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# LA1787M

**Monolithic Linear IC**

# Single-Chip Tuner IC for Car Radios

ON Semiconductor®

http://onsemi.com

## Overview

The LA1787M integrates all six blocks required in a car radio tuner on a single chip.

## Functions

- FM front end
- FM IF
- Noise canceller
- Multiple
- AM up-conversion
- FM/AM switch
- MRC

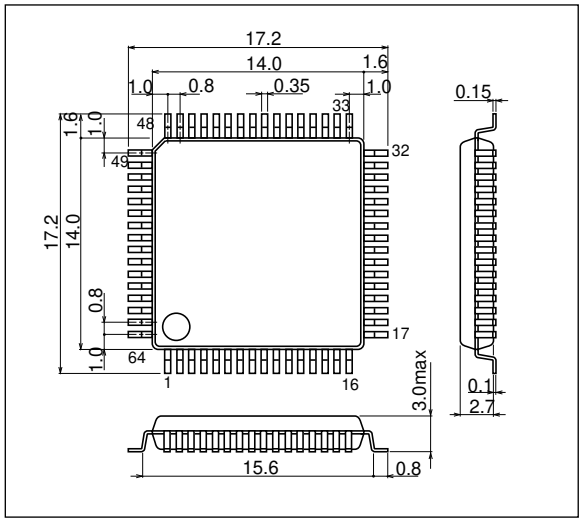
## Features

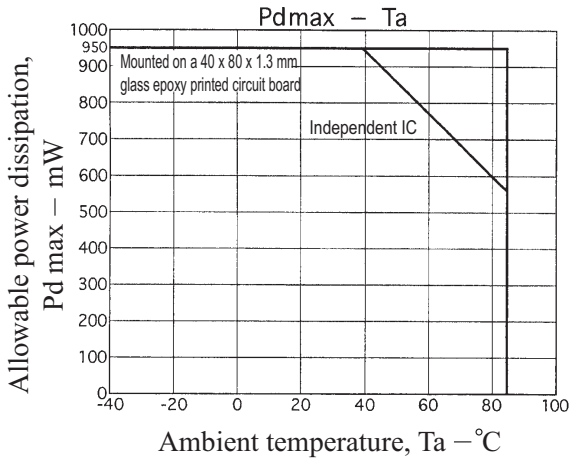
- Improved noise reduction methods
  — The FM front end provides excellent 3-signal characteristics equivalent to those of the LA1193M.
  — Superlative listenability due to improved medium and weak field noise canceller characteristics.
  — Improved separation characteristics
  — Anti-birdie filter
  — Improved AM and FM thermal characteristics
  — Excellent FM signal meter linearity
  — Modified N.C. circuit for improved noise rejection
- Improved AM adjacent channel interference characteristics (Δ40 kHz)
- Double conversion AM tuner (up conversion) Reduces the number of external components required as compared to earlier double conversion tuners, in particular, no crystal is required (when used in conjunction with the LC72144).
- Sample-to-sample variation reduction circuit built into the FM IF circuit.
  (Fixed resistors are used for the SD, keyed AGC, mute on adjustment, ATT, SNC, and HCC functions.)
- Improved FM separation temperature characteristics
- The LA1787 inherits the block arrangement of the LA1780M and supports pin-compatible designs.

## Package Dimensions

unit : mm (typ)

QIP64E(14X14)



# Specifications

## Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | $V_{CC}$1 max | Pins 6, 40, and 61 | 9 | V |
| | $V_{CC}$2 max | Pins 7, 45, 54, 59, and 60 | 12 | V |
| Allowable power dissipation | Pd max | Ta ≤ 55°C | 950 | mW |
| Operating temperature | Topr | | –40 to +85 | °C |
| Storage temperature | Tstg | | –40 to +150 | °C |

## Operating Conditions at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Recommended supply voltage | $V_{CC}$ | Pins 6, 7, 40, 45, 54, 59, 60, and 61 | 8 | V |
| | $V_{CC}$ST IND | Pin 26 | 5 | V |
| Operating supply voltage range | $V_{CC}$ op | | 7.5 to 9.0 | V |

## Operating Characteristics at Ta = 25°C, $V_{CC}$= 8.0V, in the specified test cricuit for the FM IF input

| Parameter | Symbol | Conditions | Ratings | | | unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| [FM Characteristics] At the FM IF input | | | | | | |
| Current drain | $I_{CCO}$-FM | No input, I40 + I45 + I54 + I59 + I60 + I61 | 60 | 94 | 110 | mA |
| Demodulation output | $V_O$-FM | 10.7 MHz, 100dBμ, 1 kHz, 100%mod, The pin 15 output | 205 | 310 | 415 | mVrms |
| Pin 31 demodulation output | $V_O$-FM31 | 10.7 MHz, 100dBμ, 1 kHz, 100%mod, The pin 31 output | 190 | 295 | 380 | mVrms |
| Channel balance | CB | The ratio between pins 15 and 16 at 10.7 MHz, 100 dBμ, 1 kHz | –1 | 0 | +1 | dB |
| Total harmonic distortion | THD-FM mono | 10.7 MHz, 100 dBμ, 1 kHz, 100% mod, pin 15 | | 0.3 | 1 | % |
| Signal-to-noise ratio: IF | S/N-FM IF | 10.7 MHz, 100 dBμ, 1 kHz, 100% mod, pin 15 | 75 | 82 | | dB |
| AM suppression ratio: IF | AMR IF | 10.7 MHz, 100 dBμ, 1 kHz, $f_m$ = 1 kHz, 30% AM, pin 15 | 55 | 68 | | dB |
| Muting attenuation | Att-1 | 10.7 MHz, 100 dBμ, 1 kHz. The pin 15 attenuation when V33 goes from 0 to 2 V | 5 | 10 | 15 | dB |
| | Att-2 | 10.7 MHz, 100 dBμ, 1 kHz. The pin 15 attenuation when V33 goes from 0 to 2 V*1 | 15 | 20 | 25 | dB |
| | Att-3 | 10.7 MHz, 100 dBμ, 1 kHz. The pin 15 attenuation when V33 goes from 0 to 2 V*2 | 28 | 33 | 38 | dB |
| Separation | Separation | 10.7 MHz, 100 dBμ, L+R = 90%, pilot = 10%. The pin 15 output ratio | 30 | 40 | | dB |
| Stereo on level | ST-ON | The pilot modulation such that V26 < 0.5 V | 1.2 | 2.4 | 4.4 | % |
| Stereo off level | ST-OFF | The pilot modulation such that V26 > 3.5 V | 0.6 | 1.6 | | % |
| Main total harmonic distortion | THD-Main L | 10.7 MHz, 100 dBμ, L+R = 90%, pilot = 10%. The pin 15 signal | | 0.3 | 1.2 | % |
| Pilot cancellation | PCAN | 10.7 MHz, 100 dBμ, pilot = 10%. The pin 15 signal/the pilot level leakage. DIN audio | 20 | 30 | | dB |
| SNC output attenuation | AttSNC | 10.7 MHz, 100 dBμ, L-R = 90%, pilot = 10%. V28 = 3 V → 0.6 V, pin 15 | 1 | 5 | 9 | dB |
| HCC output attenuation | AttHCC-1 | 10.7 MHz, 100 dBμ, 10 kHz, L+R = 90%, pilot = 10%. V29 = 3 V → 0.6 V, pin 15 | 0.5 | 4.5 | 8.5 | dB |
| | AttHCC-2 | 10.7 MHz, 100 dBμ, 10 kHz, L+R = 90%, pilot = 10%. V29 = 3 V → 0.1 V, pin 15 | 6 | 10 | 14 | dB |
| Input limiting voltage | Vi-lim | 100 dBμ, 10.7 MHz, 30% modulation. The IF input such that the input reference output goes down by 3 dB | 33 | 40 | 47 | dBμ |
| Muting sensitivity | Vi-mute | The IF input level (unmodulated) when V33 = 2 V | 27 | 35 | 43 | dBμ |
| SD sensitivity | SD-sen1 FM | The IF input level (unmodulated) (over 100 mV rms) such that the IF counter buffer output goes on | 54 | 62 | 70 | dBμ |
| | SD-sen2 FM | | 54 | 62 | 70 | dBμ |
| IF counter buffer output | $V_{IFBUFF-FM}$ | 10.7 MHz, 100 dBμ, unmodulated. The pin 23 output | 130 | 200 | 270 | mVrms |
| Signal meter output | $V_{SM}$ FM-1 | No input. The pin 24 DC output, unmodulated | 0.0 | 0.1 | 0.3 | V |
| | $V_{SM}$ FM-2 | 50 dBμ. The pin 24 DC output, unmodulated | 0.4 | 1.0 | 1.5 | V |
| | $V_{SM}$ FM-3 | 70 dBμ. The pin 24 DC output, unmodulated | 2.0 | 2.7 | 3.5 | V |
| | $V_{SM}$ FM-4 | 100 dBμ. The pin 24 DC output, unmodulated | 4.7 | 5.5 | 6.2 | V |
| Muting bandwidth | BW-mute | 100 dBμ. The bandwidth when V33 = 2 V, unmodulated | 150 | 220 | 290 | kHz |
| Mute drive output | $V_{MUTE-100}$ | 100 dBμ, 0 dBμ. The pin 33 DC output, unmodulated | 0.00 | 0.03 | 0.20 | V |

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| Parameter | Symbol | Conditions | Ratings | | | unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| [FM FE Mixer Input | | | | | | |
| N-AGC on input | $V_N$-AGC | 83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below | 81 | 88 | 95 | dBμ |
| W-AGC on input | $V_W$AGC | 83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below. (When the keyed AGC is set to 4.0 V.) | 104 | 110 | 116 | dBμ |
| Conversion gain | A.V | 83 MHz, 80 dBμ, unmodulated. The FE CF output | 19 | 30 | 48 | mVrms |
| Oscillator buffer output | $V_{OSCBUFFFM}$ | No input | 85 | 110 | 165 | mVrms |
| [NC Block] NC input (pin 30) | | | | | | |
| Gate time | τGATE1 | f = 1 kHz, for a 1-μs, 100-mV p-o pulse | | 55 | | μs |
| Noise sensitivity | SN | The level of a 1 = kHz, 1-μs pulse input that starts noise canceller operation. Measured at pin 30. | | 40 | | mVp-o |
| NC effect | SN-NC | The pulse rejection effect provided by the noise canceller. For a repeated 1-μs wide pulse, frequency = 10 kHz, 150 mV p-o. The ratio of the FM mode pin 15 output referenced to the AM mode pin 15 output (effective value) | 5 | | | |
| [Multipath Rejection Circuit] MRC input (pin 27) | | | | | | |
| MRC output | VMRC | V24 = 5 V | 2.2 | 2.3 | 2.4 | V |
| MRC operating level | MRC-ON | The pin 32 input level at f = 70 kHz such that pin 24 goes to 5 V and pin 27 goes to 2 V | 10 | 15 | 20 | mVrms |
| [AM Characteristics] AM ANT input | | | | | | |
| Practical sensitivity | S/N-30 | 1 MHz, 30 dBμ, $f_m$ = 1 kHz, 30% modulation, pin 15 | 20 | | | dB |
| Detector output | $V_O$-AM | 1 MHz, 74 dBμ, $f_m$ = 1 kHz, 30% modulation, pin 15 | 130 | 195 | 270 | mVrms |
| Pin 31 detector output | $V_O$-AM31 | 1 MHz, 74 dBμ, $f_m$ = 1 kHz, 30% modulation, pin 31 | 110 | 175 | 230 | mVms |
| AGC F.O.M. | $V_{AGC-FOM}$ | 1 MHz, 74 dBμ, referenced to the output, the input amplitude such that the output falls by 10 dB. Pin 15 | 51 | 56 | 61 | dB |
| Signal-to-noise ratio | S/N-AM | 1 MHz, 74 dBμ, $f_m$ = 1 kHz, 30% modulation | 47 | 52 | | dB |
| Total harmonic distortion | THD-AM | 1 MHz, 74 dBμ, $f_m$ = 1 kHz, 80% modulation | | 0.3 | 1 | % |
| Signal meter output | $V_{SM}$ AM-1 | No input | 0.0 | 0.2 | 0.5 | V |
| | $V_{SM}$ AM-2 | 1 MHz, 130 dBμ, unmodulated | 4.8 | 6 | 7.3 | V |
| Oscillator buffer output | $V_{OSCBUFF\ AM1}$ | No input, the pin 15 output | 185 | 230 | | mVrms |
| Wide band AGC sensitivity | W-AGCsen1 | 1.4 MHz, the input when V46 = 0.7 V | 92 | 98 | 104 | dBμ |
| | W-AGCsen2 | 1.4 MHz, the input when V46 = 0.7 V (seek mode) | 83 | 89 | 95 | dBμ |
| SD sensitivity | SD-sen1 AM | 1 MHz, the ANT input level such that the IF counter output turns on. | 24 | 30 | 36 | dBμ |
| | SD-sen2 AM | 1 MHz, the ANT input level such that the SD pin goes to the on state. | 24 | 30 | 36 | dBμ |
| IF buffer output | $V_{IFBUFF-AM}$ | 1 MHz, 74 dBμ, unmodulated. The pin 23 output | 200 | 290 | | mVrms |

Note: These measurements must be made using the either the IC-51-0644-824 or KS8277 IC socket (manufactured by Yamaichi Electronics).

* 1. When the resistor between pin 58 and ground is 200 kΩ.

* 2. When the resistor between pin 58 and ground is 30 kΩ.

## Function List

FM Front End (Equivalent to the Sanyo LA1193)
- Double input type double balanced mixer
- Pin diode drive AGC output
- MOSFET second gate drive AGC output
- Keyed AGC adjustment pin
- Differential IF amplifier
- Wide band AGC sensitivity setting pin, and narrow band AGC sensitivity setting pin
- Local oscillator

FM IF
- IF limiter amplifier
- S-meter output (also used for AM) 6-stage pickup
- Multipath detection pin (shared FM signal meter)
- Quadrature detection
- AF preamplifier
- AGC output
- Band muting
- Weak input muting
- Soft muting adjustment pin
- Muting attenuation adjustment pin
- IF counter buffer output (also used for AM)
- SD (IF counter buffer on level) adjustment pin
- SD output (active high) (also used for AM)

Noise Canceller
- High-pass filter (first order)
- Delay circuit based low-pass filter (fourth order)
- Noise AGC
- Pilot signal compensation circuit
- Noise sensitivity setting pin
- Function for disabling the noise canceller in AM mode

Multiplex Functions
- Adjustment-free VCO circuit
- Level follower type pilot canceller circuit
- HCC (high cut control)
- Automatic stereo/mono switching
- VCO oscillation stop function (AM mode)
- Forced monaural
- SNC (stereo noise controller)
- Stereo display pin
- Anti-birdie filter

AM
- Double balanced mixer (1st, 2nd)
- IF amplifier
- Detection
- RF AGC (narrow/wide)
- Pin diode drive pin
- IF AGC
- Signal meter output (also used for FM)
- Local oscillator circuits (first and second)
- Local oscillator buffer output
- IF counter buffer output (also used by the FM IF)
- SD (IF counter buffer on level) adjustment pin
- SD output (active high) (also used for AM)
- Wide AGC
- Detection output frequency characteristics adjustment pin (low cut, high deemphasis)
- AM stereo buffer

MRC (multipath noise rejection circuit)

AM/FM switching output (linked to the FM $V_{CC}$)

## Operating Characteristics and Symbols Used in the Test Circuit Diagrams

Switches (SW)

Switch on = 1, SW off = 0

There are two switches that use signal transfer.

— SW2: switches between the mixer input and the IF input.

— SW4: switches between noise canceler input and IF output + noise canceler input.

Types of SG used

| | |
|---|---|
| PG1 (AC1) | Used for noise canceler testing. A pulse generator and an AF oscillator are required. |
| AC2 | Used for FM front end testing. Outputs an 83 MHz signal. |
| AC3 | Used for FM IF, noise canceler, and MPX testing. Outputs a 10.7 MHz signal. Stereo modulation must be possible. |
| AC4 | Used for AM testing. Outputs 1 MHz and 1.4 MHz signals. |
| AC5 | Used with the MRC. Can also be used for AF and OSC. |

Power supply

| | | | |
|---|---|---|---|
| $V_{CC}$ | 8 V | | |
| $V_{CC}1$ | 5 V | | SD, stereo, seek/stop |
| $V_{CC}2$ | 0.1 V / 0.7 V / 2 V / 4 V | These levels must be variable. | Keyed AGC, Mute ATT |
| $V_{CC}3$ | 0.1 V / 0.6 V / 2 V | | HCC, SNC, SASC (MRC) |

• Switches

| | Parameter | ON | OFF |
|---|---|---|---|
| SW1 | AM/FM switching. The FE $V_{CC}$ is supplied to pin 62. | FM | AM |
| SW2 | FM IF switching. Pin 51/FE output | FE IF OUT (A) | AC3 (B) |
| SW3 | For conversion gain testing | Conversion gain measurement (A) | Other/purposes |
| SW4 | For switching between noise canceler input and IF output + noise canceler. | AC1 (A) | Other/purposes |
| SW5 | High-speed SD | High-speed SD | Other/purposes |
| SW6 | SEEK/STOP (IF BUFF ON/OFF) | STOP | Seek (IF buffer output) |
| SW7 | MUTE ATT 200 kΩ | MUTE 200 kΩ | OFF |
| SW8 | MUTE ATT 30 kΩ | MUTE 30 kΩ | OFF |
| SW9 | For pilot cancellation testing | When pilot cancellation is used | When pilot cancellation is not used |
| SW10 | Mute off (pin 33) | MUTE OFF | MUTE ON |

• Trimmers (variable resistors)

| | |
|---|---|
| VR1 | Separation adjustment |
| VR2 | Pilot cancellation adjustment |

Test Points

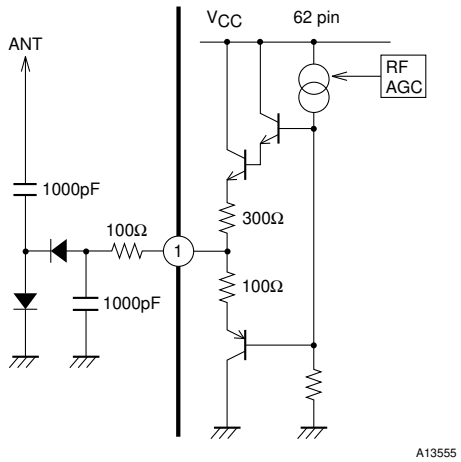
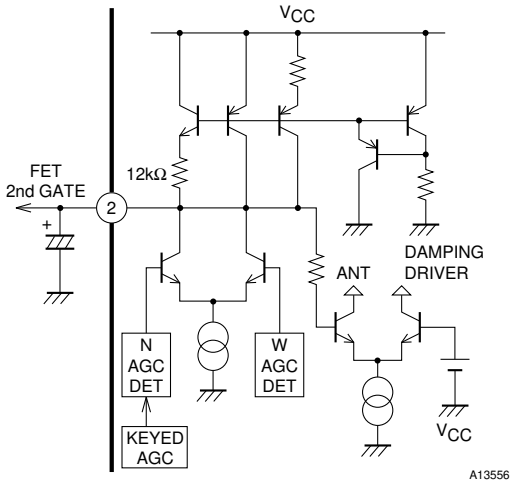
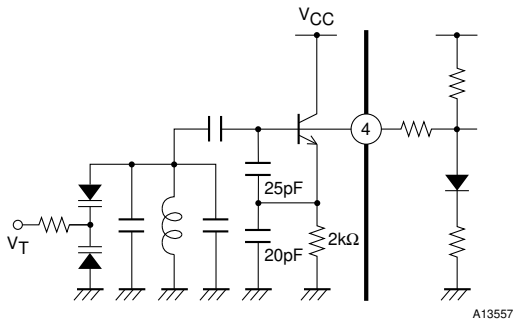
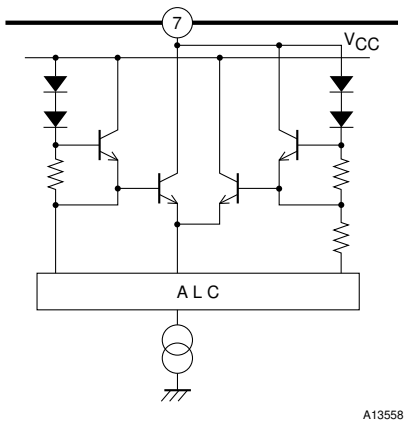
• DC voltages

| | | |
|---|---|---|
| VD1 | FM RF AGC voltage | Pin 2 |
| VD2 | AM/FM SD, AM Tweet, FM stereo indicator | Pin 26 |
| VD3 | AM/FM S-meter | Pin 24 |
| VD4 | MRC output | Pin 27 |
| VD5 | Mute drive output | Pin 33 |
| VD6 | AM antenna damping voltage | Pin 46 |
| VD7 | N.C. Gate time | Pin 8 |

• AC voltages

| | | |
|---|---|---|
| VA1 | AM/FM OSC Buff | Pin 4 |
| VA2 | First IF output | Pin 53 → CF → pin 51 load level (10.7 MHz) |
| VA3 | IF counter buffer | Pin 23 (10.7 MHz/450 kHz) |
| VA4 | MPX OUT Left ch | Pin 15 (AF) |
| VA5 | MPX OUT Right ch | Pin 16 (AF) |

## Pin Descriptions

| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 1 | Antenna damping drive | An antenna damping current flows when the RF AGC voltage (pin 2) reaches $V_{CC} - V_D$. |  |
| 2 | RF AGC | Used to control the FET second gate. |  |
| 3 | F.E.GND | | |
| 4 | OSC | Oscillator connection |  |
| 7 | AM OSC | AM first oscillator<br>This circuit can oscillator up to the SW band.<br>An ALC circuit is included. |  |

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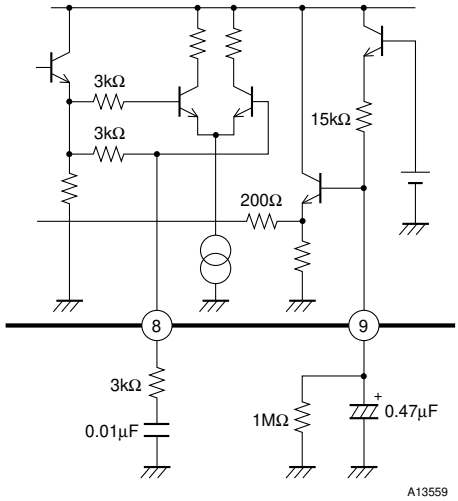
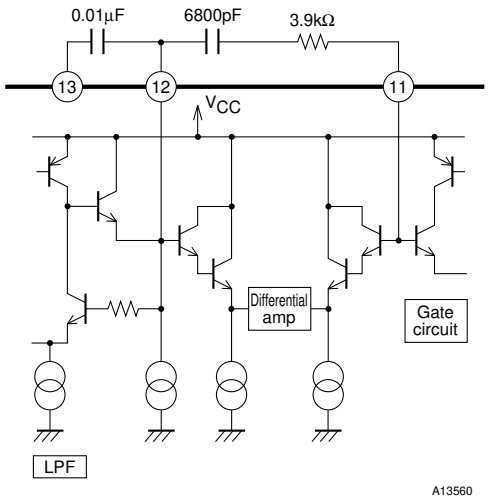
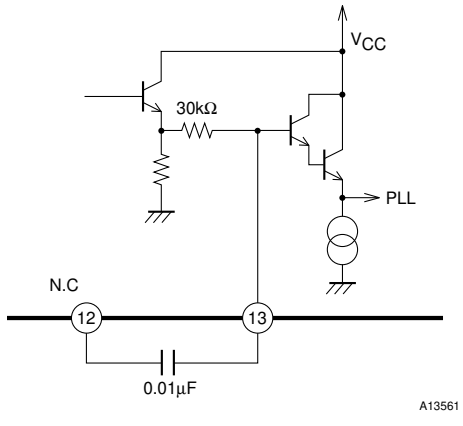
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 8<br>9 | Noise AGC sensitivity<br>AGC adjustment | After setting up the medium field (about 50 dBμ) sensitivity with the noise sensitivity setting pin (pin 8), set the weak field (about 20 to 30 dBμ) sensitivity with the AGC adjustment pin (pin 9) |  |
| 11<br>12 | Memory circuit connection | Recording circuit used during noise canceller operation. |  |
| 13 | Pilot input | Pin 13 is the PLL circuit input pin. |  |
| 14 | N.C, MPX, MRC, GND | Ground for the N.C., MPX, and MRC circuits. | |

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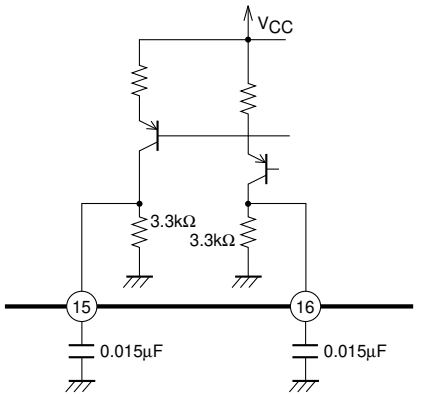
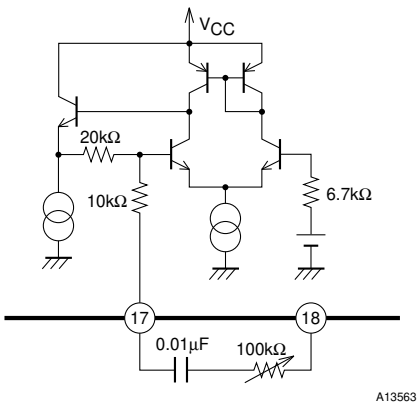
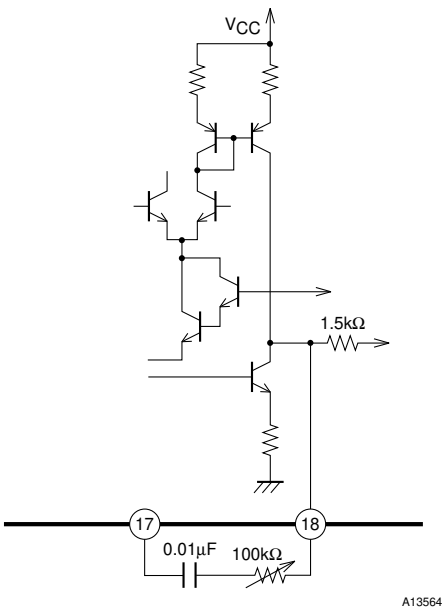
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 15<br>16 | MPX output (left)<br>MPX output (right) | Deemphasis<br>50 µs: 0.015 µF<br>75 µs: 0.022 µF |  |
| 17 | Pilot canceller signal output | Adjustment is required since the pilot signal level varies with the sample-to-sample variations in the IF output level and other parameters. |  |
| 18 | Pilot canceller signal output | Pin 18 is the output pin for the pilot canceller signal. |  |

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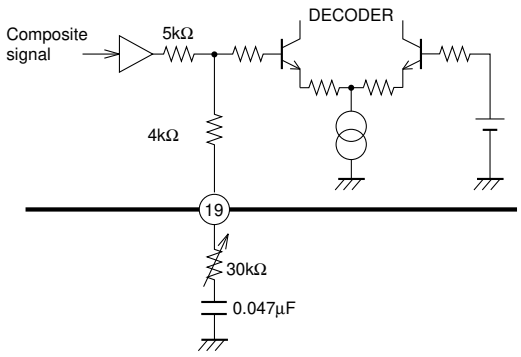
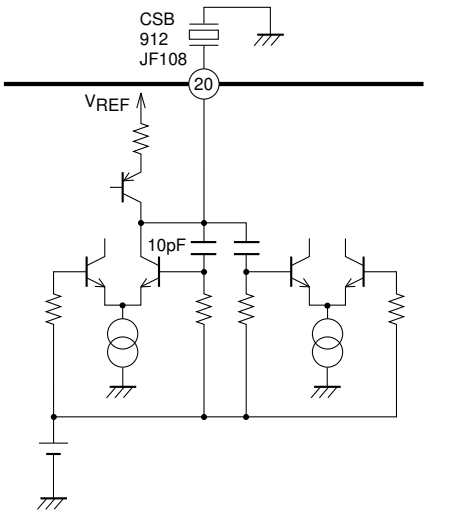
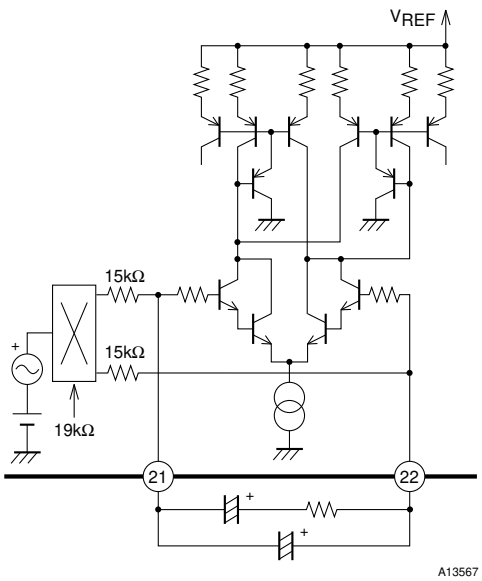
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 19 | Separation adjustment pin | Use a trimmer to adjust the subdecoder input level. (The output level is not modified in mono and main modes.) |   |
| 20 | VCO | The oscillator frequency is 912 Hz.<br>KBR-912F108<br>(Kyocera Corporation)<br>CSB-912JF108<br>(Murata Mfg. Co., Ltd.) |   |
| 21<br>22 | PHASE COMP.<br>PHASE COMP. | |   |

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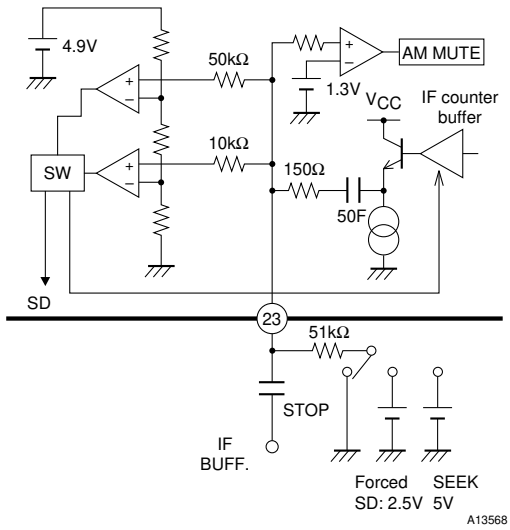
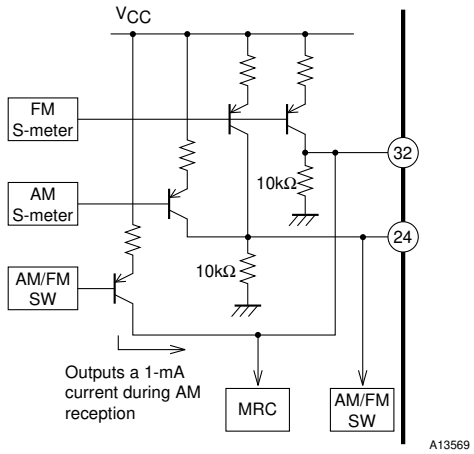
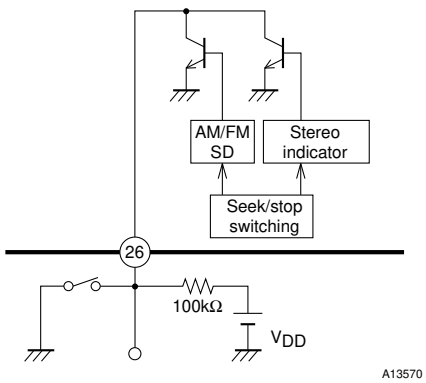
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 23 | IF counter buffer seek/stop switching | This pin functions both as the IF counter buffer (AC output) and as the seek/stop switch pin.<br>The voltage V23 switches between the following three modes.<br>During FM reception:<br>5 V: Seek mode<br>2.5 V: Forced SD mode<br>0 V: Reception mode<br>AM reception<br>(two modes: 0 and 5 V)<br>5 V: Seek mode<br>0 V: Reception mode |  |
| 24<br>32 | AM/FM signal meter<br>Dedicated FM signal meter | Fixed-current drive signal meter output<br>In AM mode, pin 32 outputs a 1-mA current. Thus the HCC circuit is turned off. |  |
| 26 | Stereo indicator for the SD pin | The voltage V23 switches between three modes as follows.<br>FM reception:<br>5 V: The SD pin operates linked to the IF counter buffer.<br>2.5 V: Forced SD mode: operates as the SD pin.<br>0.7 V: Reception mode: stereo indicator<br>AM reception: (two modes: 0 and 5 V)<br>5 V: Operates as the seek SD pin.<br>0 V: Reception mode. Not used. |  |

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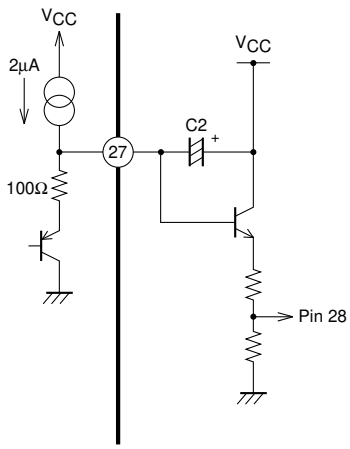
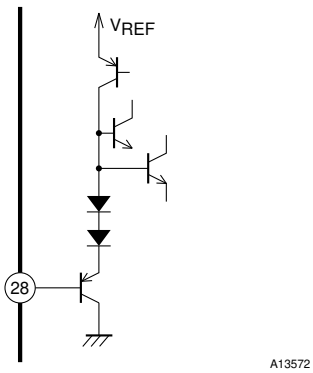
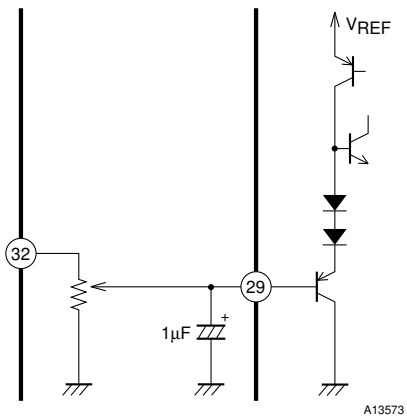
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 27 | MRC control voltage time constant | The MRC detector time constant is determined by a 100 Ω resistor and C2 when discharging and by the 2-μA current and C2 when charging. |  |
| 28 | SNC control input | The sub-output is controlled by a 0 to 1-V input. |  |
| 29 | HCC control input | The high band frequency output is controlled by a 0 to 1-V input.<br><br>It can also be controlled by the MRC output.<br><br>Use a resistor of at least 100 kΩ when controlling with the pin 32 FM S-meter signal. |  |

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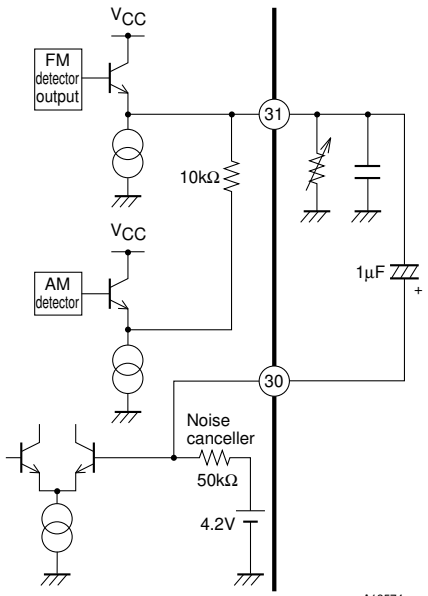
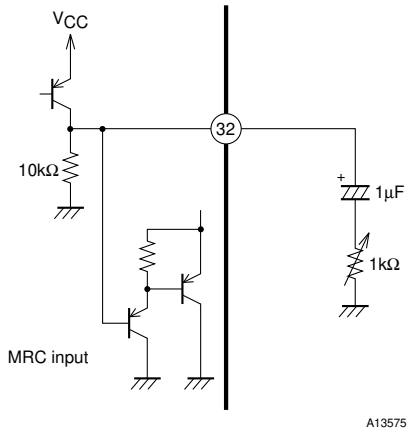
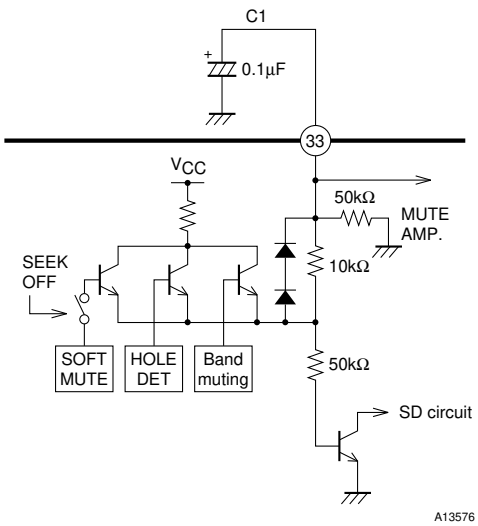
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 30 | Noise canceller input | Pin 30 is the noise canceller input. The input impedance is 50 kΩ. |   |
| 31 | AM/FM detector output | Pin 31 is the AM and FM detector output<br>In FM mode, this is a low-impedance output.<br>In AM mode, the output impedance is 10 kΩ.<br>To improve the low band separation, use a coupling capacitor of over 10 µF. | |
| 32 | IF S-meter output and MRC DC input | FM S-meter output block<br>MRC AC input block<br>Adjust the external 1-kΩ resistor to attenuate the MRC AC input and control the circuit. |   |
| 33 | Mute drive output | •The muting time constant is determined by an external RC circuit as described below.<br>Attack time: $T_A$ = 10 kΩ × C1<br>Release time: $T_R$ = 50 kΩ × C1<br>•Noise convergence adjustment<br>The noise convergence can be adjusted when there is no input signal by inserting a resistor between pin 33 and ground.<br>•Muting off function<br>Ground pin 33 through a 4-kΩ resistor. |   |

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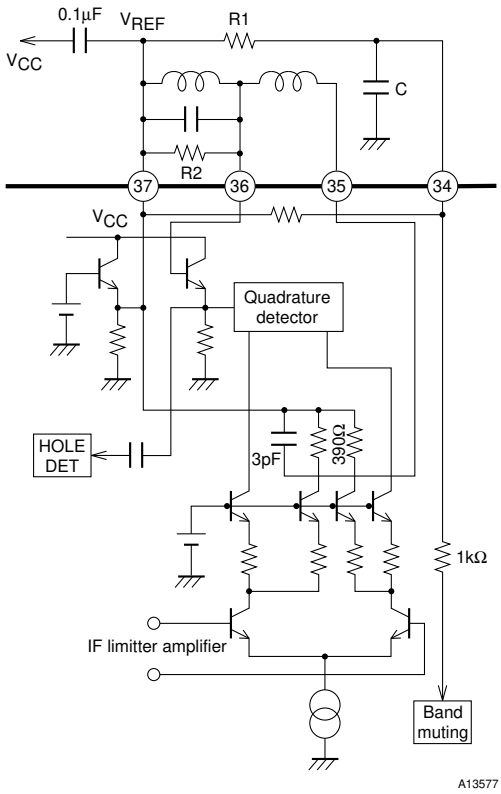
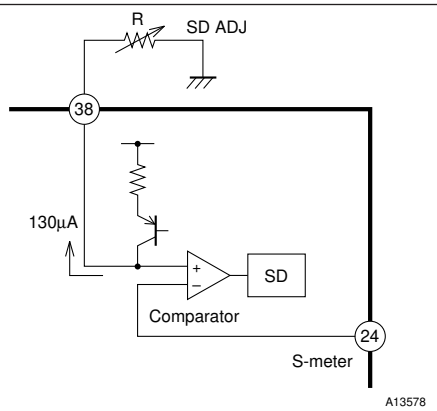
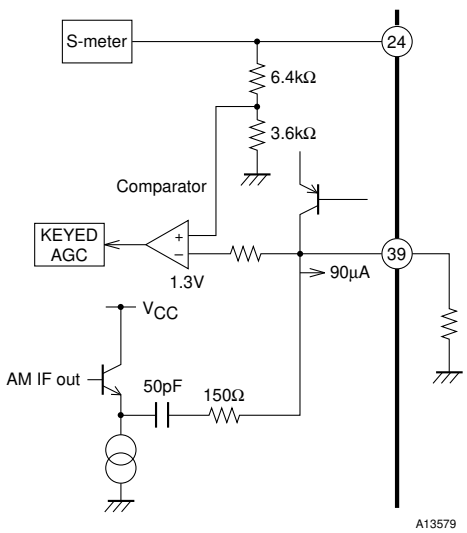
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 34<br>35<br>36<br>37 | AGC<br>QD output<br>QD input<br>$V_{REF}$ | •The resistor $R_1$ determines the width of the band muting function. Increasing the value of $R_1$ narrows the band. Reducing the value of $R_1$ widens the band.<br><br>•Null voltage<br>When tuned, the voltage between pins 34 and 37, $V_{34-37}$, will be 0 V. The band muting function turns on when $\|V_{34-37}\| \geq 0.7$ V.<br><br>$V_{37}$ = 4.9 V |  |
| 38 | FM SD ADJ | A 130-µA current flows from pin 38 and, in conjunction with the external resistance R, determines the comparison voltage. |  |
| 39 | Keyed AGC<br>AM stereo buffer | The keyed AGC operates when the voltage created by dividing the pin 24 S-meter output voltage by the 6.4 and 3.6 kΩ resistors becomes lower than the voltage determined by the resistor between pin 39 and ground.<br><br>This pin also is used as the AM stereo IF buffer pin. |  |

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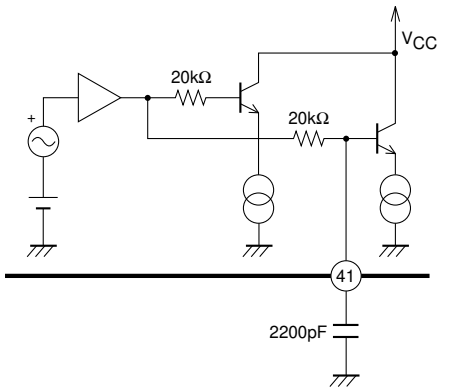
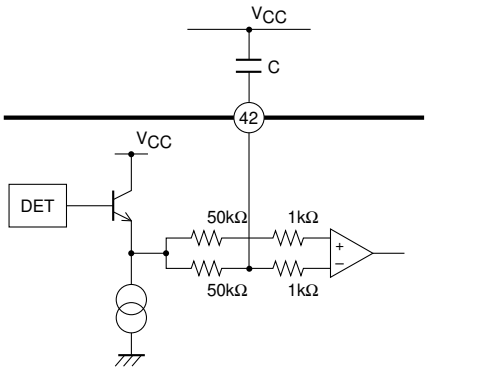
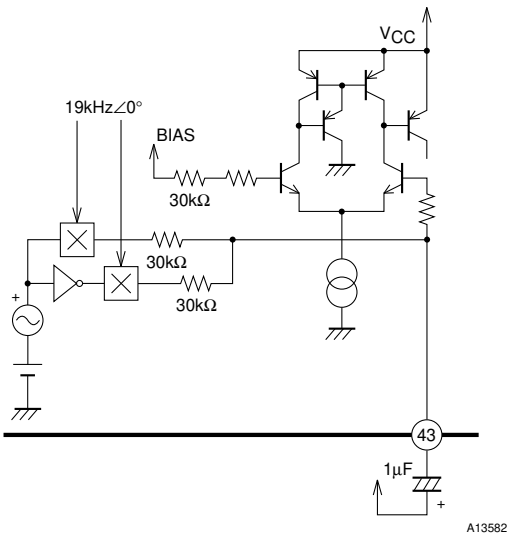
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 41 | HCC capacitor | The HCC frequency characteristics are determined by the external capacitor connected at this pin. |  |
| 42 | AM L.C. pin | This pin is used to change the frequency characteristics of the unneeded audio band under 100 Hz in AM mode to produce a clear audio signal.<br><br>Note: The LC capacitor must be connected between this pin and $V_{CC}$ (pin 40). This is because the detector circuit operates referenced to $V_{CC}$.<br><br>The cutoff frequency $f_C$ is determined by the following formula.<br><br>$f_C = 1/2\pi \times 50\ k\Omega \times C$ |  |
| 43 | Pilot detector | Inserting a 1-MΩ resistor between pin 43 and $V_{CC}$ will force the IC to mono mode. |  |

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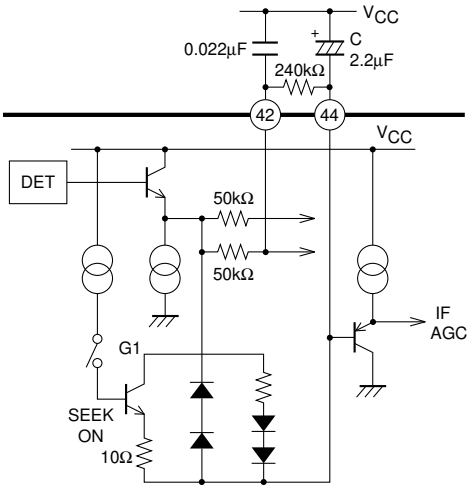
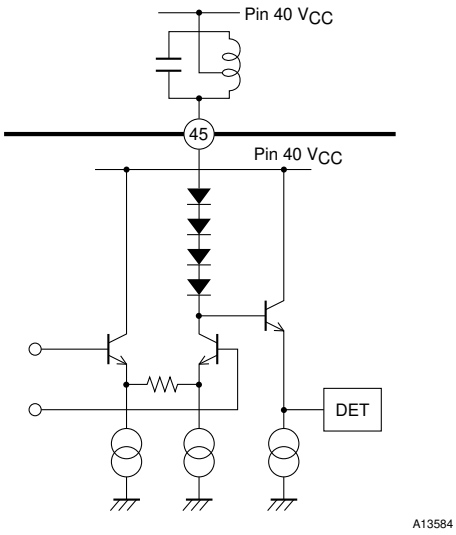
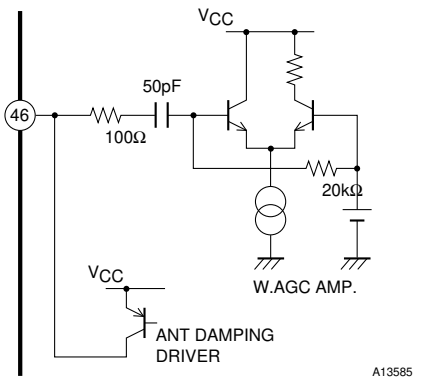
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 44 | IF AGC | G1; Used for time constant switching during seeks.<br>• Reception<br>$\tau = 2.2\ \mu F \times 300\ k\Omega$<br>• Seek<br>$\tau = 2.2\ \mu F \times 10\ \Omega$<br>The external capacitors are connected to $V_{CC}$.<br>This is because the IF amplifier operates referenced to $V_{CC}$. |  |
| 45 | IF output | The IF amplifier load |  |
| 46 | AM antenna damping drive output<br>Wide band AGC input | I46 = 6 mA (maximum)<br>This is the antenna damping current. |  |

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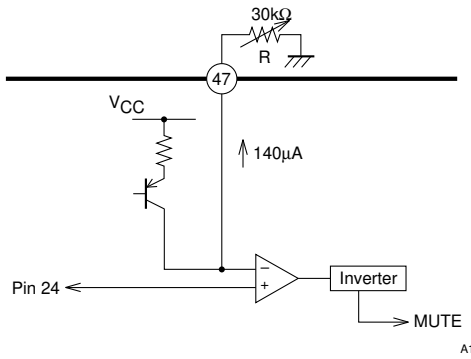
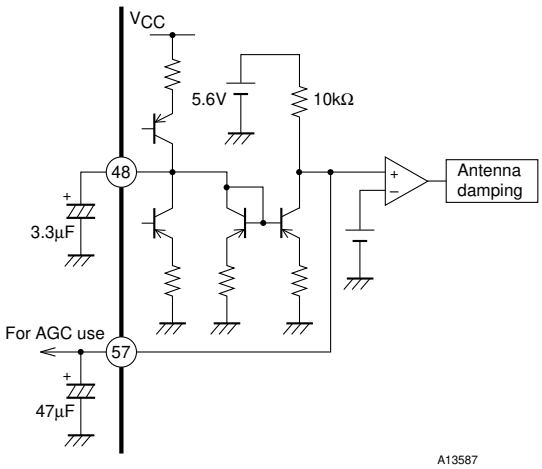
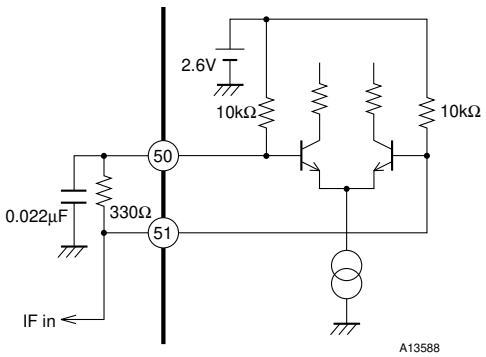
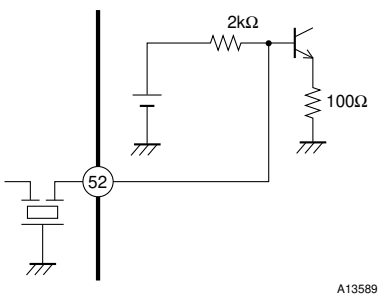
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 47 | FM muting on level adjustment | Modify the value of the external resistor to adjust the muting on level. |  |
| 48<br>57 | RF AGC bypass<br>RF AGC | RF AGC rectification capacitor<br>The low frequency distortion is determined as follows:<br>Increasing C48 and C57 improves the distortion but makes the response slower.<br>Reducing C48 and C57 aggravates the distortion but makes the response faster. |  |
| 50<br>51 | IF bypass<br>FM IF input | Due to the high gain of the limiter amplifer, care must be taken when choosing the grounding point for the limiter amplifer input capacitor to prevent oscillation. |  |
| 52 | IF input | The input impedance is 2 kΩ. |  |

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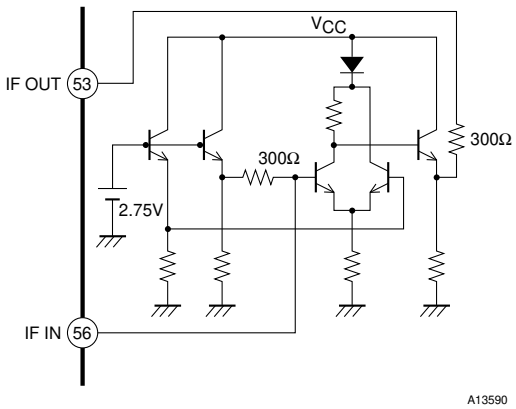
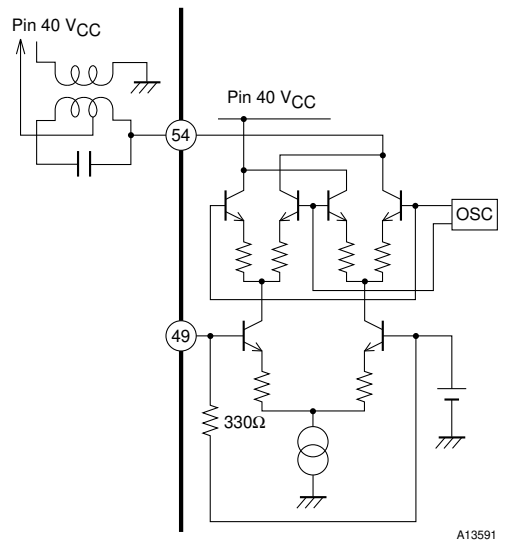
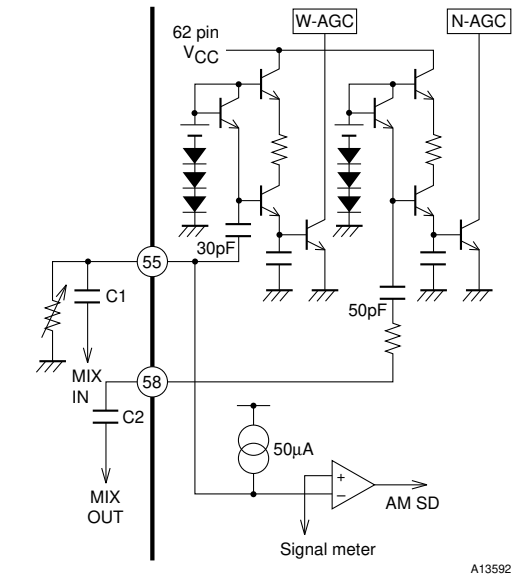
| Pin No. | Function | Description | Equivalent circuit |
|---|---|---|---|
| 53<br>56 | IF amplifier output<br>IF amplifier input | • Input and output pin or the first IF amplifier<br>• Inverting amplifier<br>V56 = 2 V<br>Input impedance: $R_{IN}$ = 330 Ω<br>V53 = 5.3 V<br>Output impedance<br>$R_{OUT}$ = 330 Ω |  |
| 54<br>49 | Mixer output: 130 µA<br>Mixer input | The mixer coil connected to the pin 54 mixer output must be wired to $V_{CC}$ (pin 40).<br>The pin 49 mixer input impedance is 330 Ω |  |
| 55<br><br>58 | W-AGC IN<br>AM SD ADJ<br><br>N-AGC IN<br>Muting attenuation adjustment pin | Pins 55 and 58 include built-in DC cut capacitors.<br>The AGC on level is determined by the values of the capacitors C1 and C2.<br>Pin 55 functions as the SD sensitivity adjustment pin in AM mode.<br>The output current I55 is 50 µA, and V55 varies depending on the value of the external resistor. The SD function operates by comparing V55 with the S-meter voltage. |  |

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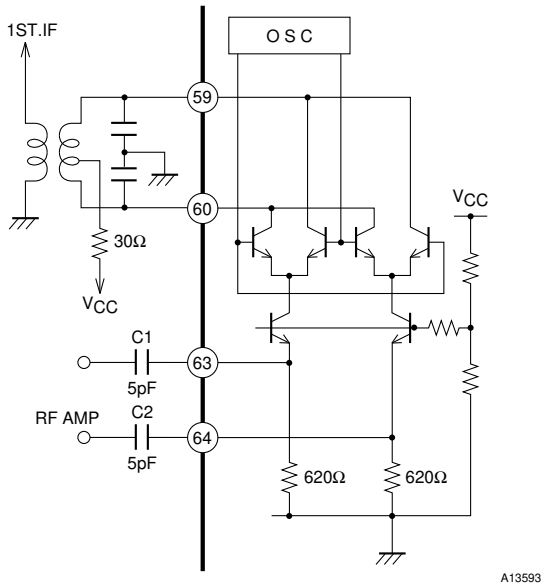
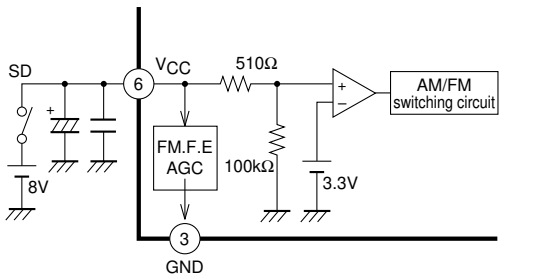
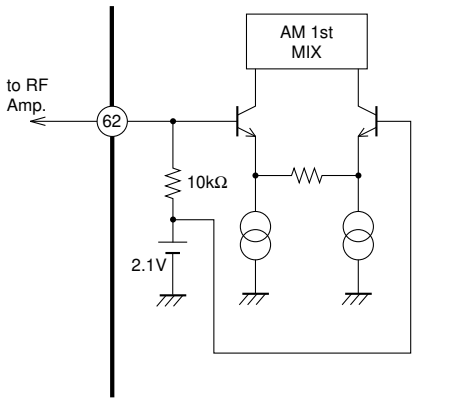
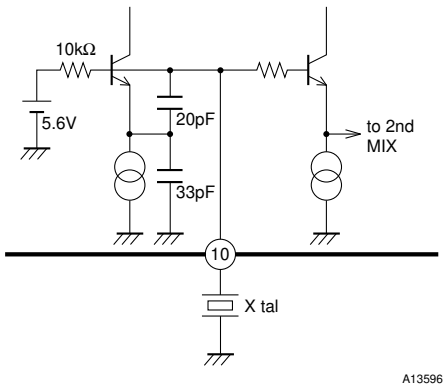
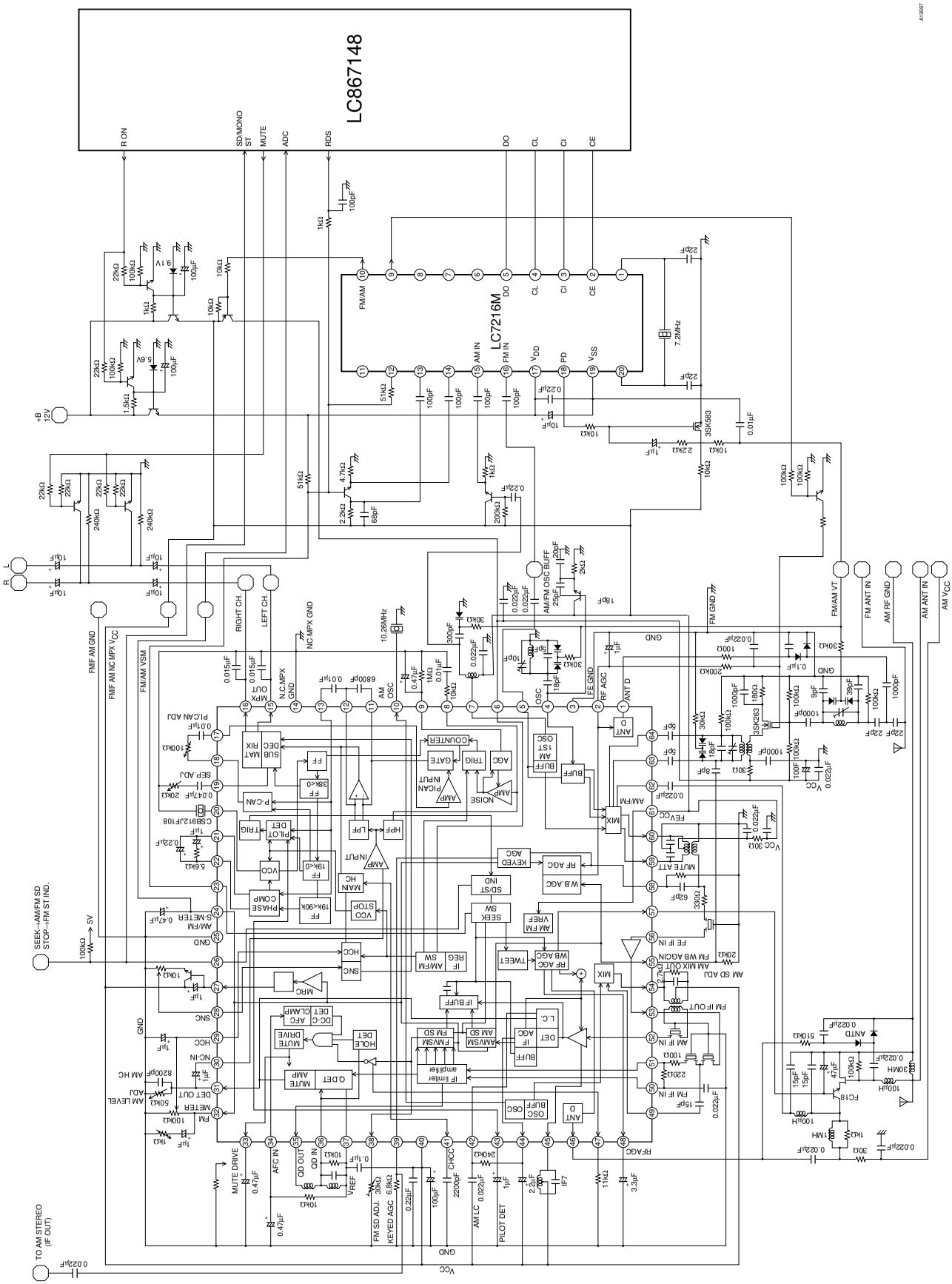
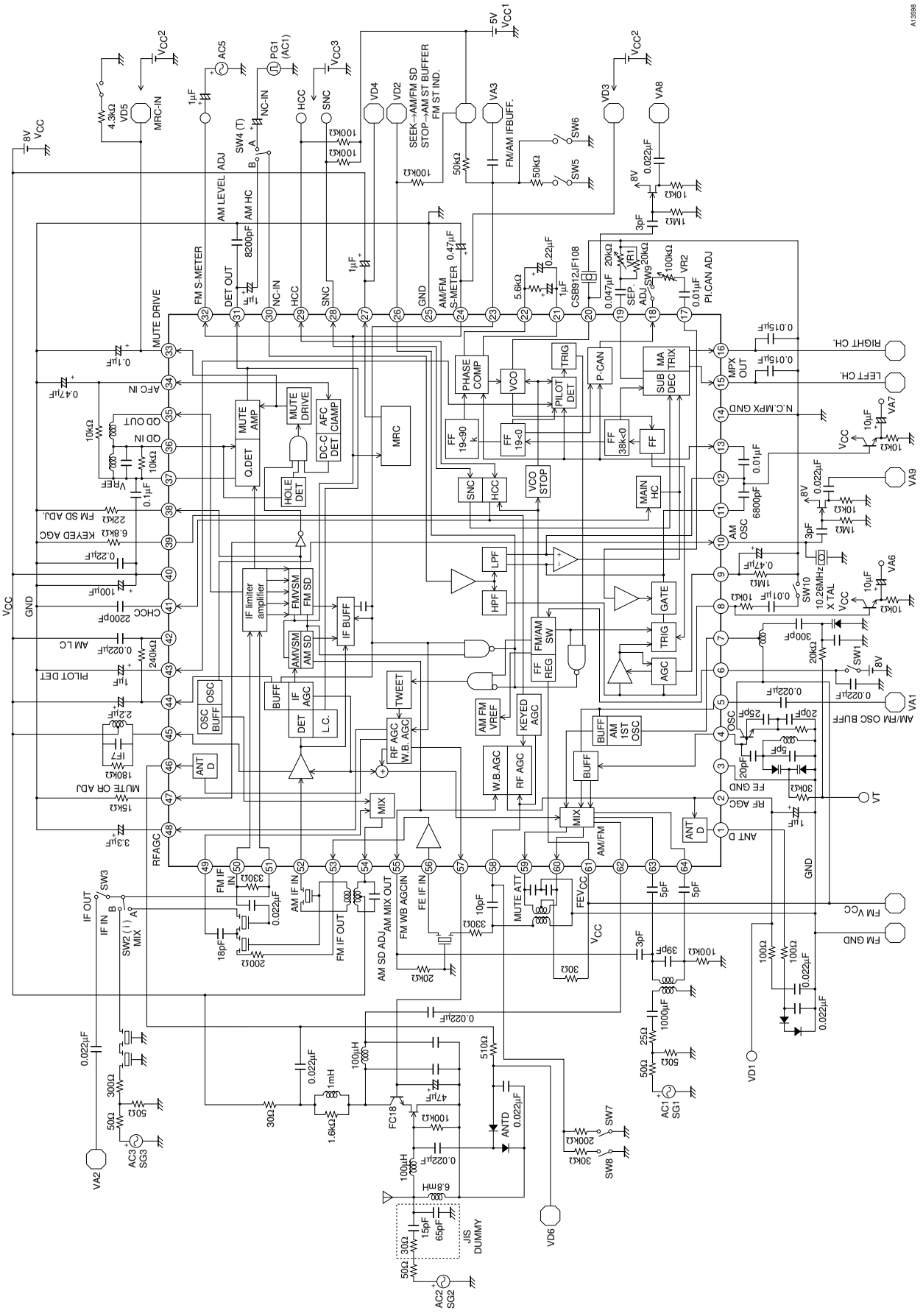
<table>
<tr><th>Pin No.</th><th>Function</th><th>Description</th><th>Equivalent circuit</th></tr>
<tr>
<td>59<br>60<br><br>63<br>64</td>
<td>Mixer output<br><br>Mixer input</td>
<td>Double balanced mixer<br>Pins 59 and 60 are the mixer 10.7-MHz output<br><br>Pins 63 and 64 are the mixer input.<br>This is an emitter insertion type circuit, and the amount of insertion is determined by the capacitors C1 and C2.<br><br>Note: The lines for pins 63 and 64 must be kept separated from the lines for pins 59 and 60.</td>
<td> 
</td>
</tr>
<tr>
<td>6</td>
<td>Front end $V_{CC}$ AM/FM switching</td>
<td>Pin 6 functions both as the FM front end $V_{CC}$ and the AM/FM switching circuit.
<table>
<tr><th>V6 voltage</th><th>Mode</th></tr>
<tr><td colspan="2">When 8 V → FM</td></tr>
<tr><td colspan="2">OPEN → AM</td></tr>
</table></td>
<td> 
</td>
</tr>
<tr>
<td>62</td>
<td>1st MIX<br>INPUT</td>
<td>First mixer input<br>The input impedance is about 10 kΩ.</td>
<td> 
</td>
</tr>
<tr>
<td>10</td>
<td>AM 2nd OSC</td>
<td>Crystal oscillator circuit<br>The Kinseki, Ltd. HC-49/U-S and a $C_L$ of 20 pF must be used.</td>
<td> 
</td>
</tr>
</table>

## Block Diagram



## AC Characteristics Test Circuit



## Test Conditions

| Parameter | Symbol | Switch states | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 | SW8 | SW9 | SW10 |
| Current drain | $I_{CCO}$-FM | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Demodulation output | $V_O$-FM | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Pin 31 demodulation output | $V_O$-FM31 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Channel balance | CB | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Total harmonic distortion (FM) | THD-FMmono | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Signal-to-noise ratio: IF | S/N-FM IF | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| AM suppression ratio: IF | AMR IF | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Muting attenuation | Att-1 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| | Att-2 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| | Att-3 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Separation | Separation | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Stereo on level | ST-ON | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Stereo off level | ST-OFF | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Main total harmonic distortion | THD-Main L | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Pilot cancellation | PCAN | ON | b | OFF | b | — | ON | OFF | OFF | OFF/ON | — |
| SNC output attenuation | AttSNC | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| HCC output attenuation 1 | AttHCC-1 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| HCC output attenuation 2 | AttHCC-2 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Input limiting voltage | Vi-lim | ON | b | OFF | b | — | ON | OFF | OFF | ON | ON |
| Muting sensitivity | Vi-mute | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| SD sensitivity 1 | SD-sen1 FM | ON | b | OFF | b | OFF | OFF | OFF | OFF | ON | — |
| SD sensitivity 2 | SD-sen2 FM | ON | b | OFF | b | ON | OFF | OFF | OFF | ON | — |
| IF counter buffer output | $V_{IFBUFF-FM}$ | ON | b | OFF | b | OFF | OFF | OFF | OFF | ON | — |
| Signal meter output (FM) | $V_{SM}$ FM-1 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| | $V_{SM}$ FM-2 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| | $V_{SM}$ FM-3 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| | $V_{SM}$ FM-4 | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Muting bandwidth | BW-mute | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| Mute drive output | $V_{MUTE-100}$ | ON | b | OFF | b | — | ON | OFF | OFF | ON | — |
| N-AGC on input | $V_{NAGC}$ | ON | a | ON | b | — | ON | OFF | OFF | — | — |
| W-AGC on input | $V_{WAGC}$ | ON | a | ON | b | — | ON | OFF | OFF | — | — |
| Conversion gain | A.V | ON | a | ON | b | — | ON | OFF | OFF | — | — |
| Oscillator buffer output | $V_{OSCBUFFFM}$ | ON | a | ON | b | — | ON | OFF | OFF | — | — |
| Gate time 1 | τGATE1 | ON | — | OFF | a | — | ON | OFF | OFF | — | — |
| Noise sensitivity | SN | ON | — | OFF | a | — | ON | OFF | OFF | — | — |
| NC effect | SN-NC | ON/OFF | — | OFF | a | — | ON | OFF | OFF | — | — |
| MRC output | $V_{MRC}$ | ON | — | OFF | b | — | ON | OFF | OFF | — | — |
| MRC operating level | MRC-ON | ON | — | OFF | b | — | ON | OFF | OFF | — | — |
| Practical sensitivity | S/N-30 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Detection output | $V_O$-AM | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Pin 31 detection output | $V_O$-AM31 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| AGC F.O.M. | $V_{AGC-FOM}$ | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Signal-to-noise ratio | S/N-AM | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Total harmonic distortion (AM) | THD-AM | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Signal meter output (AM) | $V_{SM}$ AM-1 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| | $V_{SM}$ AM-2 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Oscillator buffer output | $V_{OSCBUFF\ AM-1}$ | OFF | — | OFF | b | ON | ON | — | — | — | — |
| Wide band AGC sensitivity | W-AGCsen 1 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| | W-AGCsen 2 | OFF | — | OFF | b | ON | ON | — | — | — | — |
| SD sensitivity | SD-sen1 AM | OFF | — | OFF | b | OFF | OFF | — | — | — | — |
| | SD-sen2 AM | OFF | — | OFF | b | OFF | OFF | — | — | — | — |
| IF buffer output | $V_{IFBUFF-AM}$ | OFF | — | OFF | b | OFF | OFF | — | — | — | — |

## Usage Notes

1. Notes on $V_{CC}$ and Ground

| | |
|---|---|
| Pin 40 | $V_{CC}$ for the FM IF, AM, NC, MPX, and MRC blocks |
| Pin 25 | Ground for the FM IF and AM blocks |
| Pin 14 | Ground for the NC, MPX, and MRC blocks |
| Pin 61 | $V_{CC}$ for the FM front end, AM first mixer, and first oscillator blocks |
| * Pin 6 | $V_{CC}$ for the FM front end and AGC blocks, and the AM/FM switching pin |
| Pin 3 | Ground for the FM front end, first mixer, and first oscillator blocks |

*: When applying the $V_{CC}$ voltage to pin 6, that voltage must not exceed the pin 40 and pin 61 $V_{CC}$ voltages. (This condition must be checked carefully when first applying the pin 6 voltage.)

2. Notes on AM Coil Connection

The $V_{CC}$ used for the first oscillator coil connected to pin 7 must be at the same potential as pin 61.
Connect to the IFT connected with pin 45, and to the MIX coil connected with pin 54. $V_{CC}$ must be at the same potential as pin 40.

3. AM/FM Switching

Pin 6 is also used as the FM front end and RF AGC $V_{CC}$

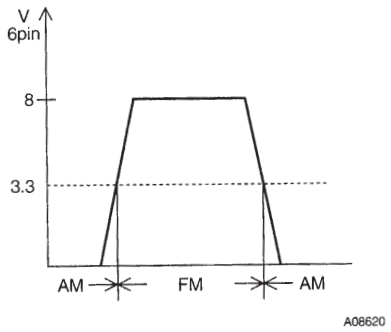


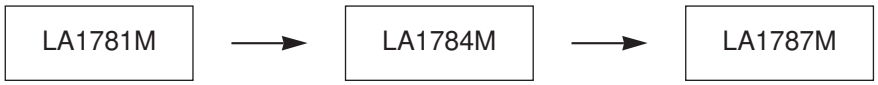

Fig. 1

| Pin 6 voltage | Mode |
|---|---|
| 8 | FM |
| OPEN | AM |

## LA1787M Overview

1. Notes on the LA1781M, LA1784M, and LA1787M

The LA1784M is a version of the LA1781M that uses an external oscillator circuit, and has the same characteristics as the LA1781M.
The LA1787M is a version of the LA1784M that features improved characteristics.




This product is a version of the LA1781M with the oscillator circuit removed. It supports the use of an external oscillator circuit.
It has the same characteristics as the LA1781M.

The LA1787M features improved characteristics over the LA1781M and LA1784M.

2. Modified circuits

The following characteristics have been improved over those of the The LA1784M.

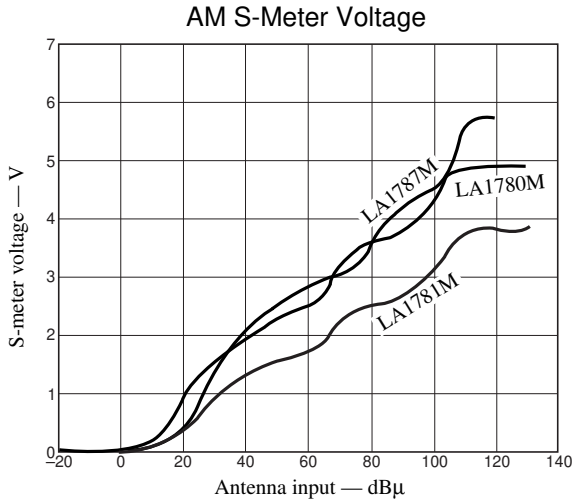
- The AM adjacent channel interference characteristics (Δ40 kHz) have been improved.
- The AM S-meter curve slope has been increased.
- The FM separation temperature characteristics have been improved.
- The stereo indicator sensitivity has been improved.
- The FM oscillator circuit has been omitted.

(1) AM interference characteristics improvement

The second signal interference and suppression have been improved for adjacent channels (±40 kHz) by increasing the AM second mixer input dynamic range.

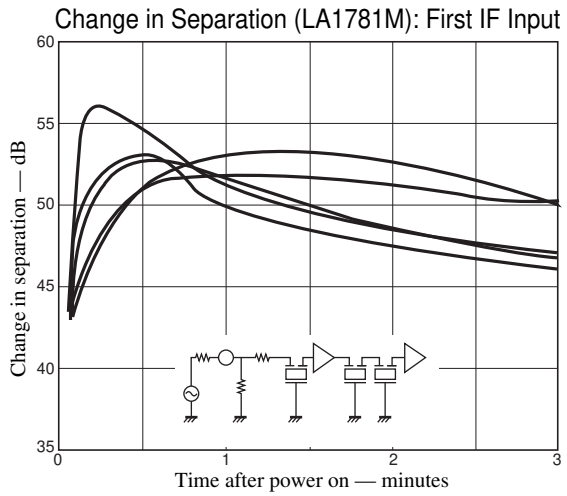
(2) The AM S-meter curve slope has been increased.

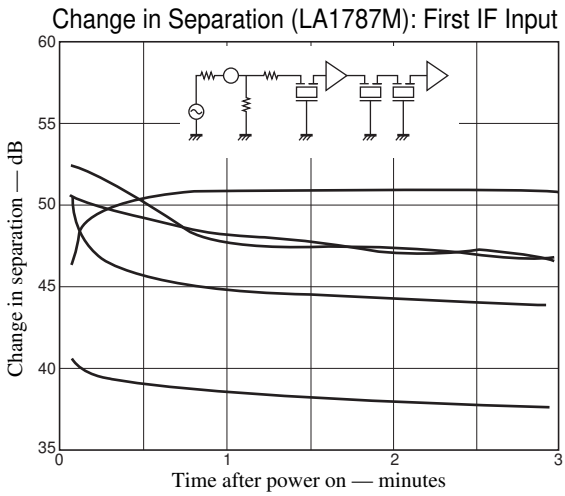
The slope of the AM S-Meter curve has been increased from that of the LA1781M and LA1784M.




(3) FM separation temperature characteristics improvement

The temperature characteristics have been improved, the amount of change in the separation due to drift when at power on has been stabilized. This makes it easier to adjust the separation.



(4) Stereo indicator sensitivity improvement

The stereo indicator sensitivity (on/off) is equivalent to that of the LA1780M

| | Stereo on level | Stereo off level |
|---|---|---|
| LA1781M/1784M | 4.1% | 3.1% |
| LA1787M/1780M | 2.6% | 1.6% |

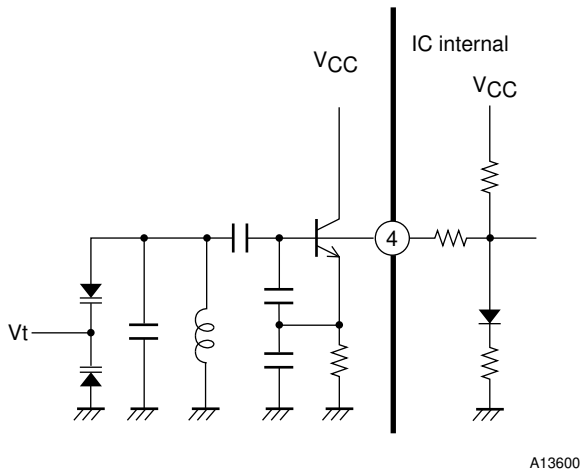
(Typical value)

*: The pilot level such that the stereo indicator goes on or off for a 10.7 MHz unmodulated IF input.

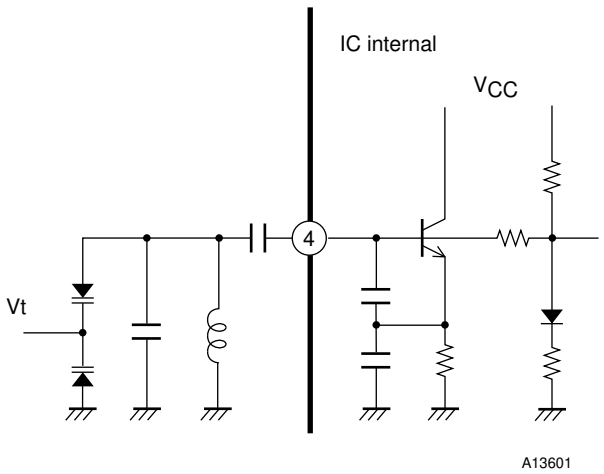
(5) FM oscillator circuit removed

The internal FM oscillator circuit provided in the LA1781M has been removed. The FM oscillator level can be adjusted by constructing an external circuit block.

*: However, this requires 4 more external parts than the LA1781M: 1 transistor and 3 resistors/capacitors.




LA1787M/1784M FM OSC




LA1780M/1781M FM OSC

3. Gain distribution

The table below shows the gain distribution of the LA1780M, LA1784M, and LA1787M. (These are measured values.) Compared to the LA1784M, the total gain is lower.

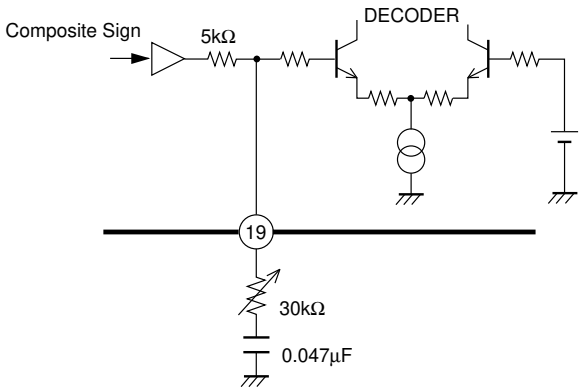
| | 1st MIX (10.7) | 1st IF (10.7) | 2nd MIX (450) | 2nd IF (450) |
|---|---|---|---|---|
| LA1780M | 10 dB | 3.3 dB | 3.2 dB | 69 dB |
| LA1784M | 7.5 dB | 13 dB | 7 dB | 66 dB |
| LA1787M | 7.5 dB | 3.5 dB | 8.6 dB | 67 dB |

First mixer : No circuit changes from the LA1784M.
First IF amplifier : Equivalent to the LA1780M circuit. (The gain is lower than that in the LA1781M and LA1784M.)
Second mixer : The mixer circuit has been modified to improve adjacent channel suppression and interference.
Second IF amplifier : Equivalent to the LA1780M circuit.

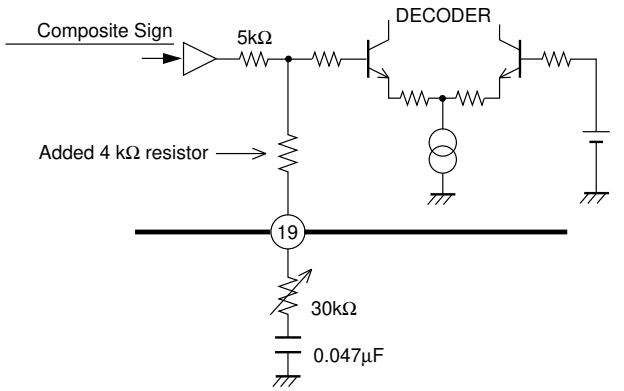
4. Changes to applications

Component values that change from LA1781M/LA1784M applications
(Since the total AM gain has changed in the LA1787M)

- AM SD adjustment resistor (pin 55): Because Vsm is higher.
- AM level adjustment resistor (pin 31): Since the post-detection audio amplifier gain is higher than in the LA1781M and LA1784M, the output level is also higher. This resistor must be changed to match the set value.
- AM mixer coil (pin 54), IFT coil (pin 45) damp resistor: Since the IF block gain is increased, the mixer (pin 54) and IFT (pin 45) coil damping must be adjusted.
- Separation adjustment resistor (pin 19): Since an internal 4 kΩ resistor has been added to the pin 19 input circuit to improve the separation temperature characteristics, the value of the external resistor must be reduced from that used with the LA1780M, LA1781M, and LA1784M. (See the following page.)




LA1781M/1784M




LA1787M

## Functions

1. Notes on the FM Front End

Notes on interference rejection characteristics

- Intermodulation characteristics

The LA1787M applies two high-band AGC functions to prevent IM (the generation of intermodulation). These are the narrow AGC (pin 58: mixer input detection type) and the wide AGC (for the pin 55 input), and this results in the antenna frequency characteristics shown in figure 2. The levels at which the AGC functions turn on are determined by the capacitors attached at pins 55 and 58.

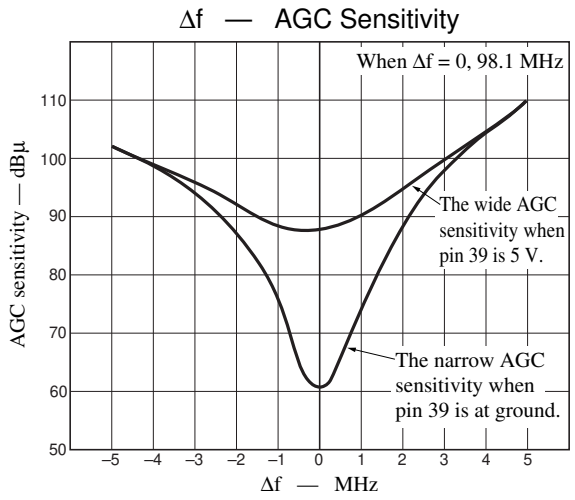



Fig. 2