

SANYO

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.

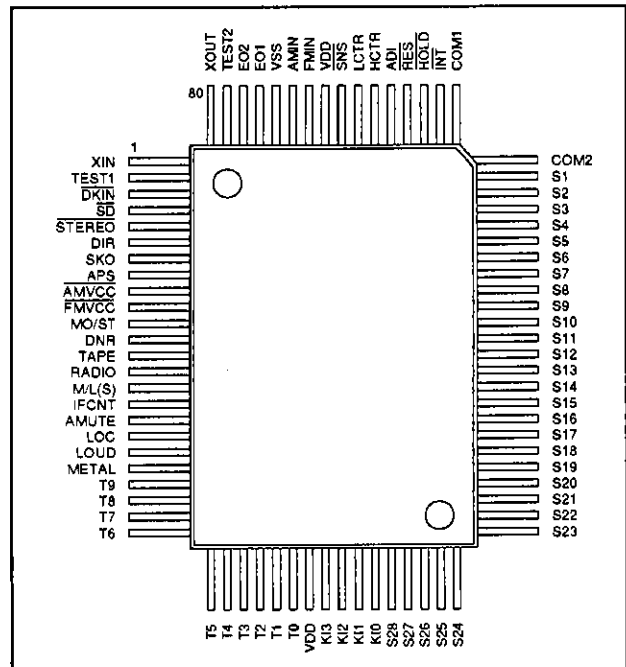
The LC7230-8221 operates over the American, European and Japanese LW, SW and FM bands and incorporates preset-channel memory for six stations in each band. In addition, the LC7230-8221 provides a separate station seek function for European frequency bands. The LC7230-8221 features a 12-hour or 24-hour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

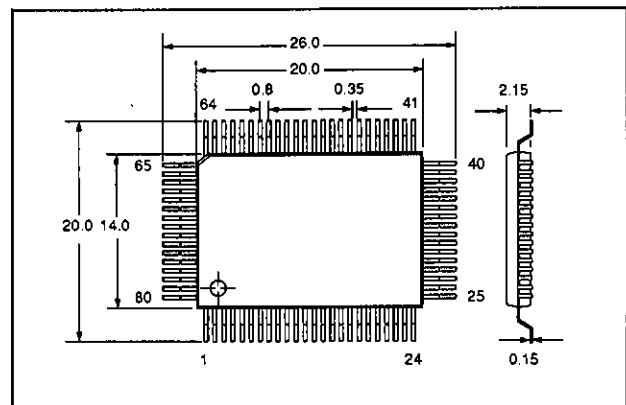
PINOUT



PACKAGE DIMENSIONS

Unit: mm

3044B-QIP80A

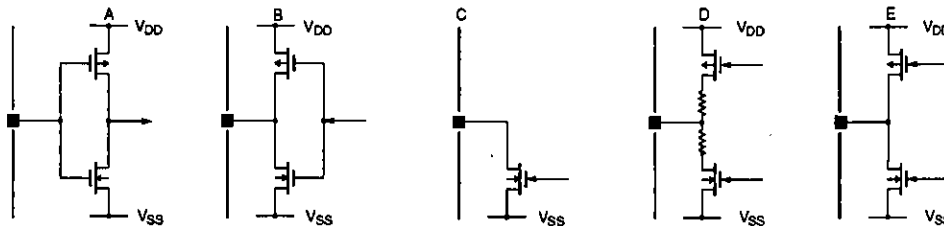


PIN DESCRIPTION

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	ML(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	K10 to K13	Active-HIGH, keypad scan inputs with 100 k Ω (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	E01	Phase comparator outputs. See equivalent circuit E.
78	E02	
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
INT, ADI, SNS, SD, STEREO and DIR input voltage range	V _{IN1}	-0.3 to 6.5	V
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, AMVCC and 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	T _{opr}	-40 to 85	°C
Storage temperature range	T _{stg}	-45 to 125	°C

Notes

1. Pins SKO, APS, AMVCC, 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	μ A
		$V_{DD} = 2.5$ 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	μ A
XIN LOW-level input current	I_{IL2}	$V_i = V_{SS}$	2.0	5.0	15.0	μ A
FMIN, AMIN, HCTR and LCTR LOW-level input current	I_{IL3}	$V_i = V_{SS}$	4.0	10.0	30.0	μ A
\overline{INT} , \overline{HOLD} , ADI, \overline{SNS} , \overline{DKIN} , \overline{SD} and \overline{STEREO} HIGH-level input current	I_{IH1}	$V_{IN} = 5.5$ V	–	–	3.0	μ A
HIGH-level input current. See note 1.	I_{IH2}	$V_{IN} = V_{DD}$	–	–	3.0	μ A
XIN HIGH-level input current	I_{IH3}	$V_{IN} = V_{DD} = 5.0$ V	2.0	5.0	15	μ A
FMIN, AMIN, HCTR and LCTR HIGH-level input current	I_{IH4}	$V_{IN} = V_{DD} = 5.0$ V	4.0	10.0	30.0	μ A
KI0 to KI3 HIGH-level input current	I_{IH5}	$V_{IN} = V_{DD} = 5.0$ V	–	50.0	–	μ A

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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}	$I_o = 50$ μ A	0.5	1.0	2.0	V
LOW-level output voltage. See note 2.	V_{OL2}	$I_o = 1$ mA	–	–	1.0	V
E01 and E02 LOW-level output voltage	V_{OL3}	$I_o = 500$ μ A	–	–	1.0	V
XOUT LOW-level output voltage	V_{OL4}	$I_o = 200$ μ A	–	–	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
SK0, APS, AMVCC and 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
E01 and E02 HIGH-level output voltage	V_{OH3}	$I_o = 500$ μ A	$V_{DD} - 1.0$	–	–	V
XOUT HIGH-level output voltage	V_{OH4}	$I_o = 200$ μ A	$V_{DD} - 1.0$	–	–	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}	$I_o = 20$ μ A	$V_{DD} - 0.7$	$V_{DD} - 0.5$	$V_{DD} - 0.35$	V
LCTR (period), $\overline{\text{HOLD}}$ and $\overline{\text{INT}}$ hysteresis width	V_N		$0.1V_{DD}$	–	–	V
SNS reject pulsewidth	t_{REJ}		–	–	50	μ s
Low-voltage detector threshold	V_{DET}		2.7	3.0	3.3	V
K10 to K13 floating-input voltage	V_{IF}	With pull-down resistors	–	–	$0.05V_{DD}$	V
K10 to K13 pull-down resistor	R_{PD}		75	100	200	k Ω
A/D converter quantization error	E	$V_{DD} = 4.5$ to 5.5 V	$-\frac{1}{2}$	–	$\frac{1}{2}$	lsb
E01 and E02 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	μ A

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
E01 and E02 HIGH-level leakage current	I_{OFFH1}	$V_0 = V_{DD}$	-	0.01	10	nA
HIGH-level leakage current. See note 3.	I_{OFFH2}	$V_0 = V_{DD}$	-	-	3.0	μA
SK0, APS, \overline{AMVCC} and \overline{FMVCC} HIGH-level leakage current	I_{OFFH3}	$V_0 = 13 V$	-	-	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.

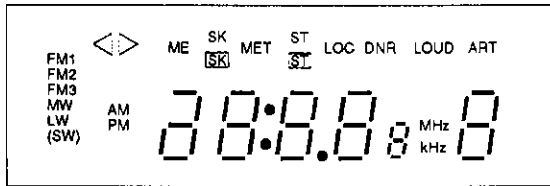


Figure 1. LCD display

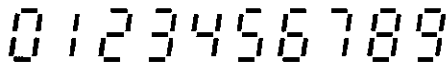


Figure 2. LCD digits

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 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.

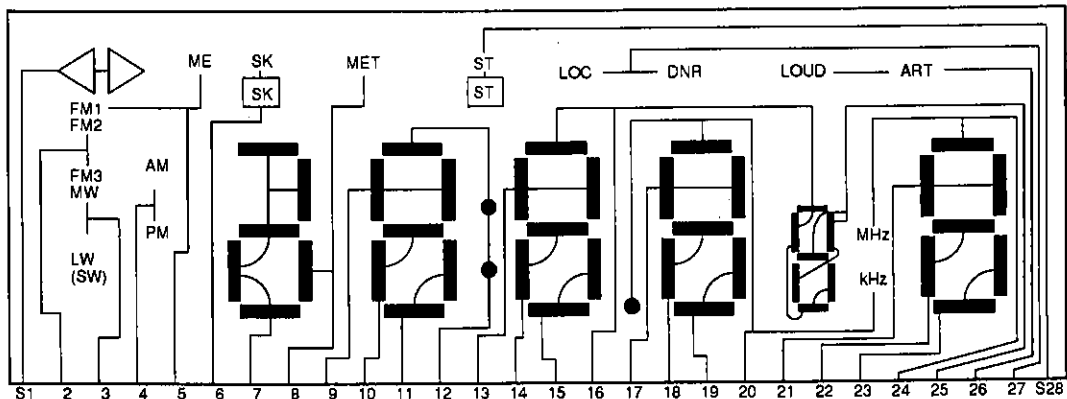


Figure 3. Segments

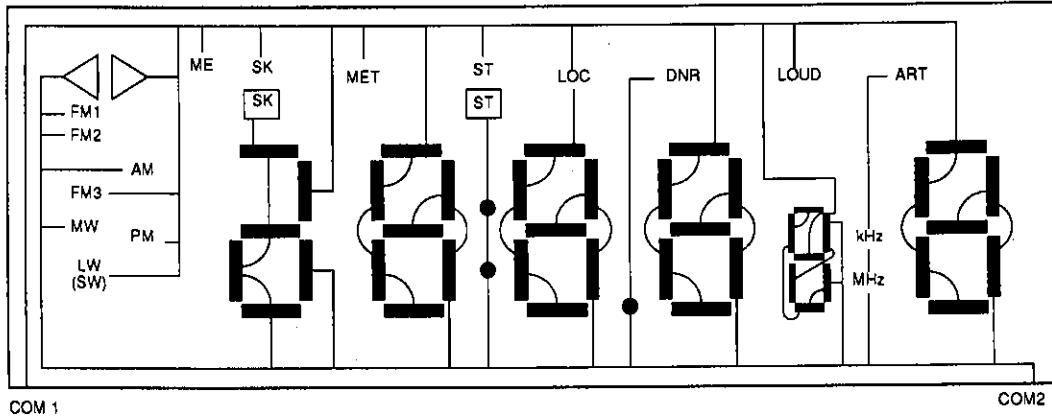


Figure 4. Commons

The LCD drive waveforms are shown in figure 5.

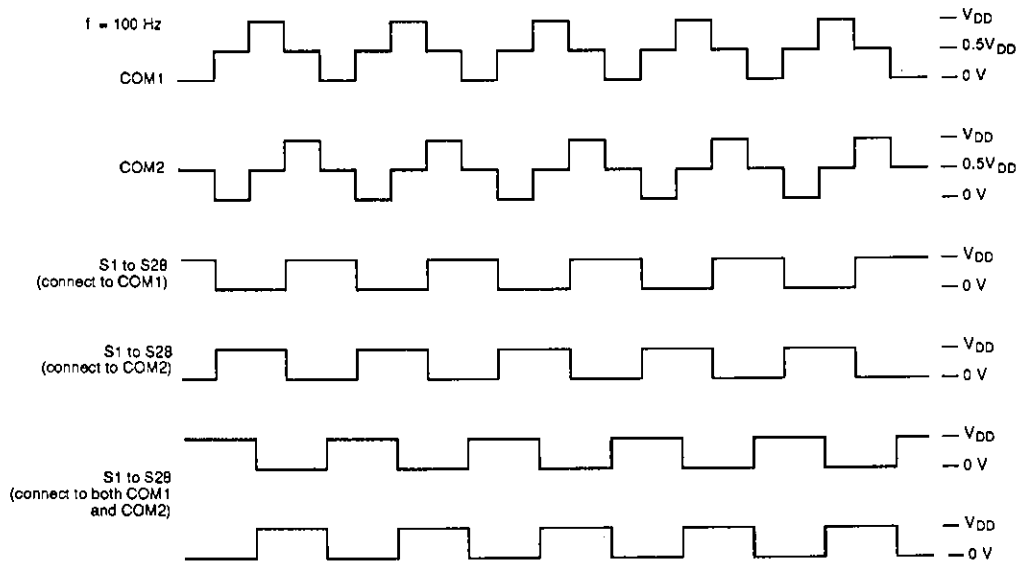


Figure 5. LCD drive waveforms

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.

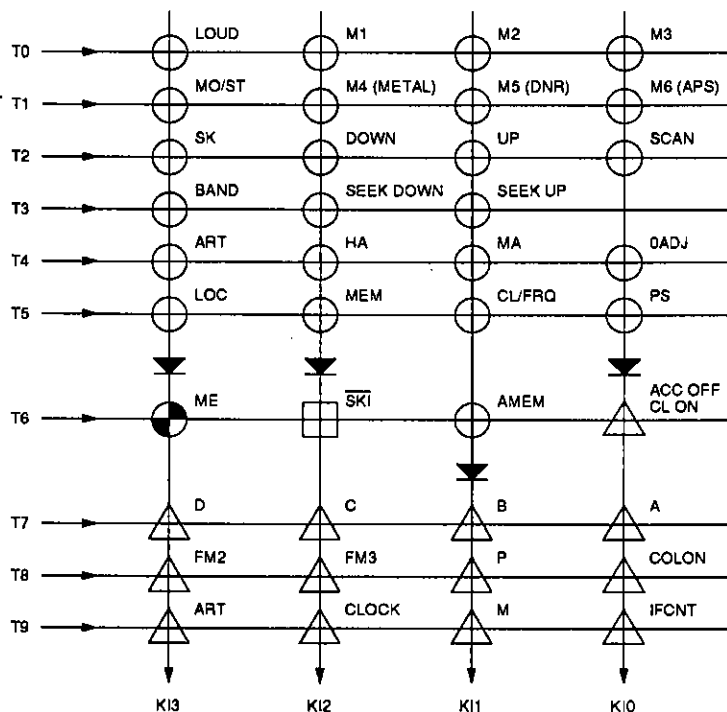


Figure 6. Keypad matrix

Note

K10 to K13 have internal pull-down resistors.

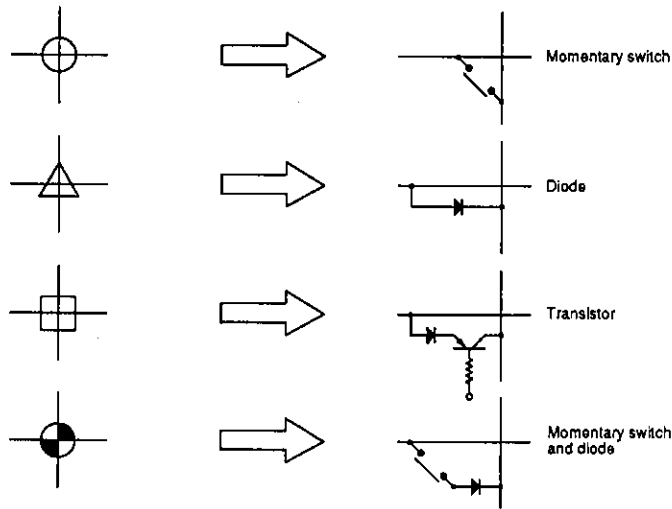


Figure 7. Symbol definitions

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	1		0	FM B	100	
						MW B	10	
	1	0	1		FM C	200		
					MW C	9		
	1	0	1		0	Europe	FM E	50
							MW D	9
1			0	0	FM D		25	
					MW D		9	
0		1	0	LW	1			
				FM D	25			
0		0	1	1	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{DKIN} goes LOW while RADIO is active, they function as the M4, M5 and M6 keys, and when \overline{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.

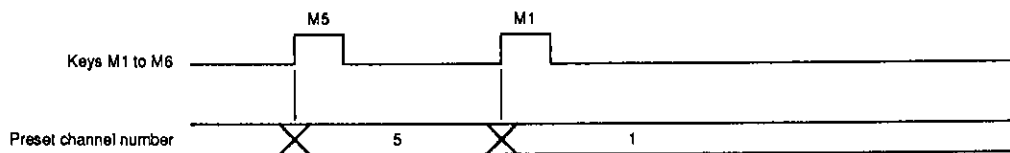


Figure 8. M1 to M6 six-key method

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.

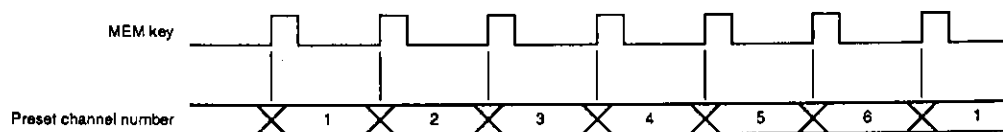


Figure 9. MEM single-key method

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.

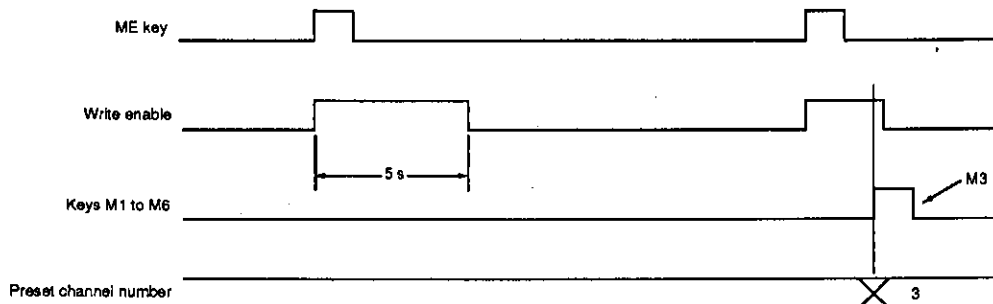


Figure 10. Writing to memory using the six-key method

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.

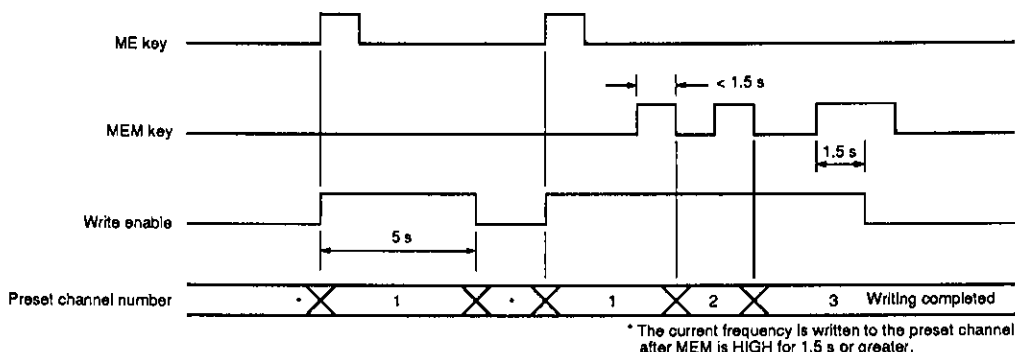


Figure 11. Writing to memory using the single-key method

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 OADJ 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.

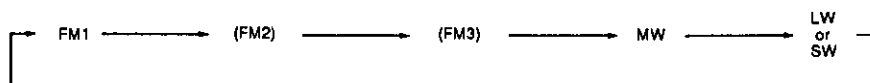


Figure 12. Frequency band selection

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.

OADJ key

The OADJ 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 OADJ 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.

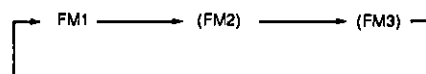


Figure 13. Preset scan of FM bands

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 dB μ or lower or when the AM IF level is 30 dB μ 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 SKI goes LOW.

Table 13. SK search functions

SK mode	SK station (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

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	SD is LOW.	SD is LOW.
Auto-retune	SD is LOW.	SD is LOW.
Auto-memory	ADI and SD are LOW.	SD is LOW.

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.

Transistor Matrix Switch

When the transistor matrix input switches SKI to LOW, the SK indicator is displayed. The input at SK is valid

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

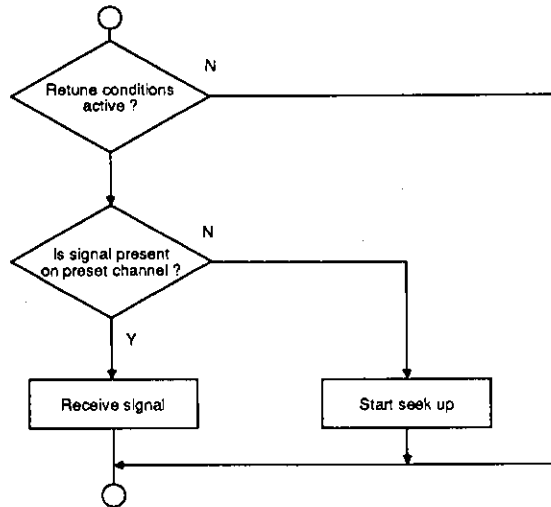


Figure 14. Auto-retune flow

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.

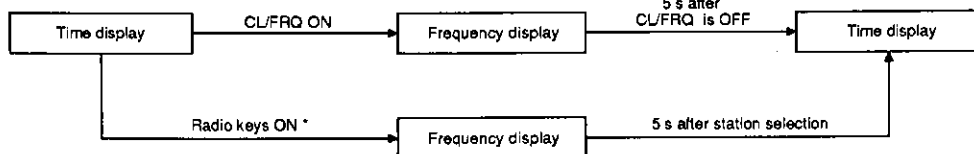
Table 11. LOC key functions

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.



* M1 to M6, MEM, SEEK UP, SEEK DOWN, SCAN, UP, DOWN, ART, AMEM, PS, MO/ST, LOC and SK keys.

Figure 15. Time priority mode

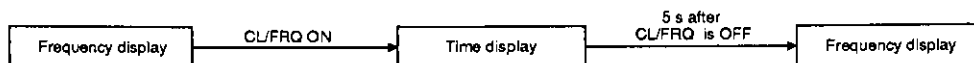


Figure 16. Frequency priority mode

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	FMVCC	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.

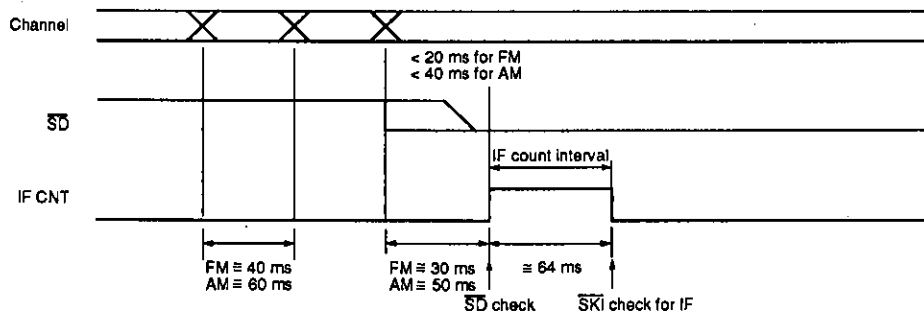


Figure 17. Seek and scan timing

Note

Channel spacing is 100 kHz/step. When \overline{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 \pm 10 kHz
MW, SW	450 \pm 3 kHz
LW	450 kHz \pm 600 Hz

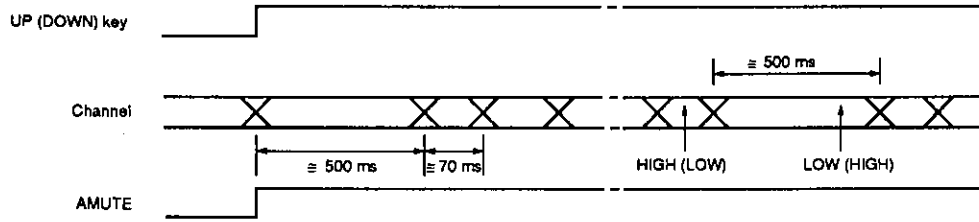


Figure 18. Manual tuning timing

Note

Channel spacing is 100 kHz/step.

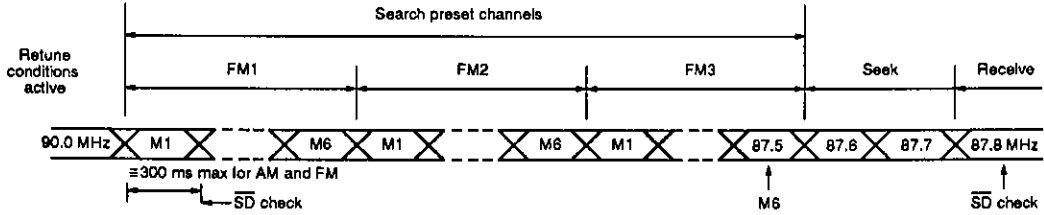


Figure 19. Auto-retune timing

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

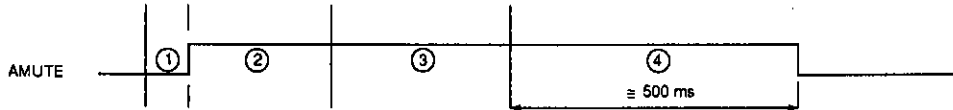


Figure 20. Bandswitching and preset reading

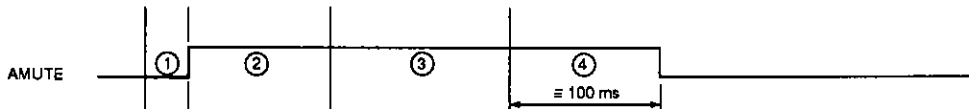


Figure 21. Manual frequency increment/decrement

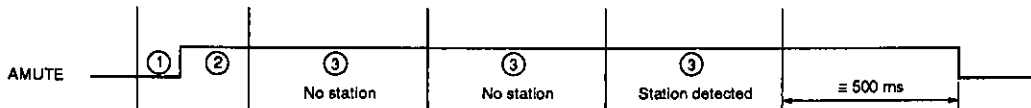


Figure 22. Seek and scan

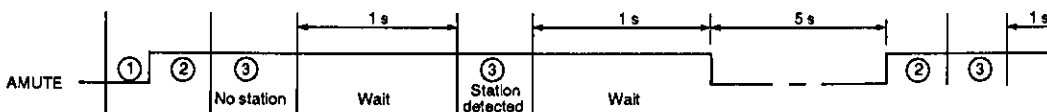


Figure 23. Preset scan

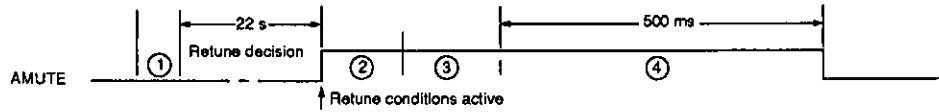


Figure 24. Auto-retune

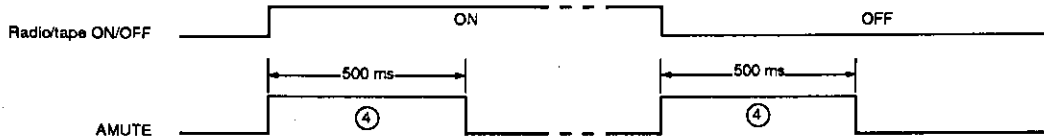


Figure 25. Radio and tape ON/OFF



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{DKIN} is HIGH. A, B, SK and C, excluding M3 to M6
					\overline{DKIN} is LOW. A, C and SK

Notes

- 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)
- 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.
- RADIO = 1 and TAPE = 1 for European frequency bands only
- 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.

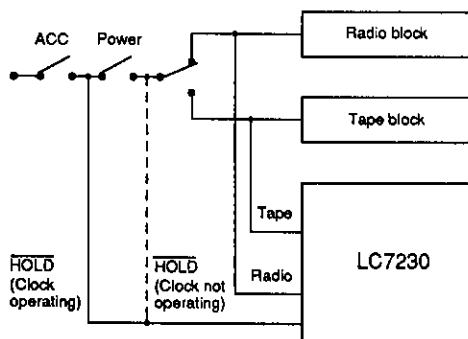


Figure 27. Connection for tape and radio functions

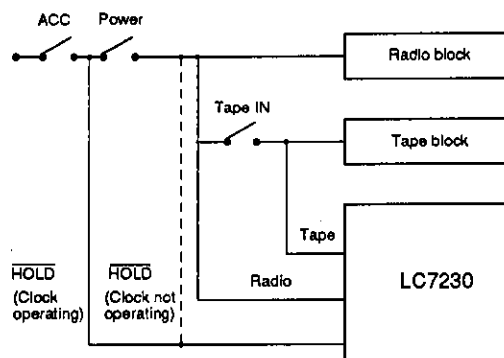


Figure 28. Connection for tape, radio and traffic information functions

Standby mode

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

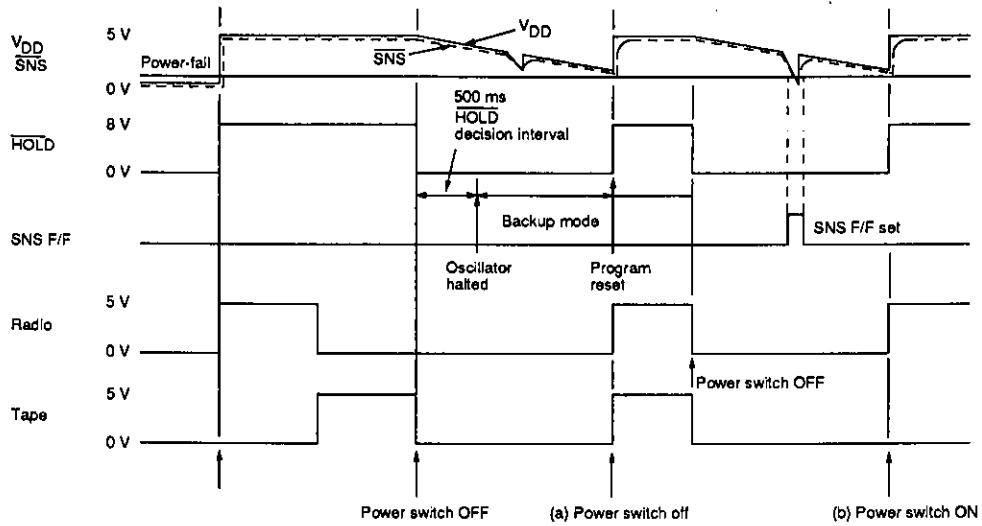


Figure 29. Standby mode

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.

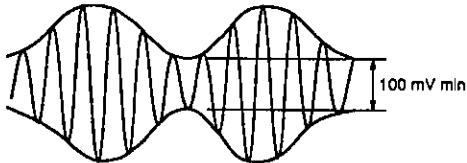


Figure 30. AM IF signal level

FM Tuner

The FM IF signal should be maintained at the level shown in figure 31 when the IF count signal is output.

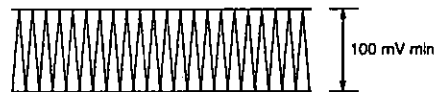


Figure 31. FM IF signal level

TYPICAL APPLICATIONS

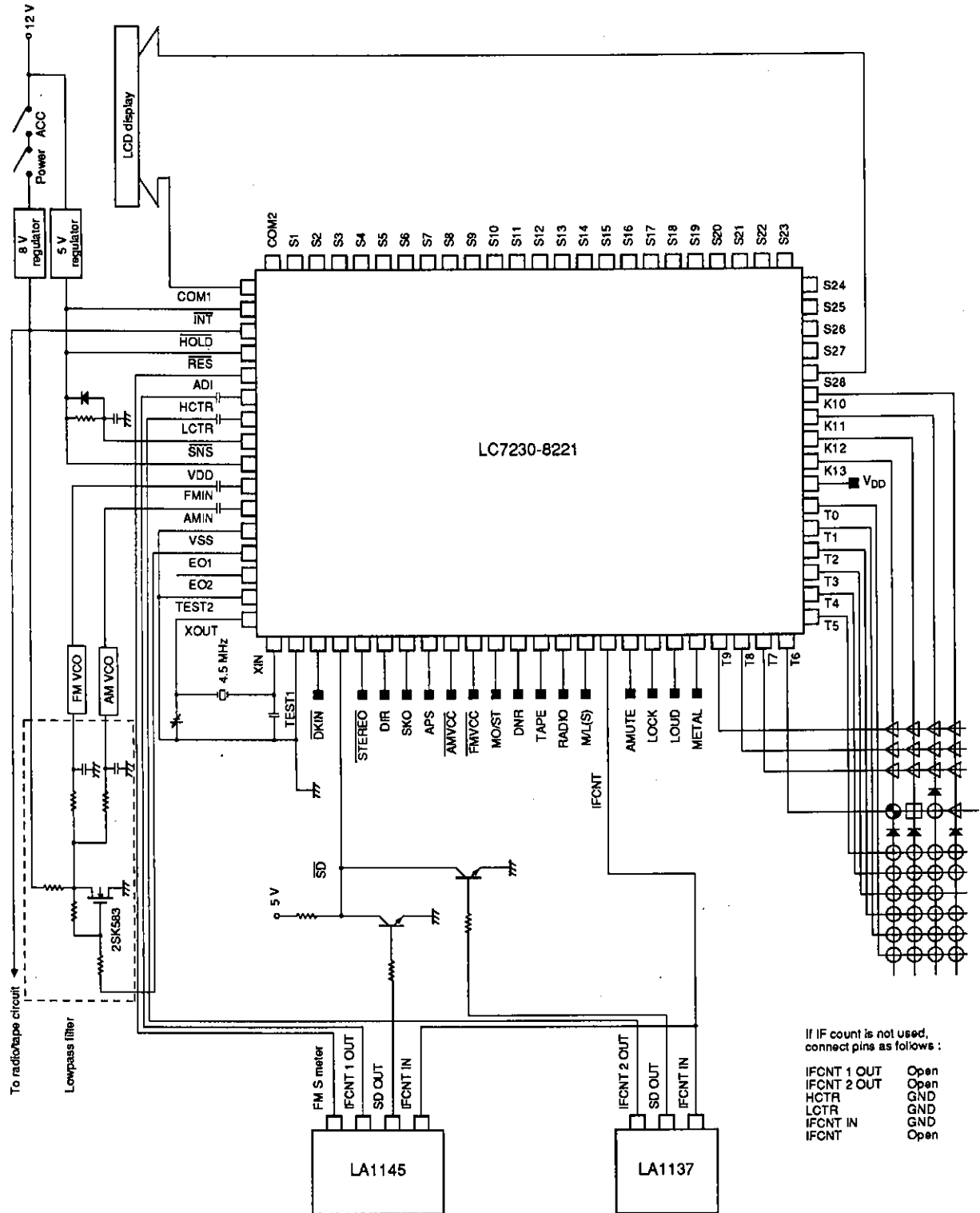


Figure 32. Without clock

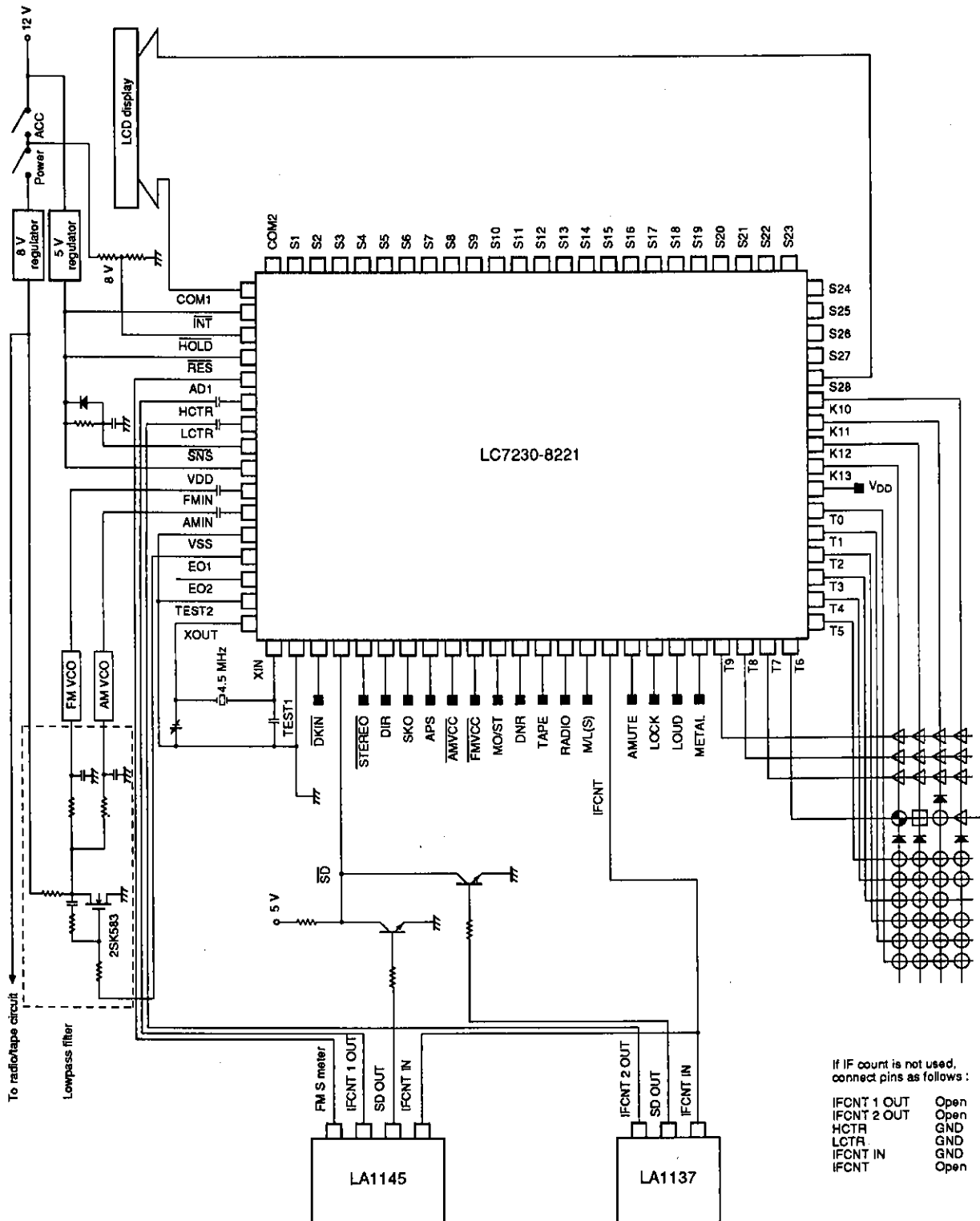


Figure 33. With clock

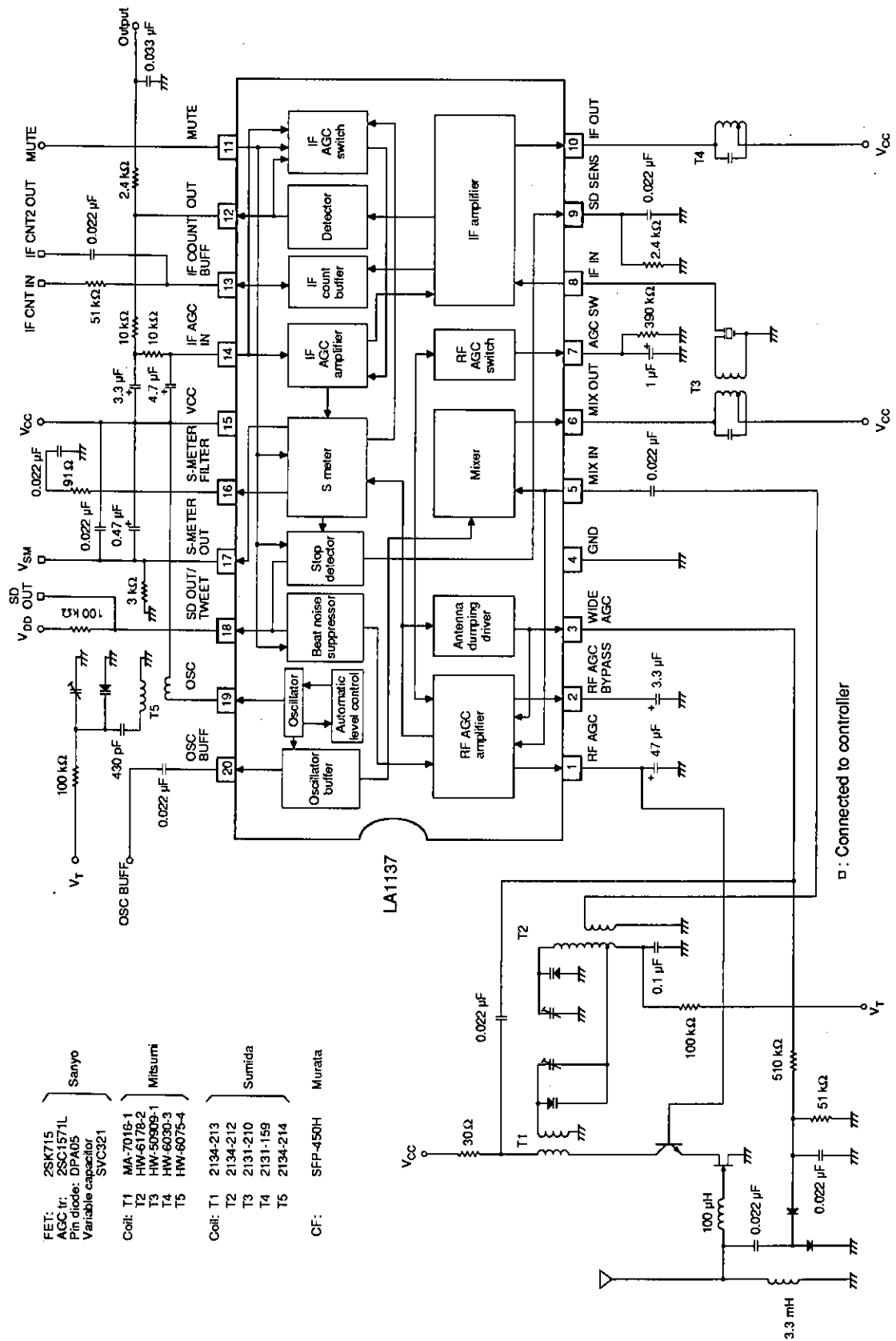


Figure 34. AM tuner

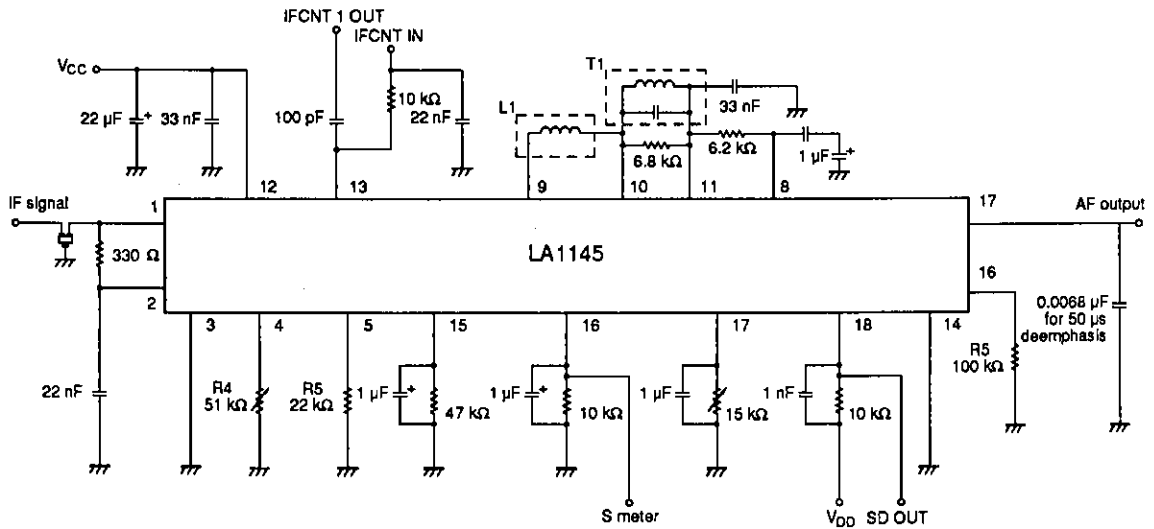


Figure 35. FM tuner

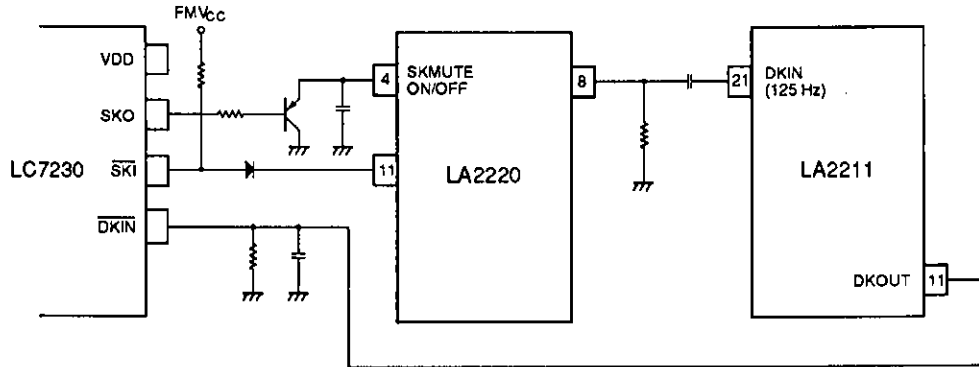


Figure 36. Traffic control decoder 1

Note

The SKI active signal is on the base of the transistor in the keypad matrix.

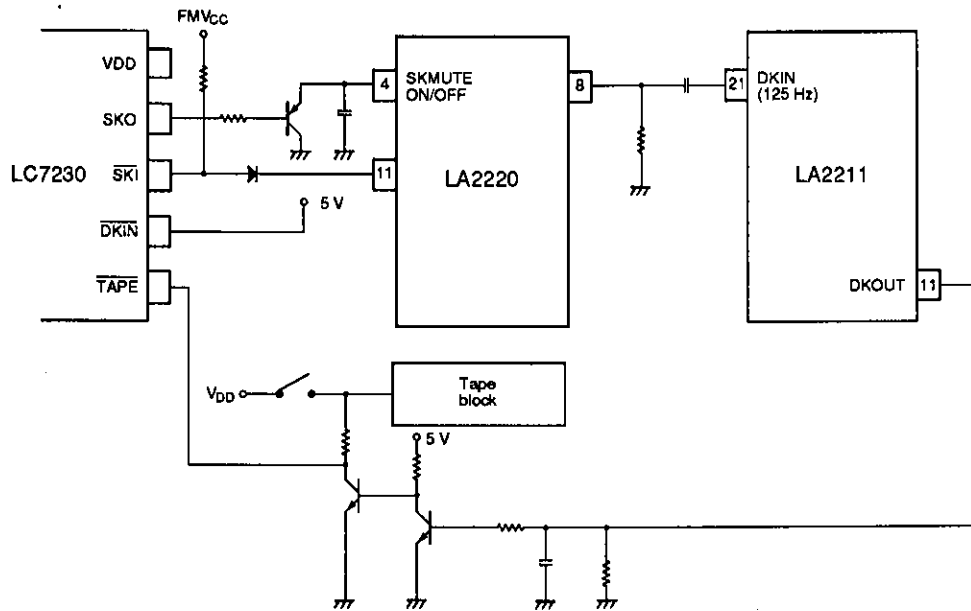


Figure 37. Traffic information decoder 2

Note

The SKI active signal is on the base of the transistor in the keypad matrix.

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