Ordering number: EN3000A

CMOS LSI

No. 3000A

LC7230-8221

Single-chip PLL and Microcontroller with LCD Driver

OVERVIEW

The LC7230-8221 is a single-chip microcontroller that incorporates a phased-locked loop (PLL) and a liquid crystal display driver, making it ideal for automatic station selection in digital tuners.

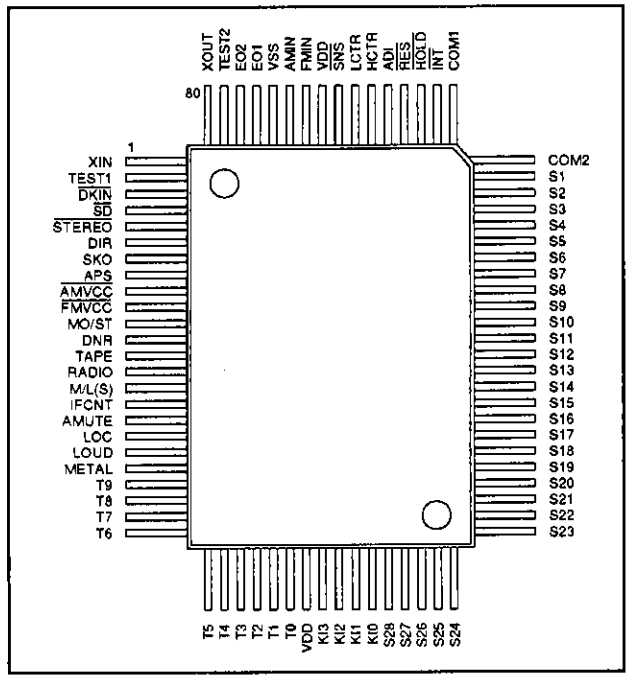
The LC7230-8221 operates over the American, European and Japanese LW, SW and FM bands and incorporates preset-channel memory for six stations in each band. In addition, the LC7230-8221 provides a separate station seek function for European frequency bands. The LC7230-8221 features a 12-hour or 24-hour time display, automatic retuning and automatic station memory functions, and a voltage-monitoring reset circuit.

The LC7230-8221 operates from a 5 V supply and is available in 80-pin QIPs.

FEATURES

- Operates over the LW (SW), MW, FM1, FM2 and FM3 bands
- Preset-channel memory for six stations per frequency band
- Last-channel memory for each frequency band
- Separate station seek function for European frequency bands
- Automatic station scanning with 5 s station pause
- Preset-channel scanning function
- 4.5 MHz reference frequency for tracking adjustment
- Automatic retuning function
- Automatic station memory
- Voltage-monitoring reset circuit
- 12-hour or 24-hour time display
- Frequency select for manual tuning
- Time-setting key select inputs
- 5 V supply
- 80-pin QIP

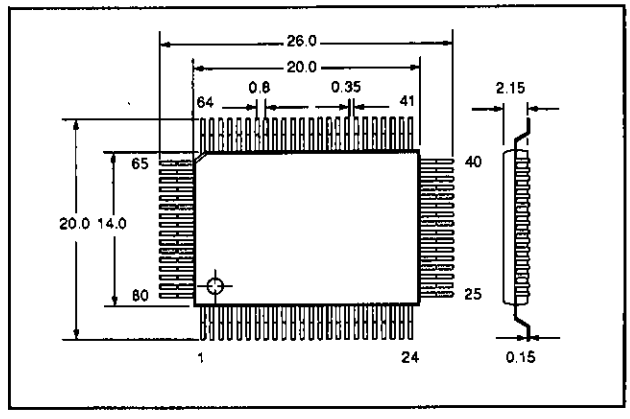
PINOUT



PACKAGE DIMENSIONS

Unit: mm

3044B-QIP80A

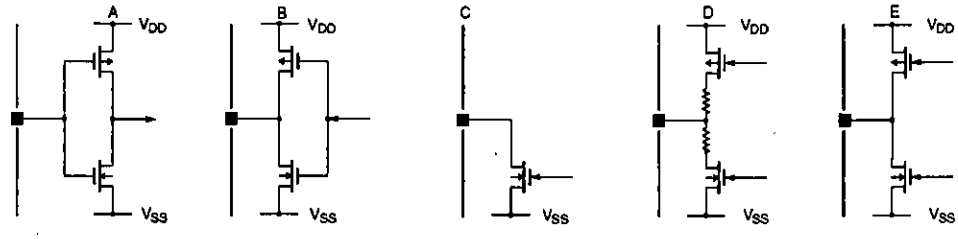


PIN DESCRIPTION

Number	Name	Description
1	XIN	4.5 MHz crystal oscillator connection
2	TEST1	Test pin. Normally connected to ground
3	$\overline{\text{DKIN}}$	Active-LOW, DK signal input and dual-function key select input. See equivalent circuit A.
4	$\overline{\text{SD}}$	Active-LOW, stop detector input. See equivalent circuit A.
5	$\overline{\text{STEREO}}$	Active-LOW, stereo indicator input. See equivalent circuit A.
6	DIR	Direction indicator input. Right indicator lights when HIGH, and left indicator, when LOW. See equivalent circuit A.
7	SKO	Active-HIGH, SK signal output. See equivalent circuit C.
8	APS	Active-HIGH, automatic-playback search indicator output when auto-retune function has not been selected. See equivalent circuit C.
9	$\overline{\text{AMVCC}}$	Active-LOW, AM tuner power supply switch control output. See equivalent circuit C.
10	$\overline{\text{FMVCC}}$	Active-LOW, FM tuner power supply switch control output. See equivalent circuit C.
11	MO/ST	Active-HIGH, monaural/stereo indicator output. See equivalent circuit B.
12	DNR	Active-HIGH, Dolby noise reduction control output. See equivalent circuit B.
13	TAPE	Active-HIGH, tape select input. See equivalent circuit A.
14	RADIO	Active-HIGH, radio select input. See equivalent circuit A.
15	M/L(S)	Active-HIGH, MW/LW(SW) bandswitching output. See equivalent circuit B.
16	IFCNT	Active-HIGH, IF signal control output. See equivalent circuit B.
17	AMUTE	Active-HIGH, audio muting control output. See equivalent circuit B.
18	LOC	Active-HIGH, local/distant station switching control output. See equivalent circuit B.
19	LOUD	Active-HIGH, loudness control output. See equivalent circuit B.
20	METAL	Active-HIGH, metal tape select output. See equivalent circuit B.
21 to 30	T0 to T9	Active-HIGH, keypad scan outputs. See equivalent circuit B.
31, 73	VDD	5 V supply
32 to 35	KI0 to KI3	Active-HIGH, keypad scan inputs with 100 kΩ (typ) pull-down resistors. See equivalent circuit A.
36 to 63	S1 to S28	LCD-panel segment driver outputs. See equivalent circuit B.
64	COM2	LCD-panel common driver outputs. See equivalent circuit D.
65	COM1	
66	$\overline{\text{INT}}$	External interrupt input. Normally connected to V_{DD}
67	$\overline{\text{HOLD}}$	Active-LOW, hold/standby mode select input. See equivalent circuit A.
68	$\overline{\text{RES}}$	Output port reset input. Normally connected to V_{DD}
69	ADI	S-meter input. Normally connected to V_{DD}. See equivalent circuit B.
70	HCTR	FM IF signal input. See equivalent circuit A.
71	LCTR	AM IF signal input. See equivalent circuit A.
72	$\overline{\text{SNS}}$	Active-LOW, power-fail monitor input. See equivalent circuit A.
74	FMIN	FM VCO signal input. See equivalent circuit A.
75	AMIN	AM VCO signal input. See equivalent circuit B.
76	VSS	Ground

Number	Name	Description
77	EO1	Phase comparator outputs. See equivalent circuit E.
78	EO2	
79	TEST2	Test input. Normally connected to ground
80	XOUT	4.5 MHz crystal oscillator connection

Equivalent Circuits



SPECIFICATIONS

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage range	V_{DD}	–0.3 to 6.5	V
$\overline{INT}$, ADI, $\overline{SNS}$, $\overline{SD}$, $\overline{STEREO}$ and DIR input voltage range	V_{IN1}	–0.3 to 6.5	V
$\overline{HOLD}$ input voltage range	V_{IN2}	–0.3 to 13	V
Input voltage range for all other pins	V_{IN3}	–0.3 to V_{DD} + 0.3	V
SKO, APS, $\overline{AMVCC}$ and $\overline{FMVCC}$ output voltage range	V_{OUT1}	–0.3 to 15	V
Output voltage range for all other pins	V_{OUT2}	–0.3 to V_{DD} + 0.3	V
Output current range. See note 1.	I_{OUT1}	0 to 5	mA
Output current range. See note 2.	I_{OUT2}	0 to 3	mA
T0 to T7 output current range	I_{OUT3}	0 to 1	mA
Power dissipation	P_D	400	mW
Operating temperature range	Topr	–40 to 85	°C
Storage temperature range	T_{stg}	–45 to 125	°C

Notes

1. Pins SKO, APS, $\overline{AMVCC}$, $\overline{FMVCC}$, LOUD, METAL, T8 AND T9
2. Pins MO/ST, DNR, TAPE, RADIO, M/L(S), IFCNT, AMUTE, LOC and S25 to S28

Recommended Operating Conditions

T_a = 25 °C

Parameter	Symbol	Rating	Unit
Supply voltage	V_{DD}	5	V
Supply voltage range for CPU and PLL operation	V_{DD1}	4.5 to 5.5	V
Supply voltage range for CPU operation	V_{DD2}	3.5 to 5.5	V
Supply voltage range for data retention	V_{DD3}	1.3 to 5.5	V

Electrical Characteristics

V_{DD} = 3.5 to 5.5 V, T_a = –40 to 85 °C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply current	I_{DD}	V_{DD} = 4.5 to 5.5 V, f_{IN}(FMIN) = 130 MHz	–	15	25	mA
		PLL halted	–	2	3	
		V_{DD} = 5.5 V, oscillator halted, T_a = 25 °C	–	–	5	µA
		V_{DD} = 2.5 V, oscillator halted, T_a = 25 °C	–	–	1	
$\overline{DKIN}$, $\overline{SD}$ and $\overline{STEREO}$ LOW-level input voltage	V_{IL1}		0	–	0.3V_{DD}	V
$\overline{HOLD}$ LOW-level input voltage	V_{IL2}		0	–	0.2V_{DD}	V
$\overline{SNS}$ LOW-level input voltage	V_{IL3}		0	–	1.5	V
KI0 to KI3 LOW-level input voltage	V_{IL4}		0	–	0.2V_{DD}	V
LOW-level input voltage. See note 1.	V_{IL5}		0	–	0.3V_{DD}	V
$\overline{DKIN}$, $\overline{SD}$ and $\overline{STEREO}$ HIGH-level input voltage	V_{IH1}		0.7V_{DD}	–	5.5	V
$\overline{INT}$ HIGH-level input voltage	V_{IH2}		0.8V_{DD}	–	5.5	V
$\overline{SNS}$ HIGH-level input voltage	V_{IH3}		1.3	–	5.5	V
KI0 to KI3 HIGH-level input voltage	V_{IH4}		0.6V_{DD}	–	V_{DD}	V
HIGH-level input voltage. See note 1.	V_{IH5}		0.7V_{DD}	–	V_{DD}	V
$\overline{HOLD}$ HIGH-level input voltage	V_{IH6}		0.8V_{DD}	–	8.0	V
XIN rms input amplitude	V_{IN1}		0.50	–	1.5	V
FMIN rms input amplitude	V_{IN2}		0.10	–	1.5	V
AMIN rms input amplitude	V_{IN3}		0.1	–	1.5	V
LCTR and HCTR rms input amplitude	V_{IN4}		0.10	–	1.5	V
ADI input voltage	V_{IN5}		0	–	V_{DD}	V
$\overline{INT}$, $\overline{HOLD}$, $\overline{RES}$, ADI and $\overline{SNS}$ LOW-level input current	I_{IL1}	V_I = V_{SS}	–	–	3.0	µA
XIN LOW-level input current	I_{IL2}	V_I = V_{SS}	2.0	5.0	15.0	µA
FMIN, AMIN, HCTR and LCTR LOW-level input current	I_{IL3}	V_I = V_{SS}	4.0	10.0	30.0	µA
$\overline{INT}$, $\overline{HOLD}$, ADI, $\overline{SNS}$, DKIN, SD and STEREO HIGH-level input current	I_{IH1}	V_{IN} = 5.5 V	–	–	3.0	µA
HIGH-level input current. See note 1.	I_{IH2}	V_{IN} = V_{DD}	–	–	3.0	µA
XIN HIGH-level input current	I_{IH3}	V_{IN} = V_{DD} = 5.0 V	2.0	5.0	15	µA
FMIN, AMIN, HCTR and LCTR HIGH-level input current	I_{IH4}	V_{IN} = V_{DD} = 5.0 V	4.0	10.0	30.0	µA
KI0 to KI3 HIGH-level input current	I_{IH5}	V_{IN} = V_{DD} = 5.0 V	–	50.0	–	µA

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
XIN input frequency	f_{IN1}		4.0	4.5	5.0	MHz
FMIN input frequency	f_{IN2}	V_{DD} = 4.5 to 5.5 V	10	–	130	MHz
AMIN(L) input frequency	f_{IN3}	V_{DD} = 4.5 to 5.5 V	0.5	–	10	MHz
AMIN(H) input frequency	f_{IN4}	V_{DD} = 4.5 to 5.5 V	2.0	–	40	MHz
HCTR input frequency	f_{IN5}	V_{DD} = 4.5 to 5.5 V	0.4	–	12	MHz
LCTR input frequency	f_{IN6}	V_{DD} = 4.5 to 5.5 V	100	–	500	kHz
T0 to T7 LOW-level output voltage	V_{OL1}	I_O = 50 μA	0.5	1.0	2.0	V
LOW-level output voltage. See note 2.	V_{OL2}	I_O = 1 mA	–	–	1.0	V
EO1 and EO2 LOW-level output voltage	V_{OL3}	I_O = 500 μA	–	–	1.0	V
XOUT LOW-level output voltage	V_{OL4}	I_O = 200 μA	–	–	1.0	V
S1 to S28 LOW-level input voltage	V_{OL5}	I_O = –0.1 mA	–	–	1.0	V
LOUD, METAL, T8 and T9 LOW-level output voltage	V_{OL6}	I_O = 5 mA	–	–	1.0	V
SKO, APS, $\overline{AMVCC}$ and $\overline{FMVCC}$ LOW-level output voltage	V_{OL7}	I_O = 5 mA, R_L = 150 to 400 Ω	0.75	–	2.0	V
COM1 and COM2 LOW-level output voltage	V_{OL8}	I_O = 20 mA	0.35	0.5	0.7	V
COM1 and COM2 middle-level output voltage	V_M	V_{DD} = 5 V, I_O = 20 mA	2.0	2.5	3.0	V
T0 to T7 HIGH-level output voltage	V_{OH1}	I_O = 1 mA	V_{DD} – 2.0	V_{DD} – 1.0	V_{DD} – 0.5	V
HIGH-level output voltage. See note 2.	V_{OH2}	I_O = 1 mA	V_{DD} – 1.0	–	–	V
EO1 and EO2 HIGH-level output voltage	V_{OH3}	I_O = 500 μA	V_{DD} – 1.0	–	–	V
XOUT HIGH-level output voltage	V_{OH4}	I_O = 200 μA	V_{DD} – 1.0	–	–	V
S1 to S28 HIGH-level output voltage	V_{OH5}	I_O = 0.1 mA	V_{DD} – 1.0	–	–	V
LOUD, METAL, T8 and T9 HIGH-level output voltage	V_{OH6}	I_O = 5 mA	V_{DD} – 1.0	–	–	V
COM1 and COM2 HIGH-level output voltage	V_{OH7}	I_O = 20 μA	V_{DD} – 0.7	V_{DD} – 0.5	V_{DD} – 0.35	V
LCTR (period), $\overline{HOLD}$ and $\overline{INT}$ hysteresis width	V_N		0.1V_{DD}	–	–	V
$\overline{SNS}$ reject pulsewidth	t_{REJ}		–	–	50	μs
Low-voltage detector threshold	V_{DET}		2.7	3.0	3.3	V
KI0 to KI3 floating-input voltage	V_{IF}	With pull-down resistors	–	–	0.05V_{DD}	V
KI0 to KI3 pull-down resistor	R_{PD}		75	100	200	kΩ
A/D converter quantization error	E	V_{DD} = 4.5 to 5.5 V	– ½	–	½	lsb
EO1 and EO2 LOW-level leakage current	I_{OFFL1}	V_O = V_{SS}	–	0.01	10	nA
LOW-level leakage current. See note 3.	I_{OFFL2}	V_O = V_{SS}	–	–	3.0	μA

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
EO1 and EO2 HIGH-level leakage current	I_{OFFH1}	$V_O = V_{DD}$	–	0.01	10	nA
HIGH-level leakage current. See note 3.	I_{OFFH2}	$V_O = V_{DD}$	–	–	3.0	μA
SKO, APS, $\overline{AMVCC}$ and $\overline{FMVCC}$ HIGH-level leakage current	I_{OFFH3}	V_O = 13 V	–	–	5.0	μA

Notes

1. Pins MO/ST, DNR, TAPE, RADIO, M/L(S), IFCNT, AMUTE and LOC
2. Pins MO/ST, DNR, TAPE, RADIO, M/L(S), IFCNT, AMUTE, LOC and S25 to S28
3. Pins MO/ST, DNR, TAPE, RADIO, M/L(S), IFCNT, AMUTE, LOC, LOUD, METAL, T0 to T9 and S25 to S28

LCD DISPLAY

The LCD display layout is shown in figure 1, and the segments displayed for each digit, in figure 2.

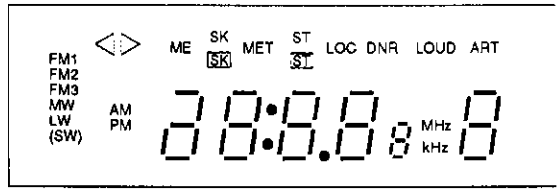


Figure 1. LCD display

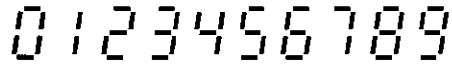


Figure 2. LCD digits

The FM2 and FM3 indicators are displayed when the number of stations which can be received is increased using the diode matrix.

The LW and SW indicators are displayed only when the corresponding European frequency band is selected.

The SK indicator is displayed when $\overline{SKI}$ is LOW. The ST indicator is displayed when $\overline{STEREO}$ is LOW.

The right arrow direction indicator is displayed when DIR is HIGH, and the left arrow direction indicator, when DIR is LOW.

The ART indicator functions as the APS key indicator when the auto-retune function has not been selected.

For European frequency bands, frequency steps of either 0 or 25 kHz are displayed as 00 kHz, and frequency steps of either 50 or 75 kHz, as 50 kHz.

The segments in the LCD panel are shown in figure 3, and the commons in the LCD panel, in figure 4.

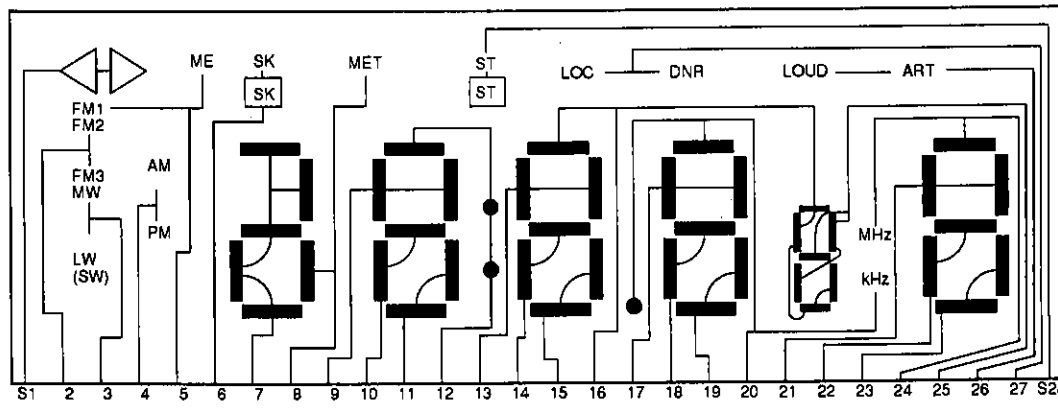


Figure 3. Segments

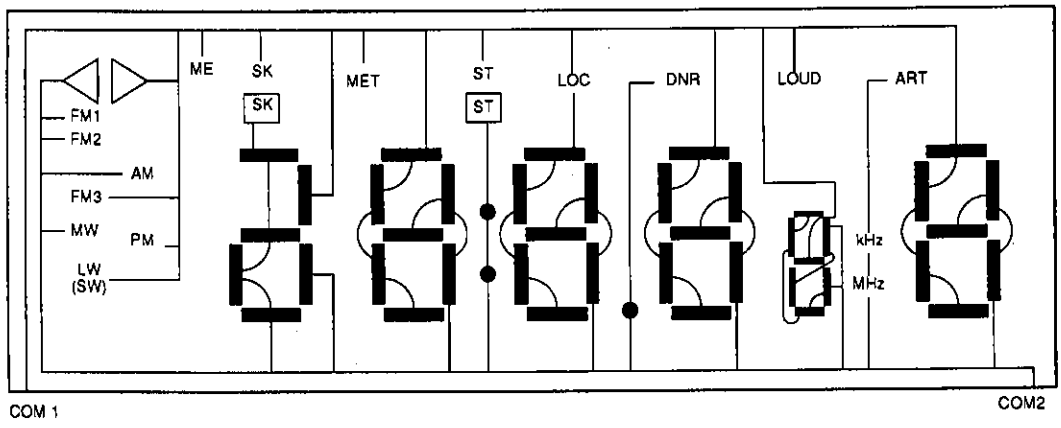


Figure 4. Commons

The LCD drive waveforms are shown in figure 5.

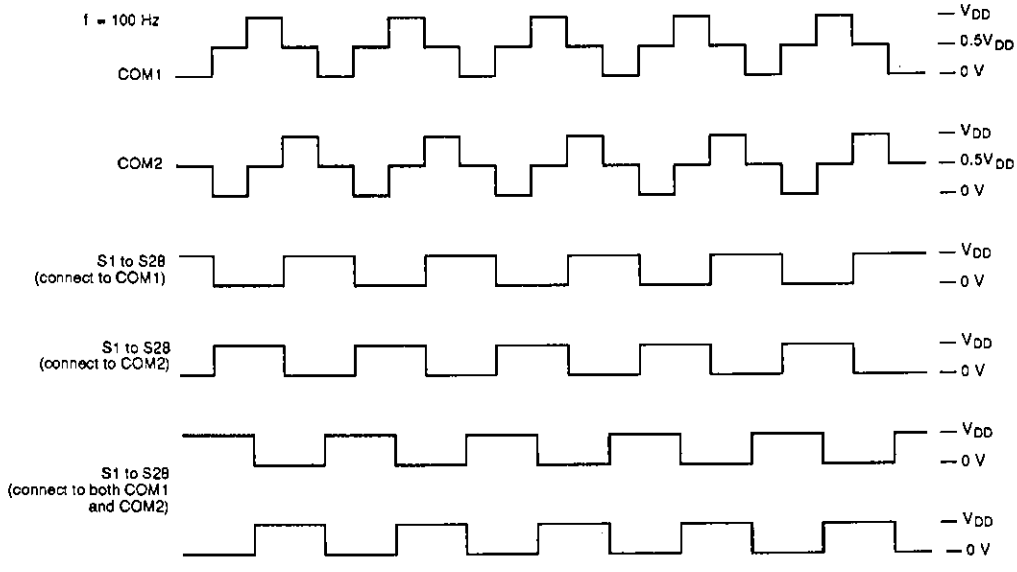


Figure 5. LCD drive waveforms

FUNCTIONAL DESCRIPTION

Band Frequencies

Table 1. Band frequencies

Region	Band	Reception frequency	Channel spacing	Comparison frequency	IF
Japan	FM A	76.0 to 90.0 MHz	100 kHz	50 kHz	−10.7 MHz
	MW A	522 to 1629 kHz	9 kHz	9 kHz	450 kHz
U.S.A.	FM B	87.5 to 108.0 MHz	100 kHz	50 kHz	10.7 MHz
	FM C	87.5 to 108.1 MHz	200 kHz	50 kHz	10.7 MHz
	MW B	530 to 1620 kHz	10 kHz	10 kHz	450 kHz
	MW C	531 to 1620 kHz	9 kHz	9 kHz	450 kHz
Europe	FM D	87.5 to 108.0 MHz	25 kHz	12.5 kHz	10.7 MHz
	FM E	87.5 to 108.0 MHz	50 kHz	12.5 kHz	10.7 MHz

Table 1. Band frequencies—continued

Region	Band	Reception frequency	Channel spacing	Comparison frequency	IF
Europe	MW D	531 to 1620 kHz	9 kHz	9 kHz	450 kHz
	MW E	522 to 1620 kHz	9 kHz	9 kHz	450 kHz
	LW A	153 to 281 kHz	1 kHz	1 kHz	450 kHz
	LW B	146 to 290 kHz	1 kHz	1 kHz	450 kHz
	SW	5940 to 6210 kHz	5 kHz	5 kHz	450 kHz

Keypad Matrix

The keypad input port matrix is shown in figure 6. The symbols in this figure are defined in figure 7.

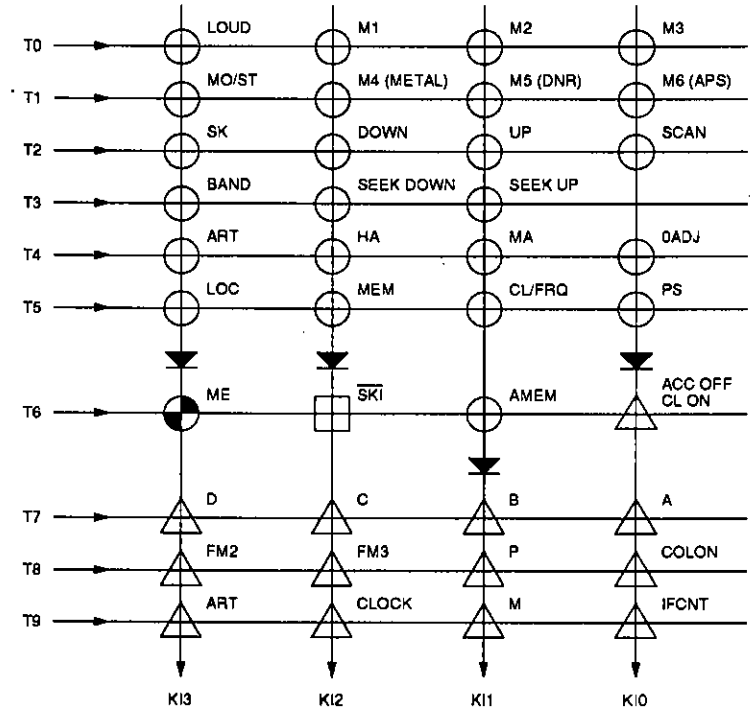


Figure 6. Keypad matrix

Note

KI0 to KI3 have internal pull-down resistors.

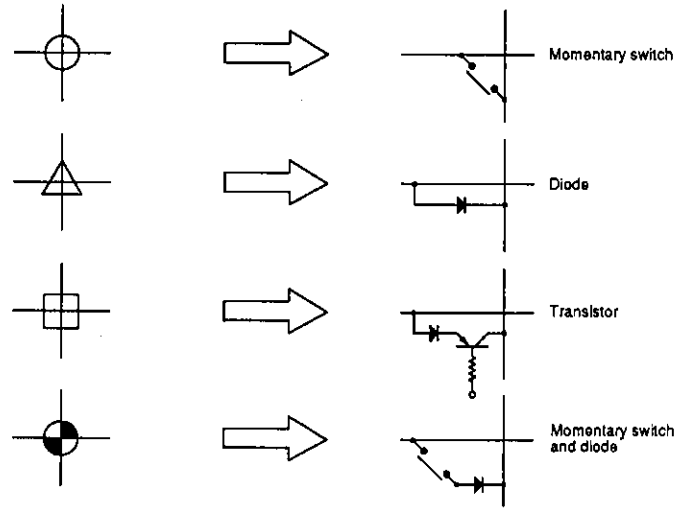


Figure 7. Symbol definitions

Diode Matrix

The diode matrix is read when the LC7230-8221 is initialized and RADIO is selected.

The frequency band is selected by the A, B, C and D diode connections as shown in table 2.

Table 2. Regional frequency band selection

D	C	B	A	Region	Band	Channel spacing (kHz/step)
0	0	0	0	U.S.A.	FM C	200
					MW B	10
0	0	0	1		FM B	100
					MW B	10
0	1	0	1		FM C	200
					MW C	9
1	0	1	0		FM B	100
					MW C	9
0	0	1	0	Europe	FM E	50
					MW D	9
0	1	0	0		FM D	25
					MW D	9
					LW	1
1	0	0	0		FM D	25
					MW D	9
0	0	1	1		FM D	25
					MW D	9
					SW	5
0	1	1	0		FM E	50
					MW D	9
					LW A	1

Table 2. Regional frequency band selection—continued

D	C	B	A	Region	Band	Channel spacing (kHz/step)
1	0	0	1	Europe	FM E	50
					MW E	9
					LW B	1
0	1	0	1	Japan	FM C	200
					MW C	9
1	0	1	0		FM B	100
					MW C	9

Note
1 = diode connected
0 = no diode connected

The number of FM frequency bands that can be received is selected by the FM2 and FM3 diode connections as shown in table 3.

Table 3. FM frequency bands selection

FM2	FM3	Bands	Stations
0	0	FM1	6
1	0	FM1, FM2	12
0	1	FM1, FM2, FM3	18
1	1	Illegal	-

Note
1 = diode connected
0 = no diode connected

The preset memory selection method is selected by the M diode connection as shown in table 4.

Table 4. Preset memory selection

M	Selection method
0	Six-key
1	Single-key

Note
1 = diode connected
0 = no diode connected

The display priority is selected by the P diode connection as shown in table 5.

Table 5. Display priority selection

P	Display priority
0	Frequency
1	Time

Note
1 = diode connected
0 = no diode connected

The colon display is selected by the COLON diode connected as shown in table 6.

Table 6. Colon display selection

COLON	Colon display
0	ON
1	Flashing at 1 Hz

Note
1 = diode connected
0 = no diode connected

The IF output control is selected by the IFCNT diode connection as shown in table 7.

Table 7. IF output control selection

IFCNT	IF output control
0	No
1	Yes

Note
1 = diode connected
0 = no diode connected

The clock function is selected by the CLOCK diode connection as shown in table 8.

Table 8. Clock selection

CLOCK	Clock selection
0	Yes
1	No

Note
1 = diode connected
0 = no diode connected

The auto-retune function is selected by the ART diode connection as shown in table 9. Note that if ART is not selected, the M6 key also functions as the APS key.

Table 9. Auto-retune selection

ART	Auto-retune selection
0	No
1	Yes

Note
1 = diode connected
0 = no diode connected

The clock display when the car ignition is turned OFF (accessories OFF) is selected by the ACC OFF CL ON diode connection as shown in table 10.

Table 10. ACC OFF CL ON selection

ACC OFF CL ON	Clock display selection
0	No
1	Yes

Note
1 = diode connected
0 = no diode connected

Key Functions

Dual-function keys

The M4/METAL, M5/DNR and M6/APS keys have dual functions when a European frequency band is selected.

When $\overline{\text{DKIN}}$ goes LOW while RADIO is active, they function as the M4, M5 and M6 keys, and when $\overline{\text{DKIN}}$ goes HIGH while TAPE is active, as the METAL, DNR and APS keys, respectively.

M1 to M6 keys

The M1 to M6 keys are used to write data to and read data from the preset-channel memory using the six-key method as shown in figure 8.

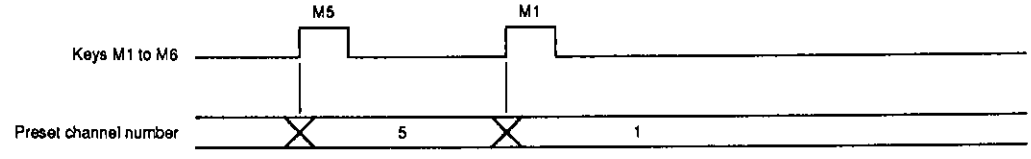


Figure 8. M1 to M6 six-key method

MEM key

The MEM key is used to write data to and read data from the preset-channel memory using the single-key method as shown in figure 9.

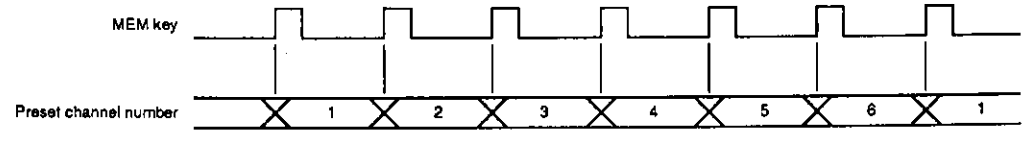


Figure 9. MEM single-key method

ME key

Frequency display mode

In frequency display mode, the ME key writes the current frequency into the preset-channel memory. The frequency can be written using either the six-key or single-key method.

In the six-key method, the ME indicator flashes when the ME key is pressed, indicating that the frequency can be written to a memory. If one of the M1 to M6 keys is pressed within the next five seconds, the frequency is written to the corresponding channel memory, as shown in figure 10, and the number of the channel is displayed.

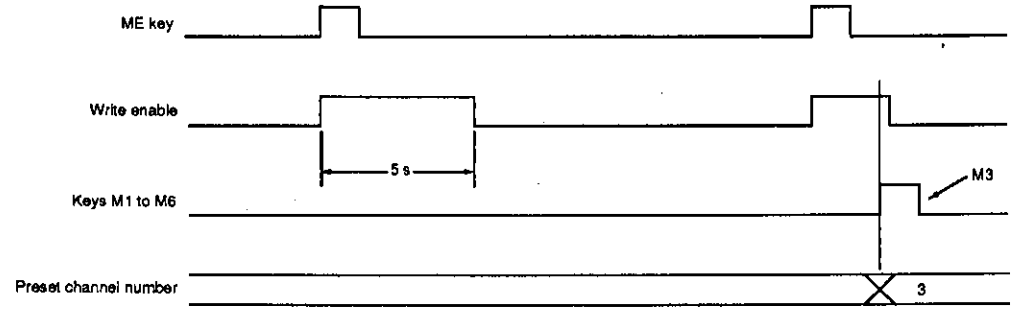


Figure 10. Writing to memory using the six-key method

In the single-key method, the current preset-channel number flashes at 2 Hz when the ME key is pressed, indicating that the frequency can be written to that channel during the next five seconds. If the MEM key is pressed for less than 1.5 s, the next channel number is displayed, and the five-second timer, restarted. If the MEM key is pressed for longer than 1.5 s, the current frequency is written to the displayed channel as shown in figure 11.

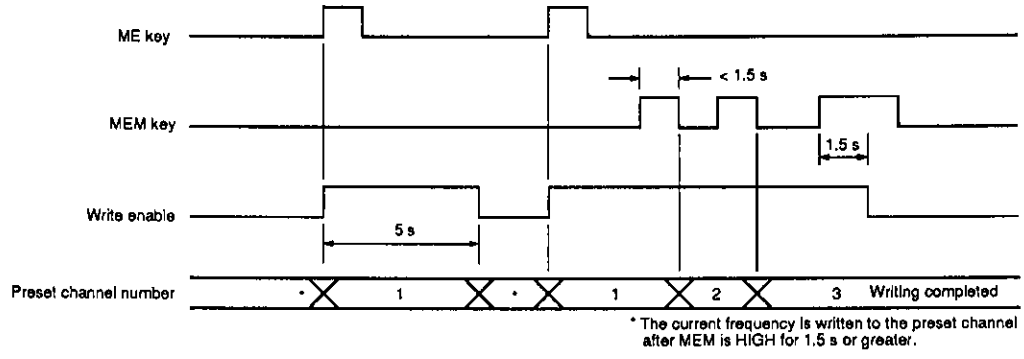


Figure 11. Writing to memory using the single-key method

Time display mode

In time display mode, the ME key is used to adjust the current time. The time can be adjusted by pressing either the HA, MA or 0ADJ keys while continuously pressing ME. In the six-key method, the M1 and M2 keys can be used instead of the HA and MA keys, respectively.

SCAN key

The SCAN key is used to initiate a station scan. During a scan, the controller pauses on each station for a period of 5 s before scanning for the next station. The controller pauses for 500 ms when crossing bands. The scan speed is 40 ms/step for FM and 60 ms/step for AM. If SCAN is pressed again while scanning has paused on a station, the scan halts on that station. Scanning is exited if SCAN is pressed twice. If SEEK UP or SEEK DOWN is pressed while scanning, seek mode is selected.

UP and DOWN keys

The UP and DOWN keys are used to tune a receiver manually. The current frequency changes up or down by one step each time the UP or DOWN key is pressed, respectively. If UP or DOWN is pressed for longer than 500 ms, the frequency changes by approximately 70 ms/step. Note that the controller pauses for approximately 500 ms when crossing bands. See figure 18.

BAND key

The BAND key is used to select the frequency band. The band is selected in the order shown in figure 12. Note that the FM2 and FM3 bands can only be selected if there is a corresponding diode connection in the diode matrix.

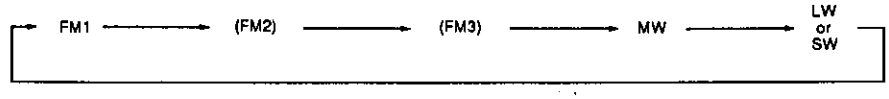


Figure 12. Frequency band selection

HA and M1 keys

The HA and M1 keys are used to increment the current time by one hour. The time is incremented when both the ME key and either the HA or M1 key are pressed simultaneously. If the keys are pressed for longer than 500 ms, the time is incremented by 4 hours/s. The minute and second digits remain unaffected.

MA and M2 keys

The MA and M2 keys are used to increment the current time by one minute. The time is incremented and the second digit is reset to zero when both the ME key and either the MA or M1 key are pressed simultaneously. If the keys are pressed for longer than 500 ms, the time is incremented by 8 min/s. The hour digits remain unaffected.

0ADJ key

The 0ADJ key is used to reset the current-time minute and second digits to zero. The digits are reset when both the ME key and the 0ADJ key are pressed simultaneously. If the minute digits are 30 or lower, the hour digits remain unaffected. If the minute digits are 31 or greater, the hour digits are incremented by one.

SEEK UP and SEEK DOWN keys

The SEEK UP and SEEK DOWN keys are used to initiate station seek in the upward and downward directions, respectively. The controller pauses for 500 ms when crossing bands. The scan speed is 40 ms/step for FM and 60 ms/step for AM. The station seek is halted when a station is detected. If the key for the opposite direction is pressed during seek, the seek changes to that direction. If a seek key is pressed twice in succession, seek mode is deselected.

If the SCAN key is pressed during seek, scan mode is selected. Scanning is in the upward direction regardless of the direction during seek.

PS key

The PS (preset scan) key is used to scan all the preset channels in order of increasing channel number. The FM bands are scanned in the order shown in figure 13. If a channel number is not currently being displayed, the scan starts from channel 1. The scan pauses for 5 s on each preset station for which a signal is being received. During preset scan, the channel numbers flash at 2 Hz. Preset scan is deselected by pressing the PS key twice.

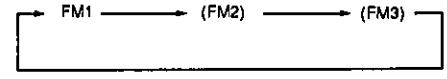


Figure 13. Preset scan of FM bands

ART key

The ART (auto-retune) key is used to initiate continuous monitoring of the received signal strength and to retune the receiver when the signal strength is too low. The stop detector input on SD is LOW when the FM IF level is 50 dBμ or lower or when the AM IF level is 30 dBμ or lower.

The receiver is retuned to preset-channel 1 every 22 s, as shown in figure 14, if SD has been LOW continuously for eleven of those 22 seconds. If SD is still LOW, retuning is halted, and if SD is HIGH, the receiver is retuned to preset-channel 2. If SD is still HIGH, seek mode in the upward direction is selected.

LOUD, MO/ST, DNR, METAL, APS and SK keys

The LOUD, MO/ST, DNR, METAL, APS and SK keys are used to select various control inputs, as shown in table 12, which are output on the pins having the same name, respectively.

Table 12. Control functions

Key	Indicator		Output level
	Name	Display	
LOUD	LOUD	OFF	LOW
		ON	HIGH
MO/ST	ST	ON	LOW
		OFF	HIGH
DNR	DNR	OFF	LOW
		ON	HIGH
METAL	METAL	OFF	LOW
		ON	HIGH

Table 12. Control functions—continued

Key	Indicator		Output level
	Name	Display	
APS	APS	OFF	LOW
		ON	HIGH
SK	SK	OFF	LOW
		ON	HIGH

The SK key is used only for the European frequency bands. The SK indicator is displayed when the SK key is pressed.

In SK mode, the SKO output goes HIGH and the band is searched for an SK broadcasting station. The search function is shown in table 13. The search is halted when $\overline{SKI}$ goes LOW.

Table 13. SK search functions

SK mode	$\overline{SK}$ station ($\overline{SKI}$ is LOW.)	SK is pressed	SEEK UP or SEEK DOWN is pressed	SEEK UP or SEEK DOWN is pressed during seek	SK is pressed during seek
OFF	OFF	Enters SK mode and initiates SK station search	Initiates normal station search	Stops at the current frequency	Enters SK mode and searches for an SK station
OFF	ON	Enters SK mode	Initiates normal station search	Stops at the current frequency	Enters SK mode and searches for an SK station
ON	OFF	Exits SK mode	Initiates SK station search	Stays in SK mode and stops at the current frequency	Exits SK mode and searches for a normal station
ON	ON	Enters SK mode and initiates SK station search	Initiates normal station search	Stops at the current frequency	Enters SK mode and searches for an SK station

$\overline{SD}$ and ADI

The input conditions for station detection during station search, and field strength detection, during auto-retune and auto-memory, are shown in table 14.

Table 14. Input conditions

Mode	FM	AM
Station search	$\overline{SD}$ is LOW.	$\overline{SD}$ is LOW.
Auto-retune	$\overline{SD}$ is LOW.	$\overline{SD}$ is LOW.
Auto-memory	ADI and $\overline{SD}$ are LOW.	$\overline{SD}$ is LOW.

Transistor Matrix Switch

When the transistor matrix input switches $\overline{SKI}$ to LOW, the SK indicator is displayed. The input at SK is valid only for FM bands in the European frequency specification. Note that this input should not be left floating.

The initial state for each operating mode is shown in table 15.

Table 15. Initial states

Mode	Initial state
Radio	FM1 band, MONO, LOC = DX, SK is OFF.
Tape	DNR, METAL and APS are OFF.
Others	LOUD is OFF.

The frequencies shown in table 16 are loaded into the preset memory at initialization.

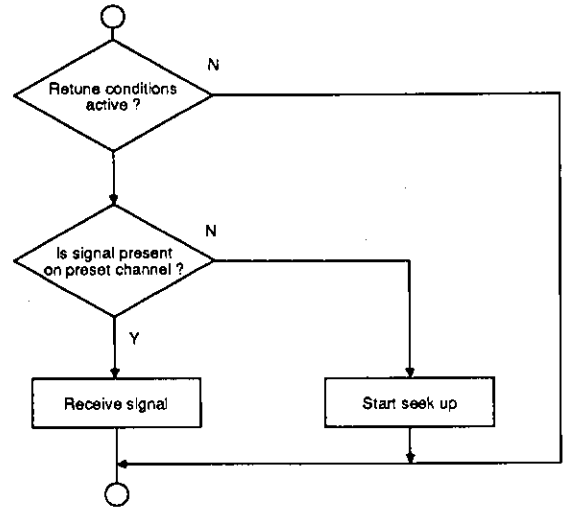


Figure 14. Auto-retune flow

The time constants of the lowpass filter and SD input circuit should be such that the PLL locks and the SD input is valid within 200 ms following a preset-channel change.

AMEM key

The AMEM (auto-memory) key is used to store stations in the preset-channel memory. The channel number 8 flashes when the AMEM key is pressed.

In FM mode, stations within each of the FM1, FM2 or FM3 bands are stored in order of descending signal strength starting from channel 1. Stations can be stored in order of ascending frequency by connecting ADI to VDD.

In AM mode, stations are always stored in order of ascending frequency.

Preset channels that do not have a station frequency are set to activate channel 1.

LOC key

The LOC key is used to switch the SCAN, SEEK, AMEM and LOC port so that distant stations are not tuned when in seek mode. The display status is shown in table 11.

Table 11. LOC key functions

Mode	Key	Display status	Normal port status	Port status during search
Radio	LOC	ON	LOW	HIGH
		OFF	LOW	LOW

CL/FRQ key

The CL/FRQ is used to change the display mode. When the display is in time priority mode, the display mode changes as shown in figure 15, and when in frequency priority mode, as shown in figure 16.

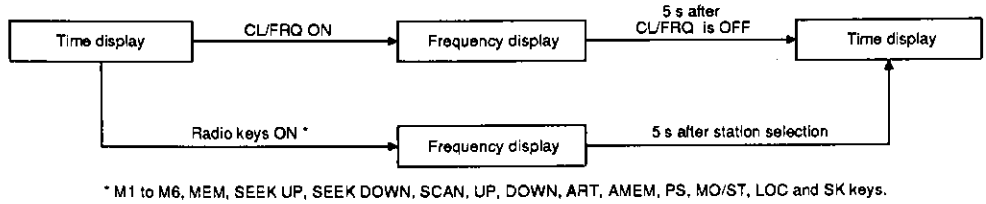


Figure 15. Time priority mode

Figure 16. Frequency priority mode

If any of the radio function keys are pressed when the time is displayed, the frequency is displayed.

Table 16. Initialization frequencies

Region	Band	M1	M2	M3	M4	M5	M6
Japan	FM A (MHz)	76.0	78.6	83.0	86.6	90.0	76.0
	MW A (kHz)	522	612	999	1404	1629	522
U.S.A.	FM B (MHz) FM C (MHz)	87.5	90.1	98.1	106.1	107.9	87.5
	MW B (kHz)	530	610	1000	1400	1620	530
	MW C (kHz)	531	612	999	1404	1620	531
Europe	FM D (MHz) FM E (MHz)	87.5	90.0	98.0	106.0	108.0	87.5
	MW D (kHz) MW E (kHz)	531	612	999	1404	1620	531
	LW A (kHz) LW B (kHz)	153	160	200	260	281	153
	SW (kHz)	5940	6000	6100	6200	6210	5940

The output signal levels for switching the frequency band power supplies are shown in table 17.

Table 17. Output signal band switching

Band	$\overline{\text{FMVCC}}$	$\overline{\text{AMVCC}}$	M/L(S)
FM	LOW	HIGH	HIGH
AM	HIGH	LOW	HIGH
LW or SW	HIGH	LOW	LOW

Timing

The timing for seek and scan, manual tuning and auto-retune are shown in figures 17, 18 and 19, respectively.

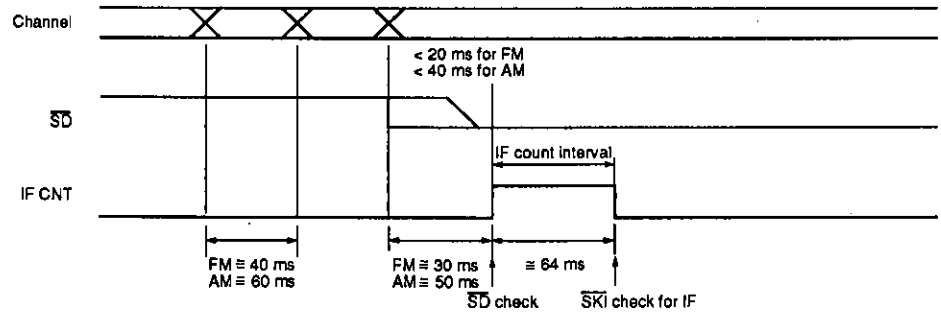


Figure 17. Seek and scan timing

Note

Channel spacing is 100 kHz/step. When $\overline{\text{SD}}$ is active, IF count tuning is used during preset memory search and seek up. The IF count range is as shown in table 18.

Table 18. IF count range

Band	Range
FM	10.7 MHz ±10 kHz
MW, SW	450 ±3 kHz
LW	450 kHz ±600 Hz

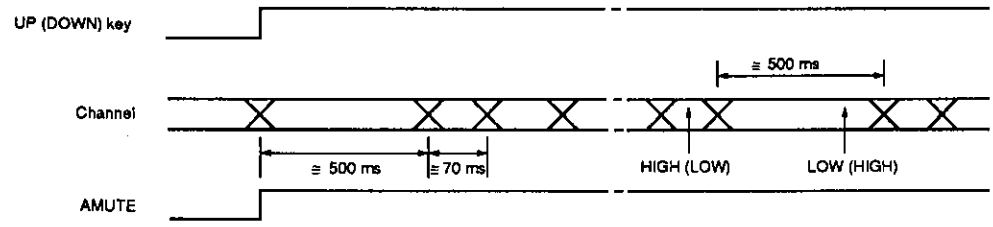


Figure 18. Manual tuning timing

Note
Channel spacing is 100 kHz/step.

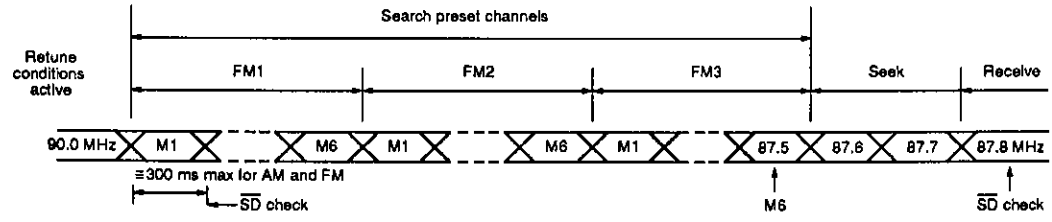


Figure 19. Auto-retune timing

Note
Channel spacing is 100 kHz/step.

The audio muting timing is shown in figures 20 to 26.
The numbers in the figures correspond to the following.

1. 40 ms keybounce interval
2. 50 ms audio muting lead time
3. 20 to 80 ms inter-station pause and data transfer to the PLL
4. Audio muting release time

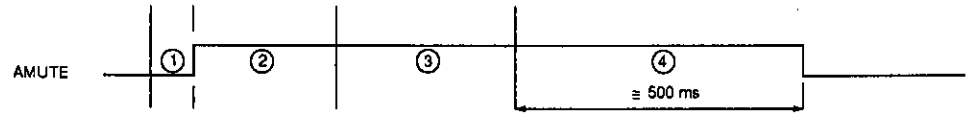


Figure 20. Bandswitching and preset reading

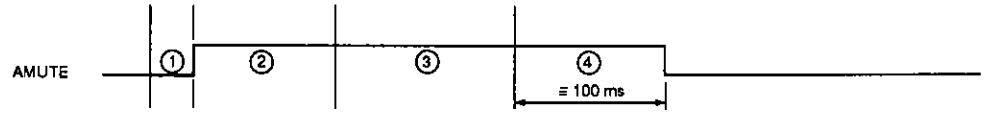


Figure 21. Manual frequency increment/decrement

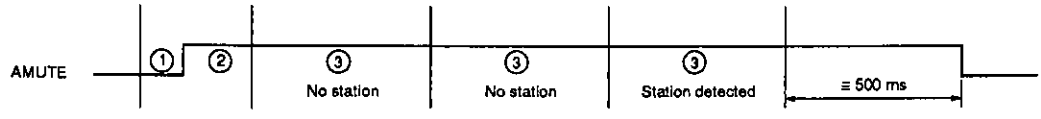


Figure 22. Seek and scan

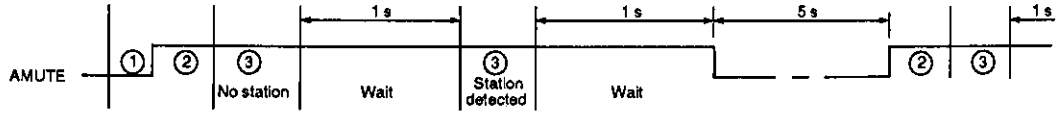


Figure 23. Preset scan

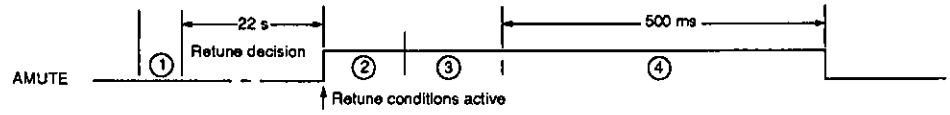


Figure 24. Auto-retune

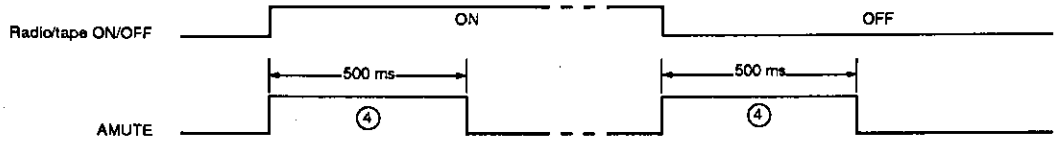


Figure 25. Radio and tape ON/OFF

Figure 26. Initial power-up

RADIO and TAPE

The RADIO and TAPE inputs for operation with and without a clock are shown in tables 19 and 20, respectively.

Table 19. Operation with clock

Function	RADIO	TAPE	Mode	Display	Key operation. See note 1.	
Tape and radio	0	0	Hold	Time. See note 4.	A. See note 4.	
Tape and radio	0	1	Time (adjustable), tape	Time and tape-related indicators	A, B	
Tape and radio	1	0	Radio, time (adjustable)	Time or radio-related indicators	A, C	
Traffic information (SK feature)	1. See note 3.	1. See note 3.	Tape and radio	Tape indicators normally displayed, time or radio indicators. See note 2.	$\overline{\text{DKIN}}$ is HIGH.	A, B, SK and C, excluding M3 to M6
					$\overline{\text{DKIN}}$ is LOW.	A, C and SK

Notes

1. A = HA, MA and 0ADJ keys (used for clock operation)
   B = DNR, METAL, LOUD and APS keys (used for tape operation)
   C = BAND, M1 to M6, MEM, UP, DOWN, SEEK UP, SEEK DOWN, SCAN, ART, PS, AMEM, MO/ST, LOC, LOUD, CL/FRQ keys (used for radio operation)
2. Selected by P junction of the diode matrix. The frequency and LOUD are displayed when P = 0, and the time, LOC, MO/ST and LOUD, when P = 1.
3. RADIO = 1 and TAPE = 1 for European frequency bands only
4. Selected by the ACC OFF CL ON junction of the diode matrix. All keys are ignored when ACC OFF CL ON = 0. HA, MA, 0ADJ and the time are displayed when ACC OFF CL ON = 1.

Table 20. Operation without clock

Function	RADIO	TAPE	Mode	Display	Key operation. See note 1.	
Tape and radio	0	0	Standby	None	All keys are ignored.	
Tape and radio	0	1	Tape	Tape function indicators only	B	
Tape and radio	1	0	Radio	Radio function indicators only	C	
Traffic information (SK feature)	1. See note 2.	1. See note 2.	Tape and radio	Tape and radio indicators normally displayed	$\overline{DKIN}$ is HIGH.	B, SK and C, excluding M3 to M6
					$\overline{DKIN}$ is LOW.	C and SK

Notes

1. A = HA, MA and 0ADJ keys (used for clock operation)
   B = DNR, METAL, LOUD and APS keys (used for tape operation)
   C = BAND, M1 to M6, MEM, UP, DOWN, SEEK UP, SEEK DOWN, SCAN, ART, PS, AMEM, MO/ST, LOC, LOUD, CL/FRQ keys (used for radio operation)
2. Selected by P junction of the diode matrix. The frequency and LOUD are displayed when P = 0, and the time, LOC, MO/ST and LOUD, when P = 1.
3. RADIO = 1 and TAPE = 1 for European frequency bands only
4. Selected by the ACC OFF CL ON junction of the diode matrix. All keys are ignored when ACC OFF CL ON = 0. HA, MA, 0ADJ and the time are displayed when ACC OFF CL ON = 1.

The connection for tape and radio functions is shown in figure 27, and for tape, radio and traffic information functions, in figure 28.

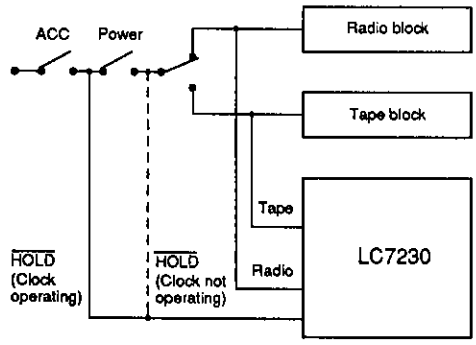


Figure 27. Connection for tape and radio functions

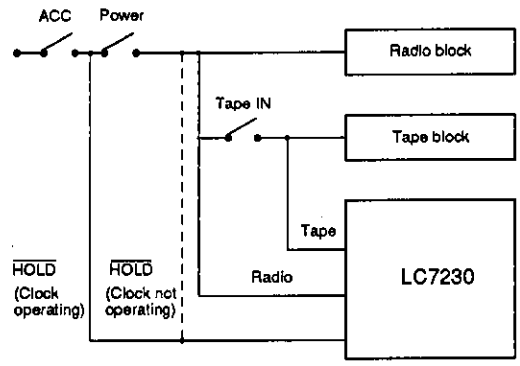


Figure 28. Connection for tape, radio and traffic information functions

Standby mode

This mode is set by driving $\overline{\text{HOLD}}$ LOW as shown in figure 29.

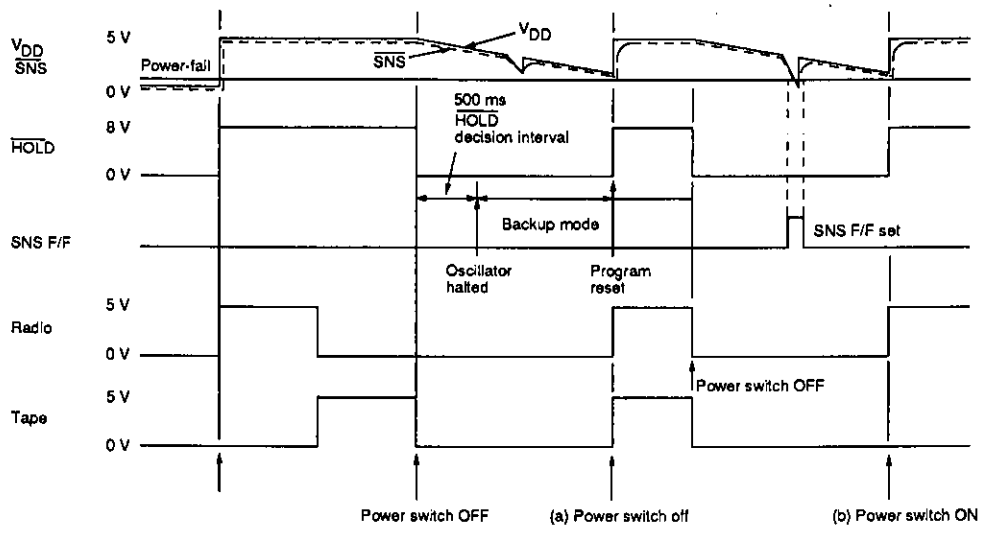


Figure 29. Standby mode

The LC7230-8221 exits standby mode at point *a*. The memory retains its data when $\overline{\text{SNS}}$ remains above the power-fail voltage. The LC7230-8221 also exits standby mode at point *b*. Memory data is initialized when $\overline{\text{SNS}}$ drops below the power-fail voltage.

Hold mode

FMIN, AMIN, HCTR, LCTR and ADI are ignored, but the clock continues to operate.

DESIGN NOTES

AM Tuner

The AM IF signal should be maintained at the level shown in figure 30 when the IF count signal is output.

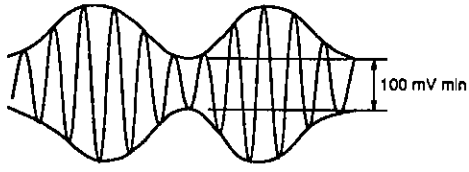


Figure 30. AM IF signal level

FM Tuner

The FM IF signal should be maintained at the level shown in figure 35 when the IF count signal is output.

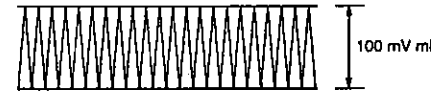


Figure 31. FM IF signal level

TYPICAL APPLICATIONS

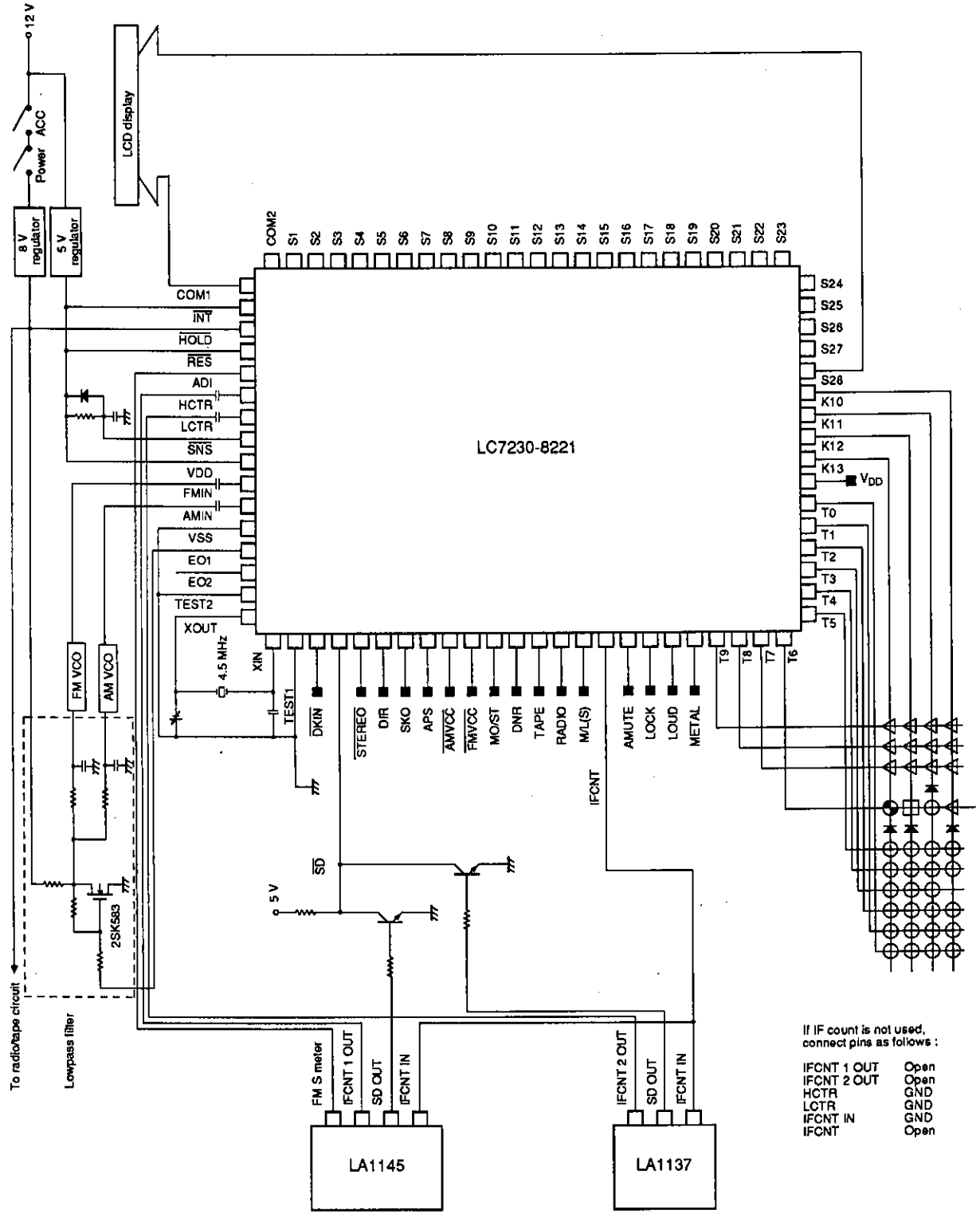


Figure 32. Without clock

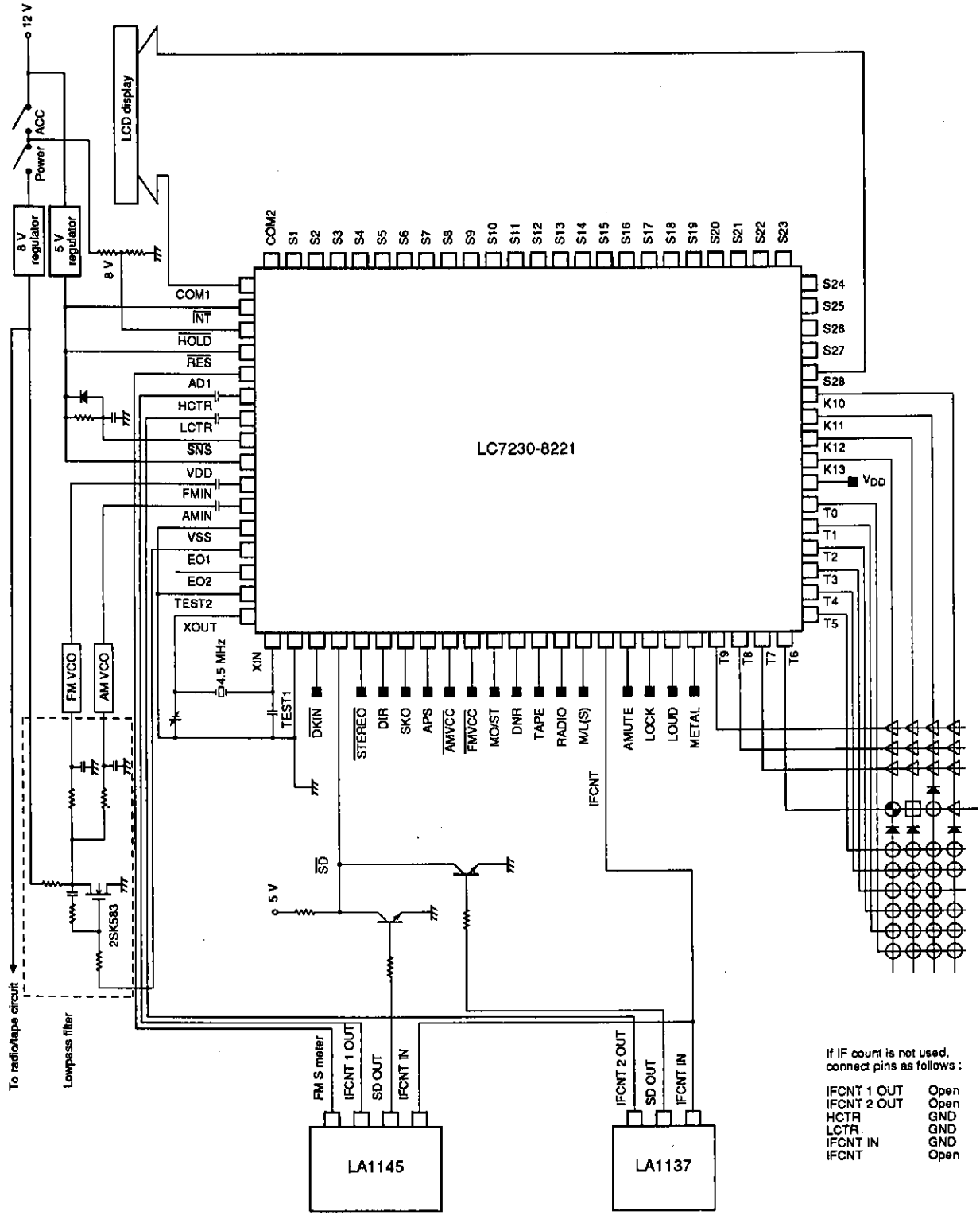


Figure 33. With clock

Ordering number: EN3100A

CMOS LSI

SANYO No.3100A

LC7230-8272

Single-Chip PLL Controller

Overview

The LC7230-8272 is a PLL, LCD driver-contained electronic tuning-use single-chip microcontroller designed for reception of LW/MW/SW/FM bands in the U.S.A., Europe, Japan and South Africa.

1. Functions and Features

(1) Receiving frequency

Area	Band	Receiving Frequency Range FM (MHz) Others (kHz)	Reference Frequency (kHz)	Step (kHz)	IF FM (MHz) Others (kHz)	Diode Matrix $B_2B_1B_0$
JAPAN	FM	76.0 to 90.0	50	100	−10.7	1 0 0
	MW	531 to 1611	9	9	450/468	
		(531 to 1629)	(9)	(9)	(↑)	
USA	FM	87.9 to 107.9	50	200/100	10.7	0 0 0
	MW	530 to 1610	10	10	450	
		(530 to 1720)	(10)	(10)	(↑)	
	FM	87.9 to 107.9	50	200/100	10.7	1 1 1
	MW	522 to 1611	9	9	450/468	
		(522 to 1719)	(9)	(9)	(↑)	
EUROPE	FM	87.50 to 108.00	25	50	10.7	0 0 1
	MW	531 to 1602	9	9	450/468	
		(522 to 1611)	(9)	(9)	(↑)	
	LW	153 to 281	1	1	450/468	
		(146 to 290)	(1)	(1)	(↑)	
	FM	87.50 to 108.00	25	50	10.7	0 1 0
	MW	531 to 1602	9	9	450/468	
		(522 to 1611)	(9)	(9)	(↑)	
	LW	153 to 281	1	1	450/468	
		(146 to 290)	(1)	(1)	(↑)	
	SW	SW1 5800 to 7300	5	5	450	
		SW2 9500 to 18000				
	FM	87.50 to 108.00	25	50	10.7	0 1 1
	MW	531 to 1602	9	9	450/468	
		(522 to 1611)	(9)	(9)	(↑)	
	LW	153 to 281	1	1	450/468	
		(146 to 290)	(1)	(1)	(↑)	
	SW	SW1 3200 to 7300	5	5	450	
		SW2 9500 to 18000	5	5	↑	
S.AFRICA	FM	87.50 to 108.00	25	50	−10.7	1 1 0
	MW	531 to 1602	9	9	450/468	
		(522 to 1611)	(9)	(9)	(↑)	
	LW	153 to 281	1	1	450/468	
		(146 to 290)	(1)	(1)	(↑)	
	FM	87.50 to 108.00	25	50	−10.7	1 0 1
	MW	531 to 1602	9	9	450/468	
		(522 to 1611)	(9)	(9)	(↑)	
	LW	153 to 281	1	1	450/468	
		(146 to 290)	(1)	(1)	(↑)	
	SW	SW1 5800 to 7300	5	5	450	
		SW2 9500 to 18000				

Note) 1. A frequency in ( ) is selected by using diode matrix "SHIFT".
2. The presence or absence of LW and U.S.A. 200/100 are selected by using diode matrix "LW200".
3. AM IF450/468 is selected by using diode matrix.

(2) Tuning method (Sawtooth wave mode: )
- Manual up/down
- Auto up/down
- Preset call by 8-button method

(3) Preset memory
FM: Mode 1 ..... 8 channels
Mode 2 ..... 8 channles
AM: (MW + LW + SW)
No distinction between mode 1 and mode 2 ... 8 channels
} 24 channels in all

(4) Auto preset scan

(5) Timer function
- Timer ..... Causes turn-ON mode only. Sleep timer (Set to the nearest 10 minutes.)
- Clock ..... 12/24hr mode 12hr: Japan, USA
24hr: Europe, South Africa

(6) Usable with remote control
The LC7461M-8103 is used.

(7) Usable with electronic volume control : 7-dot LED (using the LB1417) display available
The LC7535 is used.

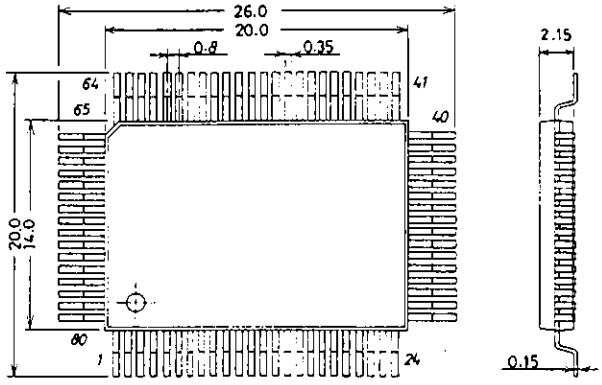
(8) Usable with the function switch : LCD display and LED (using the MLC74HC375) display available.
The LC7821 (N) is used.

(9) On-chip LCD driver : 1/2 duty 1/2 bias frame frequency 100Hz

(10) Single 5V supply

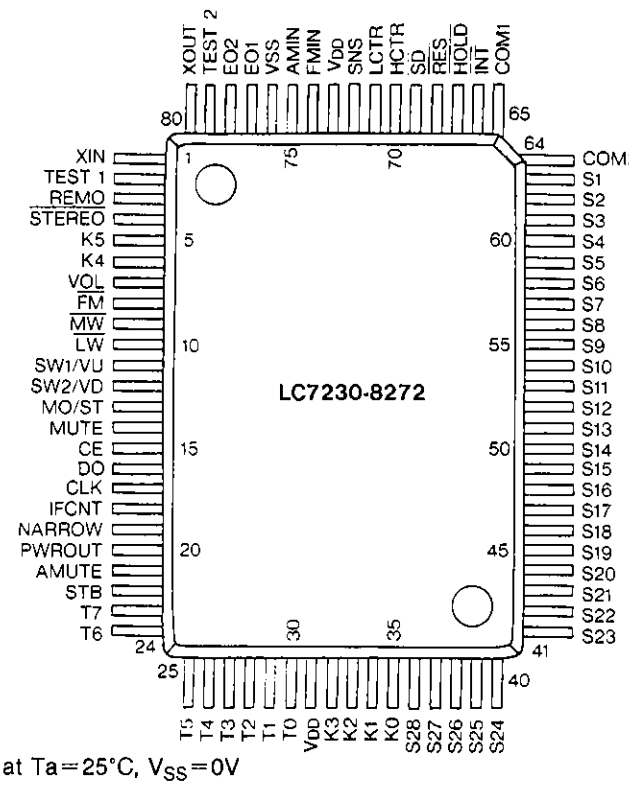
(11) Package : QIP80A

2. Package Dimensions
(unit: mm) 3044B



SANYO: QIP80A

Pin assignment



Absolute Maximum Ratings at Ta=25°C, V_{SS}=0V

				unit
Maximun Supply Voltage	V_{DD} max		−0.3 to +6.5	V
Input Voltage	V_{IN}(1)	$\overline{INT}$,$\overline{RES}$,SNS,$\overline{SD}$,REMO,$\overline{STEREO}$, K5, K4	−0.3 to +6.5	V
	V_{IN}(2)	$\overline{HOLD}$	−0.3 to +13	V
	V_{IN}(3)	Inputs other than V_{IN} (1), V_{IN} (2)	−0.3 to V_{DD} +0.3	V
Output Voltage	V_{OUT} (1)	VOL,$\overline{FM}$,$\overline{MW}$,$\overline{LW}$	−0.3 to +15	V
	V_{OUT} (2)	Outputs other than V_{OUT} (1)	−0.3 to V_{DD} +0.3	V
Output Current	I_{OUT} (1)	NARROW,PWROUT,AMUTE,STB,VOL,$\overline{FM}$,$\overline{MW}$,$\overline{LW}$	0 to 5	mA
	I_{OUT} (2)	CE,DO,CLK,IFCNT,SW1/VU,SW2/VD,MO/ST,MUTE	0 to 3	mA
	I_{OUT} (3)	T0 to T7	0 to 1	mA
Allowable Power Dissipation	Pd max	Ta=−40 to +85°C	400	mW
Operating Temperature	**Topr**		−40 to +85	°C
Storage Temperature	Tstg		−45 to +125	°C

Recommended Operating Conditions at Ta=−40 to +85°C, V_{DD}=3.5 to 5.5V

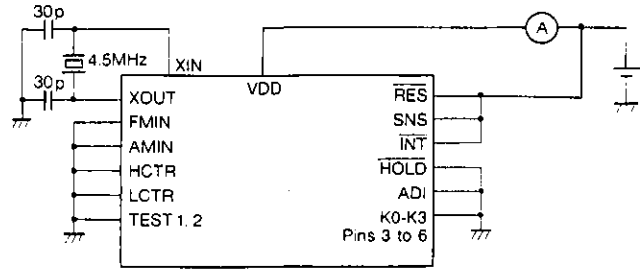
					min	typ	max	unit
Supply Voltage	V_{DD} (1)	PLL operating mode *1			4.5		5.5	V
	V_{DD} (2)	CLOCK operating mode, PLL stopped *2			3.5		5.5	V
	V_{DD} (3)	Memory hold *3			1.3		5.5	V
'H'-Level Input Voltage	V_{IH} (1)	REMO,$\overline{STEREO}$,K5,K4			0.7V_{DD}		5.5	V
	V_{IH} (2)	$\overline{RES}$,$\overline{INT}$,			0.8V_{DD}		5.5	V
	V_{IH} (3)	SNS			2.5		5.5	V
	V_{IH} (4)	K0,K1,K2,K3			0.6V_{DD}		V_{DD}	V
	V_{IH} (5)	CE,DO,CLK,IFCNT,SW1/VU, SW2/VD,MO/ST,MUTE			0.7V_{DD}		V_{DD}	V
	V_{IH} (6)	$\overline{HOLD}$			0.8V_{DD}		8.0	V
'L'-Level Input Voltage	V_{IL} (1)	REMO,$\overline{STEREO}$,K5,K4			0		0.3V_{DD}	V
	V_{IL} (2)	$\overline{RES}$,$\overline{INT}$,$\overline{HOLD}$			0		0.2V_{DD}	V
	V_{IL} (3)	SNS			0		1.3	V
	V_{IL} (4)	K0,K1,K2,K3			0		0.2V_{DD}	V
	V_{IL} (5)	CE,DO,CLK,IFCNT,SW1/VU, SW2/VD,MO/ST,MUTE			0		0.3V_{DD}	V
Input Frequency	f_{IN} (1)	XIN			4.0	4.5	5.0	MHz
	f_{IN} (2)	FMIN	V_{IN} (2)	V_{DD} (1)	10		130	MHz
	f_{IN} (3)	AMIN (MW,LW mode)	V_{IN} (4)	V_{DD} (1)	0.5		10	MHz
	f_{IN} (4)	AMIN (SW mode)	V_{IN} (5)	V_{DD} (1)	2.0		40	MHz
	f_{IN} (5)	HCTR (FMIF)	V_{IN} (6)	V_{DD} (1)	0.4		12	MHz
	f_{IN} (6)	LCTR (AMIF)	V_{IN} (7)	V_{DD} (1)	100		500	kHz
Input Amplitude	V_{IN} (1)	XIN			0.50		1.5	Vrms
	V_{IN} (2)	FMIN			0.10		1.5	Vrms
	V_{IN} (3)(4)	AMIN (MW,LW mode)			0.10		1.5	Vrms
	V_{IN} (5)(6)	HCTR,LCTR			0.10		1.5	Vrms
Input Voltage Range	V_{IN} (7)	$\overline{SD}$			0		V_{DD}	V

Refer to the item "Relationship of set type, power source and current" for *1, *2 and *3.

Electrical Characteristics/under the allowable operating conditions			min	typ	max	unit
Hysteresis Width	V_H	$\overline{RES}$,$\overline{HOLD}$,$\overline{INT}$	0.1 V_{DD}			V
Reject Pulse Width	P_{REJ}	SNS			50	μs
'H'-Level Input Current	I_{IH} (1)	$\overline{INT}$,$\overline{HOLD}$,$\overline{RES}$,$\overline{SD}$,SNS,REMO, $\overline{STEREO}$,K5,K4,V_I=5.5V			30	μA
	I_{IH} (2)	XIN,V_I=V_{DD}=5.0V	2.0	5.0	15	μA
	I_{IH} (3)	FMIN,AMIN,HCTR,LCTR, V_I=V_{DD}=5.0V	4.0	10	30	μA
	I_{IH} (4)	K0,K1,K2,K3,V_I=V_{DD}=5.0V		50		μA
'L'-Level Input Current	I_{IL} (1)	V_I=V_{SS}			3.0	μA
	I_{IL} (2)	V_I=V_{SS}	2.0	5.0	15	μA
	I_{IL} (3)	V_I=V_{SS}	4.0	10	30	μA
Input Floating Voltage	V_{IF}	K0,K1,K2,K3			0.05 V_{DD}	V
Pull-down Resistance	R_{PD}	K0,K1,K2,K3	75	100	200	KΩ
(Output OFF-State	I_{OFFH} (1)	EO1,EO2,V_O=V_{DD}		0.01	10	nA
(Leakage Current (High)	I_{OFFH} (2)	T0 to T7,STB,AMUTE,PWROUT,NARROW, IFCNT,CLK,DO,CE,MUTE,MO/ST,SW1/VU, SW2/VD:V_O=V_{DD}			3.0	μA
	I_{OFFH} (3)	V_{OL},$\overline{FM}$,$\overline{MW}$,$\overline{LW}$,V_O=13V			5.0	μA
(Output OFF-State	I_{OFFL} (1)	EO1,EO2,V_O=V_{SS}		0.01	10	nA
(Leakage Current (Low)	I_{OFFL} (2)	T0 to T7,STD,AMUTE,PWROUT,NARROW, IFCNT,CLK,DO,CE,MUTE,MO/ST,SW1/VU, SW2/VD			3.0	μA
'H'-Level Output Voltage	V_{OH} (1)	T0 toT7,I_O=1mA	V_{DD}−2.0	V_{DD}−1.0	V_{DD}−0.5	V
	V_{OH} (2)	CLK,DO,CE,MUTE,MO/ST, SW1/VU,SW2/VD:I_O=1mA	V_{DD}−1.0			V
	V_{OH} (3)	EO1,EO2:I_O=500μA	V_{DD}−1.0			V
	V_{OH} (4)	XOUT:I_O=200μA	V_{DD}−1.0			V
	V_{OH} (5)	S1 to S28:I_O=−0.1mA	V_{DD}−1.0			V
	V_{OH} (6)	NARROW,PWROUT,AMUTE, STB:I_O=5mA	V_{DD}−1.0			V
	V_{OH} (7)	COM1,COM2:I_O=20μA	V_{DD}−0.7	V_{DD}−0.5	V_{DD}−0.35	V
'L'-Level Output Voltage	V_{OL} (1)	T0 to T7:I_O=1mA	0.5	1.0	2.0	V
	V_{OL} (2)	CLK,DO,CE,MUTE,MO/ST,SW1/VU, SW2/VD:I_O=1mA			1.0	V
	V_{OL} (3)	EO1,EO2:I_O=500μA			1.0	V
	V_{OL} (4)	XOUT:I_O=200μA			1.0	V
	V_{OL} (5)	S1 to S28:I_O=0.1mA			1.0	V
	V_{OL} (6)	NARROW,PWROUT,AMUTE, STB:I_O=5mA			1.0	V
	V_{OL} (7)	COM1,COM2:I_O=20μA	0.35	0.5	0.7	V
	V_{OL} (8)	VOL,$\overline{FM}$,$\overline{MW}$,$\overline{LW}$:I_O=5mA	0.75 (150Ω)		2.0 (400Ω)	V
'M'-Level Output Voltage	V_M (1)	COM1,COM2,V_{DD}=5.0V,I_O=20μA	2.0	2.5	3.0	V
Supply Current	I_{DD} (1)	V_{DD} (1),f_{IN} (2)=130 MHz, PLL operating mode*4		15	25	mA
	I_{DD} (2)	V_{DD} (2),CLOCK operating mode (PLL stopped,HOLD mode,Fig.1)*5		2	3	mA
	I_{DD} (3)	V_{DD}=5.5V,OSC stopped, Ta=25°C,*6 (Backup mode,Fig.2)			5	μA
		V_{DD}=2.5V,OSC stopped,Ta=25°C, (Backup mode,Fig.2)			1	μA

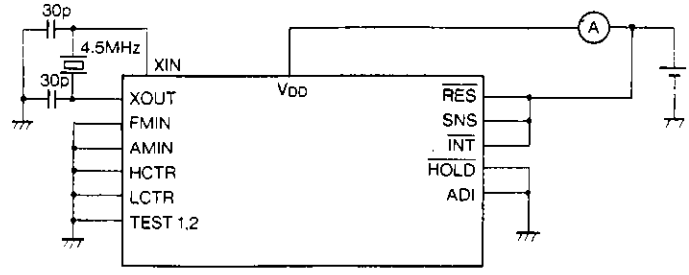
Refer to the item "Relationship of set type, power source and current" for *4, *5 and *6.

Unit (capacitance: F)



Note) Pins 7 to 30, PH, S1 to S28, COM 1, 2: Open

Fig. 1 I_{DD} (2) at HOLD Mode



Note) K0 to K3, pins 7 to 30, S1 to S28, COM 1, 2: Open

Fig. 2 I_{DD} (3) at Backup Mode

Unit (capacitance: F)

Set function grouping

Function	POWER SW	
	Tact switch usage	Mechanical switch usage
Remote controller	○	×
Timer and clock	○	×
Electronic volume	○	○
Function switch	○	○

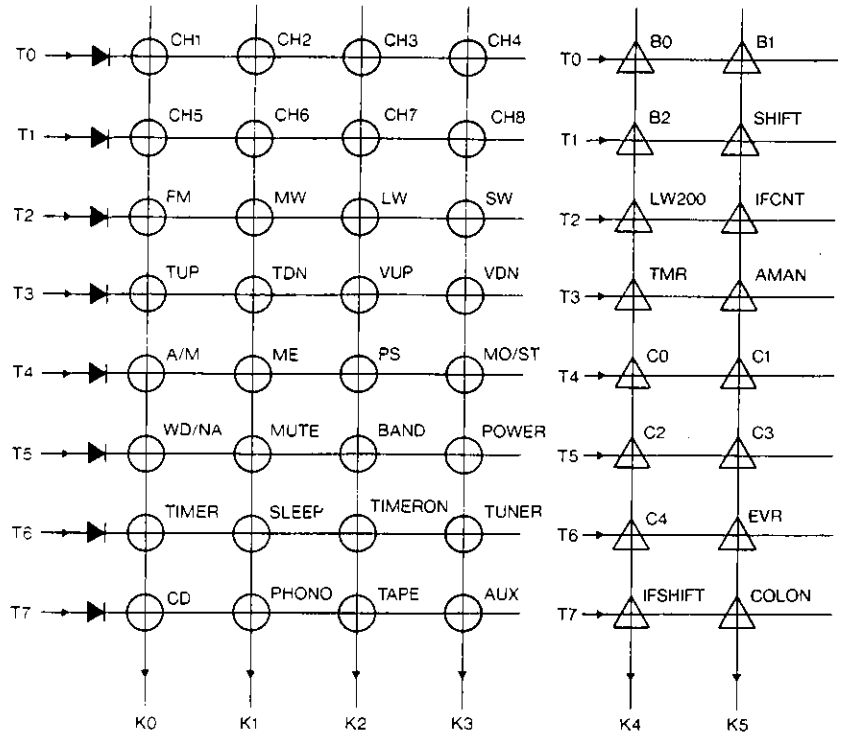
○..... Available
×..... Not available

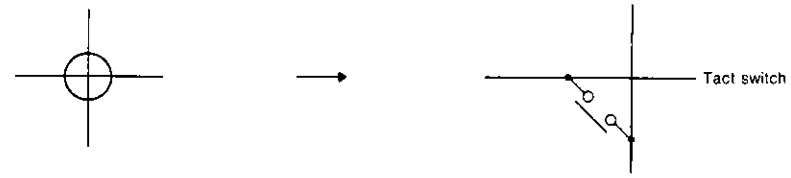
Relationship of set type, power source and current

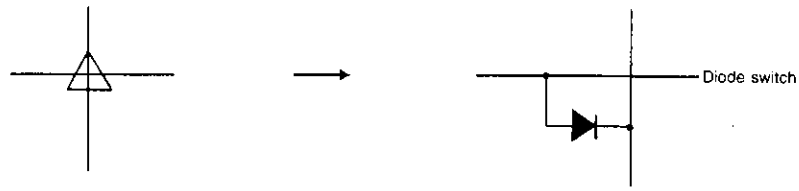
Set \ Status		When power is on		When power is off	When AC power is off
		Radio mode is on	Other than radio mode		
Power switch tact	With clock	V_{DD} (1) I_{DD} (1)	V_{DD} (2) I_{DD} (2)	V_{DD} (2) I_{DD} (2)	V_{DD} (3) I_{DD} (3)
	Without clock	V_{DD} (1) I_{DD} (1)	V_{DD} (2) I_{DD} (2)	V_{DD} (2) I_{DD} (2)	V_{DD} (3) I_{DD} (3)
Power switch mechanical	Without clock	V_{DD} (1) I_{DD} (1)	V_{DD} (2) I_{DD} (2)	V_{DD} (3) I_{DD} (3)	V_{DD} (3) I_{DD} (3)

Note) Refer to the Electrical characteristic reference for V_{DD} (1) – (3)

3. Key Matrix





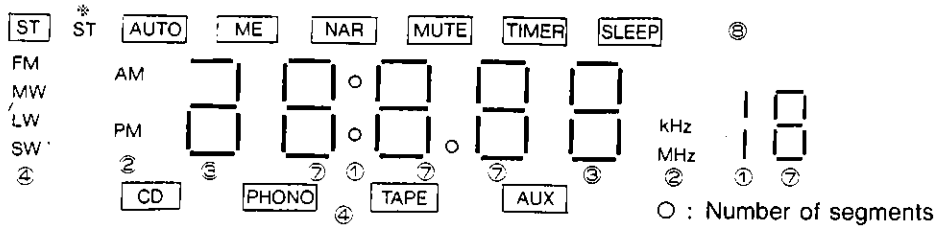


● Description of diode matrix (DIMRX) 0: Without diode 1: With diode

Name	Description	
B0 to B2	See the list of receiving frequency.	
SHIFT	0	Selection of MW, LW, SW without ( )
	1	Selection of MW, LW, SW in ( )
LW200	0	Selection of 100Hz for USA FM, absence of LW for others
	1	Selection of 200Hz for USA FM, presence of LW for others
IFCNT	0	Auto tuning without IF count (not applicable to LW)
	1	Auto tuning with IF count
TMR	0	Without timer CLOCK function
	1	With timer CLOCK function
AMAN	0	Manual tuning operation only
	1	Auto/manual tuning operation
C0 to C4	Setting of (C0,C1,C2,C3,C4)=(※)	
IFSHIFT	0	AM (MW, LW, SW) IF is set to 450kHz for all destinations.
	1	AM (MW,LW) IF, except SW and 10kHz-MW, is set to 468 kHz.
COLON	0	Always lighted
	1	Flashing at a 1Hz rate
EVR	0	Electronic volume timer correction mode: available
	1	Electronic volume timer correction mode: not available

※ See "Note" in Sample Application Circuit 4 (page 20).

4. Display



※: ST displays when tuned to an FM station and $\overline{\text{STEREO}}$ is held LOW.

Display font 0123456789

5. Key Description

- CH1 to CH8

Key for writing/calling preset channels 1 to 16 (FM), 1 to 8 (AM). CH1 key, CH2 key correspond to channel 1/9, 2/10, respectively. For example, when you push CH1 key and release it within 0.5 second, CH1 is called; and when released in 0.5 second or more, CH9 is called.
When you push ME key, P1 is displayed on the frequency display area and CH1 to 8 may be written for 5 seconds. If you push ME key once again within 5 seconds, P2 is displayed and CH9 to 16 may be written. When you push any one key of CH1 to CH8, your desired channel is written in a specified memory.

		CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	
8 channels	(Mode 1)	1	2	3	4	5	6	7	8	..... P1
	(Mode 2)	9	10	11	12	13	14	15	16	..... P2

- ME

① Used to write a new channel in the preset memory. When you push this key once, P1 (mode 1) is specified. When you push twice, P2 (mode 2) is specified. When you push once again, P1 returns.
The write enable mode is released automatically 5 seconds after this key pushed.

② When you push this key together with TIMER key, the timer setting mode (time setting mode) is entered.

- A/M (AMAN DIMRX=1)

Key for selecting the auto/manual tuning mode. Each time you push this key, the mode is switched as auto → manual → auto.... AUTO display flashes at the auto mode.

- TUP TDN

① Manual mode
Each time you push these keys, the channel No. goes up/down by one. When you hold these keys pushed for 500ms or more, the channel No. goes up/down at a 60ms/step rate.

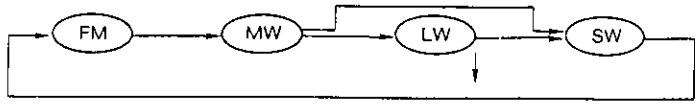
② Auto mode (AMAN DIMRX=1)
A broadcasting station is searched automatically in an up/down direction and a receiving frequency is held. If you hold this key pushed when the receiving frequency is reached, no auto stop occurs but a temporary stop (500ms) occurs. The searching rate is 60ms/step.

- FM MW LW SW

Key for band selection

- BAND

Key for band selection. Each time you push this key, band switching occurs.



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● PS

Key for preset scanning. When you push this key, the channel No. is changed in the order of increasing channel No. beginning with a channel No. currently displayed. If no channel No. is displayed, the channel No. is changed from CH1. If there is a channel that can be received during preset scanning ($\overline{SD}$="L"), a sound is generated for 5 seconds and if there is no channel that can be received, the channel No. is displayed for 1 second with no sound generated and the channel No. is changed to the next one. The channel No. flashes at a 1Hz rate during preset scanning.

When no FM channel No. is displayed. → CH1 → CH2 ..... CH8 → CH9 ..... CH16 →

When an FM channel No. is displayed. (ex. CH9) → CH10 → CH11 ..... CH16 → CH1 ..... CH8 → CH9 →

The preset scanning mode is released by pushing this key twice.

● MO/ST, WD/NA, MUTE

Key	Description	Display		Output
MO/ST	Effective at FM mode only For monaural/stereo selection	ST	Lighted	L
			Unlighted	H
WD/NA	Effective at FM mode only For wide/narrow band selection	NAR	Lighted	H
			Unlighted	L
MUTE	Effective in all modes with power ON. Unlighted and output "L" when power OFF is changed to power ON during the lighted state and when volume up or down is activated.	MUTE	Lighted	H
			Unlighted	L

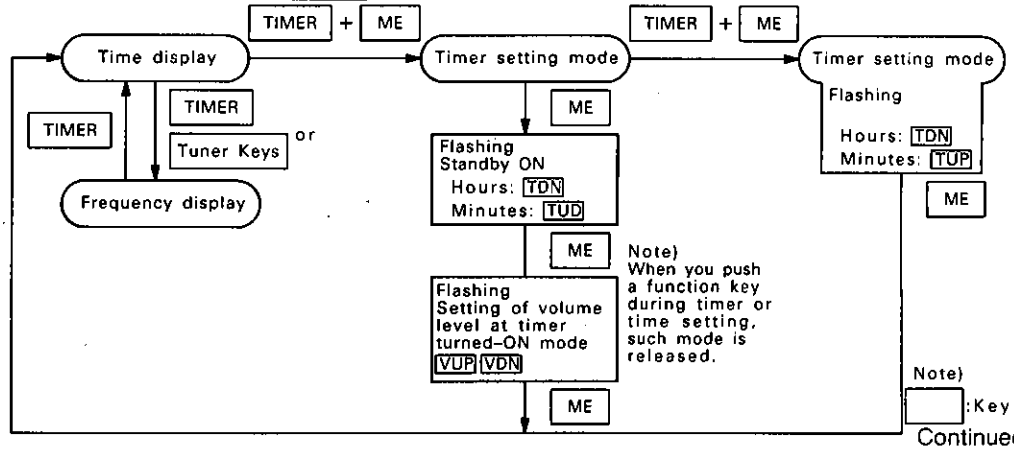
● POWER

Switch for turning ON/OFF the power supply of LC7230-8272-applied equipment. Each time you push this key, the level at output pin PWR OUT is switched as H → L → H.... The volume level at the power-ON mode is the same as for the previous power-OFF mode.

● TIMER (Causes turn-ON mode only. Not cause turn-OFF mode "ONCE" timer only.)

Key for providing time display at the timer setting mode, time setting mode or frequency display mode. When you push this key together with ME key, the timer setting mode is entered; and when you release the two keys once and push them again simultaneously, the time setting mode is entered.
When you push ME key in the timer setting mode, the timer time setting is enabled with the timer time flashing and the standby mode is entered. TDN key and TUP key are used for hours setting and minutes setting, respectively. These settings are made in an up direction only. Each time you push TDN key or TUP key, the display contents increment by one. When you hold TDN key or TUP key pushed for 500ms or more, the display contents advance at a 4 hours/second rate or 8 minutes/second rate, respectively.
When you push ME key after completion of setting, a volume level at the timer turned-ON mode can be set. A digitally displayed volume level at this moment is the same as for the previously set value. The setting range is from −16dB to −80dB. The volume level at the initial mode is −50dB.
When you push ME key after completion of setting, the time display mode returns. When you wish to check the set time only at the timer setting mode, push ME key twice to return the mode to the timer display mode.
Next, in the time setting mode the time setting is enabled with the time display flashing. The setting method is the same as for the timer setting mode. When you push ME key after completion of setting, the second display is cleared to zero and the time display mode returns.
When power is turned ON at the initial mode, the time setting mode is entered.
When you push a function key during timer setting or time setting, such mode is released.

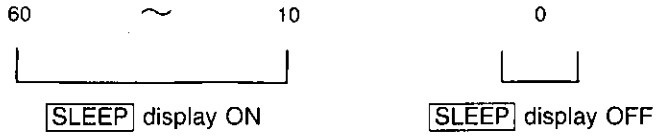
Example of volume display -50 ← −50dB display.



Continued on next page.

● SLEEP

Key for sleep time setting. When you push this key in the SLEEP display OFF state, the SLEEP display is turned ON and 60 (minutes) is displayed. Each time you push this key, 60 decrements in units of 10 minutes. When 0 is reached, SLEEP display is turned OFF and the sleep time setting mode is released. The previous mode returns 5 seconds after a sleep time is set to a specified value (SLEEP key is released).



When you push the SLEEP key while in clock display or frequency display, the remaining sleep time is displayed. 5 seconds after releasing the key the previous status will return.

● TIMER ON

Each time you push this key, TIMER display is turned ON/OFF. When turned ON, the timer operation is carried out; and when turned OFF, no timer operation is carried out.

● TUNER

When you push this key in the state where the CD, PHONO, TAPE, AUX functions are provided, the function is switched to TUNER and the frequency display is provided.

● CD

When you push this key in the state where the PHONO, TAPE, AUX, TUNER functions are provided, data is transferred to the LC7821(N), the function is switched to CD, and CD display is provided. You can also use this key for the CD power supply control signal and LED function display.

● PHONO

When you push this key in the state where theTAPE, AUX, TUNER, CD functions are provided, data is transferred to the LC7821(N), MLC74HC375, the function is switched to PHONO display is provided.

● TAPE

When you push this key in the state where the AUX, TUNER, CD PHONO functions are provided, data is transferred to the LC7821(N), MLC74HC375, the function is switched to TAPE, and TAPE display is provided.

● AUX

When you push this key in the state where the TUNER, CD PHONO functions are provided, data is transferred to the LC7821(N), MLC74HC375, the function is switched to AUX and AUX display is provided.

● VUP VDN

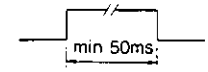
Keys for increasing/decreasing the electronic volume control level. Each time you push these keys, the level goes up/down by 1dB. When you hold theses keys pushed for 500ms or more, the level goes up/down at a 150ms/dB rate.
The level displayed for the LB1417 is shown below.

Level	1st Dot	2nd Dot	3rd Dot	4th Dot	5th Dot	6th Dot	7th Dot
Attenuation	−80dB	−52dB	−38dB	−26dB	−18dB	−10dB	−4dB

For specifications with no SW band, the volume increase/decrease signal is delivered at the SW1,2 pins.

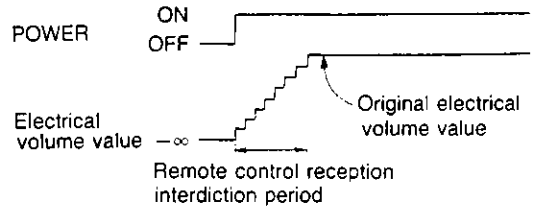
5. Remote Control

(1) The keys other than shown below are the same as for LC7230-8272-applied audio equipment.

Key Name	Description	Pin	Output Waveform
PLAY/PAUSE	PLAY/PAUSE key for CD	NARROW	Single pulse 
STOP	STOP key for CD	IFCNT	
NEXT	NEXT key for CD	$\overline{MW}$	Continuous pluse 
BACK	BACK key for CD	$\overline{LW}$	
CHUP	Each time you push this key, the channel No. goes up by one. When you hold this key pushed for 0.7 second or more, the channel No. is switched every 0.4 second. If there is no channel No. Present, the channel No. starts with CH1.		

(2) Remote control reception interdiction period.

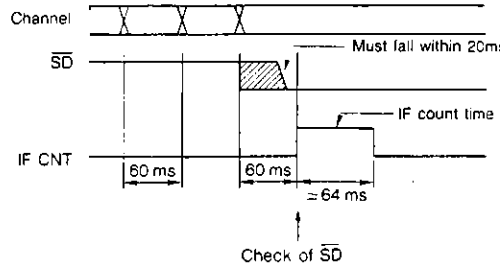
① After power on, this unit does not reveive the remote control function for the period in which the volume value returns from $-\infty$ to the original value. (When DIMRX of TMR is 1.)



② After turning the power on, unable to receive for 2 seconds. (When DIMRX of TMR is 0)

6. Timing Description

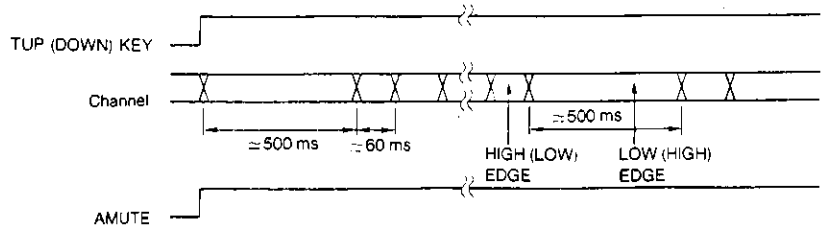
(1) Auto up/down mode



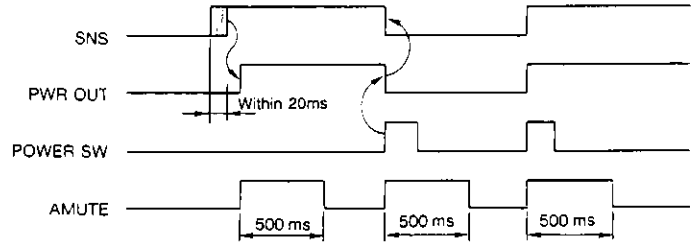
IF count tolerance

FM	10.7 MHz	±10 kHz
MW	450/468 kHz	±3 kHz
SW	450 kHz	±3 kHz
LW	450 kHz	±600 Hz

(2) Manual



(3) Power ON mode (See Sample Power Supply Connection (1).) (Including the timer, sleep timer modes)

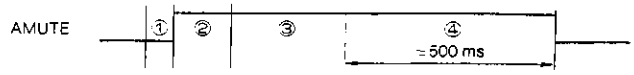


(Note) 1. Data of $-\infty$ is sent to the LC7535 immediately before power is turned OFF.
2. Data of $-\infty$ is sent to the LC7535 immediately after power is turned ON.
3. When the SNS pin is brought to "H" level after power is turned ON, the original volume level returns at a 38ms/dB rate.

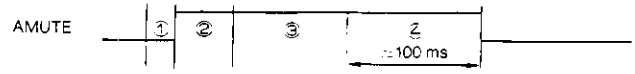
(4) Audio mute (AMUTE)

① Key chattering eliminating time (approximately 40ms)
② Audio pre-mute time (approximately 50ms)
③ Interstation wait and data transfer to PLL (20ms to 80ms)
④ Audio post-mute time
⑥ Processing required for the LC7535, LC7821(N), MLC74HC375, etc. (approximately 5ms)

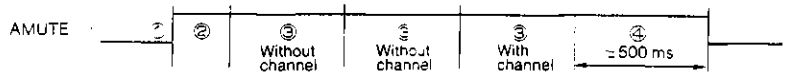
a. Band select mode, present channel read mode



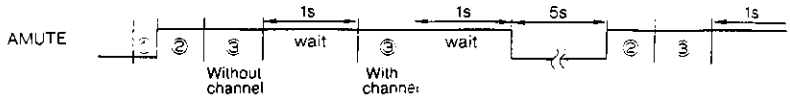
b. Manual up/down mode



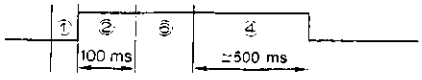
c. Auto up/down mode



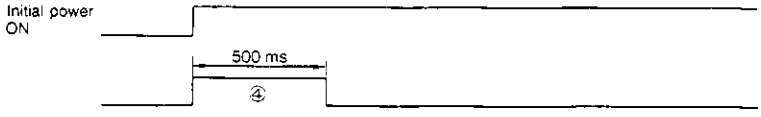
d. PS mode



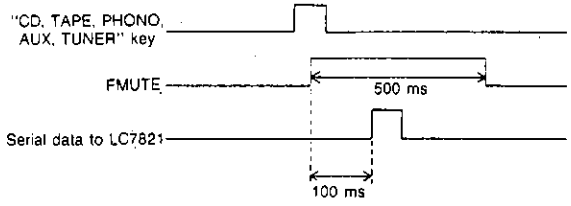
e. Function select mode (also applicable to FMUTE of the MLC74HC375(N))



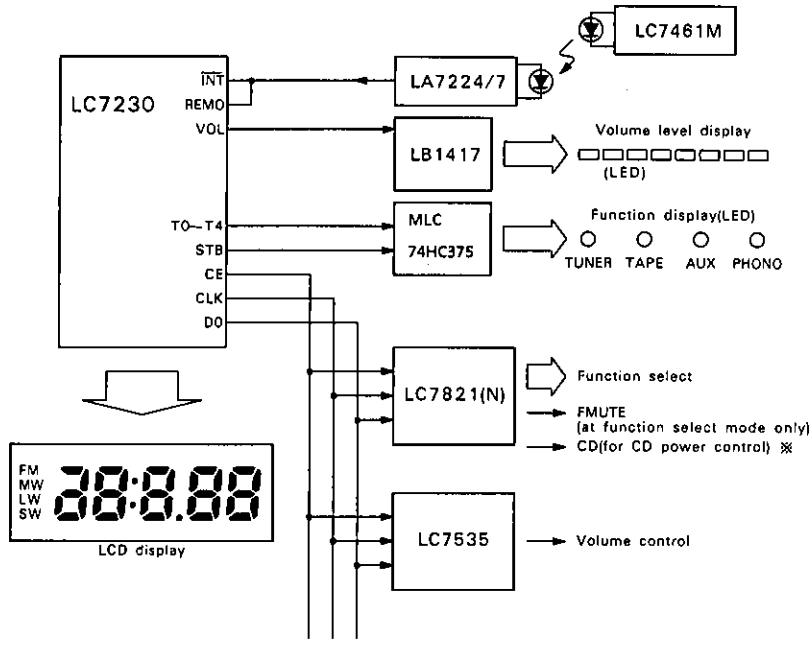
f. Initial power-ON mode



(5) FMUTE (MUTE for Switching Functions)



7. Connection with Peripheral ICs



※ Note:
CD output and NEXT($\overline{MW}$), BACK($\overline{LW}$) output when CD function is selected is changed as following. At this time in order to prevent CD error of point (A), it is necessary to delay CD output.

8. Pin Description

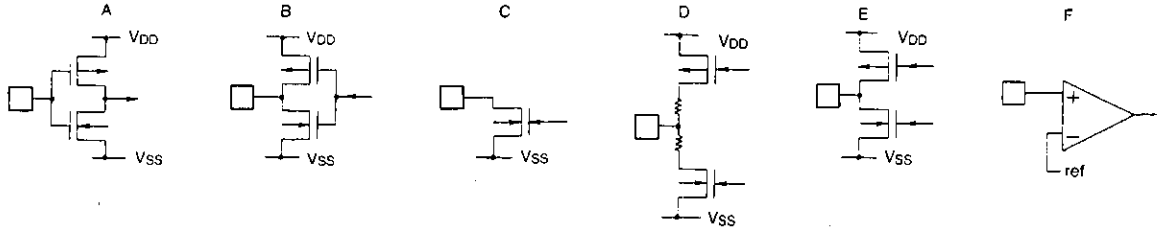
Pin Name	Pin No.	Description	Active	I/O	I/O Configuration
XIN	1	4.5 MHz crystal oscillation pins	—	I	—
XOUT	80			O	
TEST1	2	Must be connected to V_{SS}.	—	I	—
TEST2	79				
REMO	3	Remote control signal input pin. Used with $\overline{INT}$ pin. When no remote control is not in use, pulled up to V_{DD} through a resistor.	L	I	A
$\overline{STEREO}$	4	When the stereo signal is brought to "L" level, "ST" LCD indicator light goes ON.	L	I	A
VOL	7	The LB1417 is connected to this pin to provide the electronic volume control level display.	—	O	C
$\overline{FM}$	8	Used to select the power supply for each band.	L	O	C
$\overline{MW}$	9	CD NEXT signal output			
$\overline{LW}$	10	CD BACK signal output			
SW1/VU	11	Spec. With no SW band: "H" output only when VUP key is pushed	H	O	B
SW2/VD	12	Spec. With no SW band: "H" output only when VDN key is pushed			
MO/ST	13	Output pin for monaural "H"/stereo "L" selection	H	O	B
MUTE	14	"L" level at power-ON mode. Each time you push MUTE key at the power-ON mode, "H"/"L" toggle operation is carried out.	H	O	B
CE DO CLK	15 16 17	Serial data line of the LC7535, LC7821 (N)	H H ⌐¯	O	B
IFCNT	18	Signal to output the IF signal. STOP signal output at the CD mode	H	O	B

Continued on next page.

Continued from preceding page.

Pin Name	Pin No.	Description	Active	I/O	I/O Configuration
NARROW	19	Pin for IF narrow band "H"/wide band "L". PLAY/PAUSE signal output at the CD mode	H	O	B
PWR OUT	20	Power control pin	H	O	B
AMUTE	21	Audio muting pin	H	O	B
STB	22	Pin for strobe of data to the MLC74HC375. Connected to "CL"	H	O	B
T7	23	Data transfer to the MLC74HC375 : Function display-TAPE	H	O	B
T6	24	Data transfer to the MLC74HC375 : Function display-TUNER			
T5	25	Data transfer to the MLC74HC375 : Function display-AUX			
T4	26	Data transfer to the MLC74HC375 : Function display-PHONO			
T3 T2 T1 T0	27 28 29 30	Key scan output signal			
K3 K2 K1 K0	32 33 34 35	Key-in signal	H	I	A
K4 K5	6 5	Diode matrix input signal	H	I	A
S1 to S28	63 to 36	LCD segment driver pins	—	O	B
COM1 COM2	65 64	LCD common driver pins	—	O	D
$\overline{HOLD}$	67	When brought to "L" level, the backup mode is entered. A chattering of approximately 20ms is eliminated.	L	I	A
$\overline{SD}$	69	Signal to inform that a channel is received during auto tuning	L	I	F
HCTR	70	FM IF signal input pin	—	I	A
LCTR	71	AM IF signal input pin	—	I	A
SNS	72	When brought to "H" level, data is sent to the LC7821 (N), LC7535, MLC74HC375, LB1417. A chattering of approximately 20ms is eliminated.	H	I	A
FMIN	74	Local OSC input from FM VCO	—	I	A
AMIN	75	Local OSC input from AM VCO	—	I	A
EO1, 2	76 77	Phase comparator output signal	—	O	E
$\overline{INT}$	66	Remote control signal input pin. Used with REMO pin.	↓	I	A
V_{DD}	31 73	Power supply pin. Connected to +5V.	—	—	—
V_{SS}	76	Power supply pin. Connected to GND.	—	—	—
$\overline{RES}$	68	Must be connected to V_{DD}.	—	—	—

Pin input/output configuration

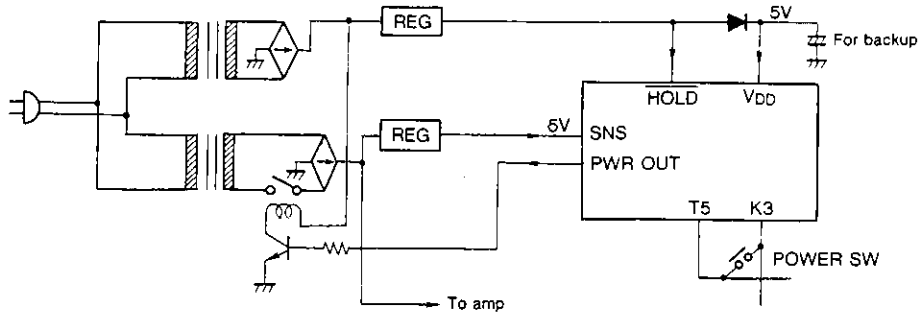


9. Band Power Supply Select Signal

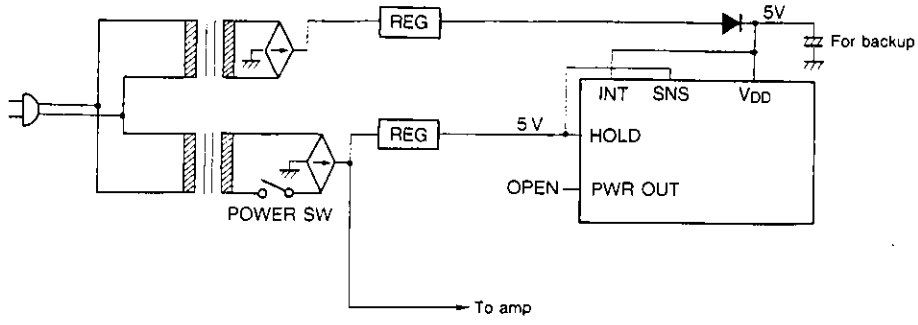
Band \ Pin	$\overline{FM}$	$\overline{MW}$	$\overline{LW}$	SW1	SW2
FM	L	H	—	—	—
MW	H	L	L	L	L
LW	H	L	H	L	L
SW1	H	L	H	H	L
SW2	H	L	H	H	H

10. Sample Power Supply Connections

(1) TMR DIMRX "0" "1" function possible
Use tact switch for power switch (when using the remote control, with timer, etc.)



(2) TMR DIMRX "0" use possible, "1" use not possible
Use mechanical switch for power switch, (when not using Remote Control, with Timer)



11. Initial Mode

- Function : TUNER
- Clock 12hr : 12:00 } Flashing Timer set value: 10:00
  24hr : 0:00
- Band : FM
- A/M : Manual (AMAN=1)
- Timer, sleep timer : Timer OFF
- Preset channel : None
- ME : OFF
- MO/ST : Stereo MO/ST pin="L"
- WD/NA : Wide WD/NA pin="L"
- Volume : −50dB
- Volume level at timer mode : −50dB
- Muting output : "L" level
- PWROUT : "L" level

12. Tracking Point

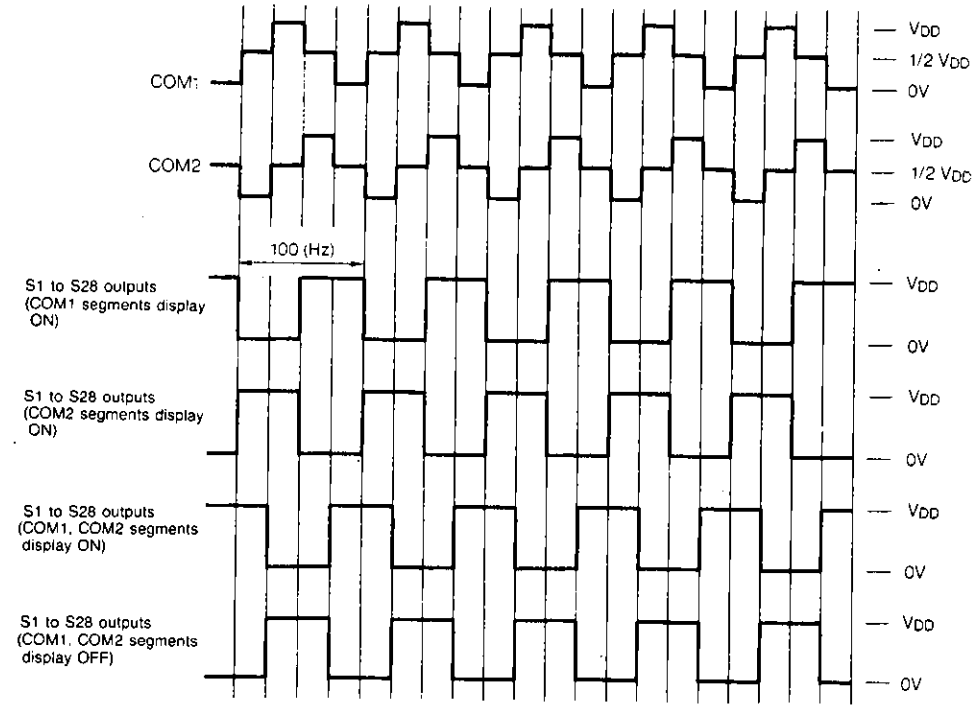
The following frequencies are loaded in each preset memory at the initial power-ON mode.

[FM:MHz, AM:kHz]

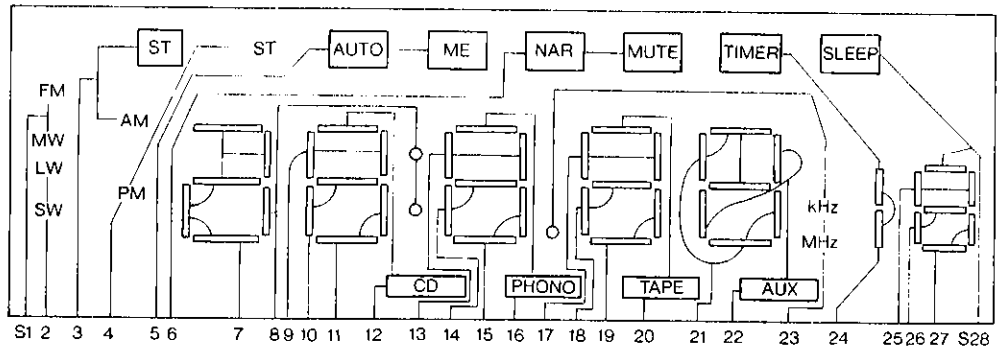
Area	Band	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	Diode Matrix $B_2B_1B_0$
JAPAN	FM	76.0	78.6	83.0	86.6	90.0	76.0	76.0	76.0	1 0 0
	MW	531	603	999	1404	1611 (1629)	531	531	531	
USA	FM	87.9	90.1	98.1	106.1	107.9	87.9	87.9	87.9	0 0 0 1 1 1
	MW	530	600	1000	1400	1610 (1720)	530	530	530	0 0 0
	MW	522	603	999	1404	1611 (1719)	522	522	522	1 1 1
EUROPE	FM	87.5	90.0	98.0	106.0	108.0	87.5	87.5	87.5	0 0 1
	MW/LW	531 (522)	603	999	1404	1602 (1611)	153 (146)	270	281 (290)	0 1 0 0 1 1
	MW/SW	↑	↑	↑	↑	↑	5800	9500	13500	0 1 0
	MW/SW	↑	↑	↑	↑	↑	5200	9500	13500	0 1 1
	MW/LW/SW	↑	↑	↑	↑	↑	153 (146)	270	281 (290)	0 1 0 0 1 1
S.AFRICA	FM	87.5	90.0	98.0	106.0	108.0	87.5	87.5	87.5	1 1 0 1 0 1
	MW/LW	531 (522)	603	999	1404	1602 (1611)	153 (146)	270	281 (290)	1 1 0
	MW/SW	↑	↑	↑	↑	↑	5800	9500	13500	1 0 1
	MW/LW/SW	↑	↑	↑	↑	↑	153 (146)	270	281 (290)	

Note 1) ( ): Value when diode matrix "SHIFT" is selected
2) CH9 to CH16 are loaded with low band edge at the FM mode.

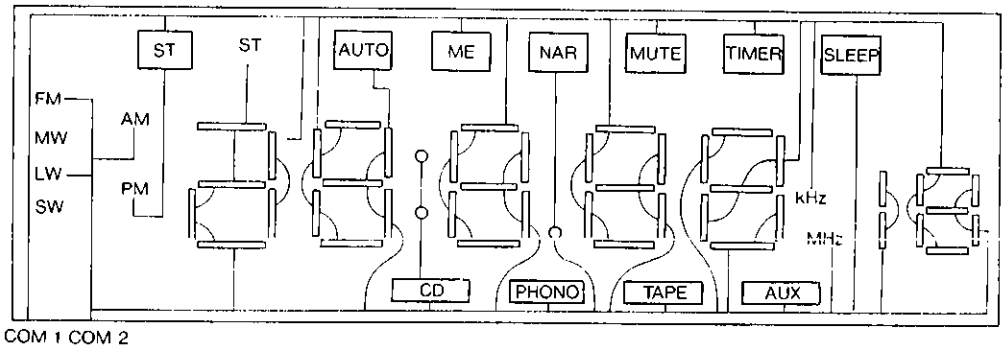
13. Waveforms on Segments, Common Pins



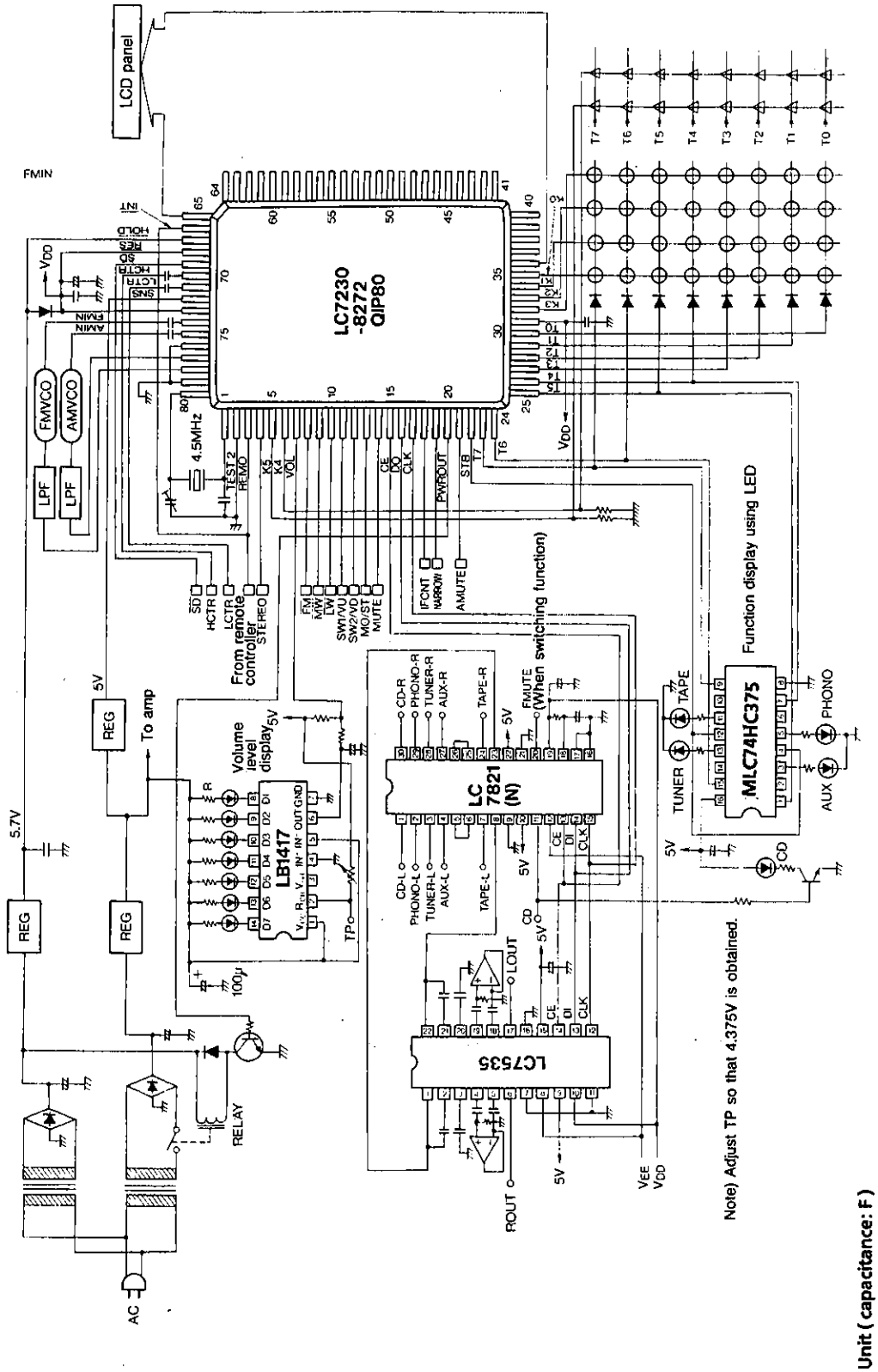
14. (1) Connection of Segments on Panel



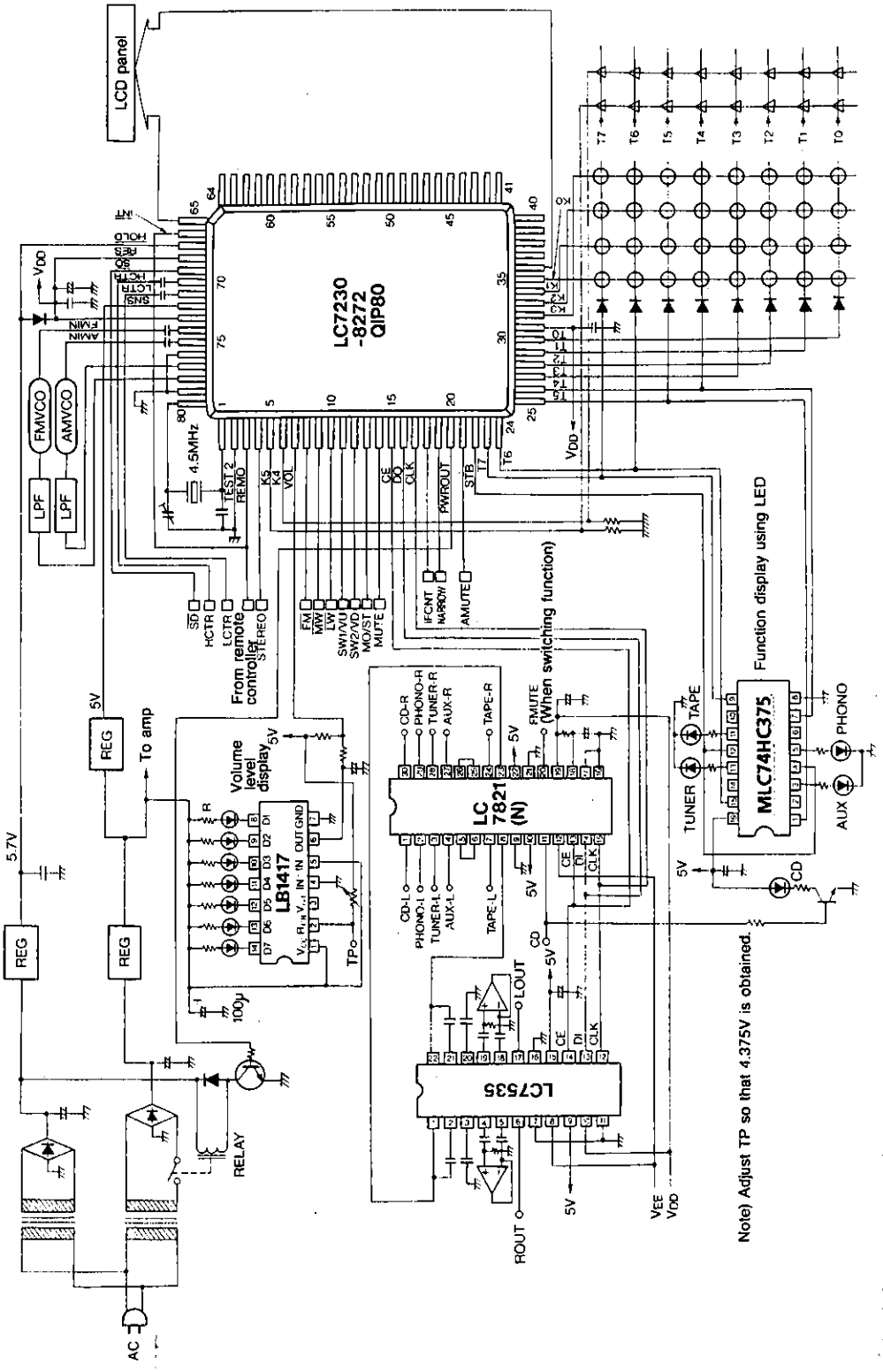
(2) Connection of Common Pins on Panel



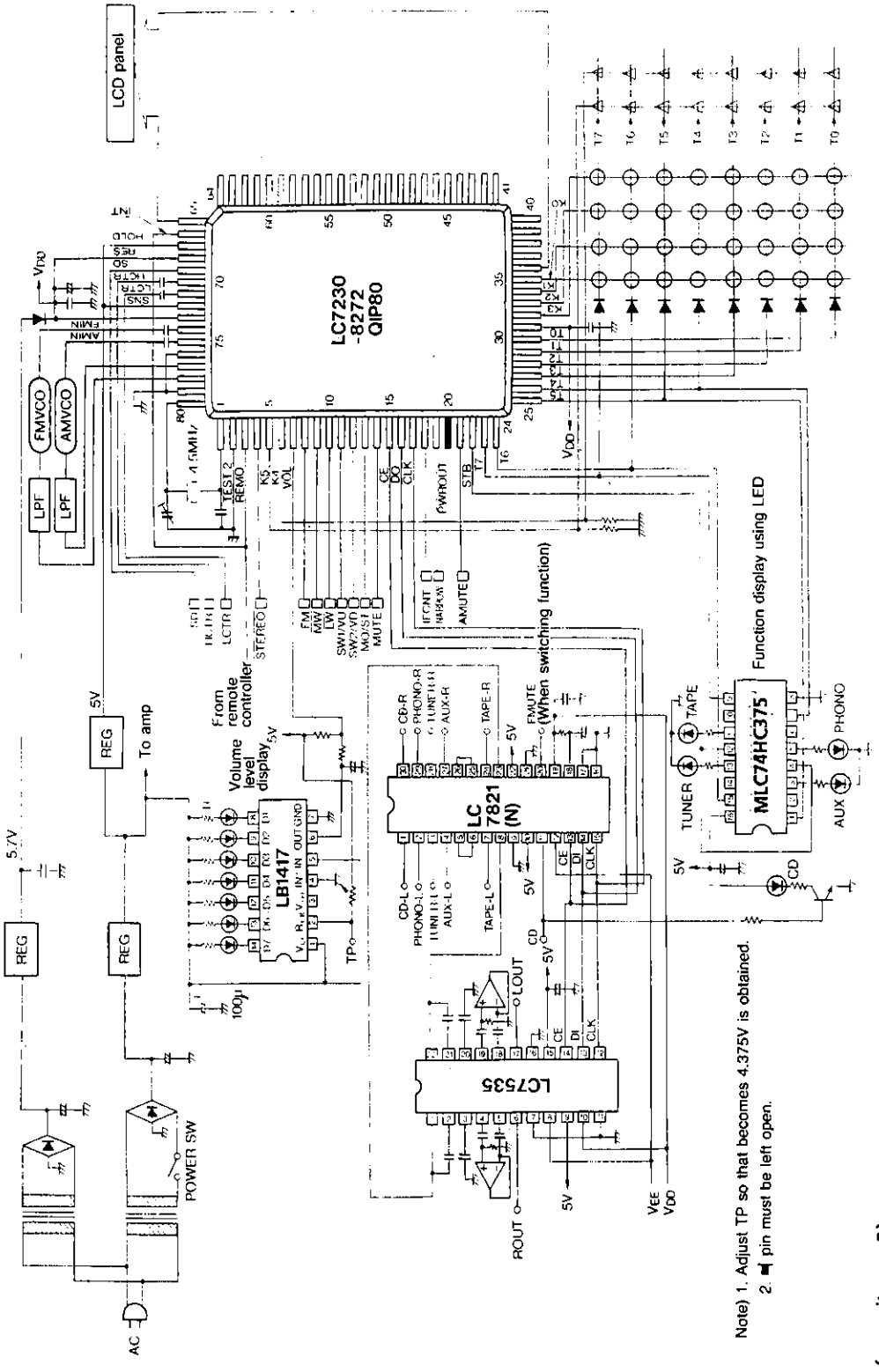
Sample Application Circuit 1 (With remote controller, timer, function switches and electric volume)
Use tact switch for power switch



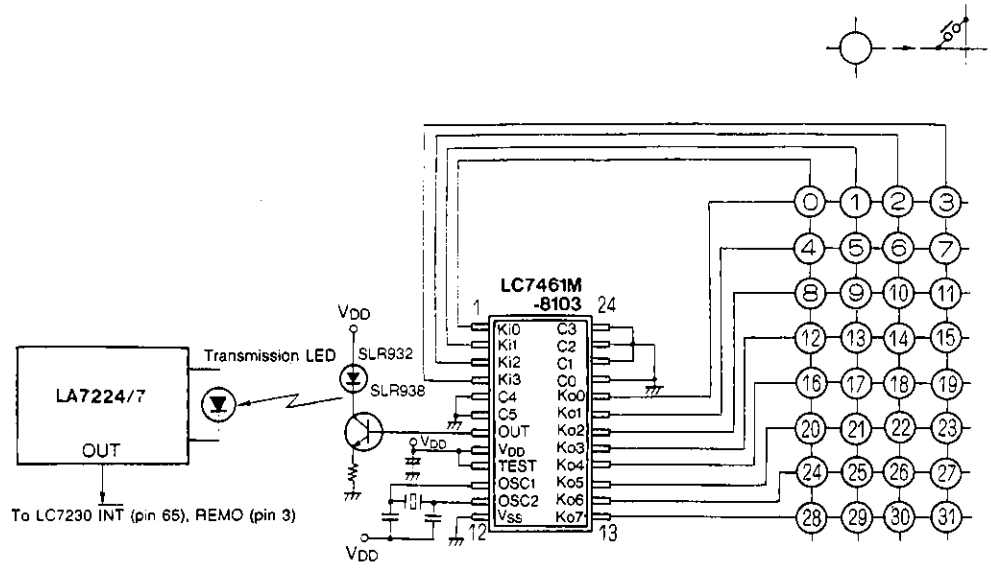
Sample Application Circuit 2 (With remote controller, timer, function switches and electric volume)
Use tact switch for power switch



Sample Application Circuit 3 (With function switches and electric volume)
Use mechanical switch for power switch



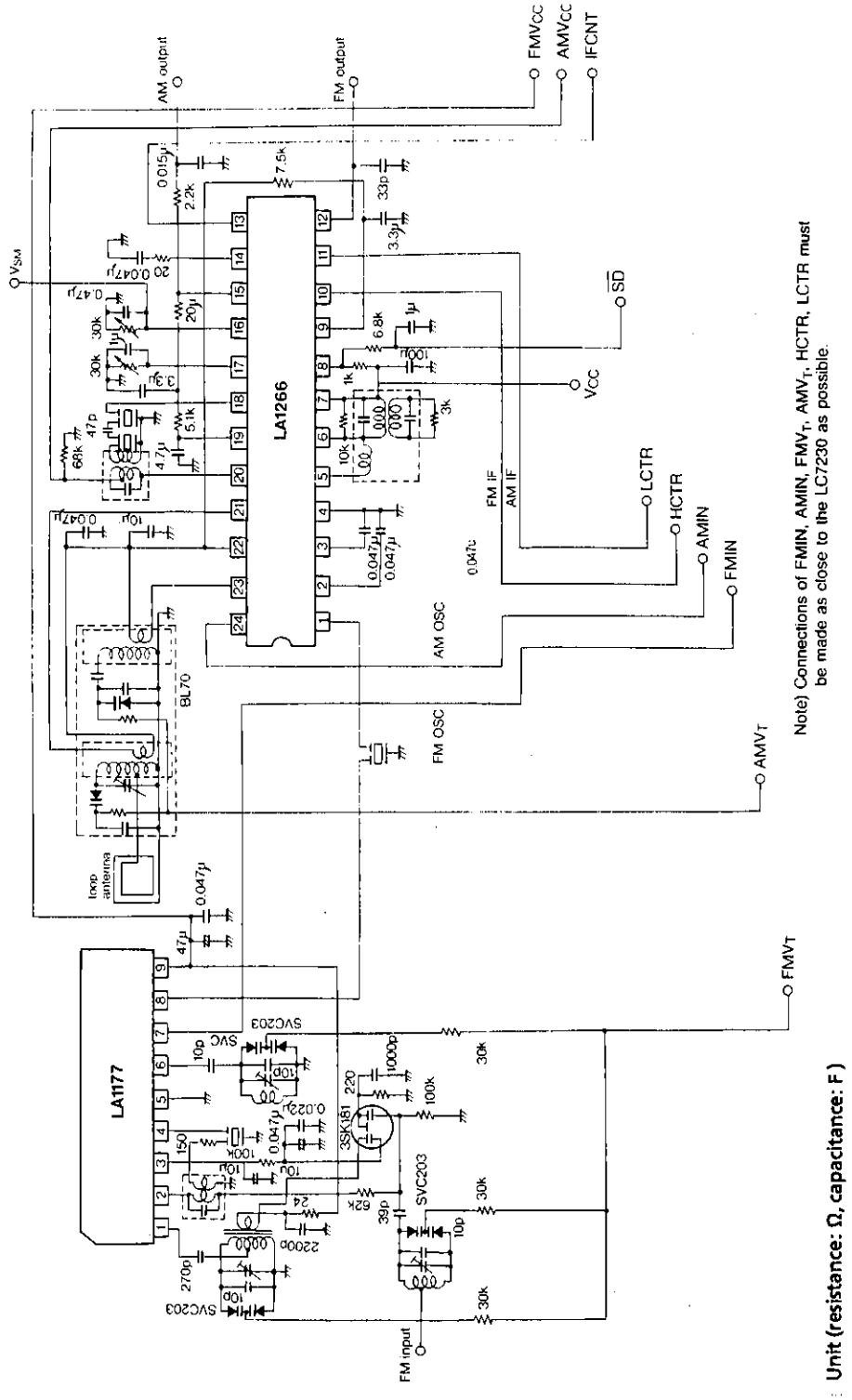
Sample Application Circuit 4



Note) The above connection of C0 – C5 is an experimental connection only.
For mass-production, other specifications authorized by Sanyo Electric Co., Ltd., are required.

No.	KEY	No.	KEY	No.	KEY	No.	KEY
0	CH1	8	FM	16	PLAY / PAUSE	24	BAND
1	CH2	9	MW	17	PS	25	POWER
2	CH3	10	LW	18	MO/ST	26	TIMER ON
3	CH4	11	SW	19	CHUP	27	TUNER
4	CH5	12	NEXT	20	TIMER	28	CD
5	CH6	13	BACK	21	SLEEP	29	PHONO
6	CH7	14	VUP	22	STOP	30	TAPE
7	CH8	15	VDN	23	MUTE	31	AUX

Sample Application Circuit 5 LA1177, LA1266



Custom Code of the LC7461M-8103

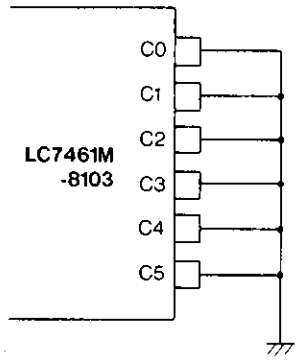
The LC7461M-8103 is a remote control signal transmission IC to be used in conjunction with the LC7230-8272.

The custom code of the LC7461M is such that the 7 bits are fixed by the internal metal mask and the remaining 6 bits are set using the IC pins.

Custom code 0100H is available for evaluation. When performing evaluation, the code of the LC7461M-8103, LC7230-8272 must be set to this code value.

When evaluation is acceptable, a custom code to be used must be assigned before mass production of equipment and your draft on remote control IC should be submitted.

How to set code 0100H for evaluation



Set C0 to C4 of the LC7230-8272 to 0.

When a custom code for mass production is assigned, C0 to C4 are set to 1 (connected to V_{DD}) or 0 (connected to V_{SS}) according to the specified code.

Note) A code of the LC7230-8272 is set according to 1 (with diode) and 0 (without diode).