

**SANYO**

No. 3000A

**LC7230-8221****Single-chip PLL and Microcontroller  
with LCD Driver****OVERVIEW**

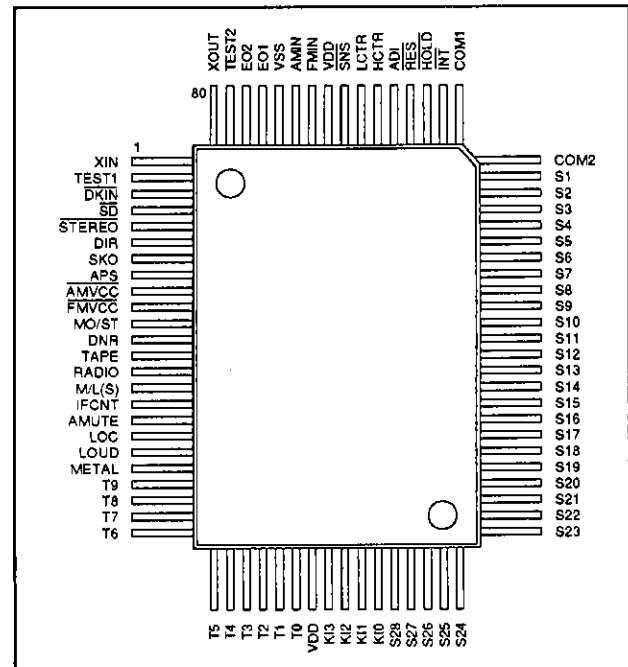
The LC7230-8221 is a single-chip microcontroller that incorporates a phased-locked loop (PLL) and a liquid crystal display driver, making it ideal for automatic station selection in digital tuners.

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.

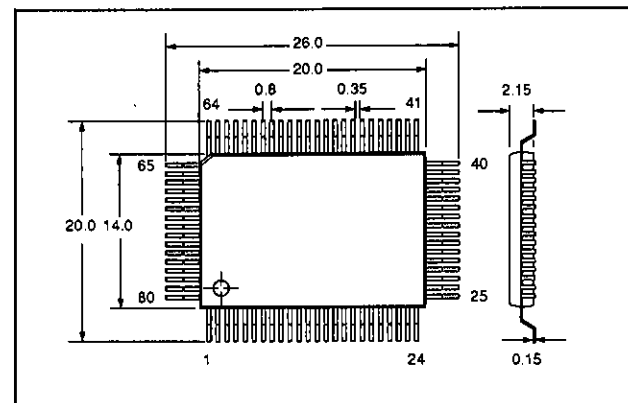
The LC7230-8221 operates from a 5 V supply and is available in 80-pin QIPs.

**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

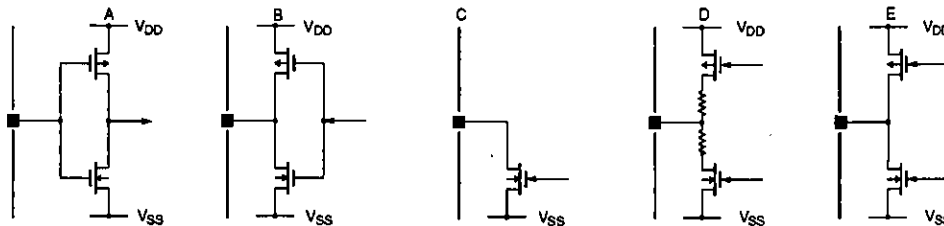
**3044B-QIP80A**

## 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 $\Omega$ (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 <sub>DD</sub>  |
| 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 <sub>DD</sub>   |
| 69       | ADI                        | S-meter input. Normally connected to V <sub>DD</sub> . 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 <sub>DD</sub>   | -0.3 to 6.5                   | V    |
| INT, ADI, SNS, SD, STEREO and DIR input voltage range | V <sub>IN1</sub>  | -0.3 to 6.5                   | V    |
| HOLD input voltage range                              | V <sub>IN2</sub>  | -0.3 to 13                    | V    |
| Input voltage range for all other pins                | V <sub>IN3</sub>  | -0.3 to V <sub>DD</sub> + 0.3 | V    |
| SKO, APS, AMVCC and FMVCC output voltage range        | V <sub>OUT1</sub> | -0.3 to 15                    | V    |
| Output voltage range for all other pins               | V <sub>OUT2</sub> | -0.3 to V <sub>DD</sub> + 0.3 | V    |
| Output current range. See note 1.                     | I <sub>OUT1</sub> | 0 to 5                        | mA   |
| Output current range. See note 2.                     | I <sub>OUT2</sub> | 0 to 3                        | mA   |
| T0 to T7 output current range                         | I <sub>OUT3</sub> | 0 to 1                        | mA   |
| Power dissipation                                     | P <sub>D</sub>    | 400                           | mW   |
| Operating temperature range                           | T <sub>opr</sub>  | -40 to 85                     | °C   |
| Storage temperature range                             | T <sub>stg</sub>  | -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<sub>a</sub> = 25 °C

| Parameter                                      | Symbol           | Rating     | Unit |
|--|------------------|------------|------|
| Supply voltage                                 | V <sub>DD</sub>  | 5          | V    |
| Supply voltage range for CPU and PLL operation | V <sub>DD1</sub> | 4.5 to 5.5 | V    |
| Supply voltage range for CPU operation         | V <sub>DD2</sub> | 3.5 to 5.5 | V    |
| Supply voltage range for data retention        | V <sub>DD3</sub> | 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,<br>$f_{IN}(FMIN) = 130$ MHz | –           | 15   | 25          | mA      |
|   |           | PLL halted   | –           | 2    | 3           |         |
|   |           | $V_{DD} = 5.5$ V, oscillator<br>halted, $T_a = 25$ °C  | –           | –    | 5           | $\mu$ A |
|   |           | $V_{DD} = 2.5$ V, oscillator<br>halted, $T_a = 25$ °C  | –           | –    | 1           |         |
| $\overline{DKIN}$ , $\overline{SD}$ and $\overline{STEREO}$ LOW-level<br>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.<br>See note 1.   | $V_{IL5}$ |  | 0           | –    | $0.3V_{DD}$ | V       |
| $\overline{DKIN}$ , $\overline{SD}$ and $\overline{STEREO}$ HIGH-level<br>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.<br>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<br>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 $\overline{SNS}$<br>LOW-level input current   | $I_{IL1}$ | $V_i = V_{SS}$   | –           | –    | 3.0         | $\mu$ A |
| XIN LOW-level input current   | $I_{IL2}$ | $V_i = V_{SS}$   | 2.0         | 5.0  | 15.0        | $\mu$ A |
| FMIN, AMIN, HCTR and LCTR<br>LOW-level input current  | $I_{IL3}$ | $V_i = V_{SS}$   | 4.0         | 10.0 | 30.0        | $\mu$ A |
| $\overline{INT}$ , $\overline{HOLD}$ , ADI, $\overline{SNS}$ , $\overline{DKIN}$ , $\overline{SD}$<br>and $\overline{STEREO}$ HIGH-level input<br>current | $I_{IH1}$ | $V_{IN} = 5.5$ V                                       | –           | –    | 3.0         | $\mu$ A |
| HIGH-level input current.<br>See note 1.  | $I_{IH2}$ | $V_{IN} = V_{DD}$                                      | –           | –    | 3.0         | $\mu$ A |
| XIN HIGH-level input current  | $I_{IH3}$ | $V_{IN} = V_{DD} = 5.0$ V                              | 2.0         | 5.0  | 15          | $\mu$ A |
| FMIN, AMIN, HCTR and LCTR<br>HIGH-level input current   | $I_{IH4}$ | $V_{IN} = V_{DD} = 5.0$ V                              | 4.0         | 10.0 | 30.0        | $\mu$ A |
| KI0 to KI3 HIGH-level input current   | $I_{IH5}$ | $V_{IN} = V_{DD} = 5.0$ V                              | –           | 50.0 | –           | $\mu$ 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   | $V_{OL1}$   | $I_o = 50$ $\mu$ A                             | 0.5            | 1.0            | 2.0             | V          |
| LOW-level output voltage.<br>See note 2.  | $V_{OL2}$   | $I_o = 1$ mA                                   | –              | –              | 1.0             | V          |
| E01 and E02 LOW-level output voltage  | $V_{OL3}$   | $I_o = 500$ $\mu$ A                            | –              | –              | 1.0             | V          |
| XOUT LOW-level output voltage   | $V_{OL4}$   | $I_o = 200$ $\mu$ 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<br>LOW-level output voltage                                      | $V_{OL6}$   | $I_o = 5$ mA                                   | –              | –              | 1.0             | V          |
| SK0, APS, AMVCC and FMVCC<br>LOW-level output voltage                                   | $V_{OL7}$   | $I_o = 5$ mA,<br>$R_L = 150$ to $400$ $\Omega$ | 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.<br>See note 2.   | $V_{OH2}$   | $I_o = 1$ mA                                   | $V_{DD} - 1.0$ | –              | –               | V          |
| E01 and E02 HIGH-level output voltage   | $V_{OH3}$   | $I_o = 500$ $\mu$ A                            | $V_{DD} - 1.0$ | –              | –               | V          |
| XOUT HIGH-level output voltage  | $V_{OH4}$   | $I_o = 200$ $\mu$ 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<br>HIGH-level output voltage                                     | $V_{OH6}$   | $I_o = 5$ mA                                   | $V_{DD} - 1.0$ | –              | –               | V          |
| COM1 and COM2 HIGH-level output voltage   | $V_{OH7}$   | $I_o = 20$ $\mu$ A                             | $V_{DD} - 0.7$ | $V_{DD} - 0.5$ | $V_{DD} - 0.35$ | V          |
| LCTR (period), $\overline{\text{HOLD}}$ and $\overline{\text{INT}}$<br>hysteresis width | $V_N$       |  | $0.1V_{DD}$    | –              | –               | V          |
| SNS reject pulsewidth   | $t_{REJ}$   |  | –              | –              | 50              | $\mu$ 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 $\Omega$ |
| 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.<br>See note 3.   | $I_{OFFL2}$ | $V_o = V_{SS}$                                 | –              | –              | 3.0             | $\mu$ 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 | $\mu A$ |
| SK0, APS, $\overline{AMVCC}$ and $\overline{FMVCC}$ HIGH-level leakage current | $I_{OFFH3}$ | $V_0 = 13 V$   | -      | -    | 5.0 | $\mu A$ |

**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.

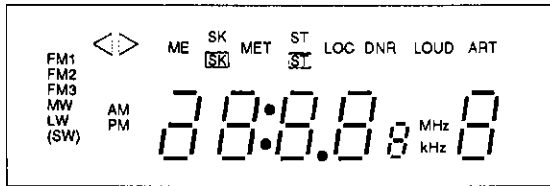


Figure 1. LCD display

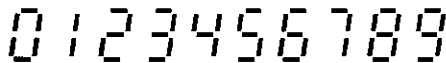


Figure 2. LCD digits

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.

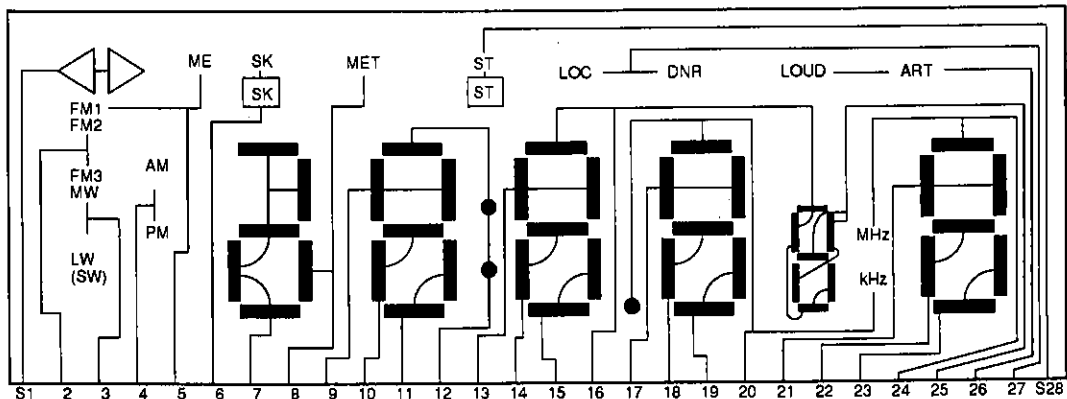


Figure 3. Segments

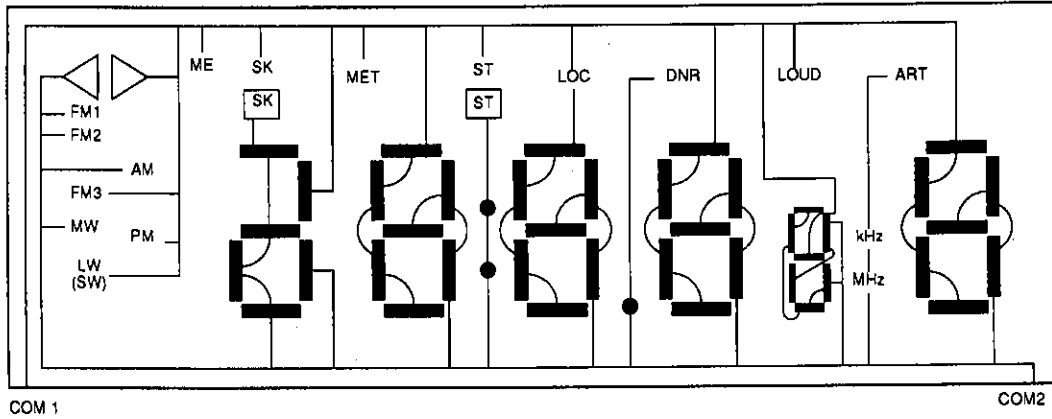


Figure 4. Commons

The LCD drive waveforms are shown in figure 5.

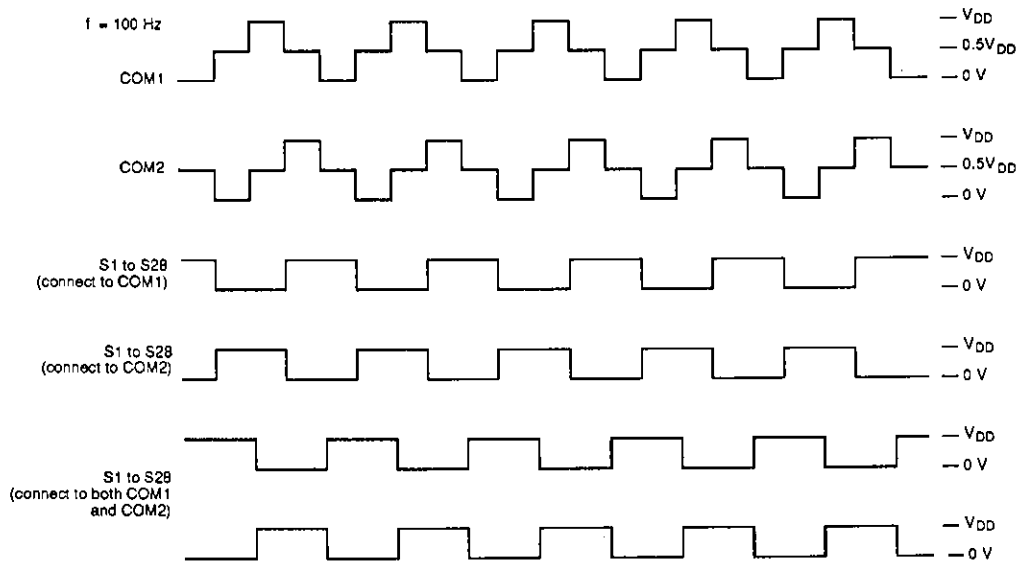


Figure 5. LCD drive waveforms

## 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.

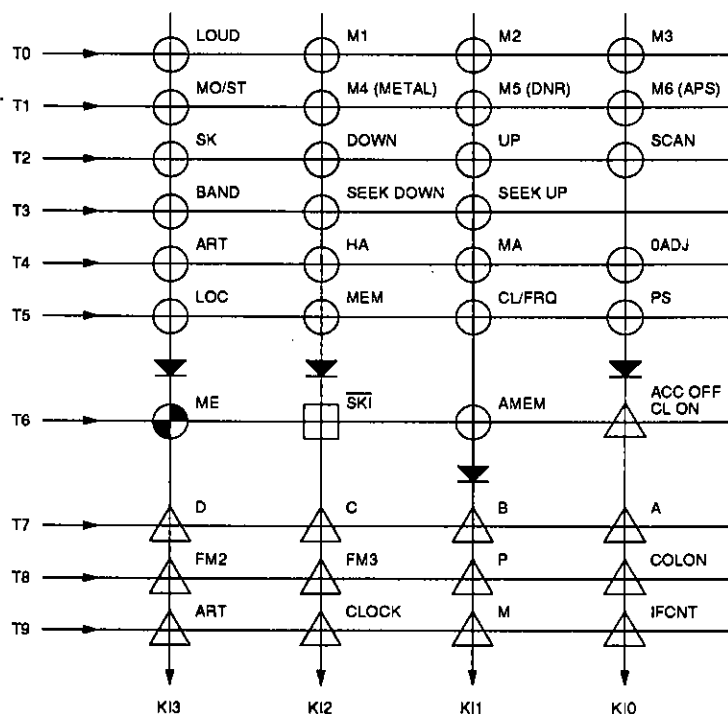


Figure 6. Keypad matrix

**Note**

K10 to K13 have internal pull-down resistors.



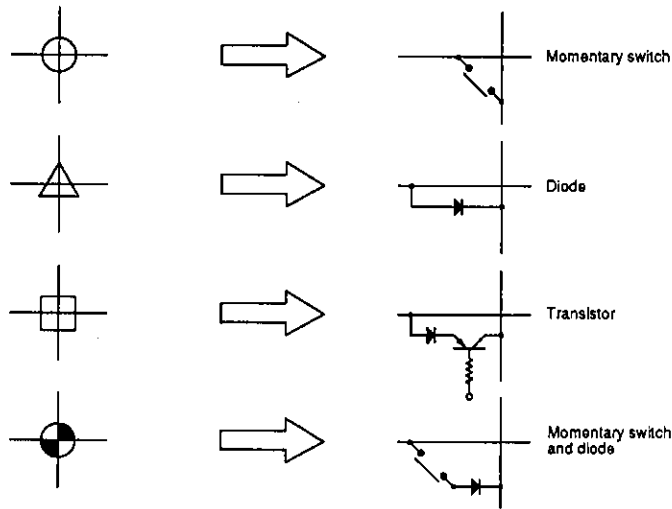


Figure 7. Symbol definitions

**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    |    |
|   | 1 | 1 | 0 | FM E   | 50   |                            |      |    |
|   |   |   |   | MW D   | 9    |                            |      |    |
| 0 | 1 | 1 | 0 | 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.

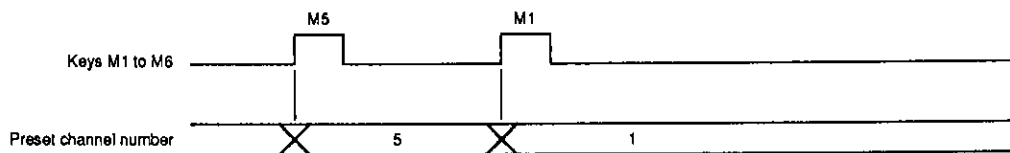


Figure 8. M1 to M6 six-key method

**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.

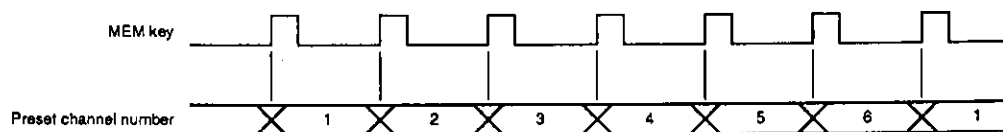


Figure 9. MEM single-key method

**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.

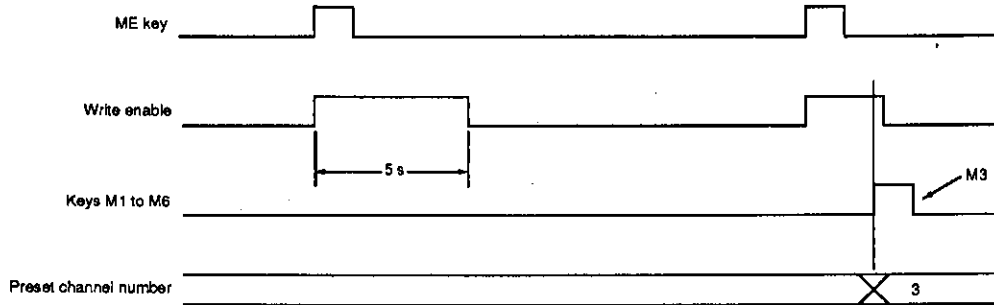
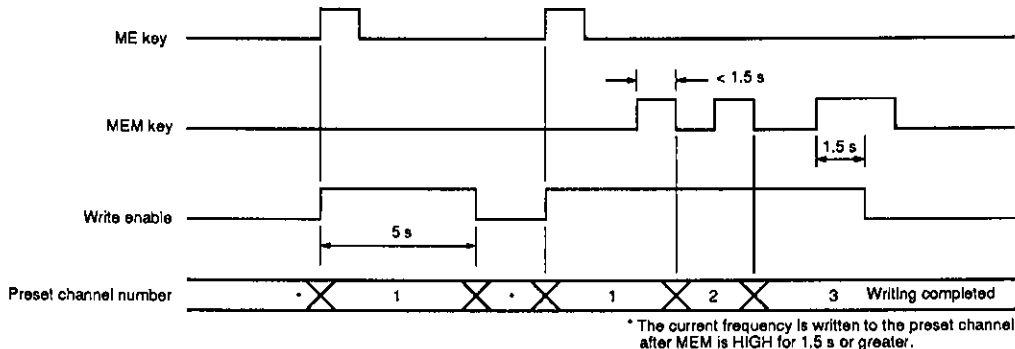


Figure 10. Writing to memory using the six-key method

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.



\* The current frequency is written to the preset channel after MEM is HIGH for 1.5 s or greater.

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.

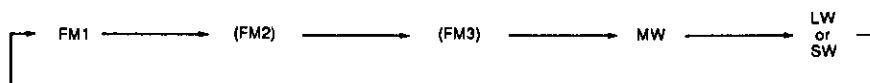


Figure 12. Frequency band selection

**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.

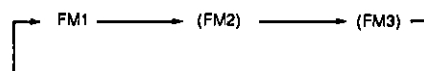


Figure 13. Preset scan of FM bands

**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 $\mu$  or lower or when the AM IF level is 30 dB $\mu$  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.

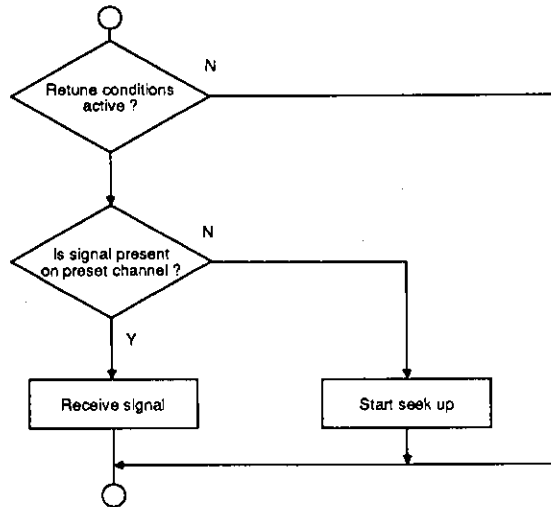


Figure 14. Auto-retune flow

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.

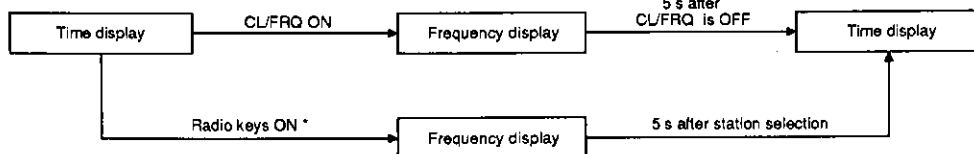
Table 11. LOC key functions

| 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

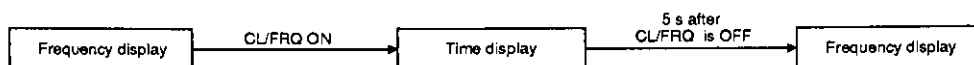


Figure 16. Frequency priority mode

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)<br>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)<br>FM E (MHz) | 87.5 | 90.0 | 98.0 | 106.0 | 108.0 | 87.5 |
|        | MW D (kHz)<br>MW E (kHz) | 531  | 612  | 999  | 1404  | 1620  | 531  |
|        | LW A (kHz)<br>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.

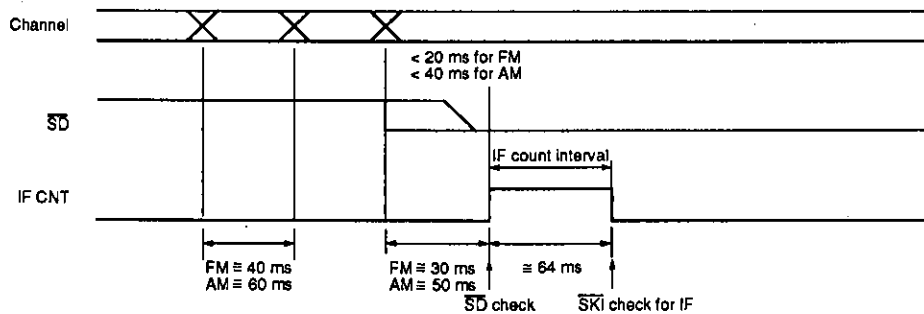


Figure 17. Seek and scan timing

**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  |



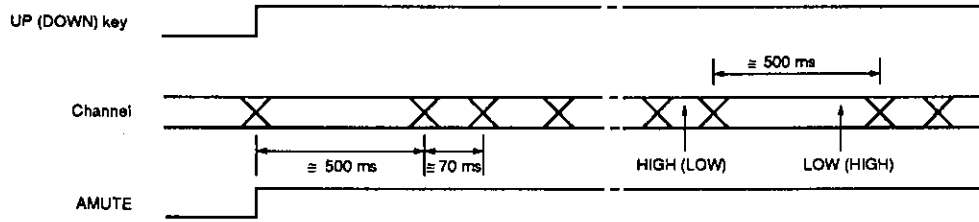


Figure 18. Manual tuning timing

**Note**

Channel spacing is 100 kHz/step.

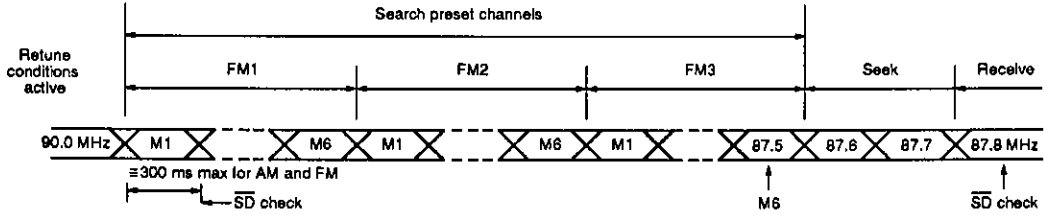


Figure 19. Auto-retune timing

**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

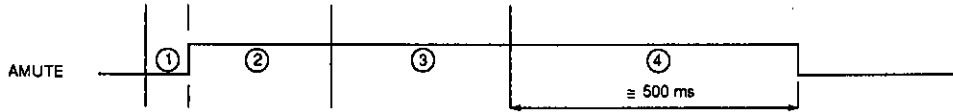


Figure 20. Bandswitching and preset reading

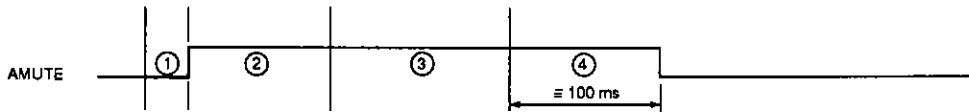


Figure 21. Manual frequency increment/decrement

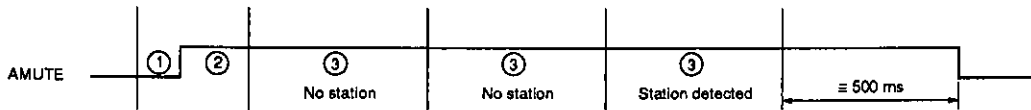


Figure 22. Seek and scan

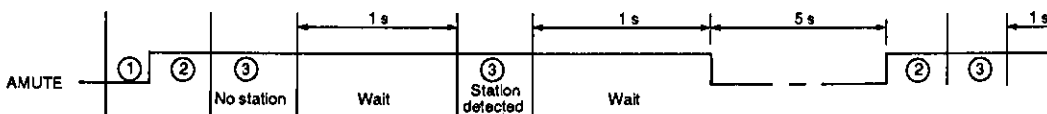


Figure 23. Preset scan

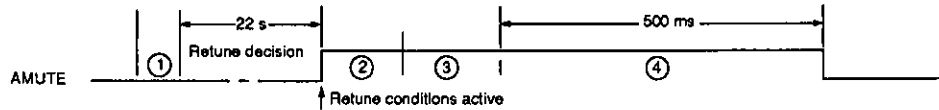


Figure 24. Auto-retune

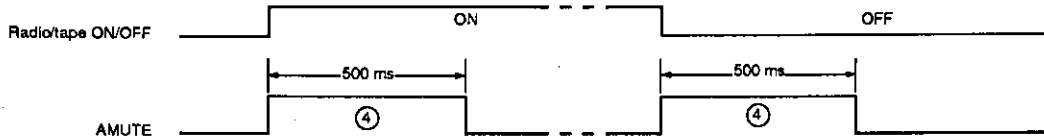


Figure 25. Radio and tape ON/OFF



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

- 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.

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

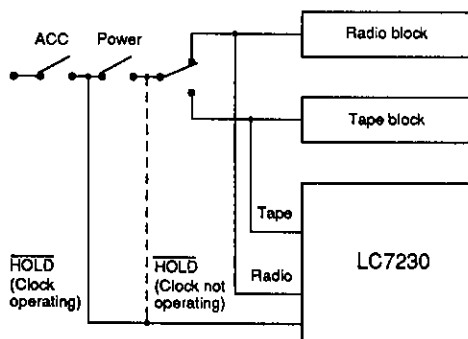


Figure 27. Connection for tape and radio functions

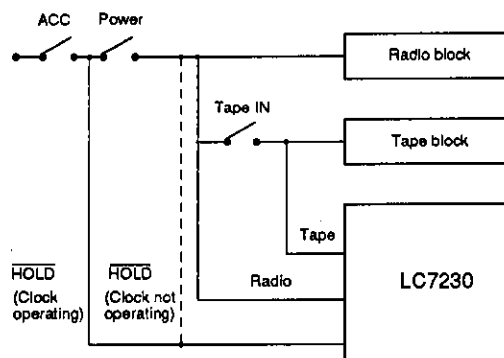


Figure 28. Connection for tape, radio and traffic information functions

**Standby mode**

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

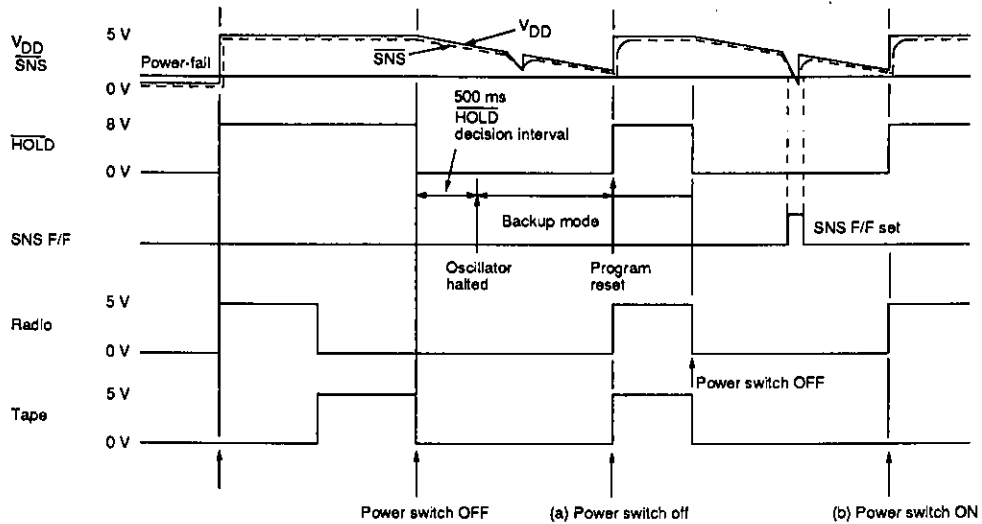


Figure 29. Standby mode

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.

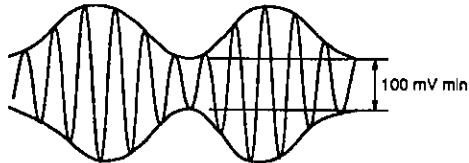


Figure 30. AM IF signal level

**FM Tuner**

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

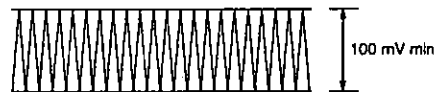


Figure 31. FM IF signal level

TYPICAL APPLICATIONS

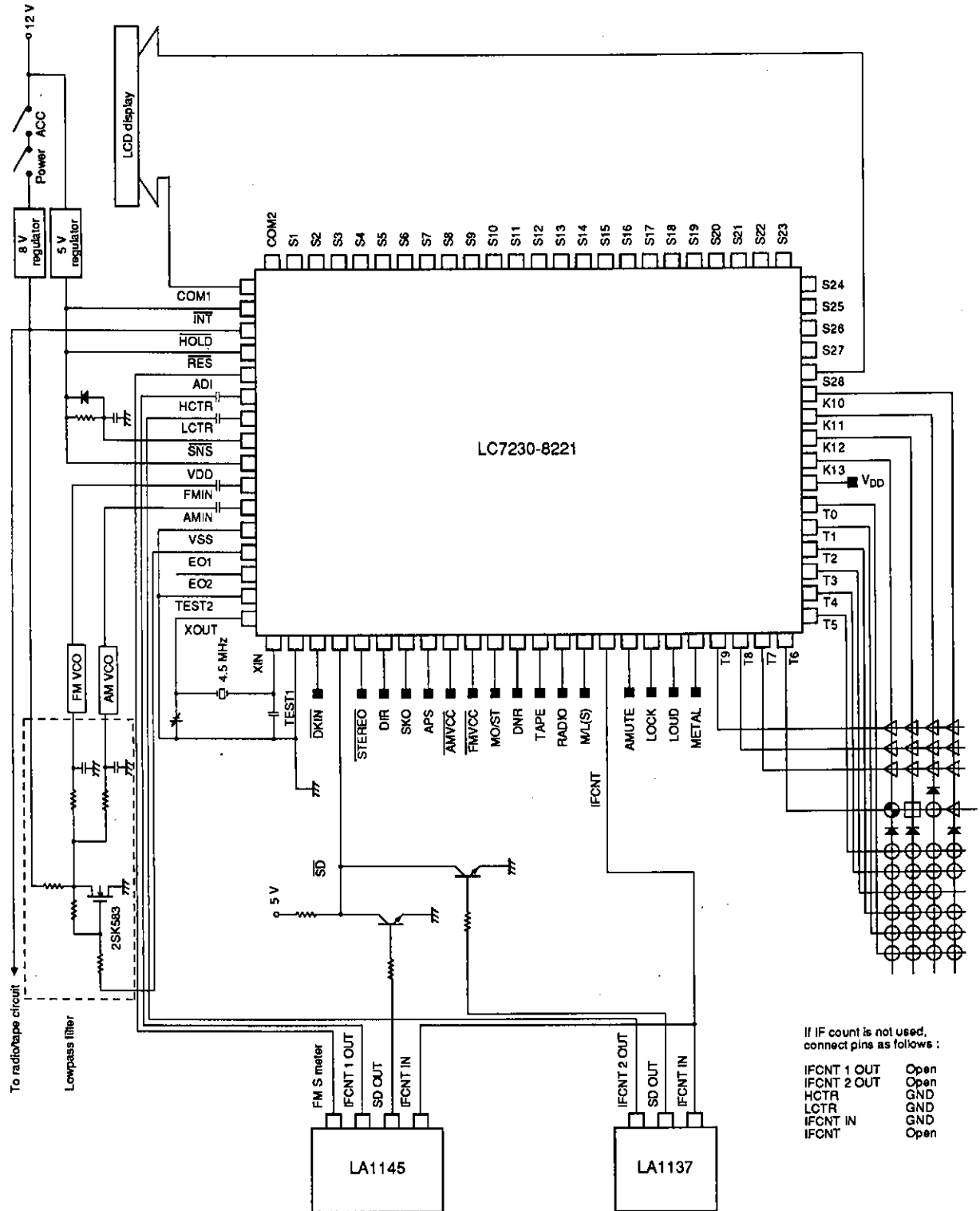
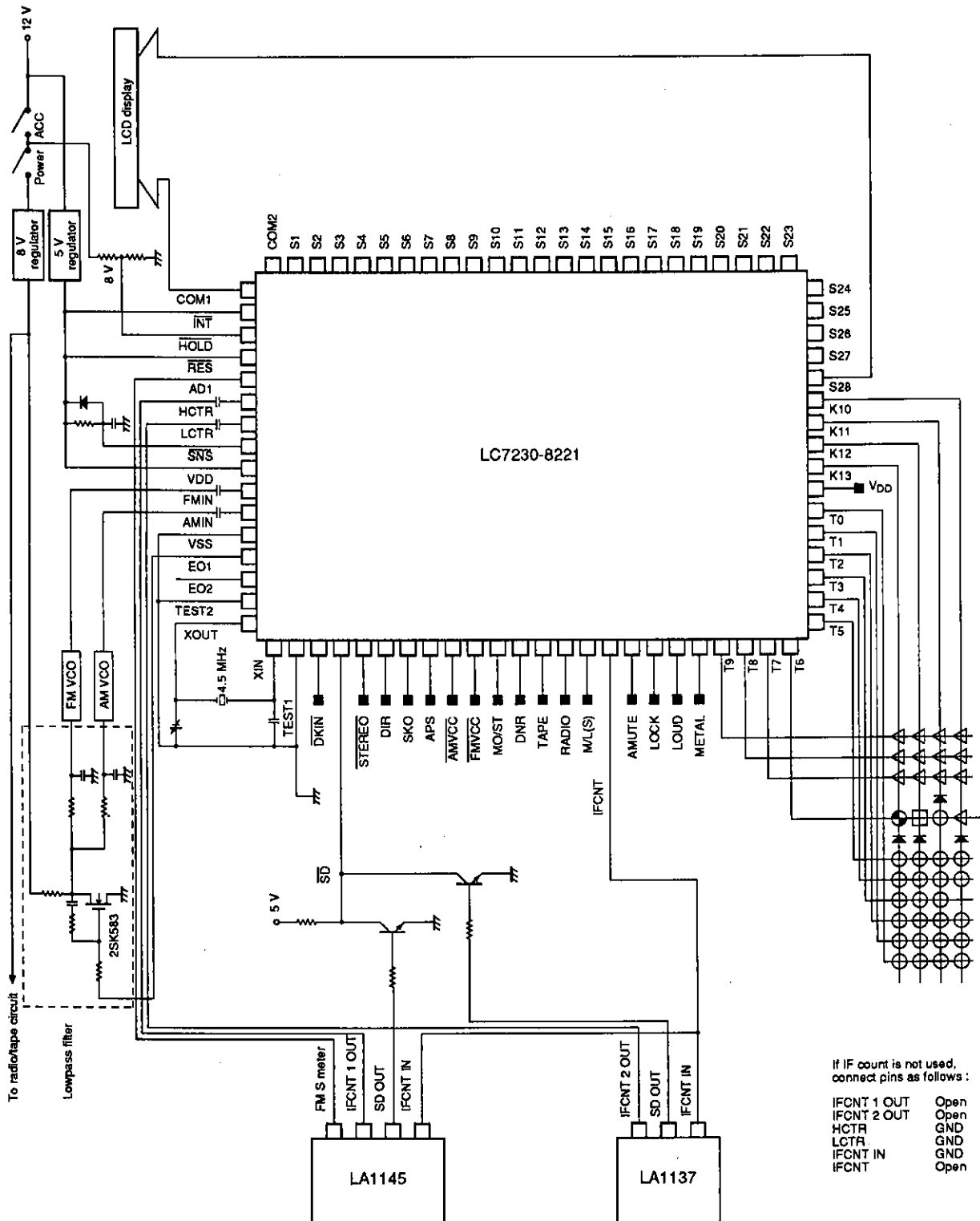


Figure 32. Without clock



If IF count is not used,  
connect pins as follows :

|             |      |
|-------------|------|
| IFCNT 1 OUT | Open |
| IFCNT 2 OUT | Open |
| HCTR        | GND  |
| LCTR        | GND  |
| IFCNT IN    | GND  |
| IFCNT       | Open |

Figure 33. With clock

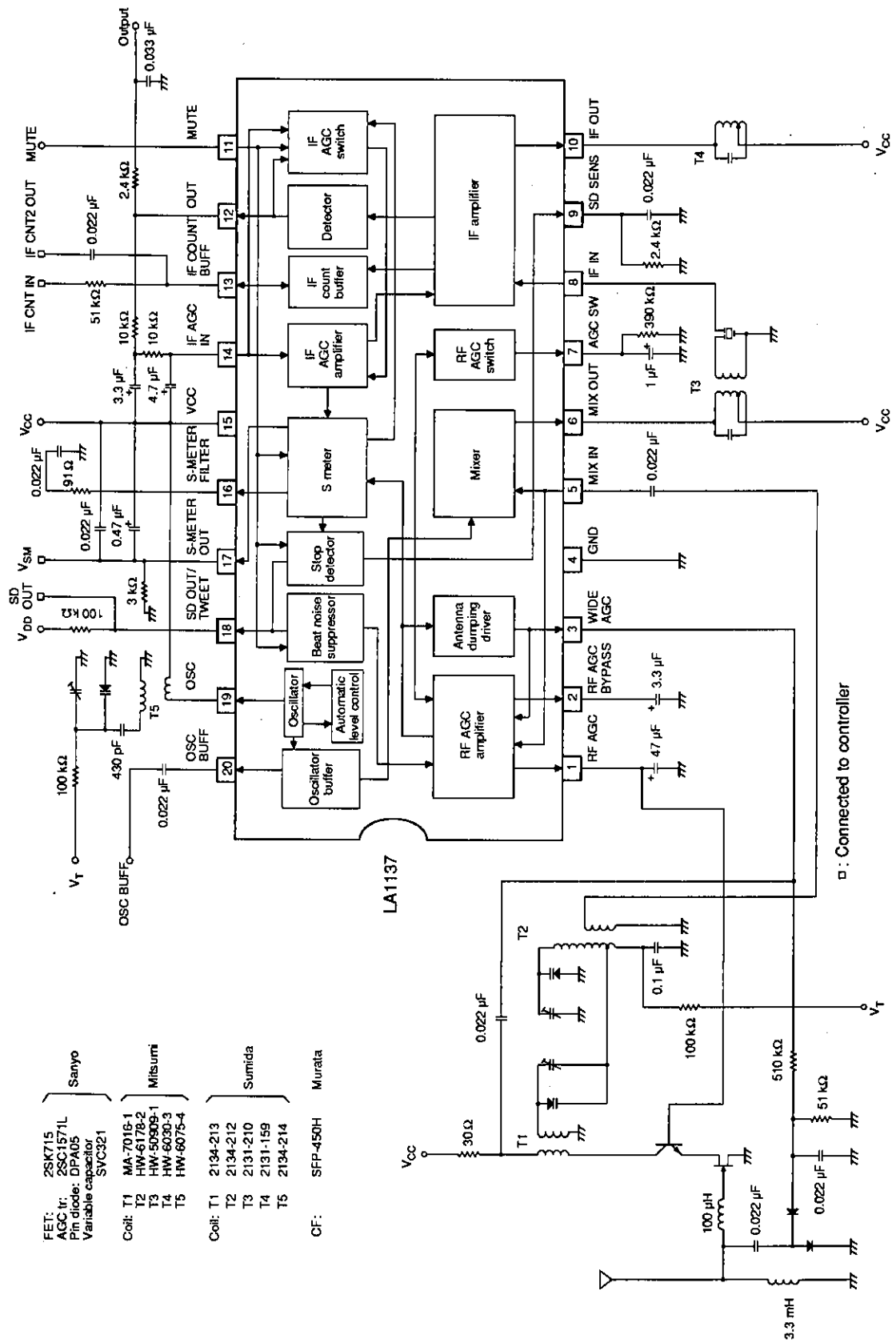


Figure 34. AM tuner

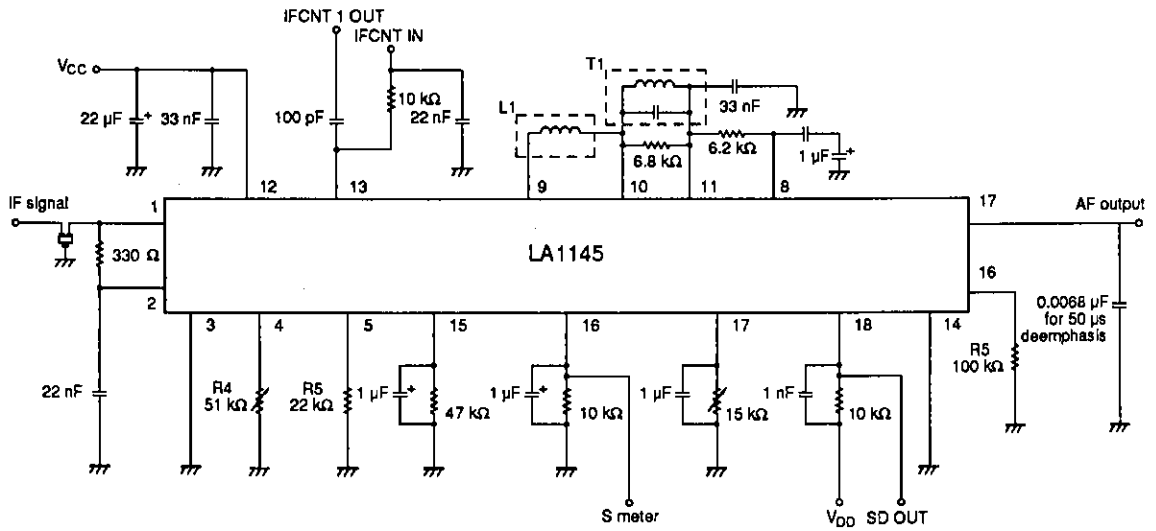


Figure 35. FM tuner

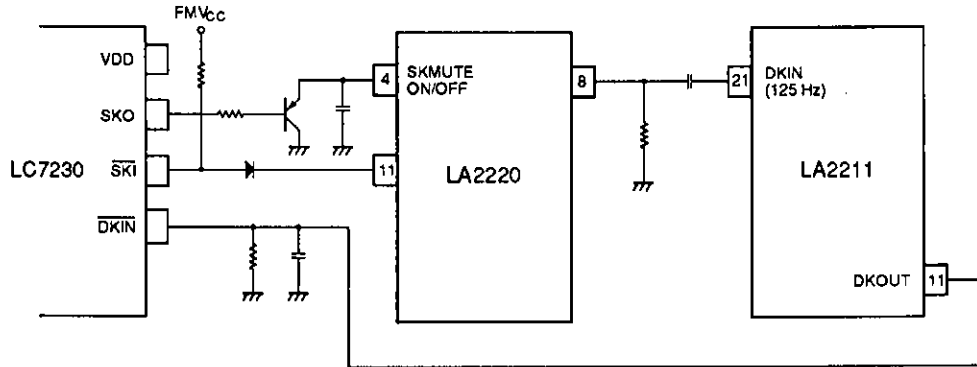


Figure 36. Traffic control decoder 1

**Note**

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



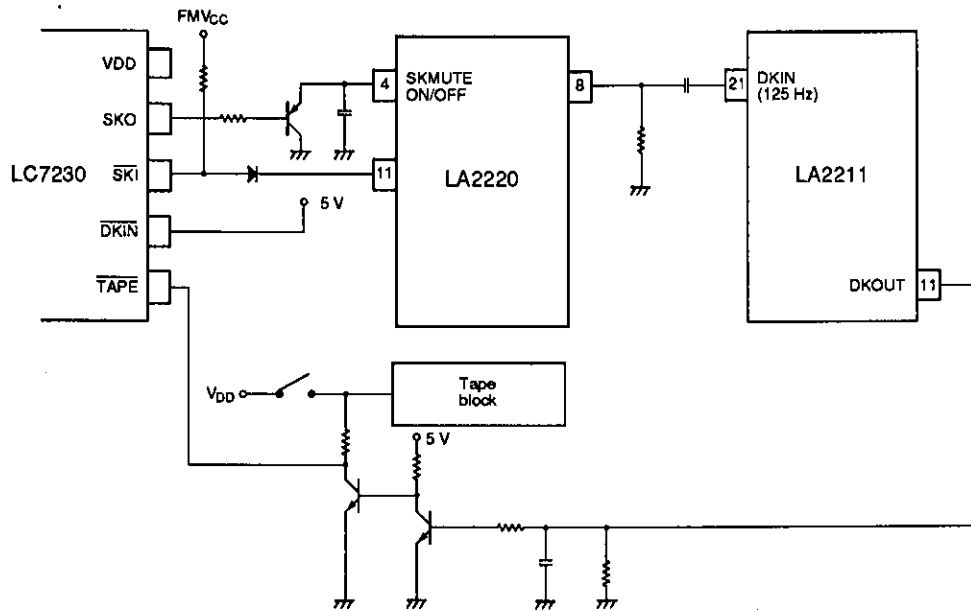


Figure 37. Traffic information decoder 2

**Note**

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

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