     │ A │─────────────────────┤
     └───┘                     │
                    ┌──────────┴───────────┐
                    │   MUTE pin → High    │       ; Apply a high level signal to the MUTE pin to inform the
                    └──────────────────────┘         external logic that data input has been enabled.

                    ┌──────────────────────┐
                    │   Is a high          │         ; 125 msec. wait while the SD pin input is detected.
         NO ────────│  level input applied │           The data is assumed to have been sent if a high level input
                    │   to the SD pin?     │           is applied to the SD pin.
                    └──────────┬───────────┘
     ┌──────────────┐        Yes               ; If no high level input is applied to the SD pin within the
     │  Is there    │          │                 125 msec. interval, this program is exited and the last channel
     │ an interval of 125 msec.?│                memory is called.
     └──────────────┘
    NO
                    ┌──────────────────────┐
                    │  Accept the FM "DATA H" │     ; The FM DATA H four bits are accepted.
   ┌───┐            └──────────────────────┘
   │ C │
   └───┘
  To calling of the last
  channel memory
                    ┌──────────────────────┐
                    │   MUTE pin → Low     │       ; The MUTE pin is switched to low level to inform the
                    └──────────────────────┘         external logic that the input data has been accepted.

                    ┌──────────────────────┐
                    │   Is a low           │        ; When a low level signal is applied to the SD pin, it is assumed
         NO ────────│  level input applied │          that sending of "DATA H" has been complete and that
                    │   to the SD pin?     │          acceptance of "DATA L" is to commence.
                    └──────────┬───────────┘
                              Yes
                                              ; Acceptance of "DATA L" is commenced here.
                    ┌──────────────────────┐
                    │   MUTE pin → High    │
                    └──────────────────────┘
```

Is a high level input applied to the SD pin?

NO

Yes

Is there an interval of 125 msec.?

NO

NO

C

Accept the FM "DATA L"   ;   The FM DATA L four bits are accepted.

MUTE pin → LOW

Is a low level input applied to the SD pin?

NO

Yes   ;   Completion of data acceptance for one FM station.

Has this program been run seven times?

A   NO   ;   After data has been accepted from the seven FM preset memories M1 to M7, acceptance of AM data is commenced.

B

MUTE pin → High

Is a high level input applied to the SD pin?

NO

Yes

Is there an interval of 125 msec.?

NO

C

Accept the AM "DATA H"   ;   The AM DATA H (four bits) are accepted.

To calling of the last channel memory

MUTE pin → LOW

Fig. 1 EXT.DATA PRESET Process Flow Chart
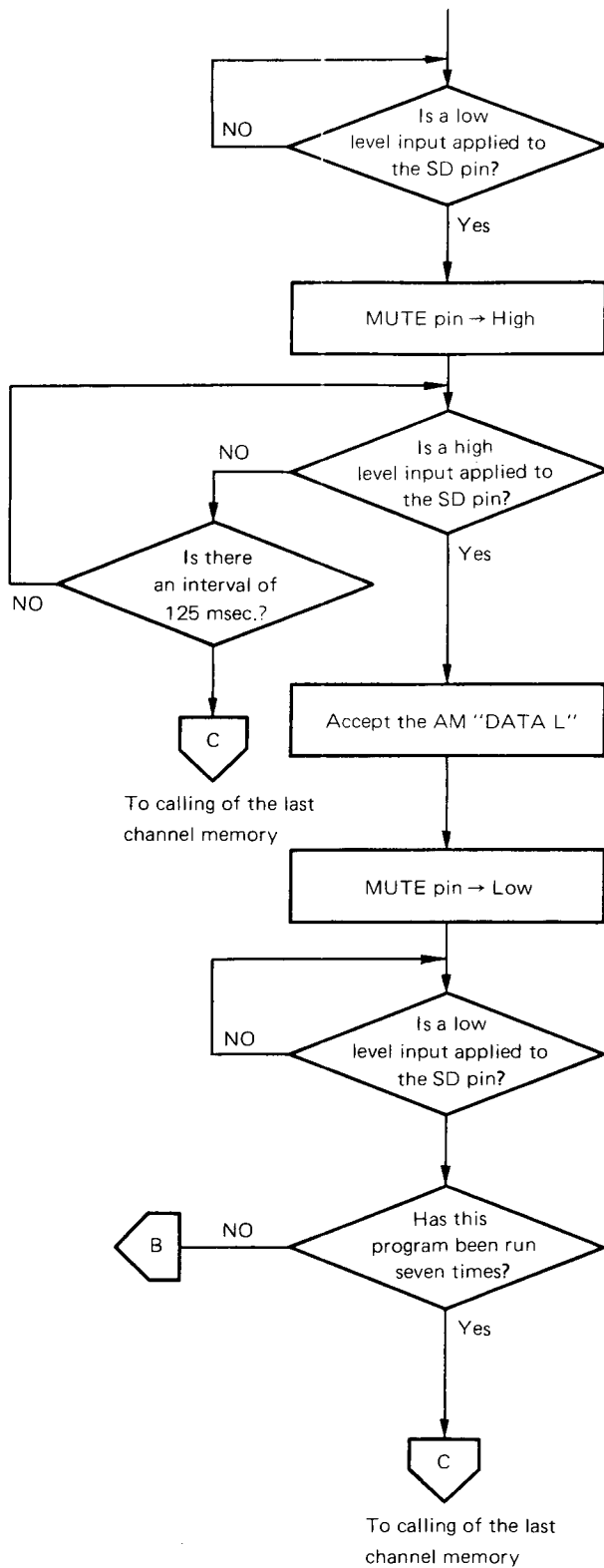
; The AM DATA L (four bits) are accepted.

; After data has been accepted from the seven AM preset memories M1 to M7, this program is exited, and the last channel memory is called to complete the EXT.DATA PRESET process.

Table 1 EXT.DATA PRESET Frequency Data (Channel Nos.)

DATA H	DATA L	U.S.A. FM	Japanese FM	U.S.A. AM	Japanese AM
0	0	87.9 MHz	76.0 MHz	530 MHz	531 MHz
0	1	88.1	76.1	540	540
0	2	88.3	76.2	550	549
0	3	88.5	76.3	560	558
0	4	88.7	76.4	570	567
0	5	88.9	76.5	580	576
0	6	89.1	76.6	590	585
0	7	89.3	76.7	600	594
0	9	89.5	76.8	610	603
0	A	89.7	76.9	620	612
0	B	89.9	77.0	630	621
0	C	90.1	77.1	640	630
0	D	90.3	77.2	650	639
0	E	90.5	77.3	660	648
0	F	90.7	77.4	670	657
1	0	90.9	77.5	680	666
1	1	91.1	77.6	690	675
1	2 *	91.3	77.8	700	684
1	3	91.5	77.9	710	693
			78.0	720	702
6	2	107.5			
6	3	107.7	85.9	1520	1422
6	4	107.9	86.0	1530	1431
6	5	107.9	86.1	1540	1440
6	6	107.9	86.2	1550	1449
6	7	107.9	86.3	1560	1458
6	8	107.9	86.4	1570	1467
			86.5	1580	1476
8	4	107.9	89.2		
8	5	107.9	89.3	1620	1611
8	6	107.9	89.4	1620	1611
8	7	107.9	89.5	1620	1611
8	8	107.9	89.6	1620	1611
8	9	107.9	89.7	1620	1611
8	A	107.9	89.8	1620	1611
8	B	107.9	89.9	1620	1611
8	C	107.9	90.0	1620	1611

NOTE: DATA H and DATA L denote hexadecimal codes.

4. DESCRIPTION OF THE DISPLAY

4.1 Dynamic Display

The display connections for a dynamic display (with the STATIC/DYNA switch OFF) are shown in the following diagram. $\overline{D_1}$ to $\overline{D_5}$ and S_a to S_g correspond to the μPD1703C-014 digit pins ($\overline{D_1}$ to $\overline{D_5}$) and segment pins (S_a to S_g). Since the μPD1703C-014 segment pins have a voltage endurance of 30 V (Pch open drain output), direct connection to the FIP (fluorescent indicator panel) is possible. The digit pins, however, require a buffer stage (PNP transistor: 2SA733 etc.) since the output signals are both complementary and active low.
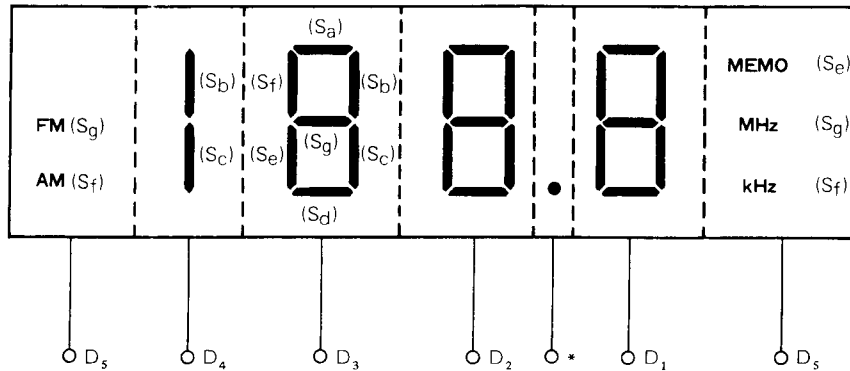

Fig. 2 Dynamic Display Connections Diagram

* The μPD1703C-014 does not provide a signal for driving this digit and segment (decimal point).
Since the segment is normally required only during FM reception, this digit may be connected to $\overline{D_5}$ for the decimal point display to be coupled to the FM display.

Examples of displays using the above fluorescent indicator panel.

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

(2) AM (U.S.A.)

(3) AM (Japan)

AM 531 kHz

(4) FM (Japan)

FM 76.1 MHz

* The **MEMO** indicator comes on for five seconds after the MEMORY momentary key is pressed to write a new frequency into memory.

If one of the preset keys M1 to M7 is pressed during that five second period, the new frequency is stored in memory, and the **MEMO** indicator goes off immediately.

4.2 Static Display

When the STATIC/DYNA key is switched on, the DATA output signal is obtained from the segment S_C pin, the CLOCK output signal is obtained from the digit $\overline{D_1}$ pin, and the LOAD signal is obtained from the $\overline{D_2}$ pin. The DATA signal output is obtained serially one bit at a time in the sequence indicated in Table 2.

Table 2   DATA Signal Output Ranking and Display Contents

Output ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Display contents	--	LW	5	0	MEM	MW	FM	!	BCD 100 kHz				BCD 1 MHz				BCD 10 MHz				BCD preset station display			
									0	1	2	3	0	1	2	4	0	1	2	4	0	1	2	4

CLOCK output signals are generated for each bit of DATA signal, resulting in the data being shifted one bit at a time. After the BCD (Binary Coded Decimal) data for the preset station display has been shifted, the LOAD signal is generated to complete the static conversion. The corresponding timing is outlined in Figure 3. The CLOCK and LOAD signals represent active high signals passed from the respective $\overline{D_1}$ and $\overline{D_2}$ pins via an inverter.
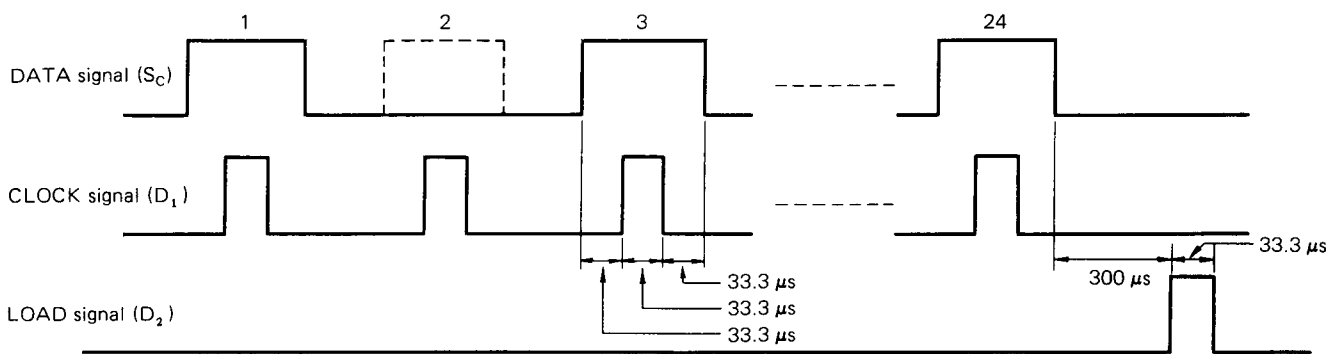

Fig. 3 Timing Chart

These pulse outputs are generated when a switch which changes the display contents is pressed, and at five second intervals after that.

Examples of static display outputs are given below. (In these examples, 1 denotes a high level output and 0 denotes a low level output.)

Example 1.   FM 104.3 MHz

Output ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Display contents	--	LW	5	0	MEM	MW	FM	!	BCD 100 kHz				BCD 1 MHz				BCD 10 MHz				BCD preset station display			
Output level	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0

1   3   4   0   2 (M2)

22

Example 2. FM 76.0 MHz

Output ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Display contents	--	LW	5	0	MEM	MW	FM	I	BCD 100 kHz				BCD 1 kHz				BCD 10 MHz				BCD preset station display			
Output level	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0

FM   0   6   7   0 (Last channel)

Example 3. AM 1 422 kHz

Output ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Display contents	--	LW	5	0	MEM	MW	FM	I	BCD 1 kHz				BCD 10 kHz				BCD 100 kHz				BCD Preset station display			
Output level	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	1	0	1	1	1	0

AM   1   2   2   4   7 (M7)

Example 4. AM 810 kHz

Output ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Display contents	--	LW	5	0	MEM	MW	FM	I	BCD 1 kHz				BCD 10 kHz				BCD 100 kHz				BCD Preset station display			
Output level	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0

AM   0   1   8   3 (M3)

5. PRESET STATION DISPLAY*

An example of preset station display connections is given in Figure 4.

A BCD (Binary Coded Decimal) code output is obtained from the segment pins S_a to S_c during the timing of the $\overline{D_5}$ digit signal. The relevant timing chart is shown in Figure 5.
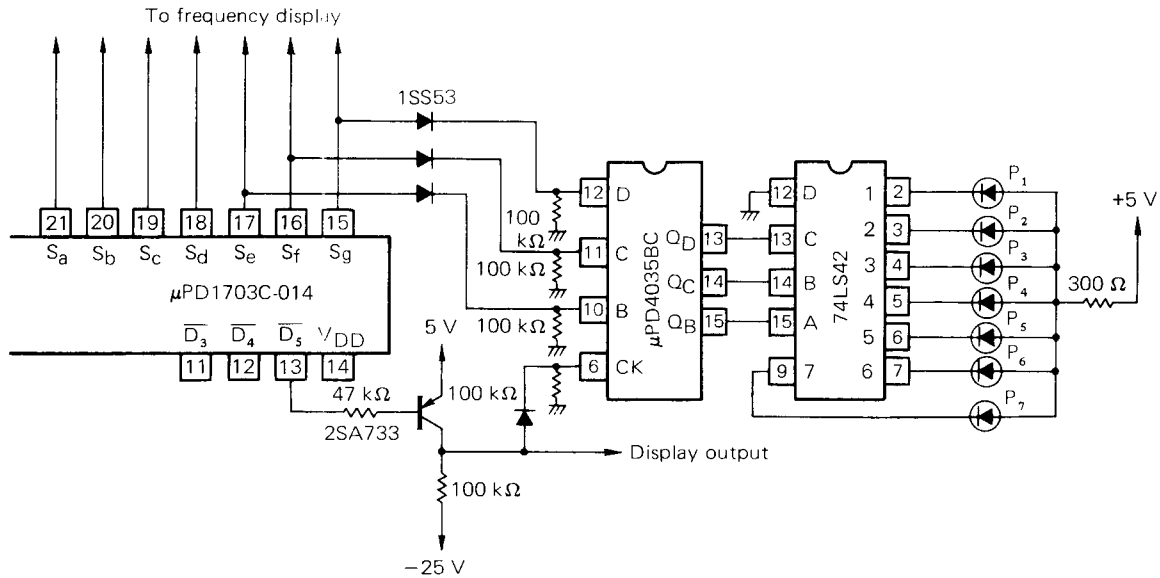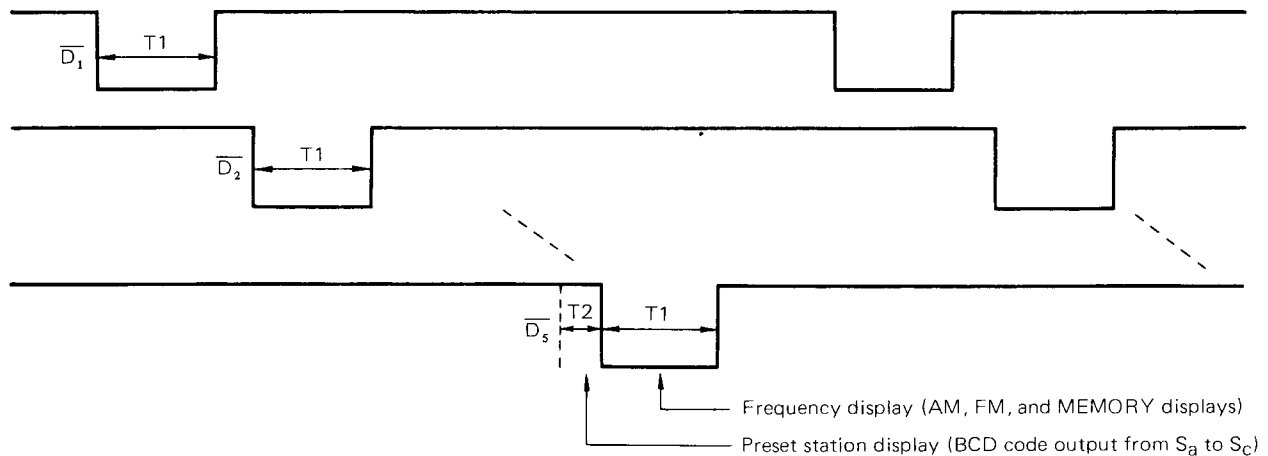

Fig. 4 Preset Station Display Connection Example

Fig. 5 Timing Chart

The "AM, FM, and MEMO" display signal outputs are obtained from the S_e, S_f, and S_g segment pins during the T1 timing of the $\overline{D_5}$ digit signal. (The output on the S_a to S_c segment pins at this time is a "blank code" output.) And the BCD output code for preset station display is obtained from the S_a to S_c pins during the T2 timing (the output on the S_e to S_g pins at this time being a "blank code" output).

---

* "Preset station display" refers to one of the dot display elements (P1 to P7 corresponding to one of the preset keys M1 to M7) which comes on when that key is pressed (for frequency store or call purposes).

The dynamic output indicated in the Figure 5 timing chart must be changed to a static output. (If display elements requiring a large current, such as LEDs, are used in the preset station display, noise generated by the dynamic display may be picked up by the receiver antenna, RF stage, or IF stage.)

The μPD4035BC device is a static converter D-F/F. Since the outputs from the μPD1703C-014 digit pins are active low, data is latched by μPD4035BC at the rising edge of the $\overline{D_5}$ active high digit signal passed via an inverter stage.

Output status of the S_a to S_g segment pins during the T1 and
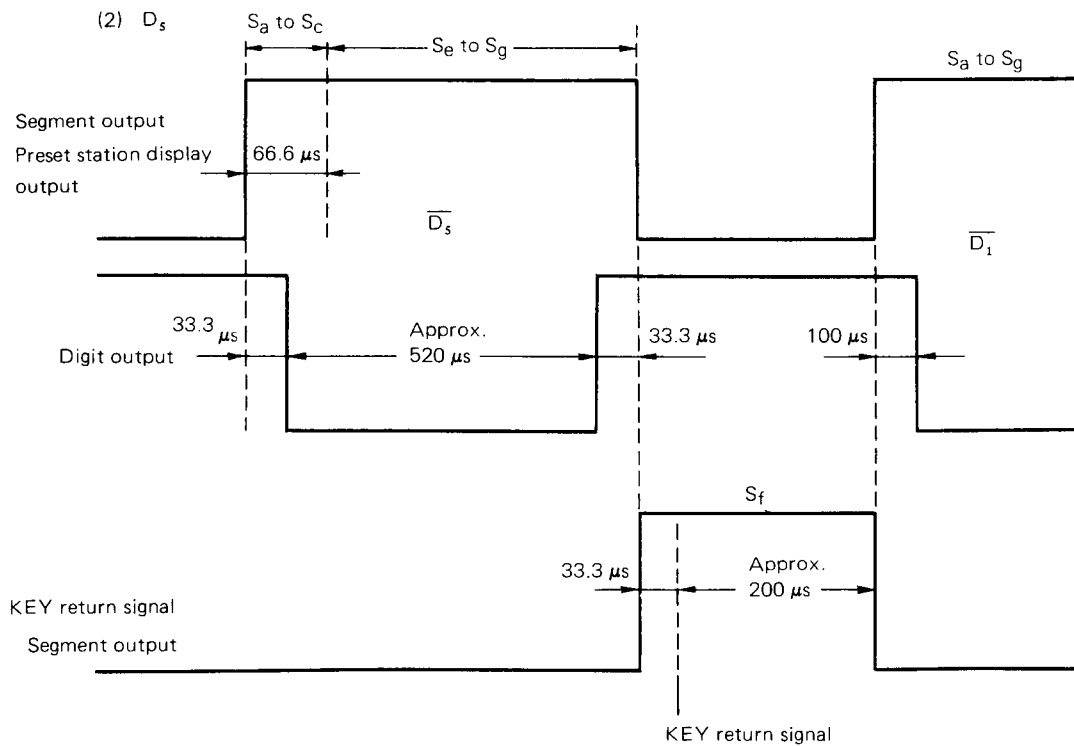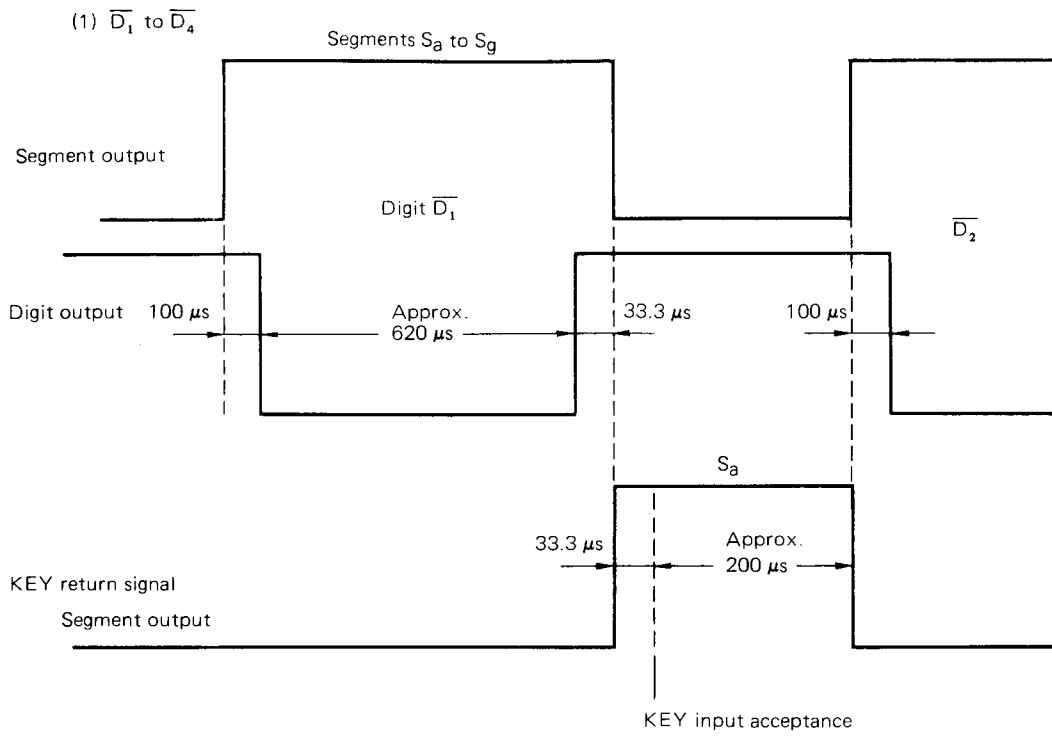
T2 Timing of the $\overline{D_5}$ Digit Signal

Segment / Timing	S_a	S_b	S_c	S_d	S_e	S_f	S_g
T1	Blank	Blank	Blank	Blank	"FM, AM, MEMO" display		
T2	BCD code output			Blank	Blank	Blank	Blank

Preset Station BCD Code Outputs

S_a	S_b	S_c	Preset station
0	0	1	P1 (M1 key)
0	1	0	P2 (M2 key)
0	1	1	P3 (M3 key)
1	0	0	P4 (M4 key)
1	0	1	P5 (M5 key)
1	1	0	P6 (M6 key)
1	1	1	P7 (M7 key)

6. TIMING CHARTS

## 6.1 Display and Key Input Acceptance

(1) $\overline{D_1}$ to $\overline{D_4}$

Segments S_a to S_g

Segment output

Digit $\overline{D_1}$

$\overline{D_2}$

Digit output   100 μs

Approx.
620 μs

33.3 μs

100 μs

S_a

33.3 μs

Approx.
200 μs

KEY return signal

Segment output

KEY input acceptance

(2) D_s

S_a to S_c

S_e to S_g

S_a to S_g

Segment output
Preset station display
output

66.6 μs

$\overline{D_s}$

$\overline{D_1}$

33.3 μs

Approx.
520 μs

33.3 μs

100 μs

Digit output

S_f

33.3 μs

Approx.
200 μs

KEY return signal

Segment output

KEY return signal

Duty:
    10.7 % ($\overline{D_1}$ to $\overline{D_4}$)
    8.9 % ($\overline{D_s}$)

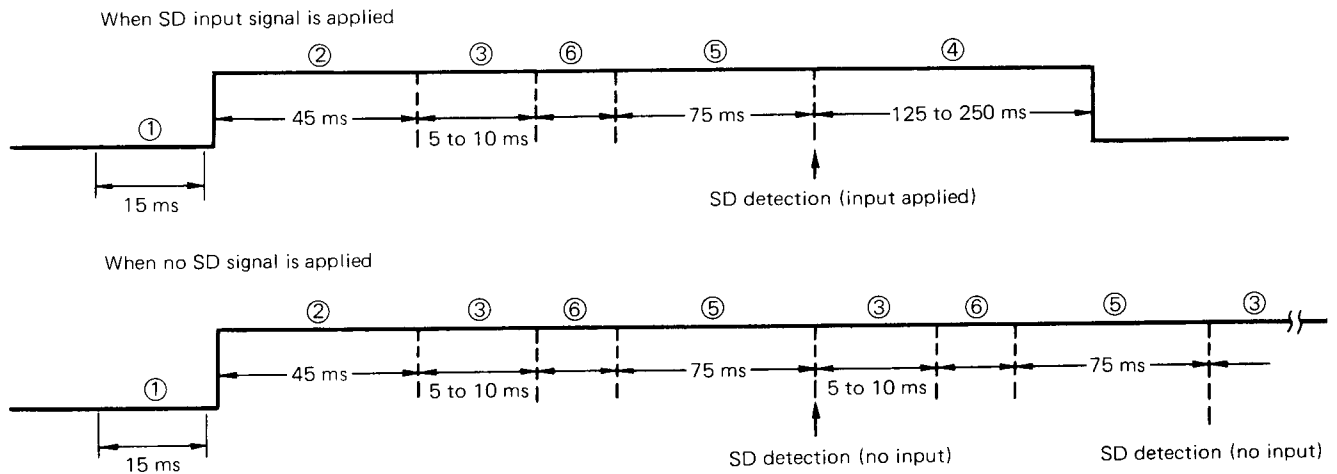## 6.2 MUTE Timing Charts

① KEY ON chattering suppression time

② MUTE "first out" time

③ Time taken to set frequency division ratio and change display contents
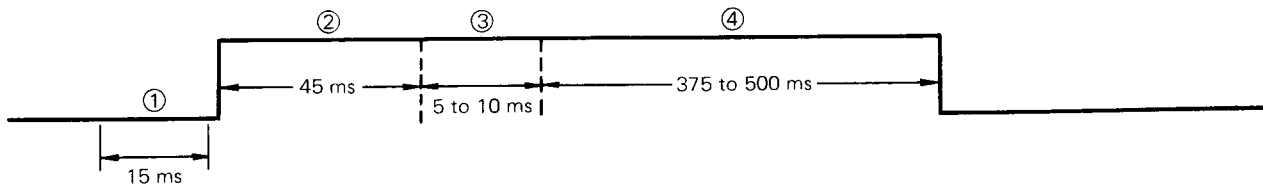
④ MUTE "last out" time
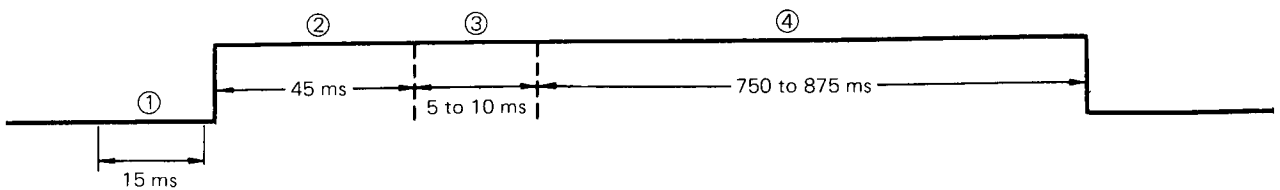
⑤ Scanning time

⑥ PLL lock time

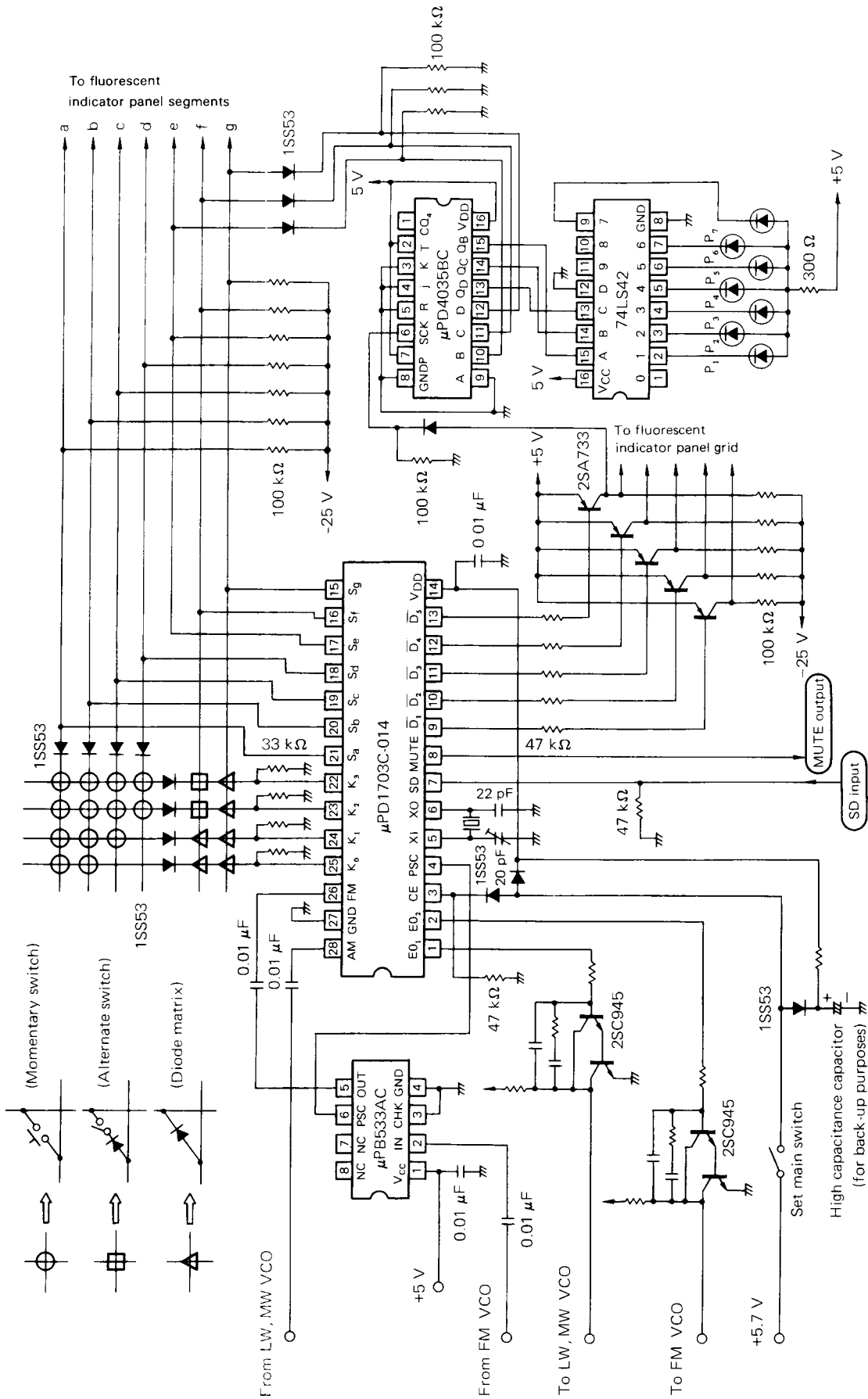### (1) MANUAL UP/DOWN

(2) AUTO UP/DOWN

When SD input signal is applied

When no SD signal is applied
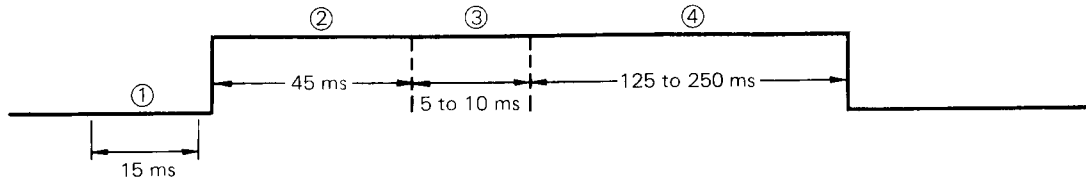
(3) PRESET MEMORY CALL

(4) FM/AM selection and when power is switched on   (CE = Low → High)

7. APPRICATION CIRCUIT

8. ELECTRICAL CHARACTERISTICS

8.1 ABSOLUTE MAXIMUM RATINGS

Power supply voltage	V_{DD}	-0.3 to +6.0	V
Input voltage	V_I	-0.3 to +V_{DD}	V
Output voltage	V_O	-0.3 to +V_{DD}	V
Output current	I_O	10	mA
Operating temperature	T_{opt}	-35 to +75	°C
Storage Temperature	T_{stg}	-55 to +125	°C
Output voltage endurance	V_{BDS}	Between S_a and S_g pins (drain - source voltage) -35	V

8.2 RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Power supply voltage	V_{DD}	4.5	5.0	5.5	V	
RAM hold voltage	V_{RAM}	2.5			V	CE pin = 0
Output voltage endurance	V_{BDS}			-30	V	S_a to S_g pins (drain-source voltage), I_{OFF}= -5 μA
Power supply voltage rise time	T_{rise}			500	ms	V_{DD} = 0 → 4.5 V

8.3 DC CHARACTERISTICS (V_{DD} = +4.5 ~ +5.5 V, T_a = -35 ~ +75 °C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
High level input voltage	V_{IH1}	$0.8V_{DD}$		V_{DD}	V	SD pin
High level input voltage	V_{IH2}	$0.7V_{DD}$		V_{DD}	V	CE pin
High level input voltage	V_{IH3}	$0.6V_{DD}$		V_{DD}	V	K_0 to K_3 pins
Low level input voltage	V_{IL1}	0		$0.3V_{DD}$	V	CE pin
Low level input voltage	V_{IL2}	0		$0.2V_{DD}$	V	SD, K_0 to K_3 pins
High level output voltage	V_{OH1}	4.0			V	PSC, MUTE, $\overline{D_1}$ to $\overline{D_5}$ pins I_{OH} = -0.2 mA
High level output voltage	V_{OH2}	4.0			V	EO_1, EO_2 pins I_{OH} = -0.5 mA
High level output voltage	V_{OH3}	3.0			V	S_a to S_g pins I_{OH} = -0.5 mA
Low level output voltage	V_{OL1}			0.5	V	EO_1, EO_2 pins I_{OL} = 0.5 mA
Low level output voltage	V_{OL2}			0.5	V	MUTE, $\overline{D_1}$ to $\overline{D_5}$, PSC pins I_{OL} = 0.2 mA
High level input current	$+I_{IH1}$	5.0	25	100	μA	K_0 to K_3 pins V_{IN} = V_{DD} = 5.0 V
High level input voltage	$+I_{IH2}$		300		μA	XI pin V_{IN} = V_{DD} = 5.0 V
Low level input current	$-I_{IL1}$		300		μA	AM, FM pins V_{IN} = 0 V, V_{DD} = 5.0 V
Output leak current	I_L		10^{-3}	1	μA	EO_1, EO_2 pins V_O = V_{DD} = 5.0 V
AC input voltage	V_{tn}	1.0		V_{DD}	V_{p-p}	AM, FM pins
Operating current	I_{DD1}		3		mA	Normal operation (except display current)
Operating current	I_{DD2}			10	μA	CE pin = 0 T_a = 25 °C, V_{DD} = 5 V
RAM hold voltage	V_{RAM}	2.5			V	CE pin = 0
Output voltage endurance	V_{BDS}			-30	V	S_a to S_g pins (drain - source voltage), I_{OFF} = -5 μA

8.4 AC CHARACTERISTICS (V_{DD} = +4.5 to +5.5 V, T_a = -35 to +75 $^\circ$C)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	CONDITION
Operating frequency	f_{AM}	0.5		2.5	MHz	AM pin, V_{in} = 1.0 V_{p-p} (MIN.), DC cut
Operating frequency	f_{FM}	0.5		8.8	MHz	FM pin, V_{in} = 0.8 V_{p-p} (MIN.), square wave, DC cut

9. PACKAGE DIMENSIONS (UNIT: mm)

28-pin Plastic DIP (400 mil)
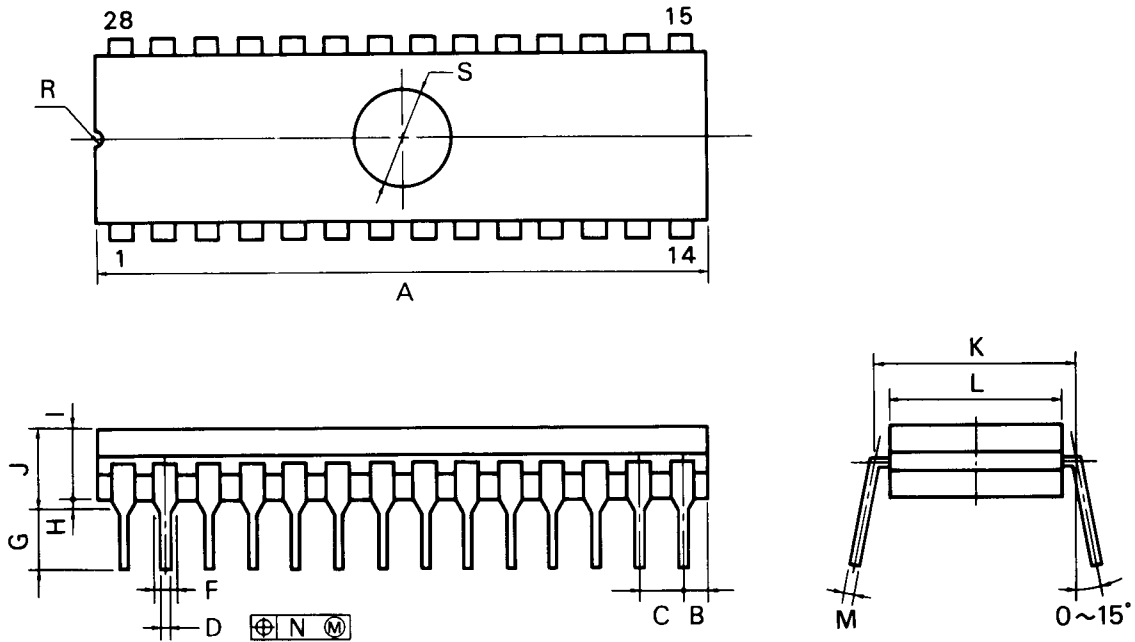
P28C-100-400

NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	38.10 MAX.	1.500 MAX.
B	2.54 MAX.	0.100 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.50^{\pm0.10}$	$0.020^{+0.004}_{-0.005}$
F	1.2 MIN.	0.047 MIN.
G	$3.5^{\pm0.3}$	$0.138^{\pm0.012}$
H	0.51 MIN.	0.020 MIN.
I	3.80	0.150
J	5.08 MAX.	0.200 MAX.
K	15.24 (T.P.)	0.600 (T.P.)
L	13.21	0.520
M	$0.25^{\pm0.05}$	$0.010^{+0.002}_{-0.003}$
N	0.25	0.01
R	R 0.65	R 0.026
S	ϕ 7.62	ϕ 0.300