

# MOS DIGITAL INTEGRATED CIRCUIT

# $\mu$ PD1705C-012

## PHASE LOCKED LOOP FREQUENCY SYNTHESIZER

## TV DIGITAL TUNING SYSTEM CONTROLLER

## CMOS LSI

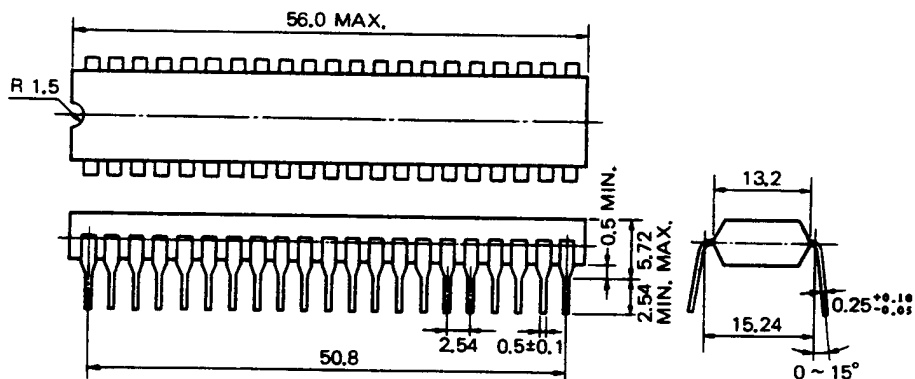
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$\mu$ PD1705C-012 is a CMOS LSI developed for television receivers of PLL frequency synthesizer system designed to U.S.A. and Canada. PLL and controller are contained on a single chip. This LSI, with the pre-scaler  $\mu$ PB562C, constitutes a high performance PLL television receiver system. Since PLL section uses pulse-swallowing system, fine tuning can be easily done with a high precision. Furthermore, it is provided with functions of remote control, clock, and timer.

### FEATURES

- PLL and controller are packed in one chip.
- Multifarious station selection modes are provided.
  - 10-key direct selection ..... with automatic/manual switching
  - channel up/down selection ..... with automatic/manual switching
- High precision fine tuning capable by the use of pulse-swallowing system (1 step 40 kHz  $\pm$  2.2 MHz, max.)
- CATV stations can be selected.
- 12-hour system clock and ON/OFF timer contained within.
- Remote control receiver contained. ( $\mu$ PD1913C and  $\mu$ PC1373H are used.)
- Provided with the function to output BCD channel number to CRT display interface.
- CMOS structure with low power consumption.
- Single power supply of +5 V.
- 42-pin dual in-line package (DIP)

### PACKAGE DIMENSIONS in millimeters



**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage	V <sub>DD</sub>	-0.3~+6.0	V
Input Voltage	V <sub>I</sub>	-0.3~+V <sub>DD</sub>	V
Output Voltage	V <sub>O</sub>	-0.3~+V <sub>DD</sub>	V
Output Current	I <sub>O</sub>	10	mA
Operation Temperature	T <sub>opt</sub>	-35~+75	°C
Storage Temperature	T <sub>stg</sub>	-55~+125	°C
Output Breakdown Voltage	V <sub>BDS1</sub>	Sa-Sg terminal: -35	V
Output Breakdown Voltage	V <sub>BDS2</sub>	CH0-CH3, MS terminal: -15	V
Output Breakdown Voltage	V <sub>BDS3</sub>	B01, B02 terminal: +15	V

**RECOMMENDED OPERATING CONDITIONS**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Supply Voltage	V <sub>DD</sub>	4.5	5.0	5.5	V	
Output Breakdown Voltage	V <sub>BDS1</sub>			-30	V	Sa-Sg terminal: I <sub>OFF</sub> = -5 μA
Output Breakdown Voltage	V <sub>BDS2</sub>			-11	V	CH0-CH3, MS terminal: I <sub>OFF</sub> = -10 μA
Output Breakdown Voltage	V <sub>BDS3</sub>			13	V	B01, B02 terminal: I <sub>OFF</sub> = -5 μA
Supply Voltage Rise Time	Trise			500	ms	V <sub>DD</sub> =0→4.5 V

**ELECTRICAL CHARACTERISTICS (Ta=-35 to +75 °C, V<sub>DD</sub>=4.5 to 5.5 V)**

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
High Level Input Voltage	V <sub>IH1</sub>	0.8V <sub>DD</sub>		V <sub>DD</sub>	V	REM terminal
High Level Input Voltage	V <sub>IH2</sub>	0.7V <sub>DD</sub>		V <sub>DD</sub>	V	AFTU, AFTD, SD, CE terminal
High Level Input Voltage	V <sub>IH3</sub>	0.6V <sub>DD</sub>		V <sub>DD</sub>	V	K0-K3 terminal
Low Level Input Voltage	V <sub>IL1</sub>	0		0.3V <sub>DD</sub>	V	AFTU, AFTD, SD, CE terminal
Low Level Input Voltage	V <sub>IL2</sub>	0		0.2V <sub>DD</sub>	V	K0-K3, REM terminal
High Level Output Voltage	V <sub>OH1</sub>	4.0			V	EO, VOL terminal: I <sub>OH</sub> = -0.5 mA
High Level Output Voltage	V <sub>OH2</sub>	4.0			V	D1-D5, MUTE, PSC, LMP terminal: I <sub>OH</sub> = -0.2 mA
High Level Output Voltage	V <sub>OH3</sub>	3.0			V	Sa-Sg terminal: I <sub>OH</sub> = -0.5 mA
High Level Output Voltage	V <sub>OH4</sub>	2.5			V	CH0-CH3, MS, POW terminal: I <sub>OH</sub> = -2.0 mA
Low Level Output Voltage	V <sub>OL1</sub>			0.5	V	EO, VOL, LMP terminal: I <sub>OL</sub> = 0.5 mA
Low Level Output Voltage	V <sub>OL2</sub>			0.5	V	D1-D5, MUTE, PSC terminal: I <sub>OL</sub> = 0.2 mA
Low Level Output Voltage	V <sub>OL3</sub>			2.0	V	B01, B02 terminal: I <sub>OL</sub> = 2.0 mA
High Level Input Current	+I <sub>IH1</sub>	10	40	100	μA	K0-K3 terminal: V <sub>IN</sub> =V <sub>DD</sub> =5.0 V
High Level Input Current	+I <sub>IH2</sub>		300		μA	X1 terminal (Pull Down): V <sub>IN</sub> =V <sub>DD</sub> =5.0 V
Low Level Input Current	-I <sub>IL</sub>		300		μA	IN terminal (Pull Up): V <sub>IN</sub> =0 V, V <sub>DD</sub> =5.0 V
High Level Input Leak Current	+I <sub>L1H</sub>			10	μA	CE, REM, AFTU, AFTD, SD terminal: V <sub>IN</sub> =V <sub>DD</sub> =5.0 V
Low Level Input Leak Current	-I <sub>L1L</sub>			10	μA	CE, REM, AFTU, AFTD, SD, K0-K3 terminal: V <sub>IN</sub> =0 V
Output Off Leak Current	I <sub>L</sub>		10 <sup>-3</sup>		μA	EO terminal: V <sub>O</sub> =V <sub>DD</sub> , V <sub>O</sub> =0 V
Frequency Response	f <sub>IN</sub>	0.5		8.8	MHz	IN terminal: V <sub>IN</sub> =0.7 V <sub>p-p</sub> (MIN.), DC
Supply Current	I <sub>DD1</sub>		3		mA	Normal Operation
Supply Current	I <sub>DD2</sub>		0.6		mA	CE terminal=0 V, V <sub>DD</sub> =5 V
Oscillation Stop Voltage	V <sub>DDS</sub>		3.2	3.8	V	

**OUTLINE OF FUNCTIONS**

**(1) BANDS**

VHF/UHF/CATV in U.S. and CANADA

- VHF : 2 ch – 13 ch
- UHF : 14 ch – 83 ch
- CATV : A ch – W ch

**(2) FUNCTION OF TUNING**

- 10-key direct selection with automatic/manual switching.
- channel up/down selection with automatic/manual switching.

**(3) MANUAL FINE TUNING (MFT)**

- 1 step : 40 kHz ± 2.2 MHz MAX.
- 1 cycle : 125 ms

**(4) AUTO FINE TUNING (AFT)**

- 1 step : 40 kHz ± 2.2 MHz MAX.
- 1 cycle : 8 ms

**(5) FUNCTION OF CLOCK AND TIMER**

- 12-hour clock (AM or PM is displayed)
- On-off timer in every 24 hours

**(6) FUNCTION OF REMOTE CONTROL**

- Contains remote control receiver
- Using the μPD1913C (transmitter) and the μPC1373H (pre-amplifier)

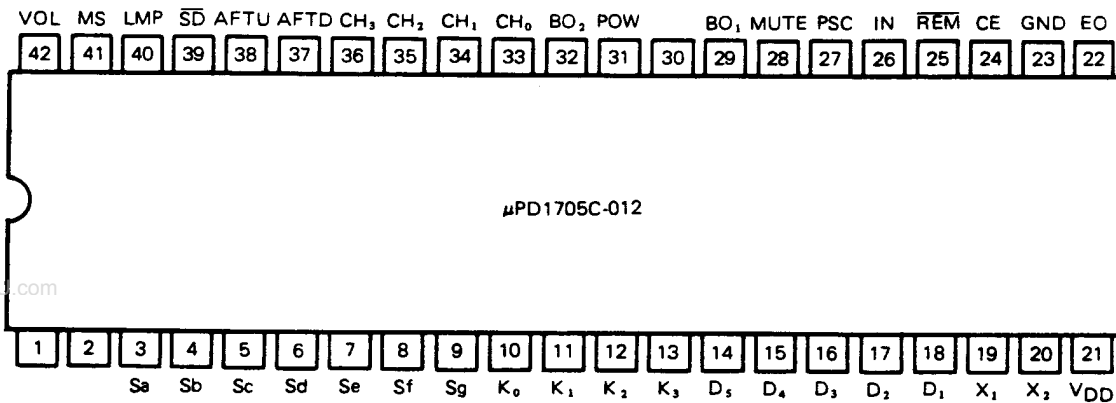
**(7) DISPLAY**

- Dynamic display in 5 digits (at 130 Hz)
  - Channel ..... 2 digits and a display of CATV, panel locked, or remote controlled reception.
  - Clock..... 4 digits and a display of AM, PM, panel locked reception, or remote controlled reception.
- BCD output terminal for CRT display interface is provided to be connected via μPD4508C to MM58146.

**(8) REFERENCE FREQUENCY**

$f_r = 5 \text{ kHz}$

PIN CONNECTION (Top View)



EXPLANATION OF INPUT AND OUTPUT TERMINALS

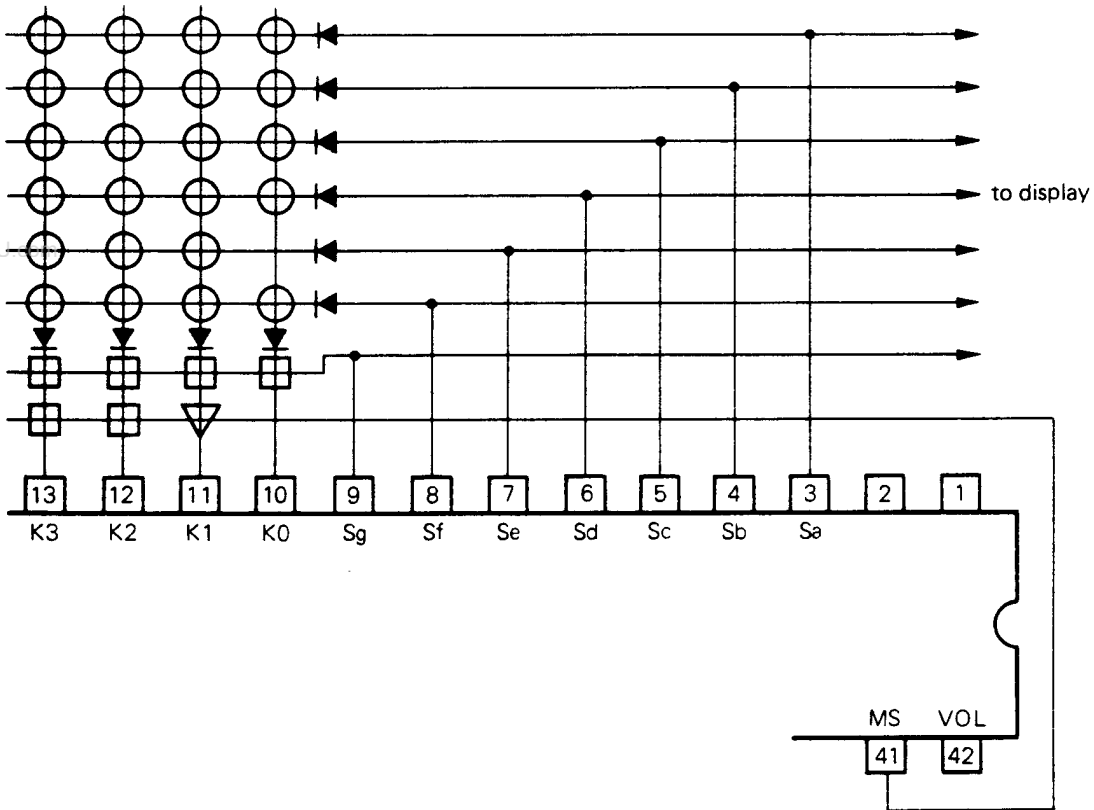
Pin Number	Symbol	Name of Terminal	Descriptions
3-9	Sa-Sg	Segment	7-segment display output, also used as output for key-matrix. High dielectric strength (-30 V). Active high.
10-13	K0-K3	Key	Input of key-matrix return signal.
14-18	D5-D1	Digit	Output of digit signal for display, also used for latch pulses for BCD output to CRT display (D3, D4). Active high.
19, 20	X1, X2	Reference Frequency Oscillator	Crystal oscillator of 4.5 MHz is connected here. Feedback resistance is contained.
21	VDD	Power Supply	Voltage of +5 V ±10 % is supplied here. VDD rise time of 500 ms or less is required. For too long rise time, initializing may not be normally performed.
22	EO	Phase Detection Output	Charge pumping output from phase detector. This output supplies tuning voltage to varactor of tuner via a low-pass filter.
23	GND	Grounding	Connected to the ground of system.
24	CE	Chip Enable	High : Normal operation Low : Memory retention (display off, PLL function disabled). Low level signal less than 134 μs is neglected.
25	REM	Remote Control Signal Input	Input terminal for remote control signal. The output of preamplifier μPC1373H is connected here. Active low.
26	IN	Local Oscillator Input	Tuner local oscillation signal is input here via prescaler μPB562C. An a.c. amplifier is contained. So input should be connected through a capacitor.
27	PSC	Pulse Swallow Control	Output terminal of pulse swallow control signal. Connected to PSC terminal of prescaler μPB562C.
28	MUTE	Muting	Output terminal of signal to cut noises when PLL is unlocked. Active high.

Pin Number	Symbol	Name of Terminal	Descriptions															
29 32	BO1 BO2	Band	Output terminal of tuner band switching signal. The form of the signal is shown below. <table border="1" style="margin-left: 20px;"> <tr> <td></td> <td>VL</td> <td>MB, VH</td> <td>SB</td> <td>UB</td> </tr> <tr> <td>BO<sub>1</sub></td> <td>L</td> <td>H</td> <td>H</td> <td>L</td> </tr> <tr> <td>BO<sub>2</sub></td> <td>H</td> <td>H</td> <td>L</td> <td>L</td> </tr> </table>		VL	MB, VH	SB	UB	BO <sub>1</sub>	L	H	H	L	BO <sub>2</sub>	H	H	L	L
	VL	MB, VH	SB	UB														
BO <sub>1</sub>	L	H	H	L														
BO <sub>2</sub>	H	H	L	L														
31	POW	Power	Output terminal for controlling power supply.															
33–36	CH0– CH3	Channel Number Output	Output terminals for BCD data to CRT display interface. The number of receiving channel is output in 2-digit dynamic BCD signal.															
37, 38	AFTU AFTD	AFT Input	Input terminal for AFT signal. AFT signal converted in binary form by comparator μPC393C is supplied here.															
39	SD	Station Detector	Input terminal for stop signal during auto tuning. Active low. However, it is necessary that it turns to low level within 100 ms after PLL locking.															
40	LMP	Lamp	Output terminal for displaying remote control signal reception. A pulse of 20 ms duration is output when remote control signal is received.															
41	MS	Mode Switch	Output terminal of return signal for sensing CATV/TV and AUT/MAN switching.															
42	VOL	Volume	Output terminal of variable-duty pulses to control volume. The signal is input to d.c. attenuator via an external lowpass filter.															

**CONNECTION TO THE MATRIX OF KEYS**

	K3 (13)	K2 (12)	K1 (11)	K0 (10)
Sa (3)	0	1	2	3
Sb (4)	4	5	6	7
Sc (5)	8	9	CLEAR	RECALL
Sd (6)	FTU	CHU	VOLU	MUTE
Se (7)	FTD	CHD	VOLD	–
Sf (8)	HADJ	MADJ	PL	POWER
Sg (9)	CLOCK	ONTIM	OFTIM	TIMER
MS (41)	CATV/TV	AUT/MAN	SDCONT	–

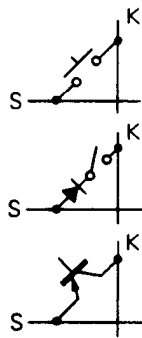
COMPOSITION OF KEYS



○ momentary key switch

□ alternate switch

▽ transistor



**EXPLANATION OF CONTROL KEYS**

Symbol	Function
0-9 (Number Key)	Used for direct channel selection. For direct channel selection, input the number of desired channel in two digits. (Channel 8 or 12 is selected by keying (0), (8) or (1), (2), respectively.) When, after keying the first digit in either of 2-9, the second keying is delayed more than 2-3 seconds, the channel corresponding to the first keyed number is selected. (keying of only (3) selects Channel 3.) If some non-existing channel number is keyed-in, no channel selection is done, and the display recovers the preceding channel number. In auto-mode (when AUT/MAN switch is on), when no station is detected in the channel specified by keying, the channel automatically shifts up as far as the channel where station can be detected.
CLEAR	If the first keying has been done wrong for direct channel selection, depress this key to recover the original state immediately. Then, follow the selection process from the beginning.
RECALL	This key switches display modes. Every time when this key is depressed, clock or channel is alternatingly displayed.
CHU (up-channel selection)	In auto-mode (when AUT/MAN switch is on), when this key is depressed, the channel shifts up until the channel transmitting wave is found. When this key is further kept pressed down, the reception of the selected channel will be kept for 600 ms and then the channel will shift up again until another station is received. This procedure is repeated until the key is released. In manual mode (when AUT/MAN switch is off), when this key is kept depressed, the channel again shifts up by 1 after a waiting time of 600 ms. This procedure is repeated until the key is released.
CHD (down-channel selection)	This key is only different from CHU in the shifting down-channel, instead of up-channel. Others are the same as CHU.
FTU (fine tuning upward)	This key serves for fine tuning. It is enabled only in manual mode. Depressing this key and then releasing within 500 ms makes the tuning frequency shift upward by 40 kHz. After the depression is kept for 500 ms, the tuning frequency is raised by 40 kHz, once after every 125 ms. When the upper limit (+2.2 MHz) is reached by this procedure, the frequency goes down to the lower limit (-2.2 MHz) and again the upward shifting starts. When other channel is selected, the fine tuning condition is resetted.
FTD (fine tuning downward)	This key is only different from FTU in the frequency shift downward instead of upward. Other features are the same as FTU.
VOLU (increase volume)	This is the key to control sound level. When this key is depressed the sound level is raised by 1 step in every 100 ms until the key is released. The total number of steps is 64, (duty ratios are 0, 3/67-65/67) so as to adjust the sound level smoothly.
VOLD (decrease volume)	This key is only different from VOLU in the volume level attenuating instead of raising. Other features are the same as VOLU.
MUTE (muting)	This key is used to mute sound. Every time when this key is depressed, mute output is reversed. The muting is released when power is turned on, when a volume control key (VOLU or VOLD) is operated, or when any channel is selected.
POW (power)	This key controls the power source. Every time when this key is depressed, power output is reversed. When power is in off-state, only POW key, PL key, time adjuster key and switch is in enabled condition. When power is turned on, channel is on display, while it is turned off, clock is displayed.
PL (panel lock)	This key prevents misoperation. When panel lock is on, keys other than POW key and PL key are ineffective. When power is on, panel lock is released.

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Symbol	Function
<b>HADJ</b> (hour adjust)	This key is used to adjust hour. This is effective only when a time adjuster switch (CLOCK, ONTIM, or OFTIM) is on position. When this key is depressed and then released within 500 ms, the hour is advanced by 1 hour. If the depression is held longer than 500 ms, the hour is further advanced by 1 hour once every 250 ms after the 500 ms until the key is released.
<b>MADJ</b> (minute adjust)	This key is used to adjust minute. The performance is basically the same as HADJ. When the advancement reaches 60 minutes, it returns to zero without counting up in hour.
<b>CLOCK</b> (clock adjustment)	This is the clock adjustment mode switch. When this is turned on, clock is displayed and HADJ and MADJ keys are available. While this is on, the clock is stopped, and, when the switch is turned off, the clock start from 0 second. When panel lock is on, the clock cannot be adjusted by turning this switch on, but, it should be noted that second is reset to 0 by this switch.
<b>ONTIM</b> (on-timer adjustment)	This is the on-timer adjustment mode switch. When this switch is turned on, the on-timer mode is displayed and the on-timer can be adjusted to the desired setting by using HADJ and MADJ keys.
<b>OFTIM</b> (off-timer adjustment)	This is the off-timer adjustment mode switch. When this switch is turned on, the off-timer mode is displayed and the off-timer can be adjusted to the desired setting by using HADJ and MADJ keys.
<b>TIMER</b> (timer)	This is the timer selection switch. When this switch is turned on, the timer acts at the preset time. When it is off, the timer does not act at the preset time.
<b>CATV/TV</b> (band switching)	This is the band selection switch. When the switch is on, CATV is selected, and when off, TV is selected. When CATV is selected, Channels 2–36 (Channels 2–13: VHF, and, Channels 14–36: CATV) can be received, while TV is selected, Channels 2–83 (Channels 2–13: VHF, and, Channels 14–83: UHF) can be received. The switching initialize the channel to Channel 2.
<b>AUT/MAN</b> (auto/manual)	This is the mode selection switch for channel selection and fine tuning. When this is on, auto mode is taken, and when off, manual mode is taken. In auto mode, the channel selection is accompanied by the detection of broadcast signal and AFT acts always. In manual mode, no signal detection is performed. At the same time, MFT mode is taken and FTU and FTD keys are effective.
<b>SDCONT</b> (station detect control)	This is the broadcast signal detection time adjustment switch. Usually it is off where the station signal detection is started about 100 ms after PLL lock. When it is on, the time for detection is prolonged by the unit of 100 ms until the switch is turned off. Therefore it is possible to control station signal detection time by external signal using transistor switch.



**RELATION BETWEEN CATV CHANNEL AND INPUT CHANNEL NUMBER**

The correspondence of CATV channels to actually keyed-in channel numbers as well as displayed channel numbers is shown in the following table.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

**EXPLANATION OF REMOTE CONTROL SYSTEM**

The μPD1705C-012 contains remote-control receiver. Combined with μPD1913C (transmitter) and μPC1373H (receiver preamplifier), it can be remote controlled.

Functions enabled by the remote control are:

- direct channel selection with 10-key (auto/manual)
- channel up/down selection (auto/manual)
- channel selection clearing (see the description above of CLEAR key)
- Power on/off
- muting on/off
- panel lock on/off
- volume up/down (in 64 steps).....initial level 25 %
- remote-controlled reception identification signal (on LMP terminal)

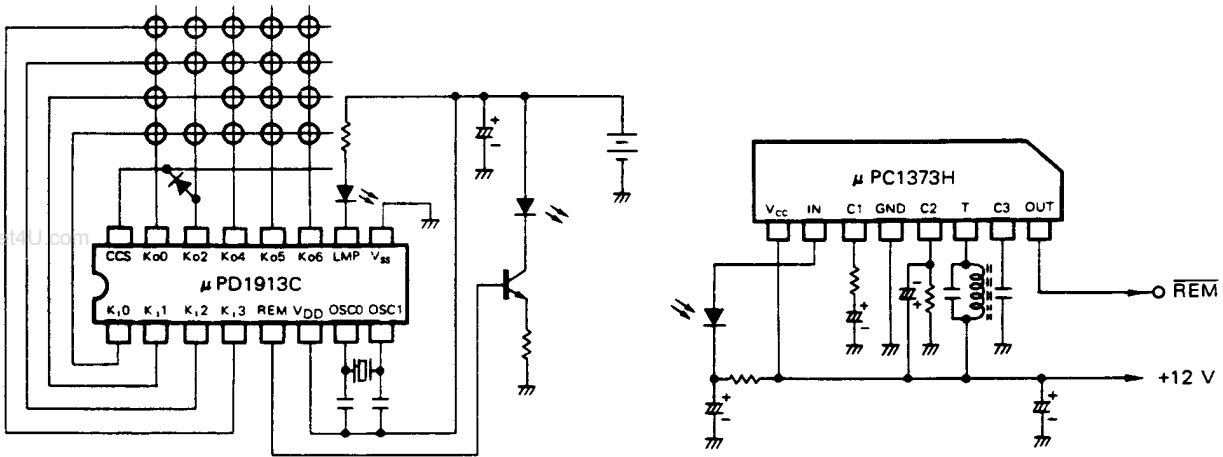
Note : When the μPD1705C-012 receives remote control signal the reception identification pulse of about 20 ms is issued from LMP terminal. Use this pulse externally with some external time constnat.

Note : The custom code of C0 – C7 = 00100000 is used for transmission. The function does not start with codes other than this. For details of custom code, see the catalogue for μPD1913C.

**\*COMPOSITION OF KEYS AT THE μPD1913C**

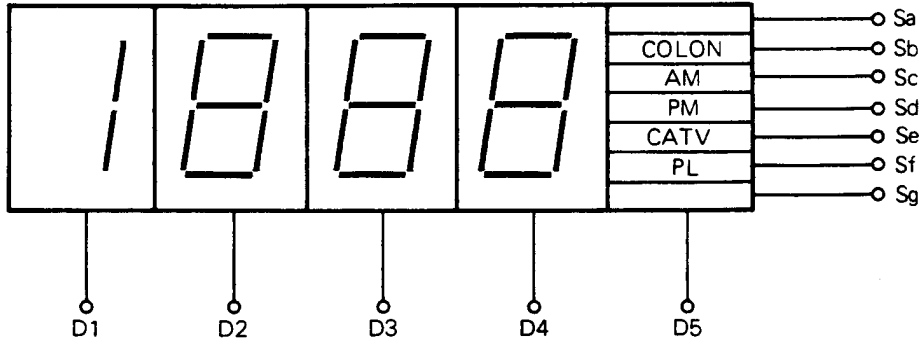
	K10 (1)	K11 (2)	K12 (3)	K13 (4)
K00 (15)	CHU	CHD	VOLU	VOLD
K02 (14)	POWER	MUTE	MUTE	PL
K04 (13)	0	1	2	3
K05 (12)	4	5	6	7
K06 (11)	8	9	CLEAR	RECALL

**APPLICATION OF REMOTE CONTROL SYSTEM**



**DISPLAY FORMAT**

Display format is 7-segment 5-digit dynamic display. (repetition frequency: 130 Hz and duty ratio: 15 %)  
 Display is connected in the following fashion.



**CLOCK DISPLAY**

Clock is displayed in 4 digits of numerics and 1 digit of dot (AM or PM, COLON, and PL).



**CHANNEL DISPLAY**

Channel is displayed in 2 digits of numerics and 1 digit of dot (CATV and PL). The digit of ten is displayed at D3 timing and the digit of one at D4 timing.



Note : Channel and clock are alternately displayed by operating RECALL key. When power line is connected or when power switch is turned off, clock is displayed. Whereas, when power switch is turned on or when selection key (0-9, CHU, CHD) or CATV/TV switch is operated, channel is displayed. Furthermore, when clock adjustment switch (CLOCK, ONTIM, and OFTIM) is on, clock is displayed.

**OPERATION OF CLOCK AND TIMER**

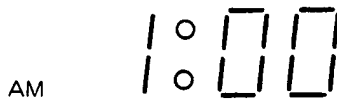
**CLOCK**

Clock should be adjusted following the schedule below.

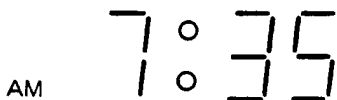
- 1) Turn CLOCK switch on. Only clock is displayed. When no adjustment is done before, only AM and COLON are displayed.



- 2) Press HADJ key to adjust hour. The display of AM1:00 appears at the moment of key depression. The display continues to advance until the key is released.



- 3) Press MADJ key to adjust minute. The displayed minute continues to advance until the key is released. No counting up occurs in hour if the minute reaches 60.



- 4) Turn CLOCK switch off coincidentally with other clock or time signal. The clock starts from 0 second at the moment of switch off.

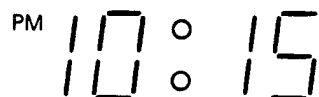
**TIMER**

Adjust timer according to the following procedure.

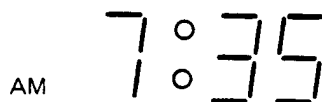
1) Turn ONTIM (OFTIM) switch on. Timer is displayed.



2) Adjust timer to the desired time in the same procedure as clock adjustment.



3) Turn ONTIM (OFTIM) switch off. The display is changed to clock.



4) Turn TIMER switch on.

Note : During panel lock, clock cannot be adjusted. But when CLOCK switch is turned on/off, clock is reset to 0 second.

Note : When both on-timer and off-timer are set to the same time, off-timer is dominating.

Note : While CLOCK switch is on, clock does not advance.

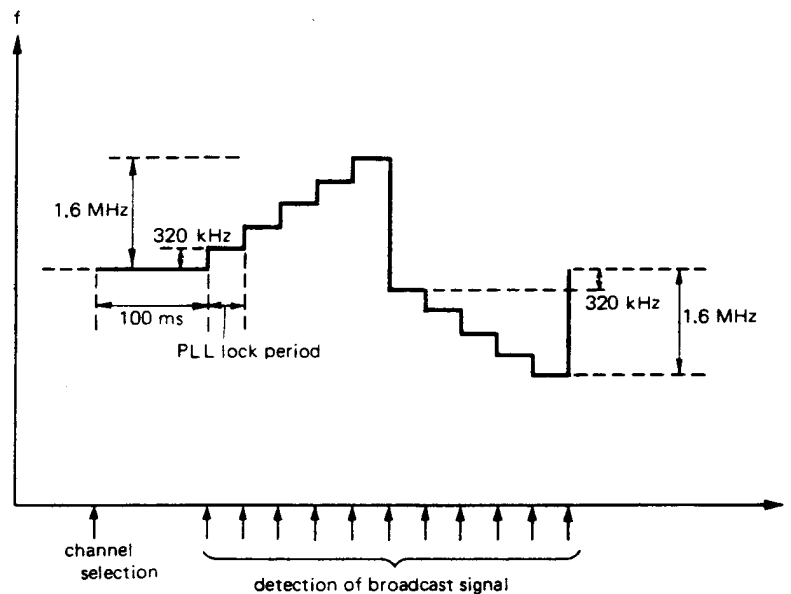
Note : While one of time adjustment switches is on, remote control is ineffective.

Note : Do not turn on two or more time adjustment switches at a time.

## AUTO-SEARCH FUNCTION

$\mu$ PD1705C-012 is provided for channel selection with a function to tune in automatically to a transmitting station by detecting the presence of the wave (when in auto mode). The searching of channels are performed in an specified direction (up-channel for up-channel selection, or down-channel for down-channel selection), or, in up-channel direction when direct selection is performed.

If there were a deviation in the frequency of wave transmitted by a station, the reception of signal at the right frequency might be impossible. In such cases, the receiving frequency is shifted by 320 kHz as far as  $\pm 1.6$  MHz to be tuned in the transmitted signal. When a signal is detected half ways, the searching is finished. When the detection is not completed in  $\pm 1.6$  MHz range, the next channel will be sought. The searching procedure within a channel is shown in the following figure.



## FINE TUNING

$\mu$ PD1705C-012 has a high precision fine tuning function to correspond to frequency shift of station. In virtue of this feature, the shift in receiving frequency can be easily compensated to keep the optimum receiving condition. Two types of fine tuning functions are available; manual (MFT) and auto (AFT).

### 1) MFT (manual fine tuning)

This tuning is operated with FTU or FTD key. Selection of another channel resets the fine tuning status.

FTU and FTD keys are effective only when AUT/MAN switch is off (in manual mode). The fine tuning is done in 40 kHz step at every 125 ms and the limit of frequency shift is  $\pm 2.2$  MHz.

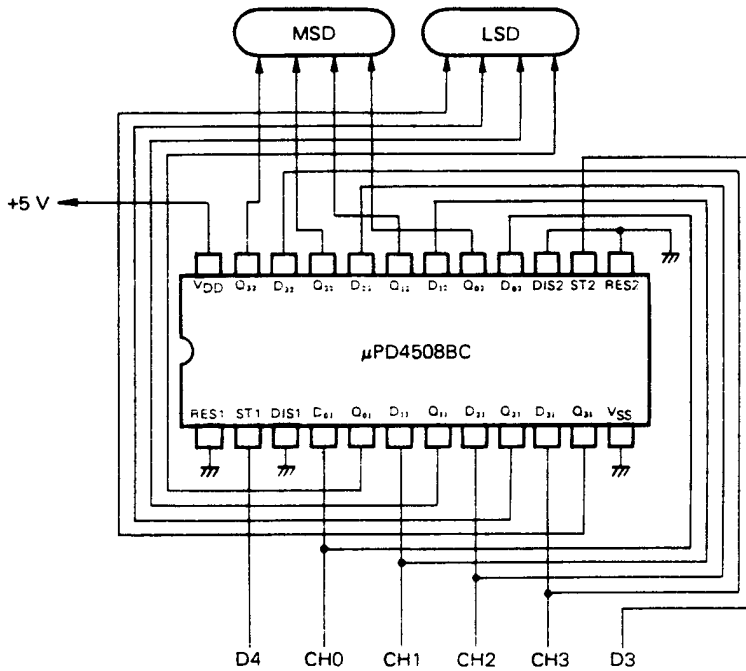
### 2) AFT (auto fine tuning)

It is effective only when AUT/MAN switch is on (in auto mode). This is operated by external AFT signal and it always follows the change in AFT signal. However, it is ineffective during channel selection. The fine tuning is done in 40 kHz step at every 8 ms and the limit of frequency change is  $\pm 2.2$  MHz. AFT is operated by the signal applied to AFTU or AFTD terminal. When AFTU terminal is at high level, the tuning frequency is raised, while AFTD terminal is at high level, the frequency is lowered. When both AFTU and AFTD terminals are assigned with low level, the operation is stopped.

Note : In either AFT or MFT, when the frequency is shifted as far as the upper or lower limit respectively, the frequency is shifted back to the lower or upper limit. Thus the fine tuning is continued cyclically.

**CRT DISPLAY**

μPD1705C-012 is provided with terminals (CH0–CH3) for output of BCD channel number for CRT display. This output is presented in dynamic format which is the same as the display format (that is, digit of 10 is output at the timing of D3 and digit of 1 is output at the timing of D4). Therefore, by providing a latch (μPD4508BC) externally, the output can be taken outside.



**OUTPUT PATTERN**

numeric	BCD output
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
	1 1 1 1

APPLICATION CIRCUIT

