Ordering number : EN5724

Monolithic Linear IC

LA1780M

Single-Chip Tuner IC for Car Radios

Overview

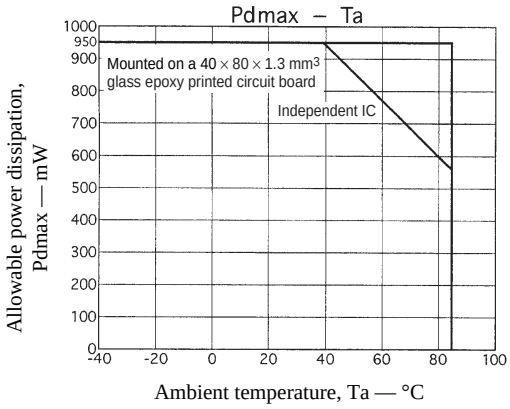
The LA1780M integrates all six blocks required in a car radio tuner on a single chip. The LA1780M is based on the LA1888NM, and features improvements to each of the blocks; improvements designed to provide improved noise characteristics, especially for noise related to multipath, three-signal intermodulation distortion, and two-signal suppression.

Functions

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

Features

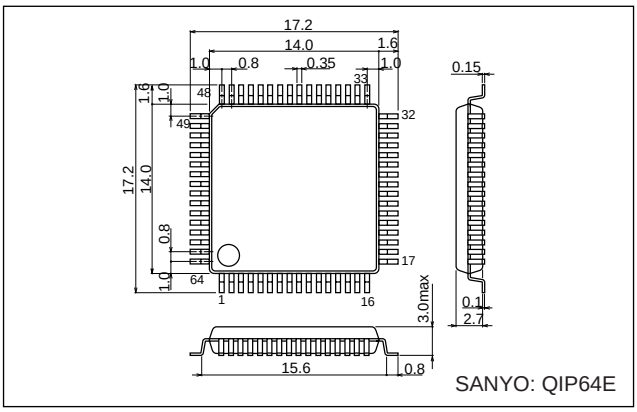
- Improved noise reduction methods
  - — The FM front end provides excellent 3-signal characteristics equivalent to those of the LA1193M.
  - — Superlative listenability due to improved medium and weak field noise canceller characteristics.
  - — Improved separation characteristics
  - — Anti-birdie filter
  - — Improved AM and FM thermal characteristics
  - — Excellent FM signal meter linearity
  - — Modified N.C. circuit for improved noise rejection
- 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.)
- Since the LA1780M retains the block structure of the LA1888NM, products using that IC can be easily converted, allowing further end product miniaturization.



Package Dimensions

Unit:mm

3159-QFP64E



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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	220	330	440	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	100	150	200	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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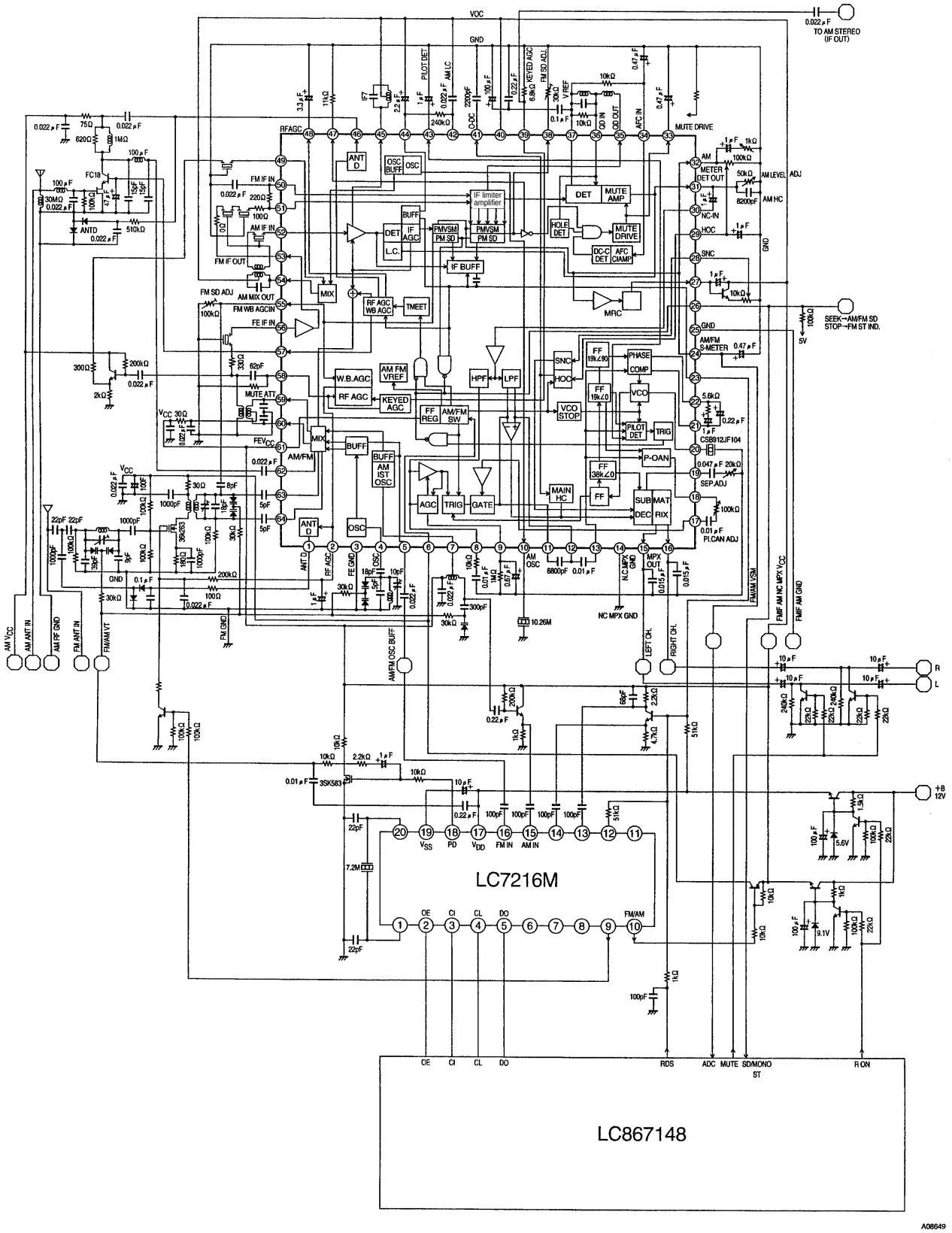
Parameter	Symbol	Conditions	Ratings			unit
			min	typ	max	
[FM FE Mixer Input						
N-AGC on input	V_N-AGC	83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below	80	87	94	dBμ
W-AGC on input	V_WAGC	83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below. (When the keyed AGC is set to 4.0 V.)	100	106	112	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	260	370	480	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	85	120	170	mVrms
Pin 31 detector output	V_O-AM31	1 MHz, 74 dBμ, f_m = 1 kHz, 30% modulation, pin 31	75	110	150	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	56	61	66	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, non mod	3.8	4.8	6.2	V
Oscillator buffer output	$V_{OSCBUFF\ AM1}$	No input, the pin 5 output	185	230		mVrms
Wide band AGC sensitivity	W-AGCsen1	1.4 MHz, the input when V46 = 0.7 V	83	89	95	dBμ
	W-AGCsen2	1.4 MHz, the input when V46 = 0.7 V (seek mode)	74	80	86	dBμ
SD sensitivity	SD-sen1 AM	1 MHz, the ANT input level such that the IF counter output turns on.	26	32	38	dBμ
	SD-sen2 AM	1 MHz, the ANT input level such that the SD pin goes to the on state.	26	32	38	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.

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	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 1	Att-1	ON	b	OFF	b	—	ON	OFF	OFF	ON	—
Muting attenuation 2	Att-2	ON	b	OFF	b	—	ON	OFF	OFF	ON	—
Muting attenuation 3	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 1	V_{SM} FM-1	ON	b	OFF	b	—	ON	OFF	OFF	ON	—
Signal meter output 2	V_{SM} FM-2	ON	b	OFF	b	—	ON	OFF	OFF	ON	—
Signal meter output 3	V_{SM} FM-3	ON	b	OFF	b	—	ON	OFF	OFF	ON	—
Signal meter output 4	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	THD-AM	OFF	—	OFF	b	ON	ON	—	—	—	—
Signal meter output 1	V_{SM} AM-1	OFF	—	OFF	b	ON	ON	—	—	—	—
Signal meter output 2	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 1	W-AGCsen 1	OFF	—	OFF	b	ON	ON	—	—	—	—
Wide band AGC sensitivity 2	W-AGCsen 2	OFF	—	OFF	b	ON	ON	—	—	—	—
SD sensitivity 1	SD-sen1 AM	OFF	—	OFF	b	OFF	OFF	—	—	—	—
SD sensitivity 2	SD-sen2 AM	OFF	—	OFF	b	OFF	OFF	—	—	—	—
IF buffer output	$V_{IFBUFF-AM}$	OFF	—	OFF	b	OFF	OFF	—	—	—	—

Block Diagram



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)

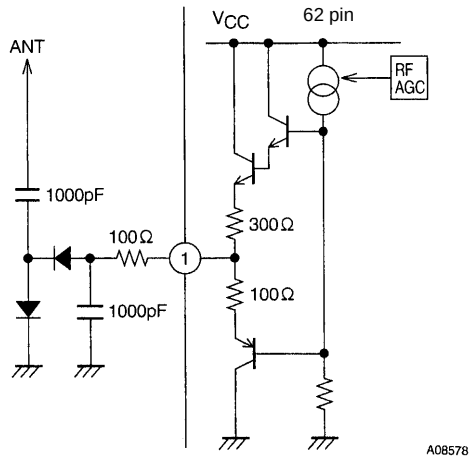
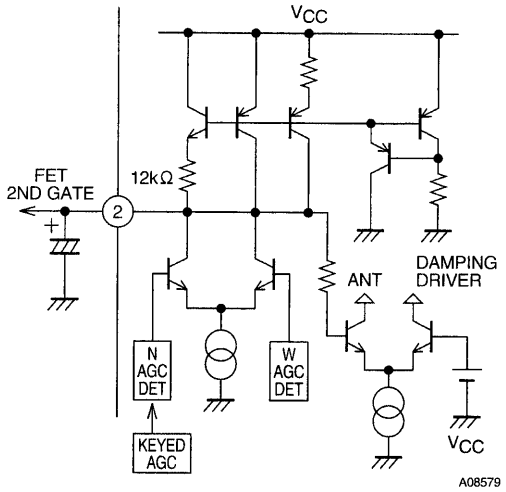
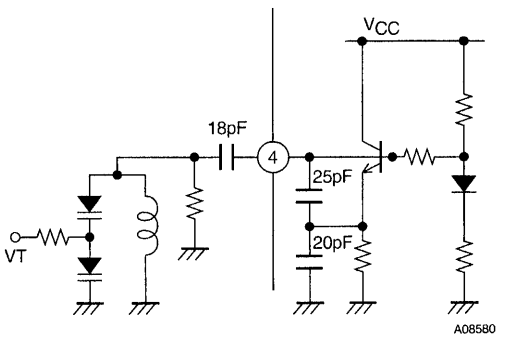
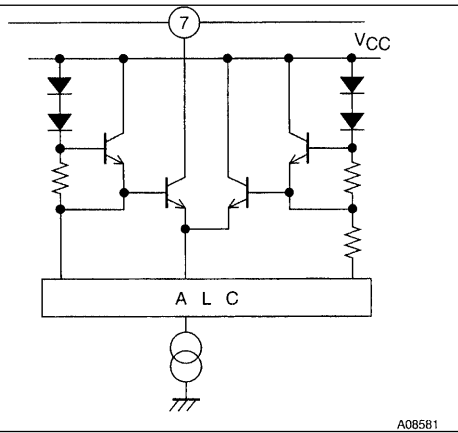
Noise Canceller
- High-pass filter (first order)
- Delay circuit based low-pass filter (fourth order)
- Noise AGC
- Pilot signal compensation circuit
- Noise sensitivity setting pin
- Function for disabling the noise canceller in AM mode

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})

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 The transistor and capacitors required for the oscillator circuit are integrated on the chip.	
7	AM OSC	AM first oscillator This circuit can oscillator up to the SW band. An ALC circuit is included.	

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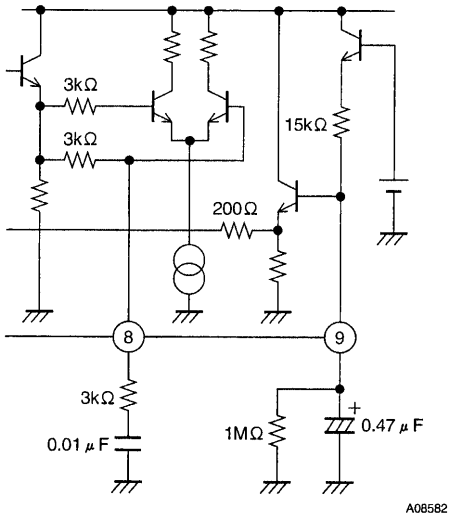
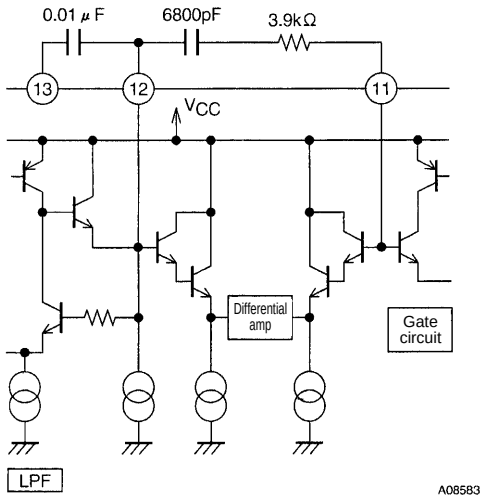
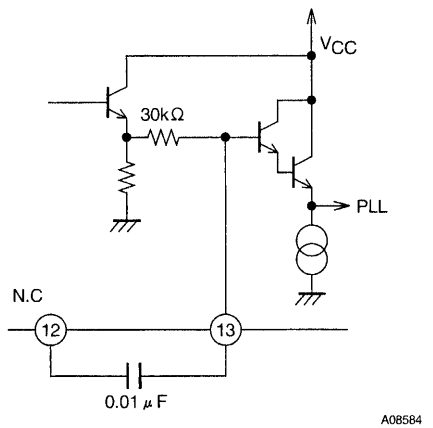
Pin No.	Function	Description	Equivalent circuit
8 9	Noise AGC sensitivity AGC adjustment	After setting up the medium field (about 50 dBμ) sensitivity with the noise sensitivity setting pin (pin 8), set the weak field (about 20 to 30 dBμ) sensitivity with the AGC adjustment pin (pin 9)	
11 12	Memory circuit connection 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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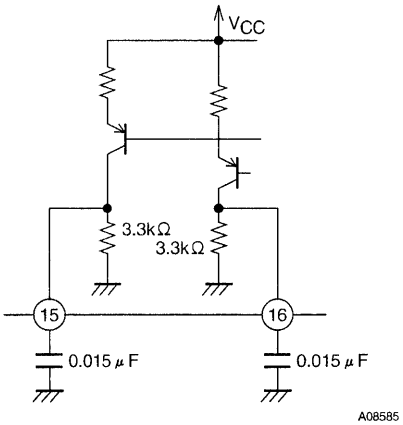
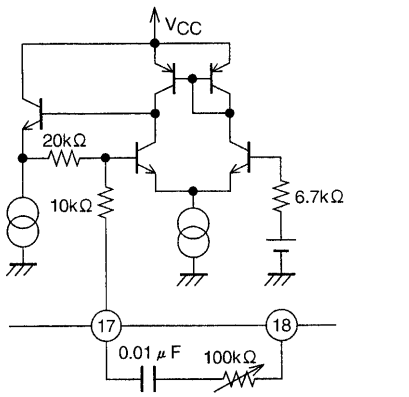
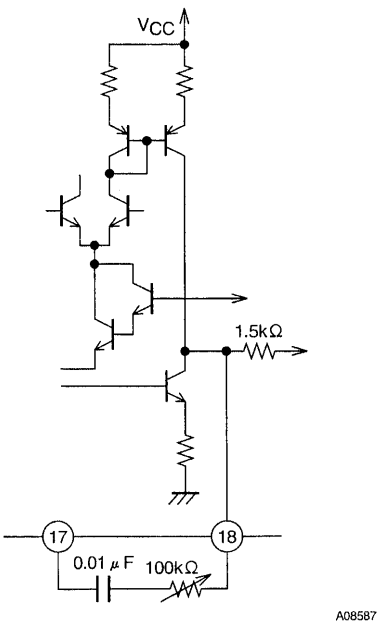
Pin No.	Function	Description	Equivalent circuit
15 16	MPX output (left) MPX output (right)	Deemphasis 50 µs: 0.015 µF 75 µs: 0.022 µF	
17	Pilot canceller signal output	Adjustment is required since the pilot signal level varies with the sample-to-sample variations in the IF output level and other parameters.	
18	Pilot canceller signal output	Pin 18 is the output pin for the pilot canceller signal.	

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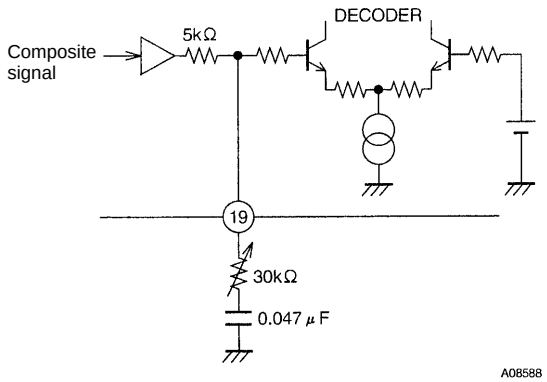
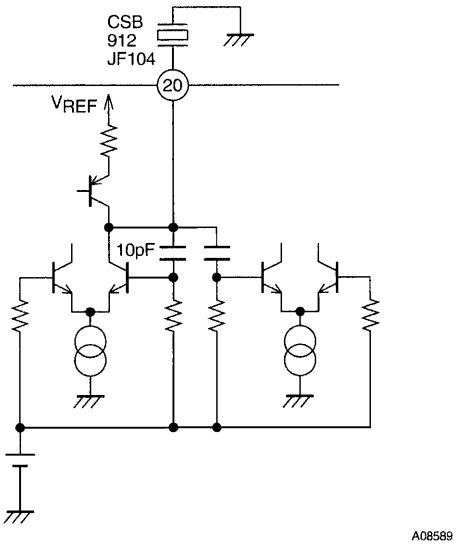
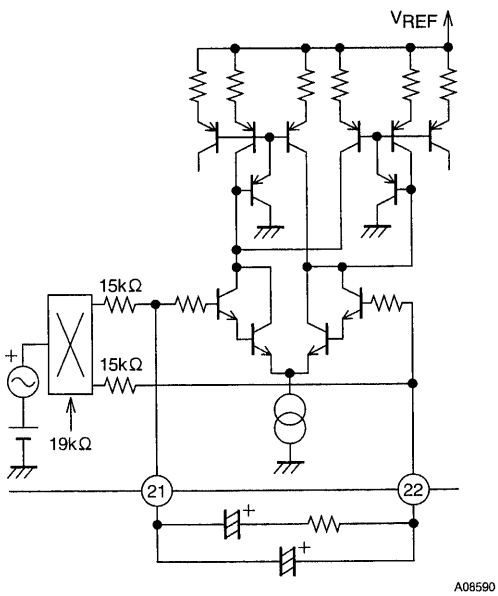
Pin No.	Function	Description	Equivalent circuit
19	Separation adjustment pin	Use a trimmer to adjust the subdecoder input level. (The output level is not modified in mono and main modes.)	
20	VCO	The oscillator frequency is 912 Hz.	
21 22	PHASE COMP. PHASE COMP.		

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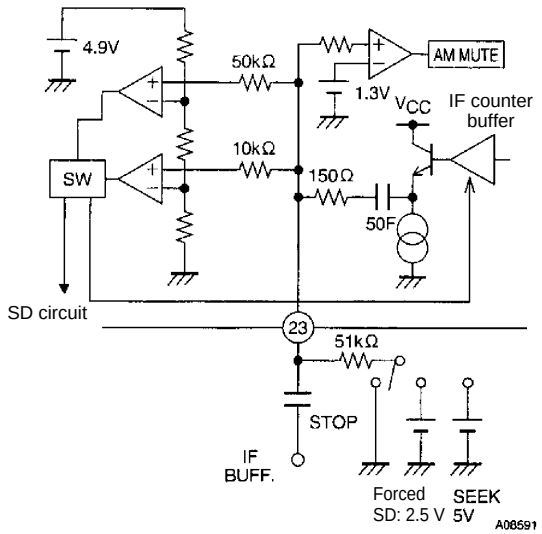
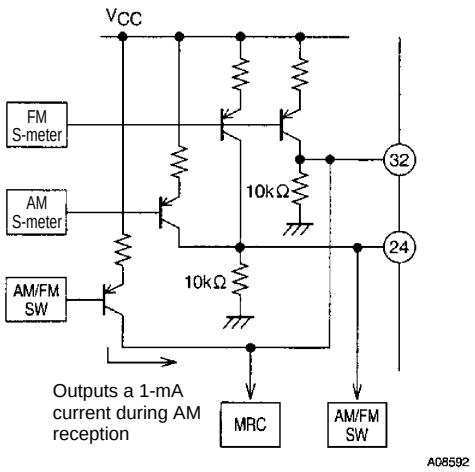
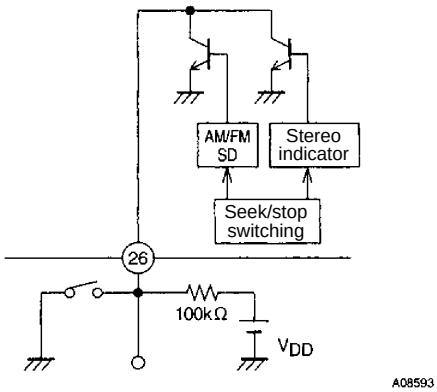
Pin No.	Function	Description	Equivalent circuit
23	IF counter buffer seek/stop switching	This pin functions both as the IF counter buffer (AC output) and as the seek/stop switch pin. The voltage V23 switches between the following three modes. During FM reception: 5 V: Seek mode 2.5 V: Forced SD mode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

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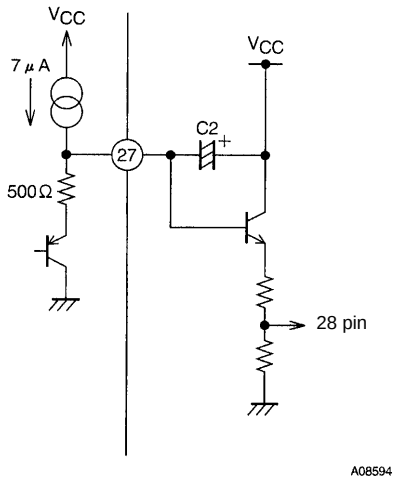
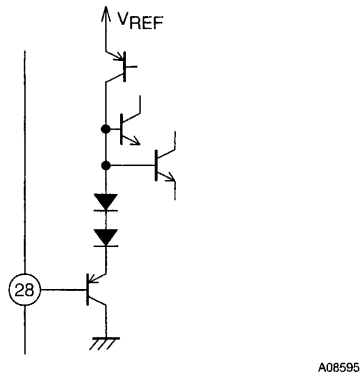
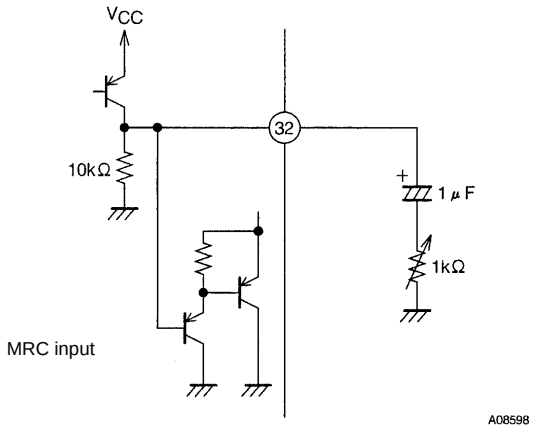
Pin No.	Function	Description	Equivalent circuit
27	MRC control voltage time constant	The MRC detector time constant is determined by a 1-kΩ resistor and C2 when discharging and by the 7-μA current and C2 when charging.	
28	SNC control input	The sub-output is controlled by a 0 to 1-V input.	
29	HCC control input	The high band frequency output is controlled by a 0 to 1-V input. It can also be controlled by the MRC output. Use a resistor of at least 100 kΩ when controlling with the pin 32 FM S-meter signal.	

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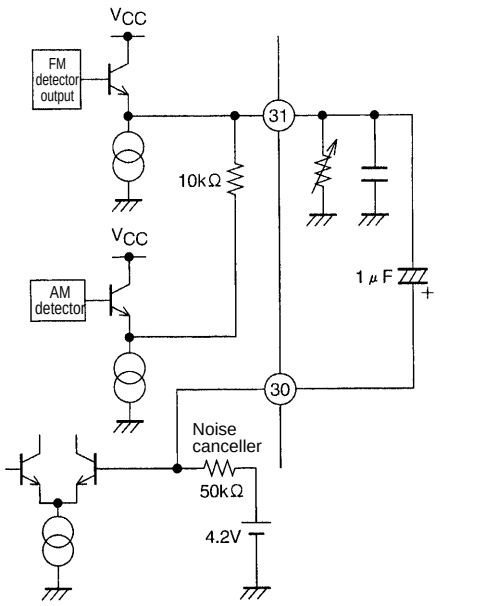
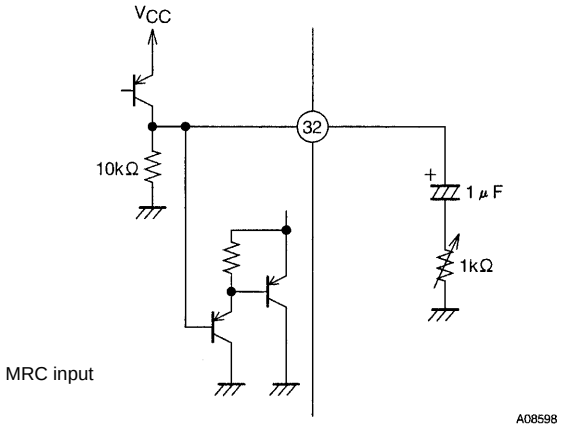
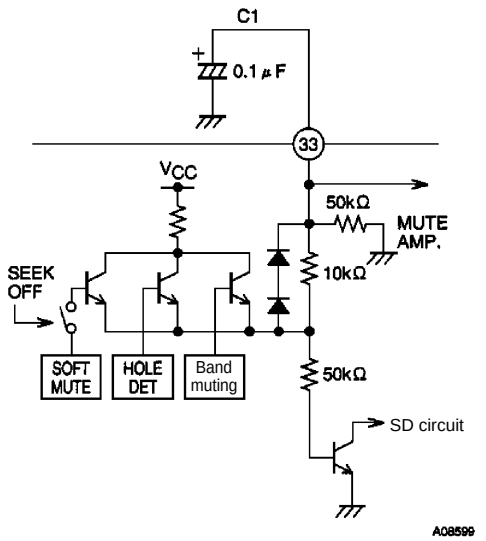
Pin No.	Function	Description	Equivalent circuit
30 31	Noise canceller input AM/FM detector output	Pin 30 is the noise canceller input. The input impedance is 50 kΩ. Pin 31 is the AM and FM detector output In FM mode, this is a low-impedance output. In AM mode, the output impedance is 10 kΩ. To improve 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 MRC AC input block 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. Attack time: T_A = 10 kΩ × C1 Release time: T_R = 50 kΩ × C1 •Noise convergence adjustment The noise convergence can be adjusted when there is no input signal by inserting a resistor between pin 33 and ground. •Muting off function Ground pin 33 through a 4-kΩ resistor.	

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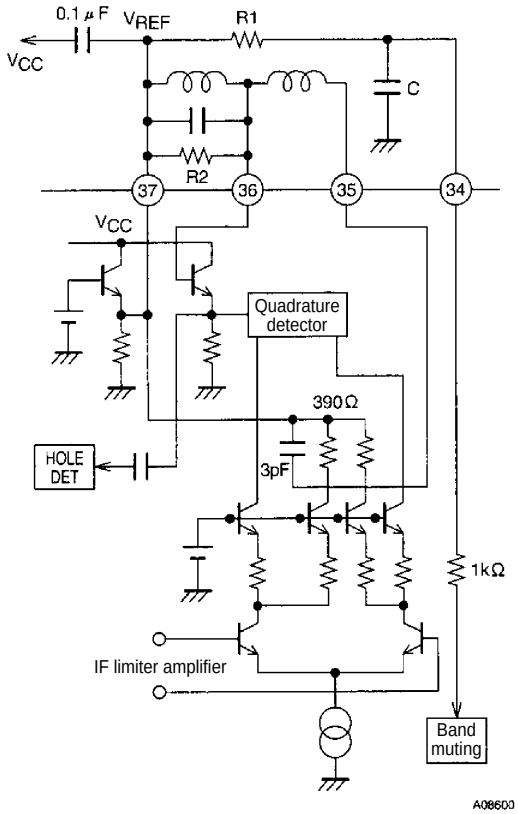
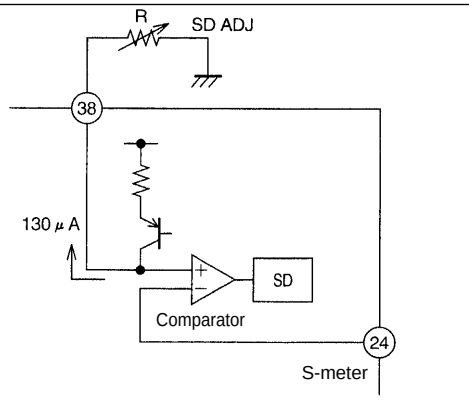
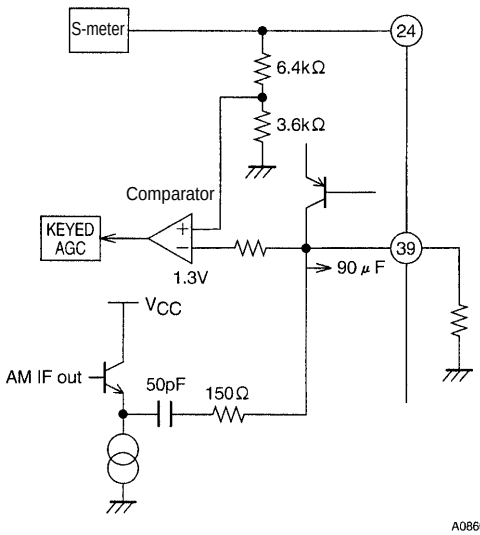
Pin No.	Function	Description	Equivalent circuit
34 35 36 37	AGC QD output QD input V_{REF}	•The resistor R_1 determines the width of the band muting function. Increasing the value of R_1 narrows the band. Reducing the value of R_1 widens the band. •Null voltage When tuned, the voltage between pins 34 and 37, V_{34-37}, will be 0 V. The band muting function turns on when $\|V_{34-37}\| \geq 0.7$ V. 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 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. This pin also is used as the AM stereo IF buffer pin.	

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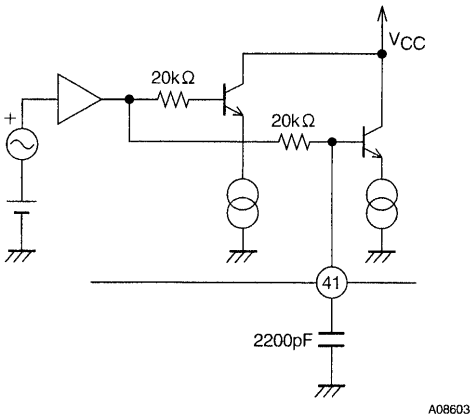
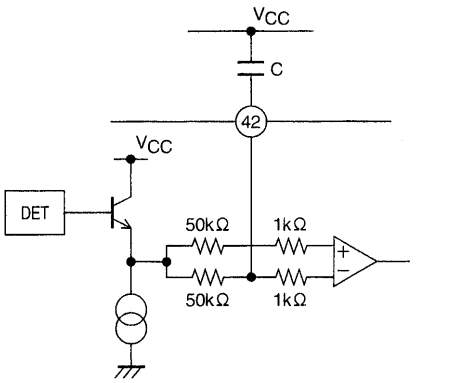
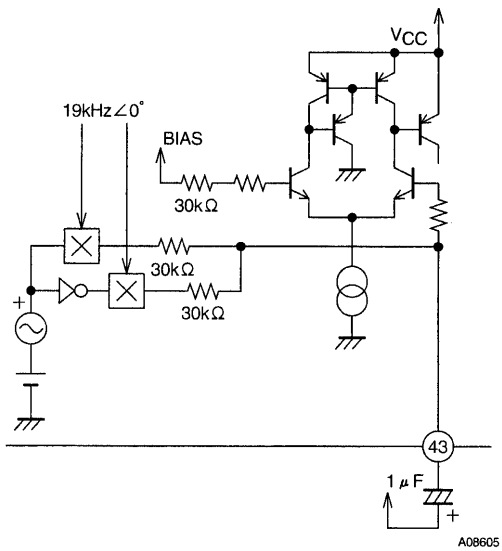
Pin No.	Function	Description	Equivalent circuit
41	HCC capacitor	The HCC frequency characteristics are determined by the external capacitor connected at this pin.	
42	AM L.C. pin	This pin is used to change the frequency characteristics of the unneeded audio band under 100 Hz in AM mode to produce a clear audio signal. 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}. The cutoff frequency f_C is determined by the following formula. $f_C = 1/2\pi \times 50\ k \times C$	
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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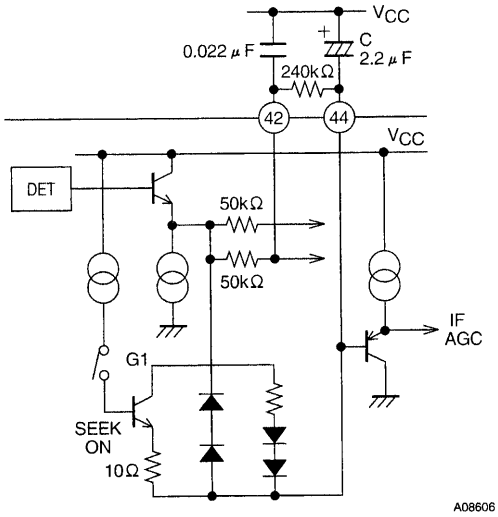
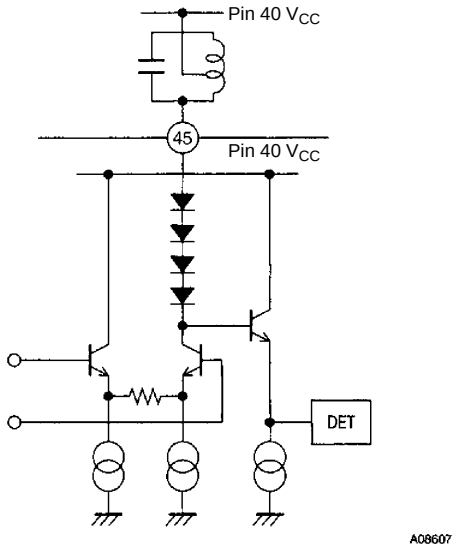
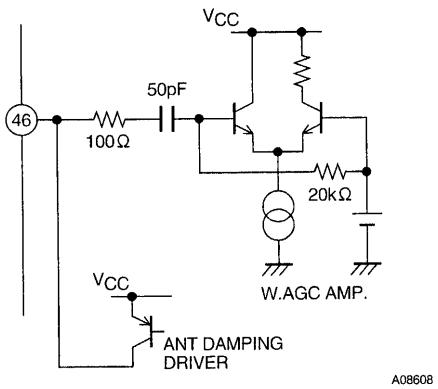
Pin No.	Function	Description	Equivalent circuit
44	IF AGC	Q1: Used for time constant switching during seeks. τ = 2.2 µF × 300 k • Seek τ = 2.2 µ × 10 The external capacitors are connected to V_{CC}. This is because the IF amplifier operates referenced to V_{CC}.	
45	IF output	The IF amplifier load	
46	AM antenna damping drive output Wide band AGC input	I46 = 6 mA (maximum) This is the antenna damping current.	

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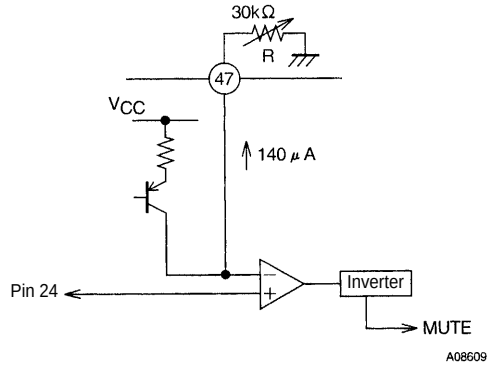
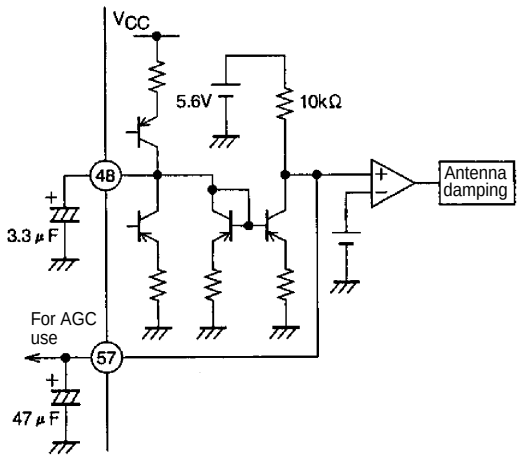
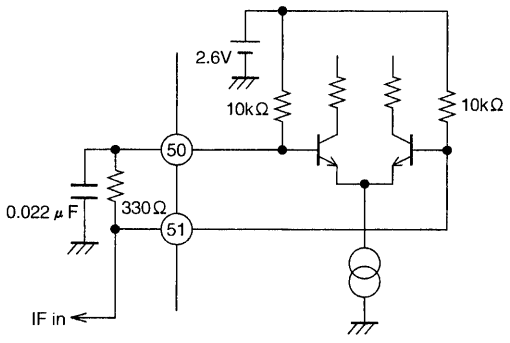
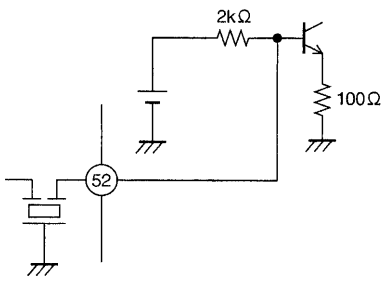
Pin No.	Function	Description	Equivalent circuit
47	FM muting on level adjustment	Modify the value of the external resistor to adjust the muting on level.	
48 57	RF AGC bypass RF AGC	RF AGC rectification capacitor The low frequency distortion is determined as follows: Increasing C48 and C57 improves the distortion but makes the response slower. Reducing C48 and C57 aggravates the distortion but makes the response faster.	
50 51	IF bypass 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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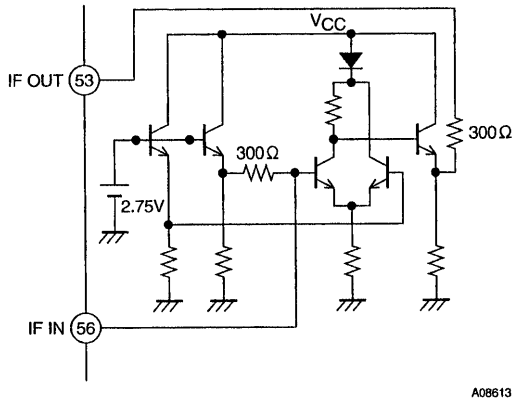
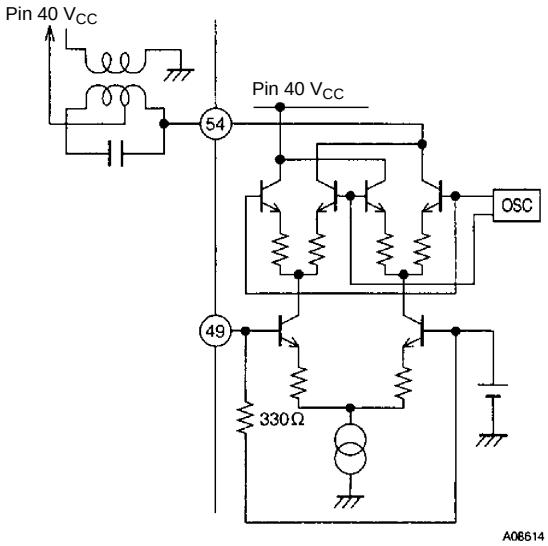
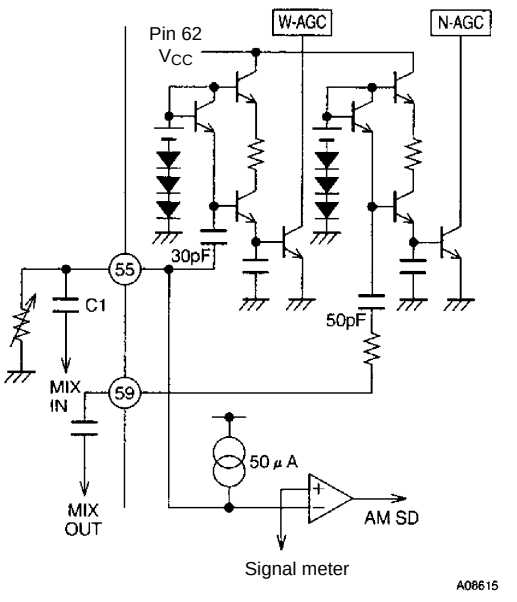
Pin No.	Function	Description	Equivalent circuit
53 56	IF amplifier output IF amplifier input	• Input and output pin or the first IF amplifier • Inverting amplifier V56 = 2 V Input impedance: R_{IN} = 330 Ω V53 = 5.3 V Output impedance R_{OUT} = 330 Ω	
54 49	Mixer output: 130 µA Mixer input	The mixer coil connected to the pin 54 mixer output must be wired to V_{CC} (pin 40). The pin 49 mixer input impedance is 330 Ω	
55 58	W-AGC IN AM SD Adj N-AGC IN Muting attenuation adjustment pin	Pins 55 and 58 include built-in DC cut capacitors. The AGC on level is determined by the values of the capacitors C1 and C2. Pin 55 functions as the SD sensitivity adjustment pin in AM mode. 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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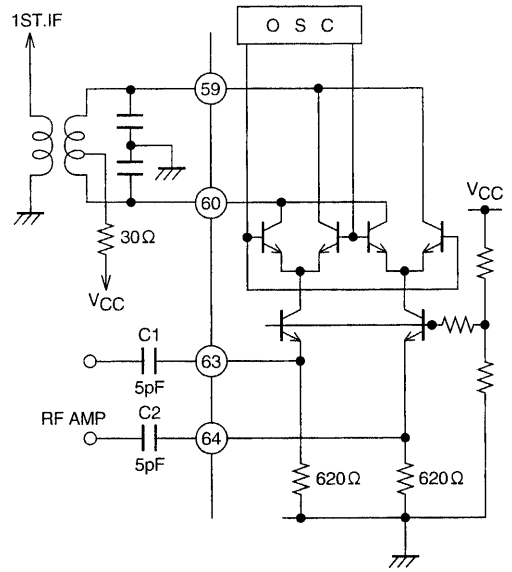
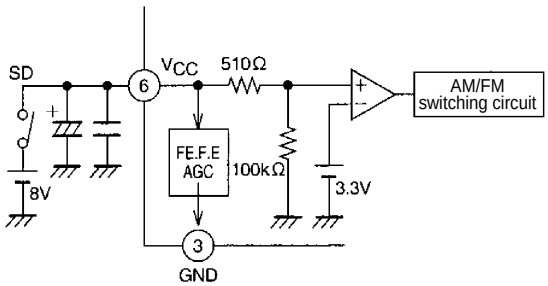
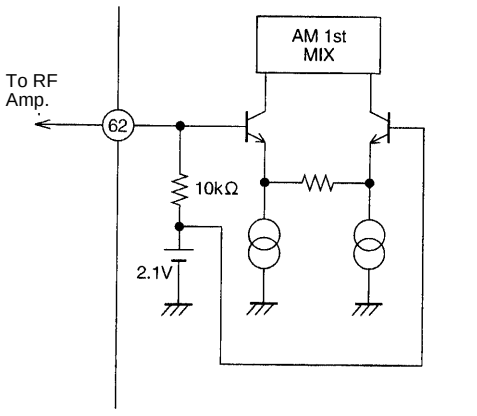
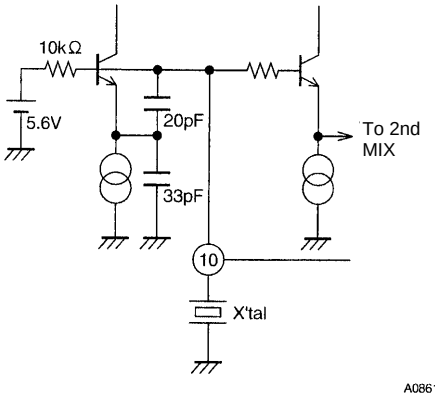
<table>
<tr><th>Pin No.</th><th>Function</th><th>Description</th><th>Equivalent circuit</th></tr>
<tr>
<td>59
60
63
64</td>
<td>Mixer output

Mixer input</td>
<td>Double balanced mixer
Pins 60 and 61 are the mixer 10.7-MHz output

Pins 63 and 64 are the mixer input.
This is an emitter insertion type circuit, and the amount of insertion is determined by the capacitors C1 and C2.

Note: The lines for pins 63 and 64 must be kept separated from the lines for pins 60 and 61.</td>
<td> 
</td>
</tr>
<tr>
<td>6</td>
<td>Front end V_{CC} AM/FM switching</td>
<td>Pin 62 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 INPUT</td>
<td>First mixer input
The input impedance is about 10 kΩ.</td>
<td> 
</td>
</tr>
<tr>
<td>10</td>
<td>AM 2nd OSC</td>
<td>Crystal oscillator circuit
The Kinseki, Ltd. HC-49/U-S and a C_L of 20 pF must be used.</td>
<td> 
</td>
</tr>
</table>

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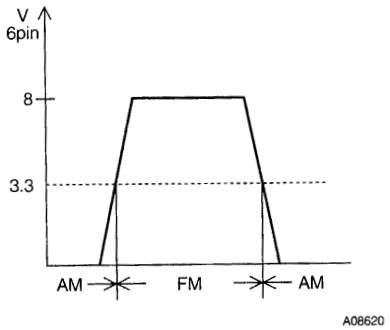
Usage Notes

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

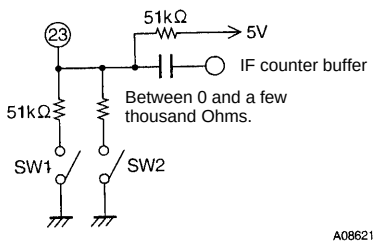
2. Notes on AM Coil Connection
   The V_{CC} used for the first oscillator coil connected to pin 7 must be at the same potential as pin 61.
   Connect to the IFT connected with pin 45, and to the MIX coil connected with pin 54. V_{CC} must be at the same potential as pin 40.

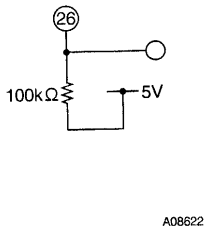
3. AM/FM Switching
   Pin 6 is also used as the FM front end and RF AGC V_{CC}



Pin 6 voltage	Mode
8	FM
OPEN	AM

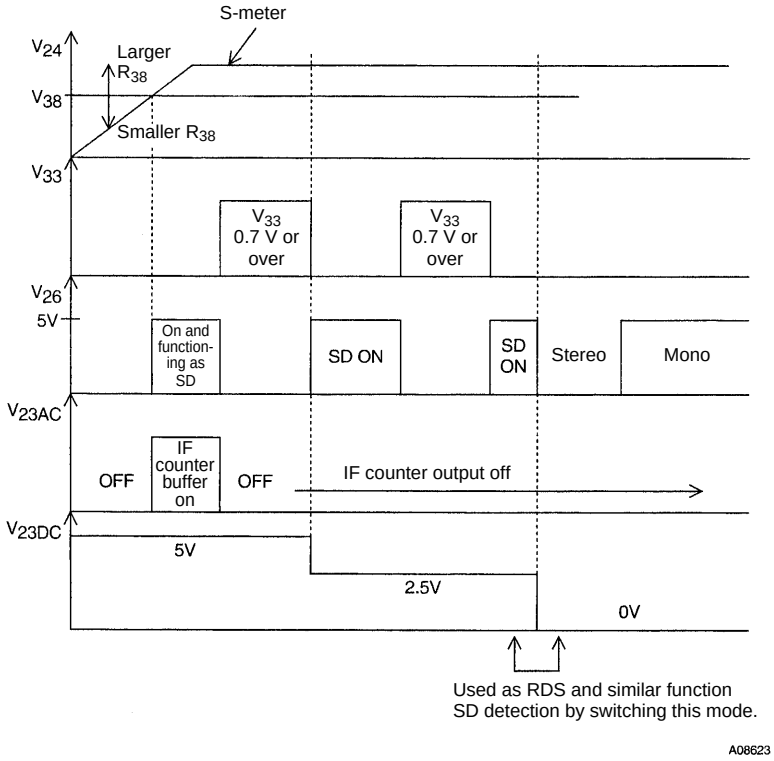
4. Relationship between Pin 23 and Pin 26
   • FM mode
   Pin 26 functions as both the stereo indicator and the SD pin.
   Pin 23: DC-input seek/stop pin (control pin)
   AC output IF counter buffer pin



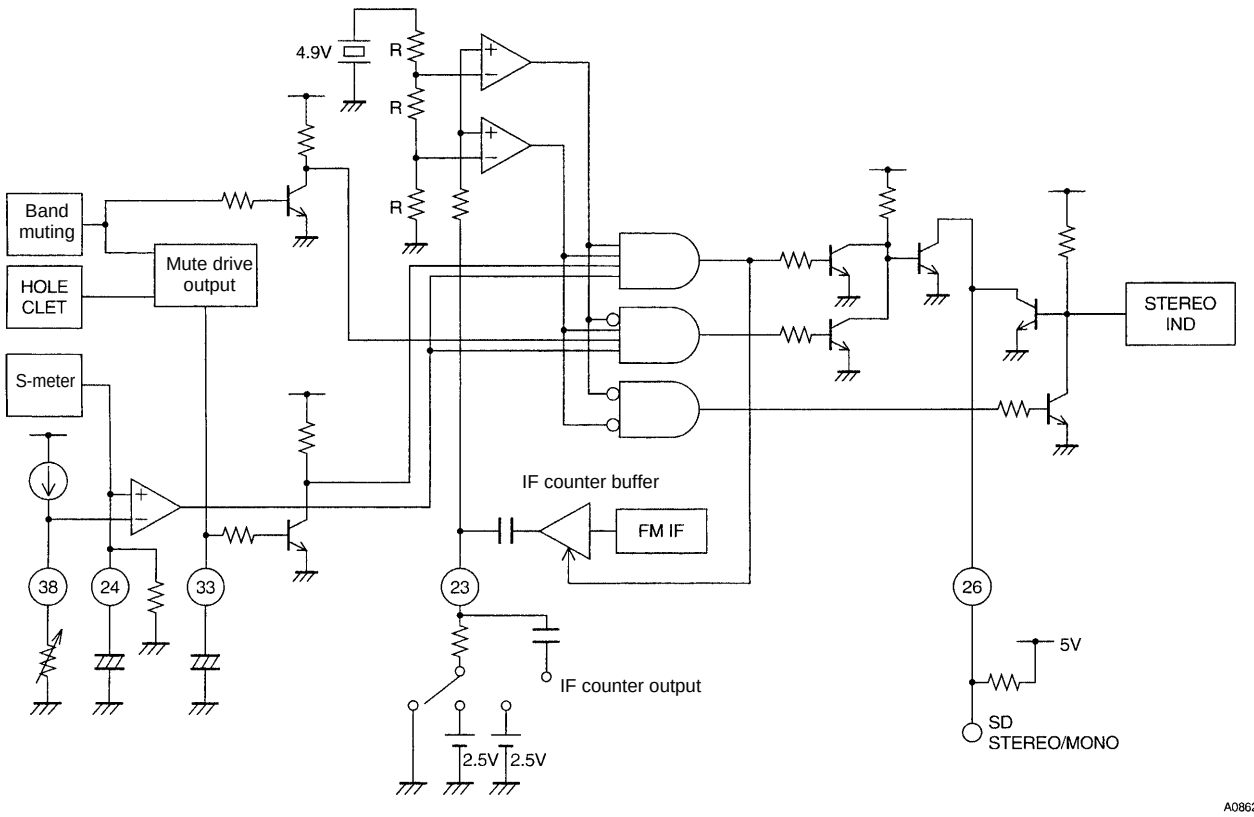


The Pin 23 Control Function and the Relationship between Pin 23 and Pin 26

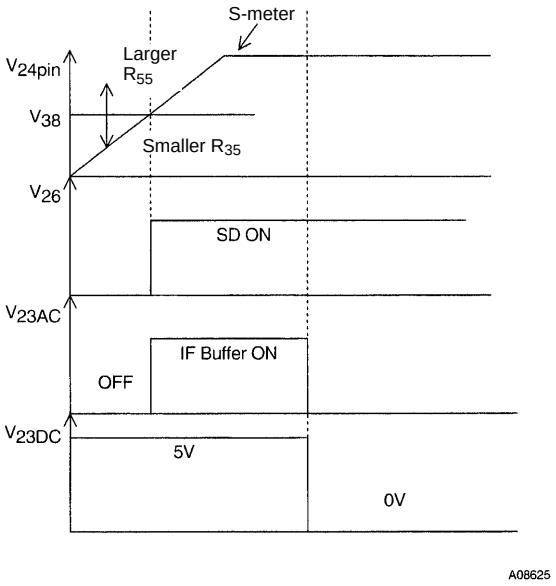
SW1	SW2	Pin 23 voltage	Pin 26	Pin 26
OPEN	OPEN	5 V	IF counter buffer on	SD
ON	OPEN	2.5 V	OFF	High-speed SD
—	ON	Under 0.7 V	OFF	Stereo indicator



Notes on FM SD

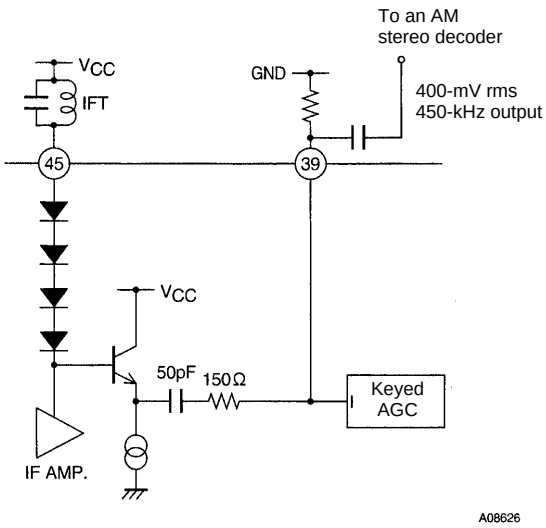


• AM mode



Pin 55: AM SD Adjustment Pin

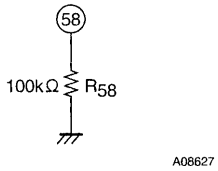
• Pins that support AM stereo



• To attenuate the pin 39 AC level:
Add a capacitor between pin 39 and ground.
For example, if a capacitor is added between pin 39 and ground, and pin 51 is attached, the AM IF output will be reduced by about 6 dB.

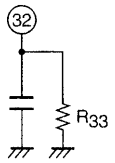
• Notes on the muting attenuation

The resistor between pin 58 and ground switches the muting attenuation to one of three levels, –20, –30, and –40 dB. This is also related to the tuner's total gain.



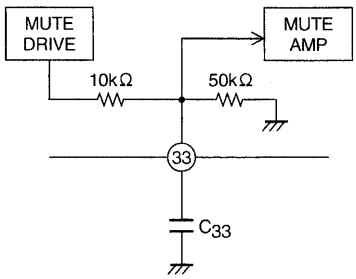
A08627

R	Mute ATT
OPEN	–20 dB
200k	–30 dB
30k	–40 dB



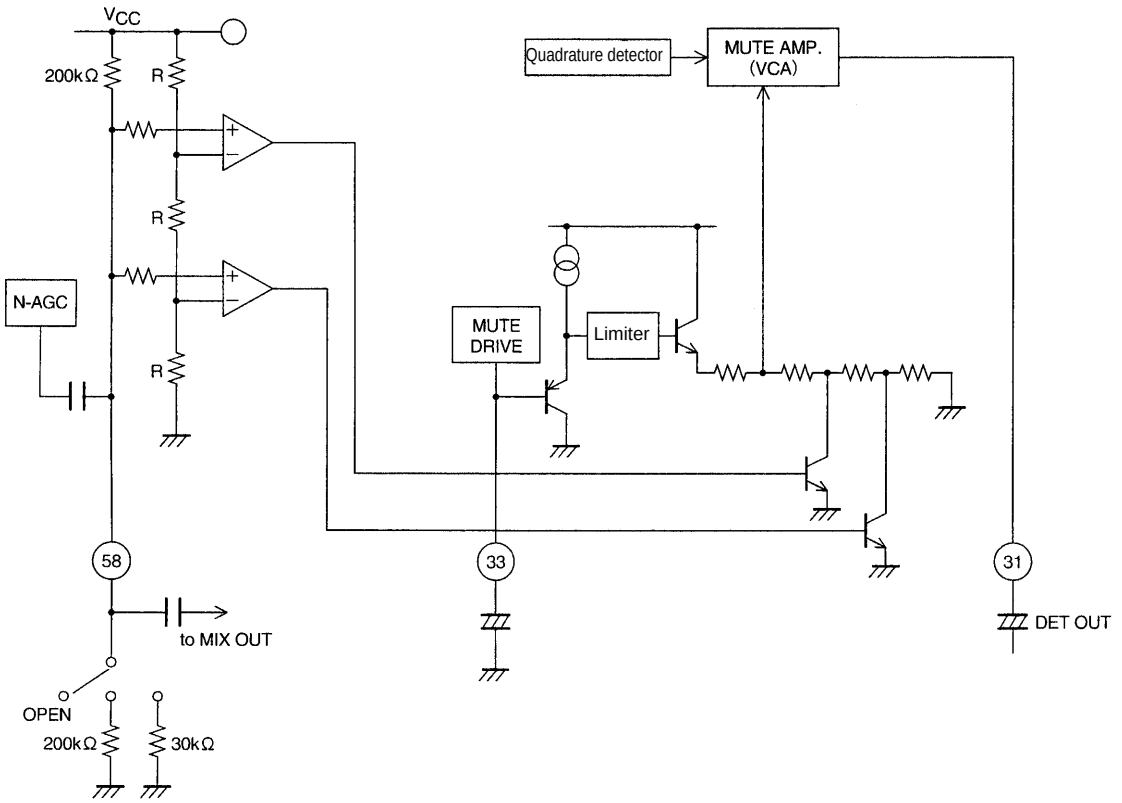
A08628

If R33 is reduced, the attenuation will be reduced as listed in the table above.



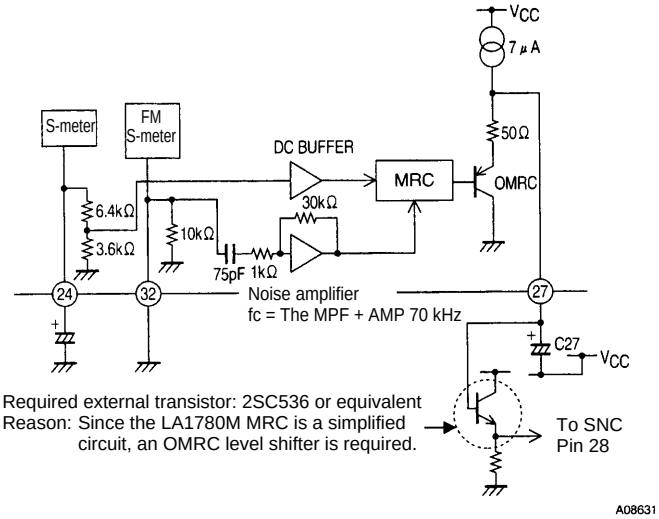
A08629

Muting time constants
Attack: 10 k × C33
Release: 50 k × C33



A08630

• MRC circuit

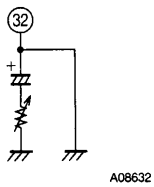


• If there is no AC noise on pin 32:

$$V24 = V27 - V_{BE}$$
$$\uparrow$$
$$Q_{MRC}$$

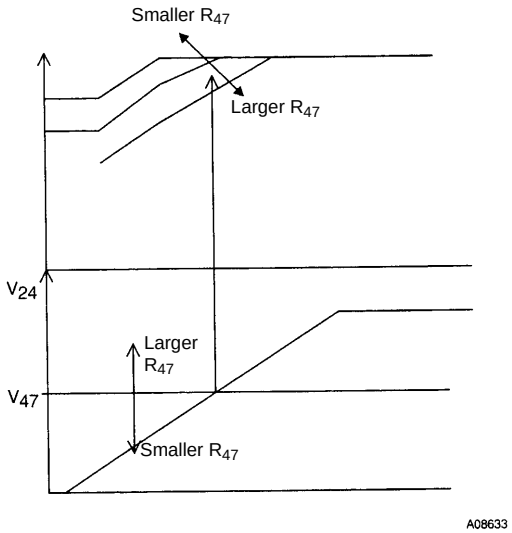
V27 will be about 2.5 V for an antenna input of 60 dBμ or higher.

• Since the MRC noise amplifier gain is fixed, the MRC circuit is adjusted by reducing the AC input level.



• The MRC circuit attack and release times are determined by the capacitor C27 on pin 27.
Attack: 7 μA × C27
Release: 500 Ω × C27

5. FM Soft Muting



By comparing the pin 47 mute on adjustment voltage to the S-meter voltage (V24), the muting on point can be adjusted.

- Noise canceller notes

The characteristics of the noise canceller have been improved by implementing the circuit that determines the gate time in logic. In earlier noise canceller circuits, since the time constant was determined with an RC circuit such as the one shown in figure 5, the rise time was influenced by the RC circuit time constant as show in figure 6. This meant that the rise was delayed and the associated switching delay resulted in a reduction of the circuit's ability to exclude noise.

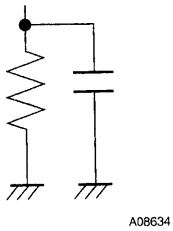


Figure 5

In the LA1780M, the rise time is made shorter by implementing the circuit that determines the gate time in logic. This allows the LA1780M to eliminate noise reliably.

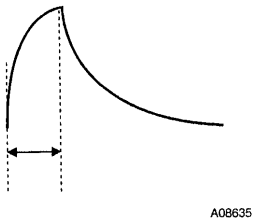


Figure 6

- Gain distribution (FM)

This section analyzes the gain in each of the blocks in the LA1780M when the Sanyo recommended circuit is used.

Test conditions

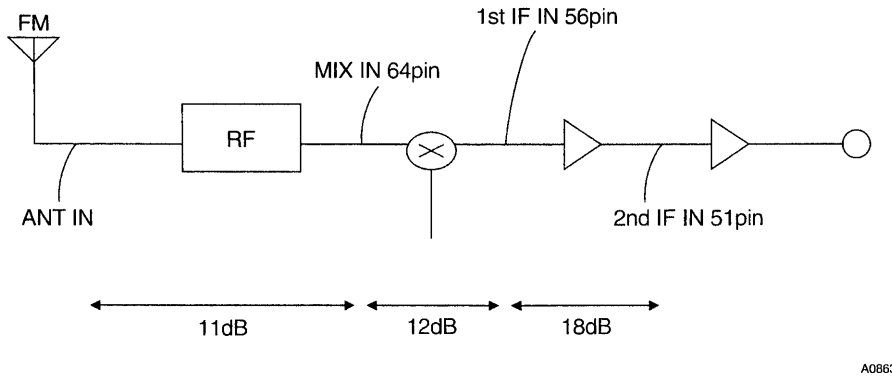
Ambient temperature: 26°C
Antenna and mixer input frequency: 98.1 MHz
First and second IF input frequency: 10.7 MHz

Input levels when VSM = 2 V were measured to be:

Antenna input: 19 dBμ
Mixer input: 30 dBμ
First IF input: 42 dBμ
Second IF input: 60 dBμ

These values allow the gains in each block to be calculated as follows.

RF gain: 11 dB
Mixer gain: 12 dB



AM

This section analyzes the gain in each of the blocks in the LA1780 when the Sanyo recommended circuit is used.

Test conditions

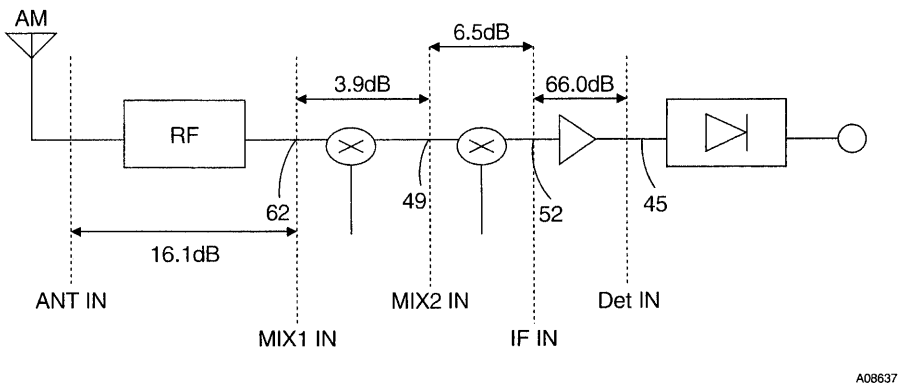
Ambient temperature: 26°C
Antenna and mixer 1 input frequency: 1 MHz
Mixer 2 input frequency: 10.71 MHz
IF and detector input frequencies: 450 kHz
An AM dummy is attached.

When an input level such that the output becomes –35 dBm is determined, the I/O characteristics of each stage were determined to be as follows:

Antenna input: 9.5 dBμ
Mixer 1 input: 25.6 dBμ
Mixer 2 input: 29.5 dBμ
IF input: 36.0 dBμ
Detector input: 102.0 dBμ

These values allow the gains in each block to be calculated as follows.

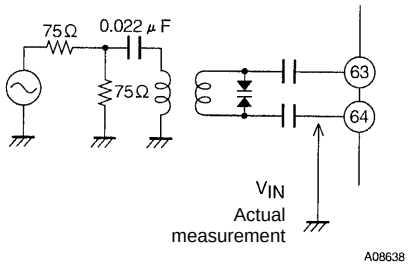
RF gain: 16.1 dB
Mixer 1 gain: 3.9 dB
Mixer 2 gain: 6.5 dB
IF gain: 66.0 dB



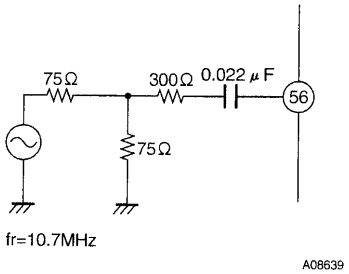
• Input circuits used at each stage

[FM]

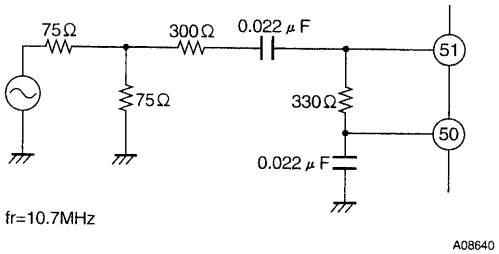
Mixer input



First IF input

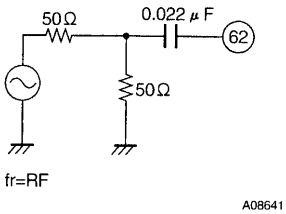


IF input

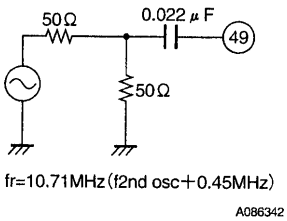


[AM]

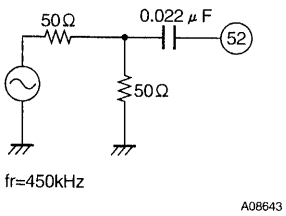
First mixer input



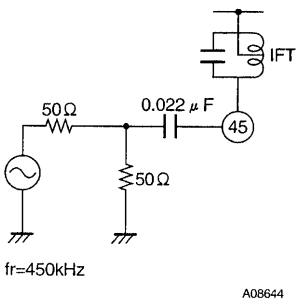
Second mixer input



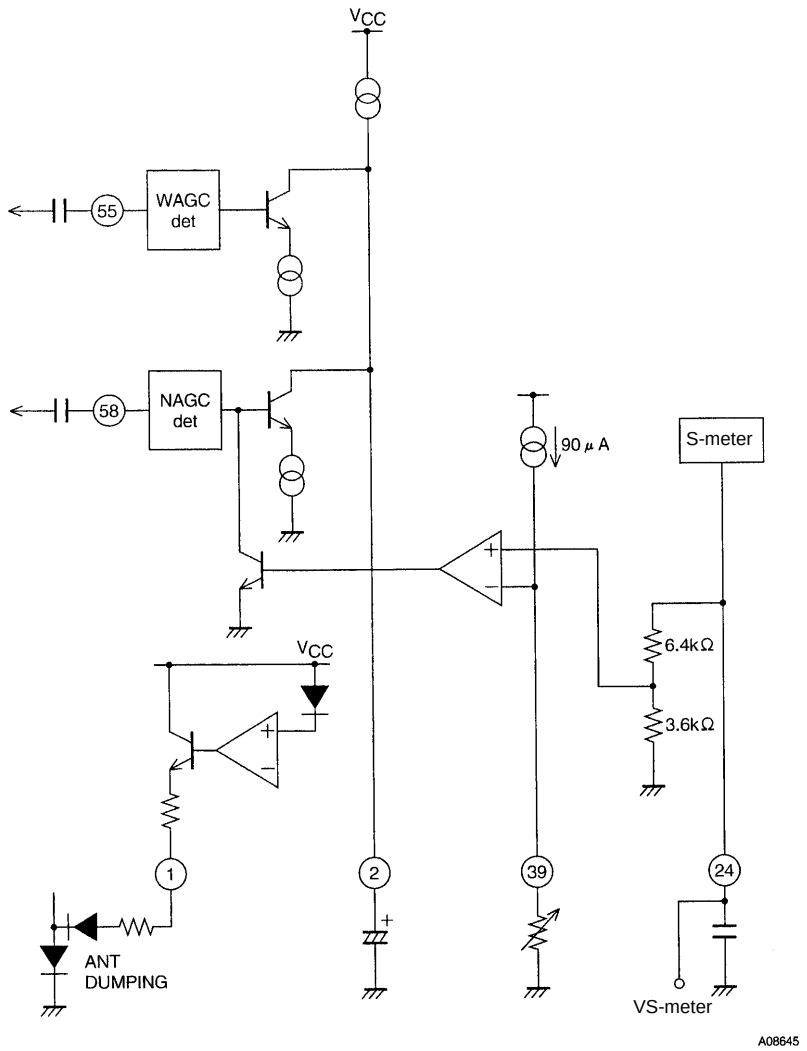
IF input



Detector input

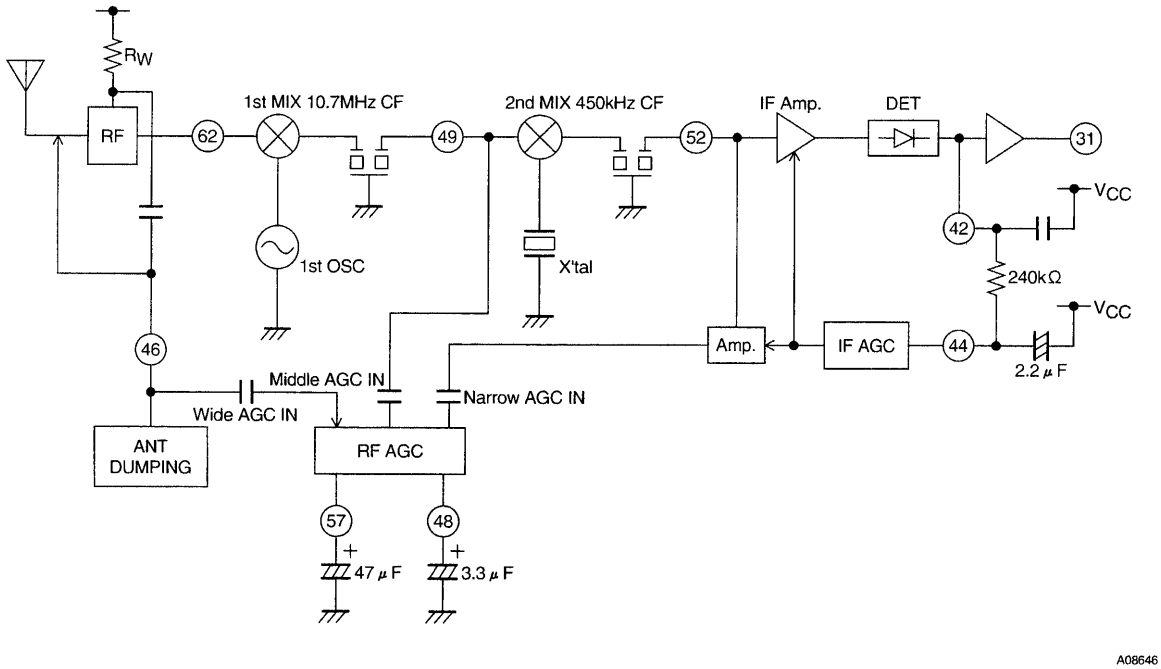


• 3D AGC (keyed AGC) settings



· The antenna damping function operates by providing the pin diode antenna damping current from the pin when the pin 2 voltage becomes equal to $V_{CC} - V_{BE}$.
· The noise AGC circuit operates as follows:
When the pin 39 voltage is greater than (6.4/3.6) times the pin 24 voltage, the ACG circuit is off.
When the pin 39 voltage is less than (6.4/3.6) times the pin 24 voltage, the ACG circuit is on.

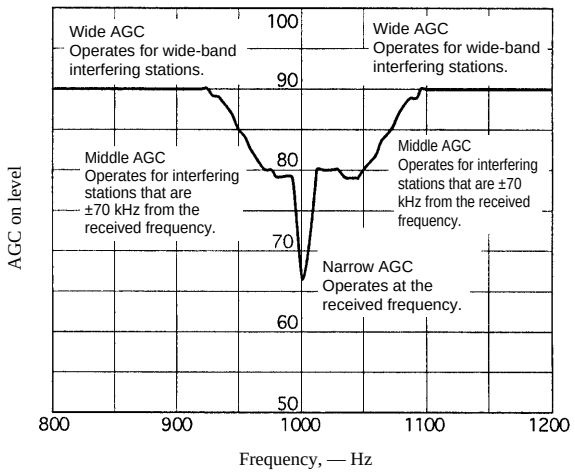
AM AGC System



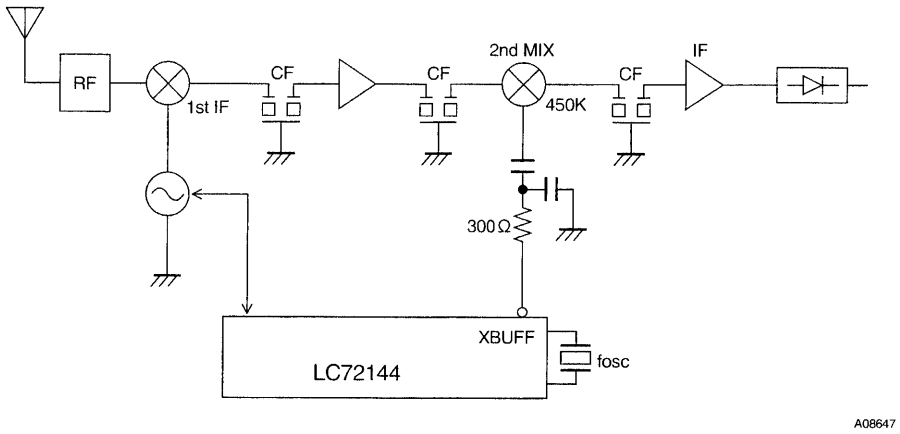
The LA1780M RF AGC is picked up from three locations.

- The wide AGC determined by Rw
- The middle AGC picked up from the pin 49 second mixer input
  The operating bandwidth is 150 kHz to 180 kHz (the bandwidth of the 10.7 MHz CF)
- The narrow AGC picked up from pin 52
  The operating bandwidth is 7 kHz (the bandwidth of the 450 kHz CF)

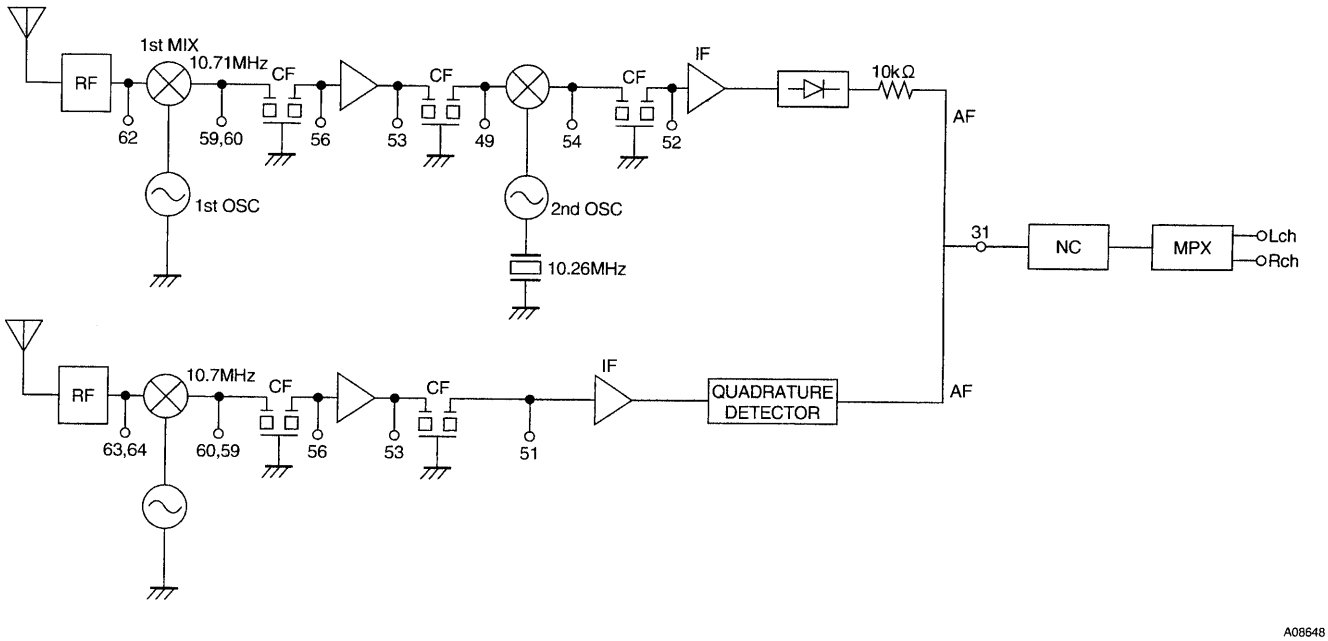
AM AGC Frequency Characteristics



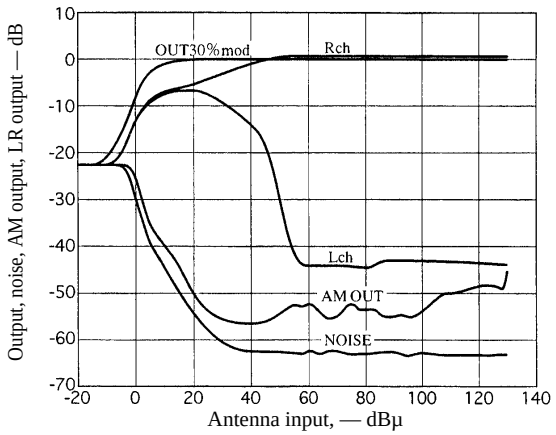
• Sample AM application using the LC72144 and the LA1780M



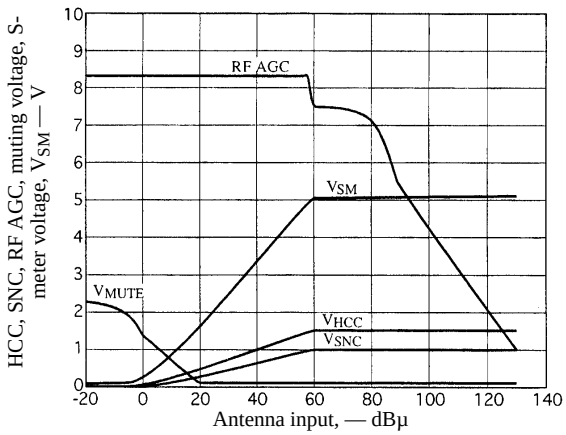
		AM 1st IF	Step	FM IF
1	f_{OSC} 10.25 MHz	10.7 MHz	10 K, 11 K	10.7 MHz
2	f_{OSC} 10.35 MHz	10.8 MHz	9 K, 10 K	10.8 MHz



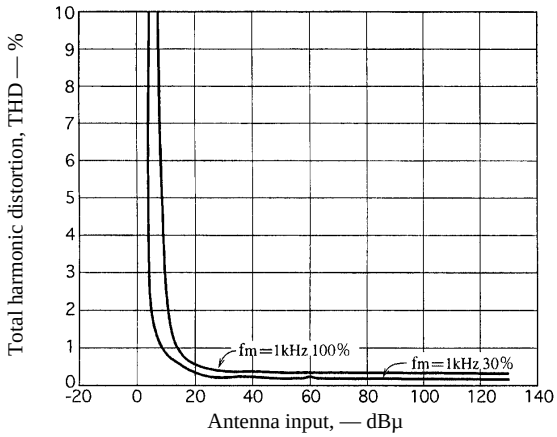
FM I/O Characteristics



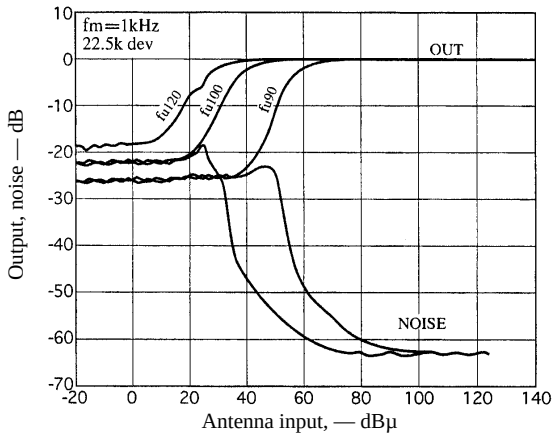
FM I/O Characteristics



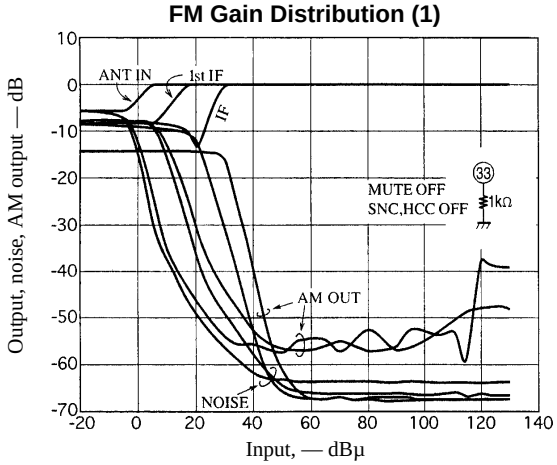
FM Distortion



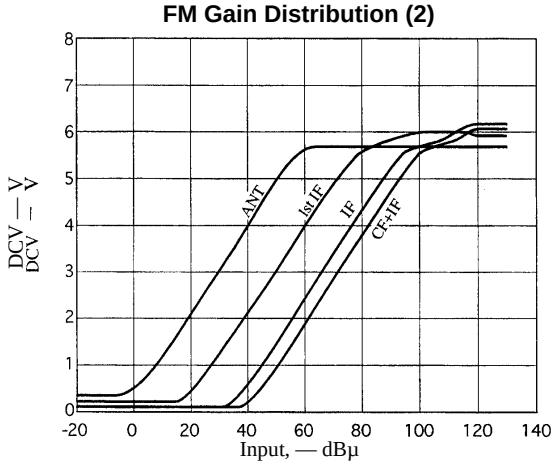
FM Sensitivity Suppression



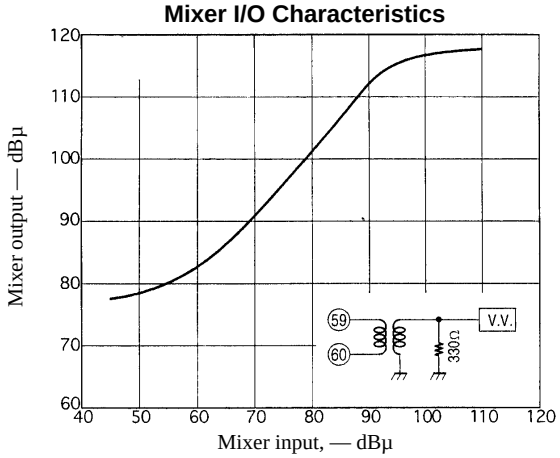
FM Gain Distribution (1)



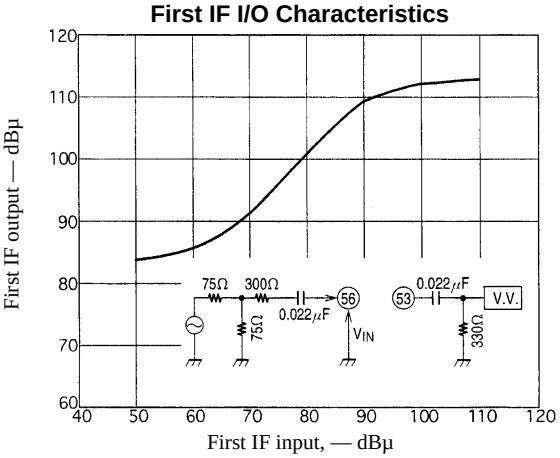
FM Gain Distribution (2)



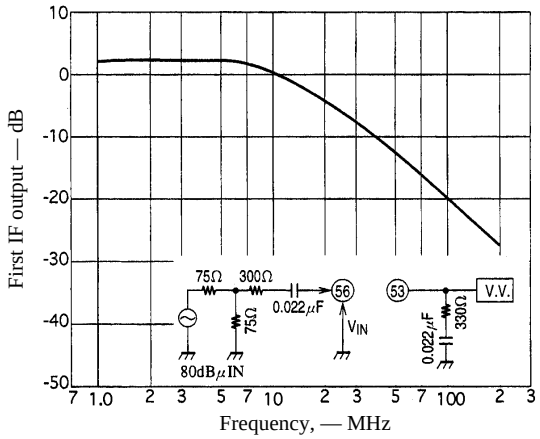
Mixer I/O Characteristics



First IF I/O Characteristics

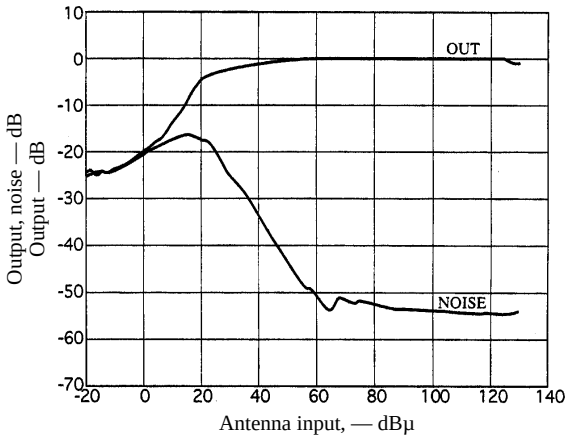


First IF Frequency Characteristics.



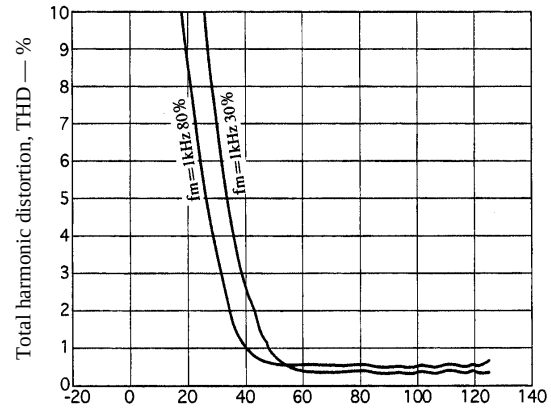
Frequency, — MHz

AM I/O Characteristics



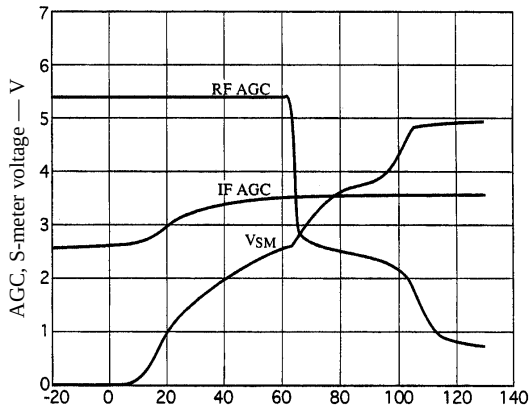
Antenna input, — dBμ

AM Distortion



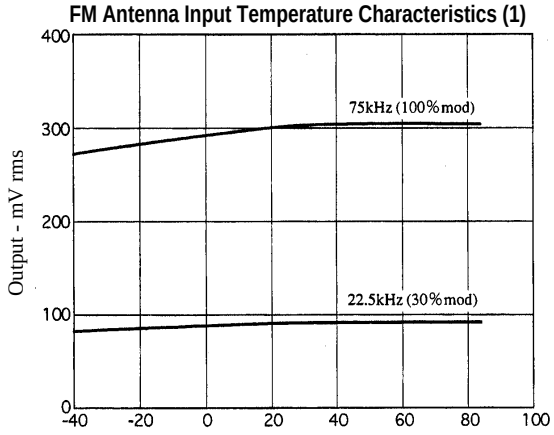
Antenna input, — dBμ

AM DC Characteristics



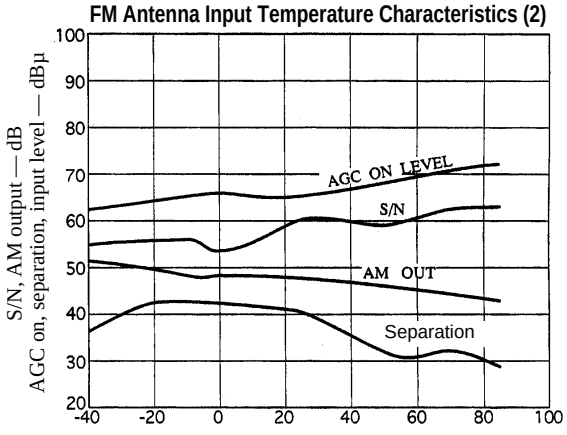
Antenna input, — dBμ

FM Antenna Input Temperature Characteristics (1)



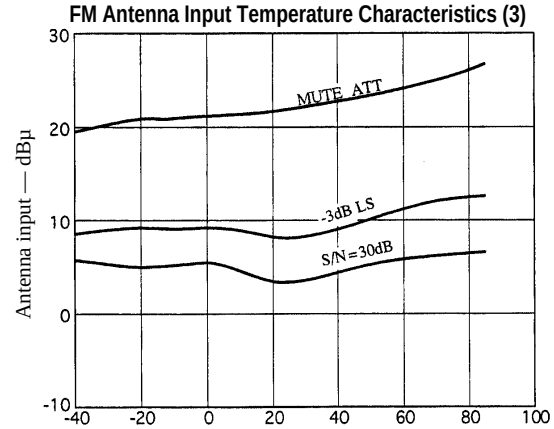
Ambient temperature, Ta — °C

FM Antenna Input Temperature Characteristics (2)



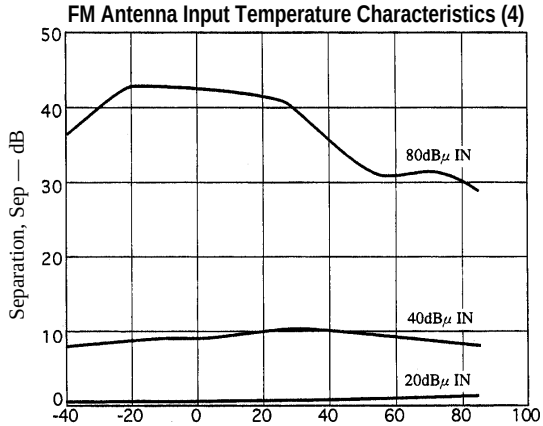
Ambient temperature, Ta — °C

FM Antenna Input Temperature Characteristics (3)



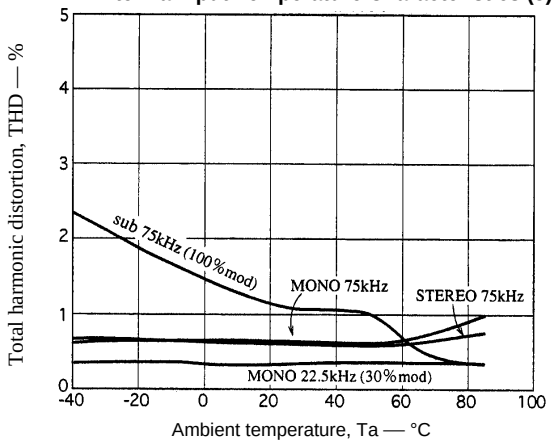
Ambient temperature, Ta — °C

FM Antenna Input Temperature Characteristics (4)

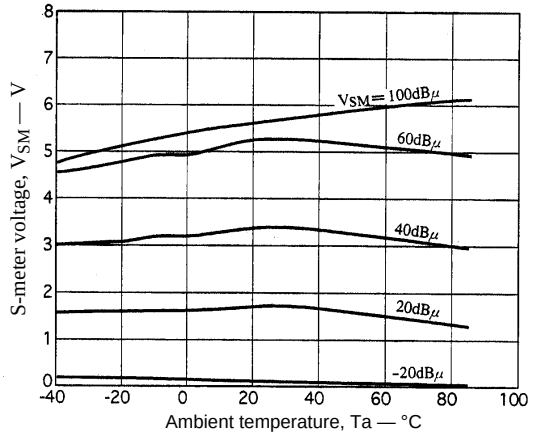


Ambient temperature, Ta — °C

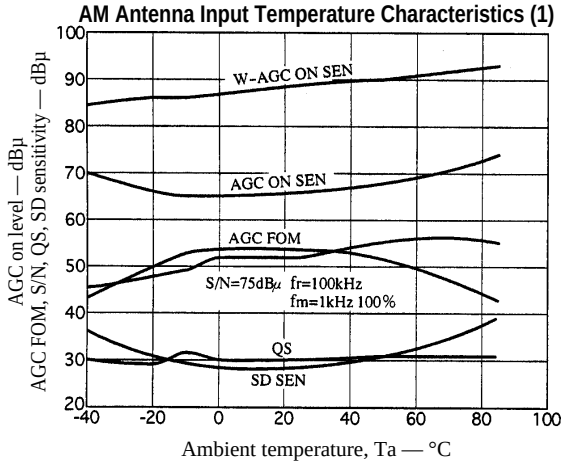
FM Antenna Input Temperature Characteristics (5)



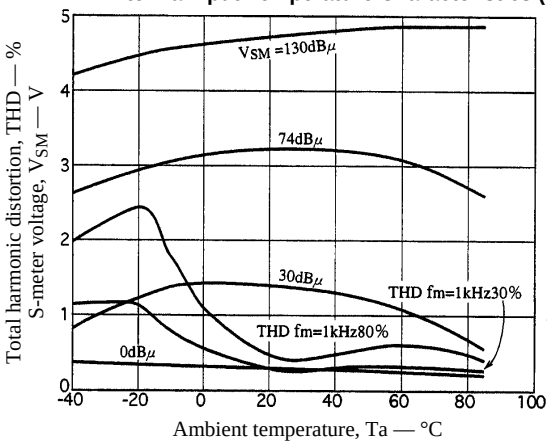
FM Antenna Input Temperature Characteristics (6)



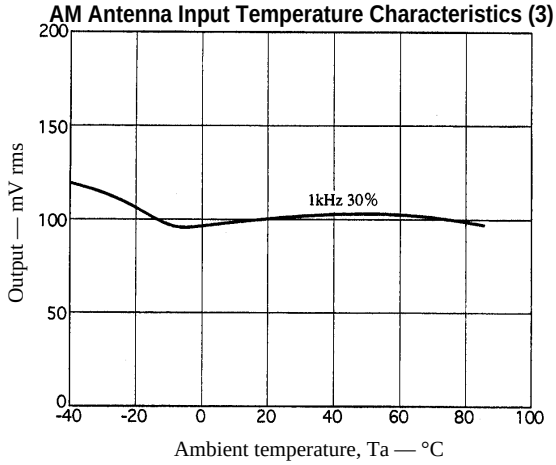
AM Antenna Input Temperature Characteristics (1)



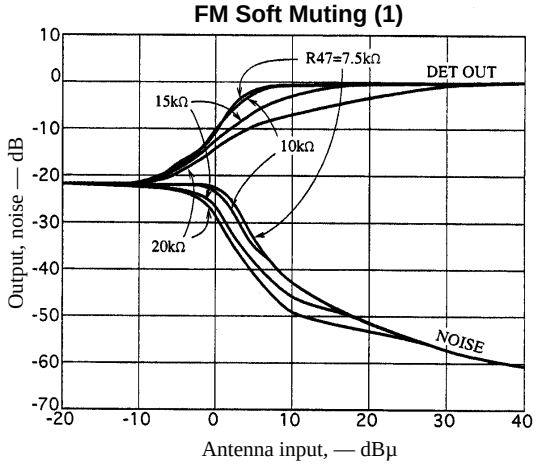
AM Antenna Input Temperature Characteristics (2)



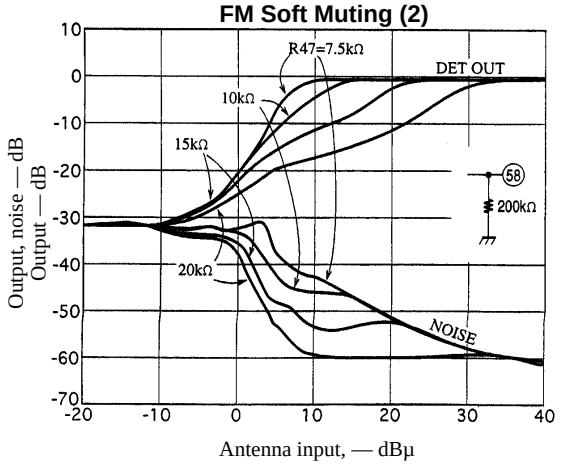
AM Antenna Input Temperature Characteristics (3)



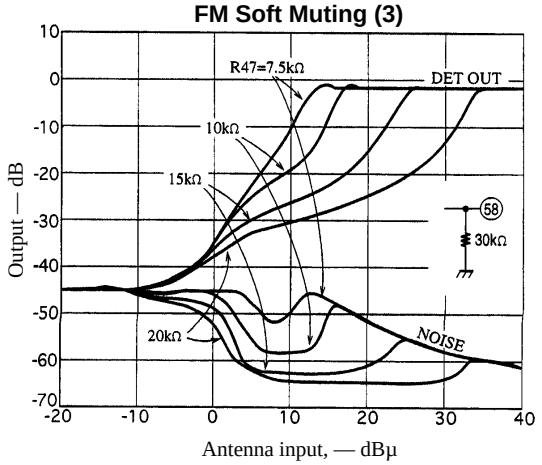
FM Soft Muting (1)



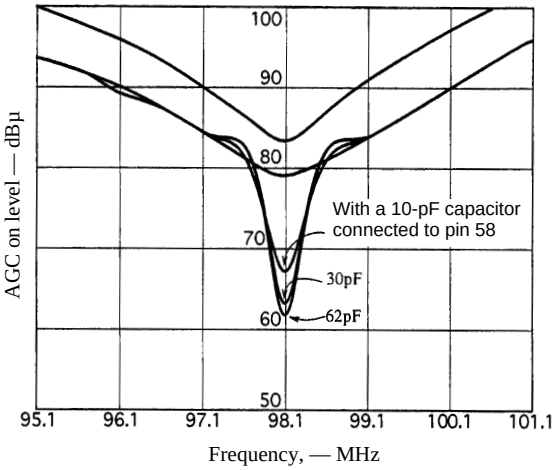
FM Soft Muting (2)



FM Soft Muting (3)



AM AGC Frequency Characteristics



AM AGC Frequency Characteristics