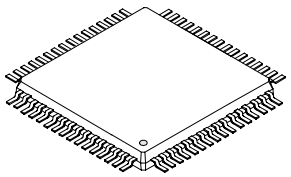
SINGLE-CHIP TUNER IC FOR CAR RADIOS

DESCRIPTION

The SA1787 is a high performance tuner circuit for AM and FM car radio. It integrates mixer, IF amplifier, signal detection circuit and stereo decoder for AM and FM. It achieves stereo tuning with advanced technology and less peripheral components.



QFP-64-14 x 14-0.8

FEATURES

FM-Part

* RF AGC generation for RF and IF detection
* I/Q mixer for 1st FM IF 10.7MHz with image rejection
* Excellent FM signal meter linearity
* MPX integrated in a single chip
* Improve FM separation temperature characteristics
* Improve FM thermal characteristics

AM-Part

* Wide and narrow AGC generation
* Mixer for 1st IF 10.7MHz, AM up conversion
* Mixer for 2nd IF 450kHz, AM down conversion
* Integrated AM-demodulator
* AM IF and audio noise blanking
* Improve AM adjacent channel interference characteristics
* Improve AM thermal characteristics

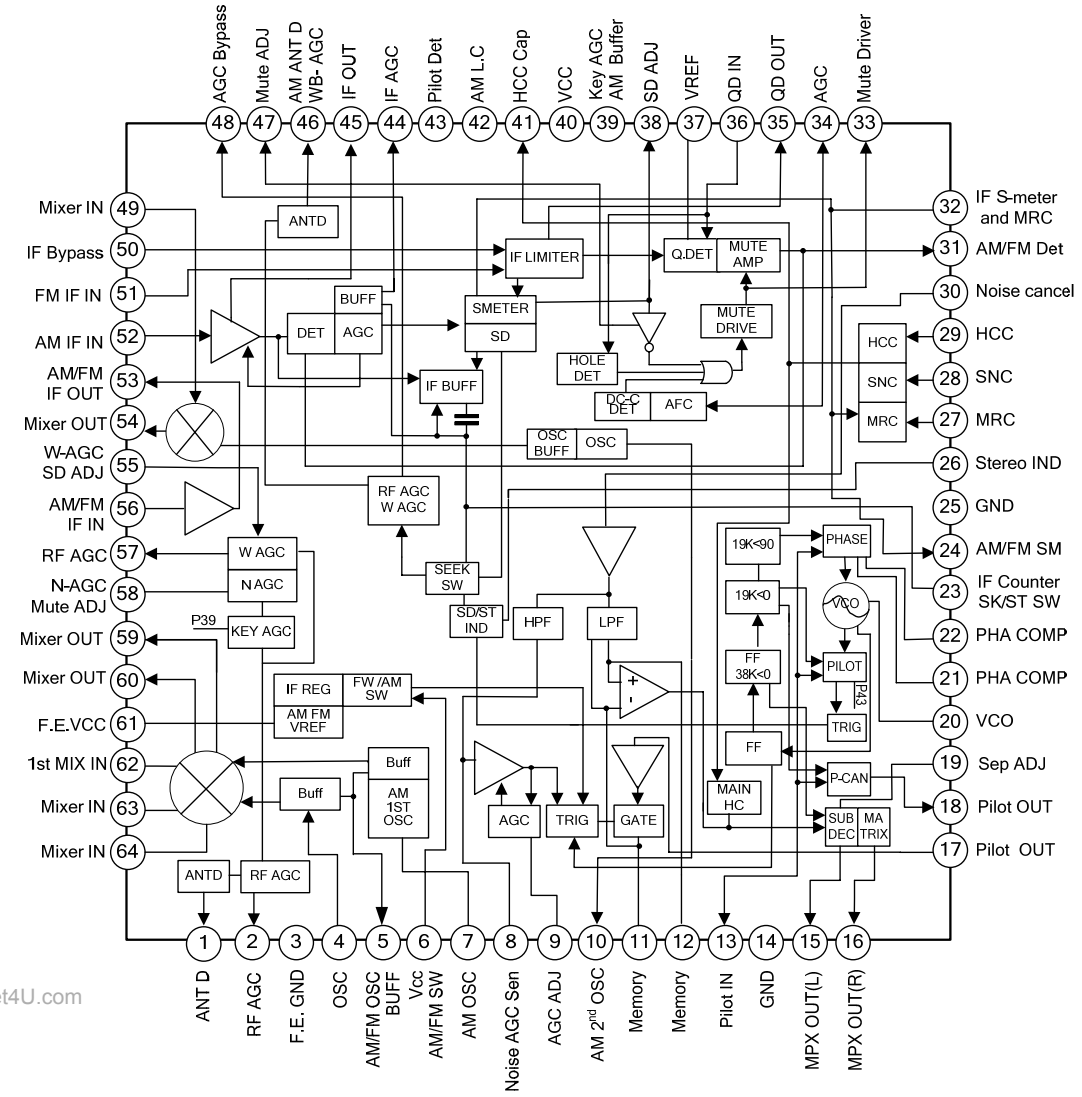
APPLICATIONS

* Car Radios

ORDERING INFORMATION

Device	Package	Marking
SA1787	QFP-64-14x14-0.8	SA1787

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Conditions	Ratings	Unit
Maximum Supply Voltage	V_{CC1} max	Pins 6, 40, and 61	9	V
	V_{CC2} 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

Characteristics	Symbol	Conditions	Ratings	Unit
Recommended Supply Voltage	VCC	Pins 6, 7, 40, 45, 54, 59, 60, and 61	8	V
	VCCST IND	(Pin 26)	5	V
Operating Supply Voltage Range	VCC op		7.5 to 9.0	V

ELECTRICAL CHARACTERISTICS (Special for FM IF input test, Ta = 25°C, VCC= 8.0V)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
[FM Characteristics] At The FM IF Input						
Current Drain	ICCO-FM	No input, I40 + I45 + I54 + I59 + I60 + I61	70	105	120	mA
Demodulation Output	VO-FM	10.7 MHz, 100dBμ, 1 kHz, 100%mod, output at pin 15	230	340	420	mVrms
Pin 31 Demodulation Output	VO-FM31	10.7 MHz, 100dBμ, 1 kHz, 100%mod, output at pin 31	190	305	390	mVrms
Channel Balance	CB	The ratio of 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	77	84		dB
AM Suppression Ratio: IF	AMR IF	10.7 MHz, 100 dBμ, 1 kHz, fm = 1 kHz, 30% AM, pin 15	57	66		dB
Muting Attenuation	Att-1	10.7 MHz, 100 dBμ, 1 kHz. Attenuation at pin 15 when V33 changes from 0 to 2 V	5	11	15	dB
	Att-2	10.7 MHz, 100 dBμ, 1 kHz. Attenuation at pin 15 when V33 changes from 0 to 2 V*1	15	22	25	dB
	Att-3	10.7 MHz, 100 dBμ, 1 kHz. Attenuation at pin 15 when V33 changes from 0 to 2 V*2	28	32	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, V26<0.5V	1.2	2.4	4.4	%
Stereo off Level	ST-OFF	The pilot modulation, V26>3.5V	0.6	1.7		%

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Main Total Harmonic Distortion	THD-Main L	10.7 MHz, 100 dBμ, L+R = 90%, pilot = 10%. Signal at pin 15		0.2	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	6	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, output voltage reduces 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) , the IF counter buffer output is turned on	54	63	70	dBμ
	SD-sen2 FM		54	62	70	dBμ
IF Counter Buffer Output	VIFBUFF-FM	10.7 MHz, 100 dBμ, unmodulated. Output at pin 23	120	170	250	mVrms
Signal Meter Output	VSM FM-1	No input. DC output at pin 24, unmodulated	0.0	0.2	0.4	V
	VSM FM-2	50 dBμ. DC output at pin 24, unmodulated	0.4	1.3	1.6	V
	VSM FM-3	70 dBμ. DC output at pin 24, unmodulated	2.0	2.7	3.5	V
	VSM FM-4	100 dBμ. DC output at pin 24, unmodulated	4.7	5.0	5.5	V
Muting Bandwidth	BW-mute	100 dBμ. The bandwidth when V33 = 2 V, unmodulated	150	220	290	kHz
Mute Drive Output	VMUTE-100	100 dBμ, 0 dBμ. DC output at pin 33, unmodulated	0.00	0.10	0.20	V
[FM FE Mixer Input]						
N-AGC on Input	VN-AGC	83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below	79	88	99	dBμ

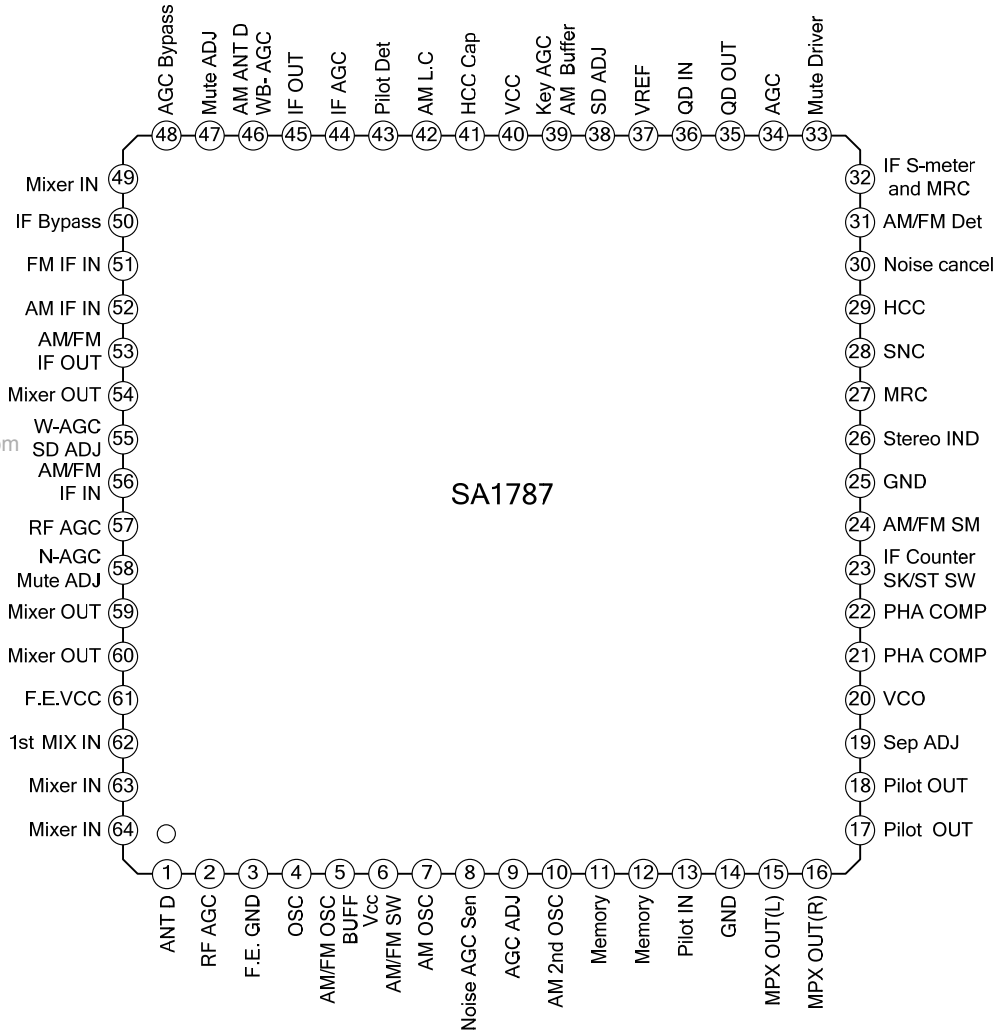
Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
W-AGC on Input	VWAGC	83 MHz, unmodulated. The input such that the pin 2 voltage is 2.0 V or below. (When the keyed AGC is set to 4.0 V.)	104	110	116	dBμ
Conversion Gain	A.V	83 MHz, 80 dBμ, unmodulated. output at The FE CF	19	30	48	mVrms
Oscillator Buffer Output	VOSCBUFFF	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 pulse, frequency = 10 kHz, 150 mV p-o. The ratio of outputs at pin 15 in FM mode and in AM mode (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, voltage at pin 24 is 5V and pin 27 is 2V	10	15	20	mVrms
[AM Characteristics] AM ANT Input						
Practical Sensitivity	S/N-30	1 MHz, 30 dBμ, fm = 1 kHz, 30% modulation, pin 15	20			dB
Detector Output	VO-AM	1 MHz, 74 dBμ, fm = 1 kHz, 30% modulation, pin 15	130	195	270	mVrms
Pin 31 Detector Output	VO-AM31	1 MHz, 74 dBμ, fm = 1 kHz, 30% modulation, pin 31	110	175	230	mVms
Agc F.O.M.	VAGC-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, fm = 1 kHz, 30% modulation	47	52		dB
Total Harmonic Distortion	THD-AM	1 MHz, 74 dBμ, fm = 1 kHz, 80% modulation		0.3	1	%
Signal Meter Output	VSM AM-1	No input	0.0	0.4	0.7	V
	VSM AM-2	1 MHz, 130 dBμ, unmodulated	4.8	6	7.3	V
Oscillator Buffer Output	VOSCBUFF	No input	185	230		mVrms

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Wide Band AGC Sensitivity	W-AGCsen1	1.4 MHz, the input when V46 = 0.7 V	91	97	105	dBμ
	W-AGCsen2	1.4 MHz, the input when V46 = 0.7 V (seek mode)	83	90	95	dBμ
SD Sensitivity	SD-sen1 AM	1 MHz, the ANT input level such that the IF counter output turns on.	25	31	36	dBμ
	SD-sen2 AM	1 MHz, the ANT input level such that the SD pin goes to the on state.	25	31	36	dBμ
IF Buffer Output	VIFBUFF-AM	1 MHz, 74 dBμ, unmodulated. No modulation. Output at pin 23	170	260		mVrms

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

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

PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Pin Name	I/O	Descriptions
1	ANT D	O	An antenna damping current for FM pin diode drive output
2	RF AGC	O	RF AGC voltage to control the LNA second gate. AGC is applied at the voltage of Vcc-Vbe.
3	F.E.GND	I/O	Ground of AM/FM front end
4	OSC	I/O	Oscillator connection for FM 1st Mixer
5	AM/FM OSC BUFF	O	AM/FM oscillator buffer output
6	VCC AM/FM SW	I/O	V6=8V→FM and pin6 is FM front end VCC V6=open→AM
7	AM OSC	I/O	AM first oscillator for up conversion This circuit can oscillator up to the SW band.
8	Noise AGC Sen	I	Noise sensitivity setting pin for setting up the medium field(about 50 dBμ)
9	AGC ADJ	I	The AGC Dynamic Range adjustment pin for 20 to 30dBμ
10	AM 2nd OSC	O	Oscillator circuit for AM 2nd Mixer
11	Memory	I/O	Memory circuit for noise canceller operation.
12	Memory	I/O	
13	Pilot IN	I	The PLL circuit MPX signal input pin.
14	GND	I/O	Ground for the N.C., MPX, and MRC circuits.
15	MPX OUT (L)	O	MPX output
16	MPX OUT (R)	O	
17	Pilot OUT	O	Output pin for the pilot canceller signal. The resistor and capacitor between pin17 and pin18 need to be adjusted with the sample-to-sample variations.
18	Pilot OUT	O	
19	Sep ADJ	I	The input level of subdecoder is varied through the resistor and capacitor outside. (The output level of MONO and MAIN remain unchanged)
20	VCO	I/O	Attach a 912KHz crystal oscillator outside.
21	PHASE COMP.	I/O	Pilot phase detector
22	PHASE COMP.	I/O	Pilot phase detector
23	IF Counter SK/ST SW	I/O	In seek mode, pin23 is FM/AM IF counter buffer. Also, pin23 functions as switch: In FM mode: Pin23 = 5V: Seek mode Pin23 = 2.5V: Forced SD mode Pin23 = 0 V: Reception mode In AM mode: Pin23 = 5 V: Seek mode Pin23 = 0 V: Reception mode

Pin No.	Pin Name	I/O	Descriptions
24	AM/FM SM	O	AM/FM S-meter voltage output
25	GND	I/O	Ground for FMIF and AM
26	Stereo IND	O	In FM mode: Pin23 = 5V: pin26 operates linked to the IF counter buffer. Pin23 = 2.5V: pin26 operates as the SD pin. Pin23 = 0 V: pin26 operates as stereo indicator. In AM mode: Pin23 = 5 V: pin 26 operates as the seek SD pin. Pin23 = 0 V: pin26 is not used.
27	MRC	O	The MRC detector time constant for Multipath-Noise Detector. The time is determined by a 100Ω resistors and capacitor.
28	SNC	I	With the pin28 input voltage, the attenuation of (L-R) decode is controlled, such as decrease sepatation and reduce the noise felt in the stereo mode.
29	HCC	I	The pin29 can be controlled by the MRC output. The pin29 can also be controlled with the pin 32 , using an external resistors at least 100 kΩ. At weak input, high pass is cut to reduce the noise feeling.
30	Noise Cancel	I	Noise canceller input. The input impedance is 50 kΩ.
31	AM/FM Det	O	AM and FM detector output. Output impedance Low impedance in the FM mode and 10 kΩ in the AM mode
32	IF S-meter and MRC	O	Pin32 is for NC noise extraction and for multipath noise extraction. Attenuate the MRC AC input by adjust the resistor outside. In AM mode, pin 32 outputs a 1-mA current. Thus the HCC circuit is turned off.
33	Mute Driver	O	The muting time constant is determined as follows by CR: Attack time: TA = 10 kΩ * C1 Release time: TR = 50 kΩ* C1 Noise convergence adjustment Muting off function MUTE is turned OFF when pin 33 is shorted circuited through a 4-kΩ resistor with GND.
34	AGC	I/O	A resistor R should be connected between pin34 and pin37; R determines the bandwidth of the muting function. Narrows the band by increasing the value of R. Widens the band by reducing the value of R.
35	QD OUT	O	Detector output
36	QD IN	I	Detector input

Pin No.	Pin Name	I/O	Descriptions
37	VREF	O	V37 = 4.9V
38	SD ADJ	I/O	The SD comparison voltage is determined with the external resistance R and the current flow at pin 38.
39	Key AGC AM Buffer	I/O	When the voltage of V24*0.36 becomes lower than the voltage determined by the resistor between pin 39 and ground, the keyed AGC is turned on. The pin39 is also used as the AM stereo IF buffer pin.
40	VCC	I/O	VCC for FMIF and AM NC MPX
41	HCC Cap	O	With pin 41 external capacitor High-Cut frequency characteristics are set.
42	AM L.C.	I/O	Frequency characteristics of unnecessary voice band of 100Hz or less is changed to produce the clear sound in the AM mode. Note: The LC capacitor must be connected between the pin42 and VCC This is because the detector circuit operates referenced to VCC. AM LC f characteristic: fC = 1/2π*50 k Ω* C
43	Pilot Det	O	Inserting a 1-MΩ resistor between pin 43 and VCC causes the forced mono mode.
44	IF AGC	O	Time constant changeover at Seek switch. • Reception Time constant depends on the external capacitor of pin 44: C44*300kΩ • Seek Time constant is: C44*10Ω
45	IF OUT	O	The IF amplifier load
46	AM ANT D WB-AGC	O	I46 = 6mA (maximum) An antenna damping current for AM pin diode drive output
47	Mute ADJ	I	Muting on level can be changed by modify the value of the external resistor
48	AGC Bypass	O	RF AGC rectifier capacitor。 Determination of the distortion radio during low-frequency modulation: Increasing C48 and C57 : Distortion→improved Response→slow Reducing C48 and C57 : Distortion→worse Response→quick
57	RF AGC	O	
50	IF Bypass	I	Choose IF bypass capacitor to GND to prevent the limiter AMP from osillation
51	FM IF IN	I	FM 10.7M AMP input

Pin No.	Pin Name	I/O	Descriptions
52	AM IF IN	I	AM 450kHz AMP input input impedance=2 kΩ.
53	AM/FM IF OUT	O	AM/FM 10.7M first IF AMP output. Output impedance=330Ω V53=5.3V
56	AM/FM IF IN	I	AM/FM 10.7M first IF AMP input Input impedance = 330Ω V56=2.0V
54	Mixer OUT	O	AM 2nd Mixer OUT (The coil of pin 54 must be connected to the pin40)
49	Mixer IN	I	AM 2nd Mixer IN (The pin 49 mixer input impedance is 330Ω)
55	W-AGC SD ADJ	I/O	Include built-in DC cut capacitors. Determination of the AGC on level is by the values of the capacitors attached to this pin In AM mode, pin55 is SD sensitivity adjustment pin by comparing V55 with the S-meter voltage V55 = R55*50uA
58	N-AGC Mute ADJ	I/O	Include built-in DC cut capacitors. Determination of the AGC on level is by the values of the capacitors attached to this pin
59，60	Mixer OUT	O	AM/FM 1st mixer output
61	F.E.VCC	I/O	VCC for front end
62	1st MIX IN	I	AM first mixer input The input impedance=10 kΩ.
63，64	Mixer IN	I	AM/FM 1st mixer input. This is an emitter insertion type input circuit, and the amount of insertion is determined by the capacitors C63 and C64. (The lines for pins 63 and 64 must be kept separated from the lines for pins 59 and 60)

FUNCTION DESCRIPTION

1. FM Front End

Oscillator

Figure 1 shows the type of oscillator circuit used in this IC.

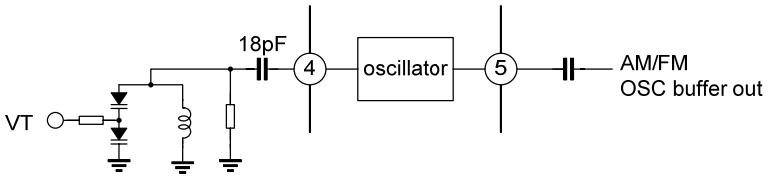


Figure 1

Figure 2 shows the type of FM first IF amplifier used in this IC.

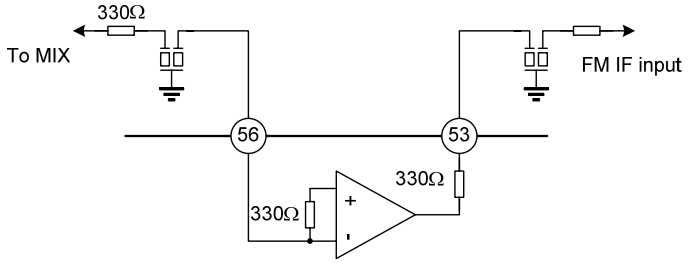


Figure 2

- ✧ Input impedance: 330 Ω
- ✧ Output impedance: 330Ω
- ✧ Gain: 20 dB

2. FM IF

Figure 3 shows an overview of the FM SD and the IF count buffer.

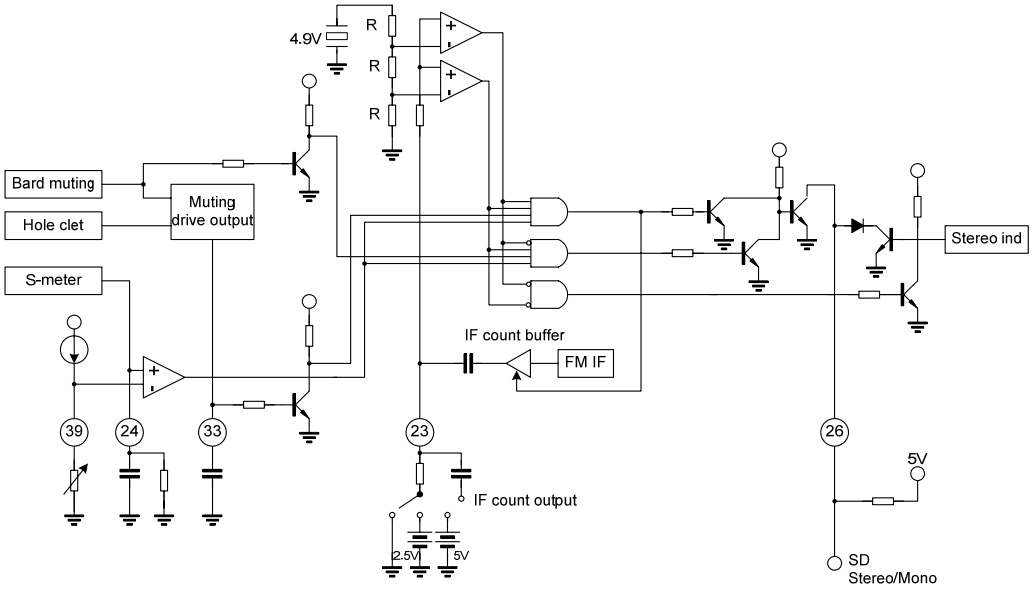


Figure 3

Figure 4 shows the relationship between the FM SD, the IF count buffer output, the S-meter, and the muting drive output.

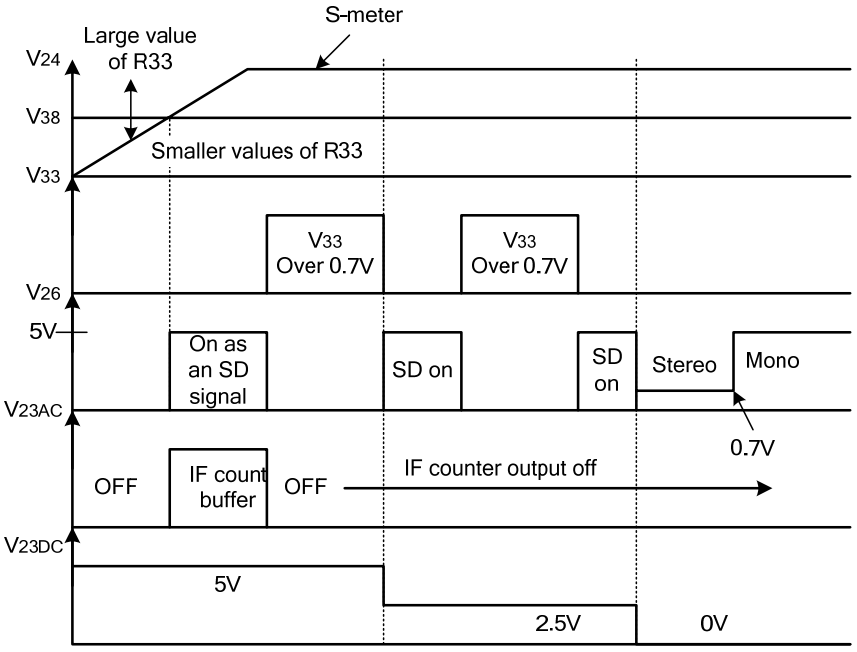


Figure 4

3. AM

SD and the IF buffer are operated by comparing the S-meter level (V24) and the 5 V reference voltage as shown in figure 5.

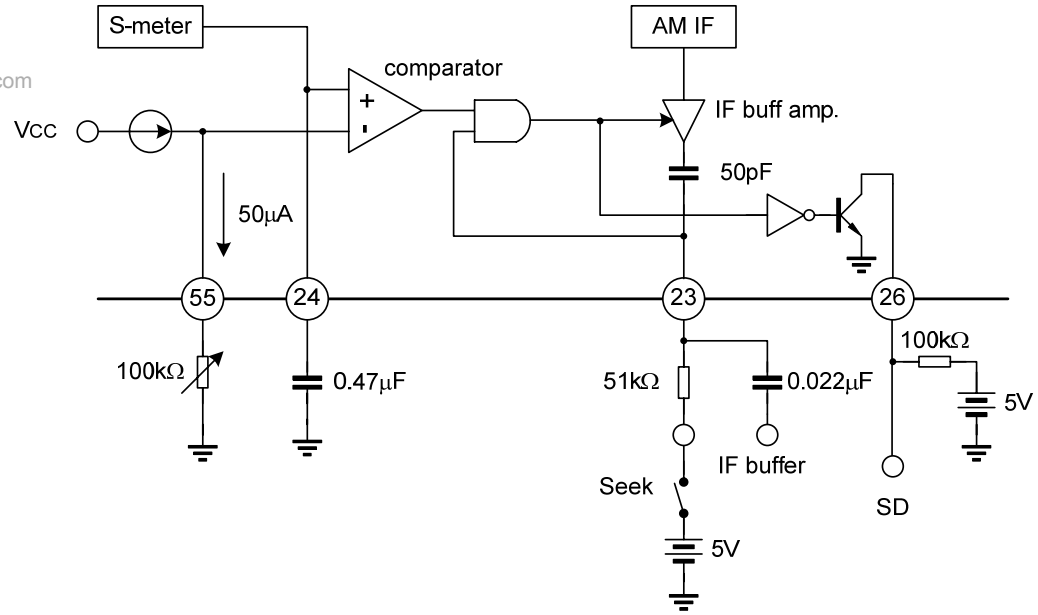


Figure 5

Figure 6 shows the relationship between the AM SD, the IF count buffer, and the S-meter.

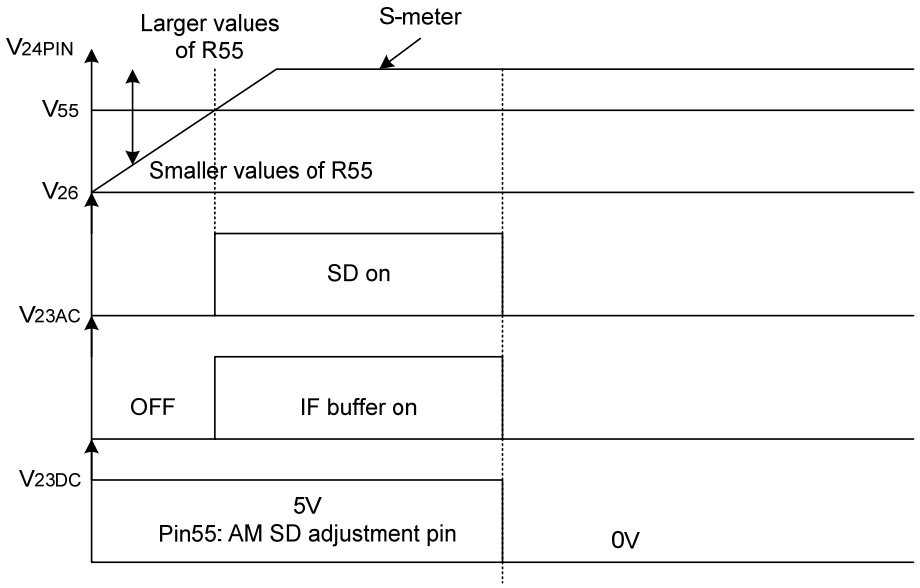


Figure 6

AM high band cut and detector output level adjustment methods

Figure 7, the pin 31 AM and FM tuner output has an impedance of 10 kΩ in AM mode and a few tens of Ohms in FM mode. Therefore, R31 is used to lower the AM detector output level and C31 determines the AM high band frequency characteristics.

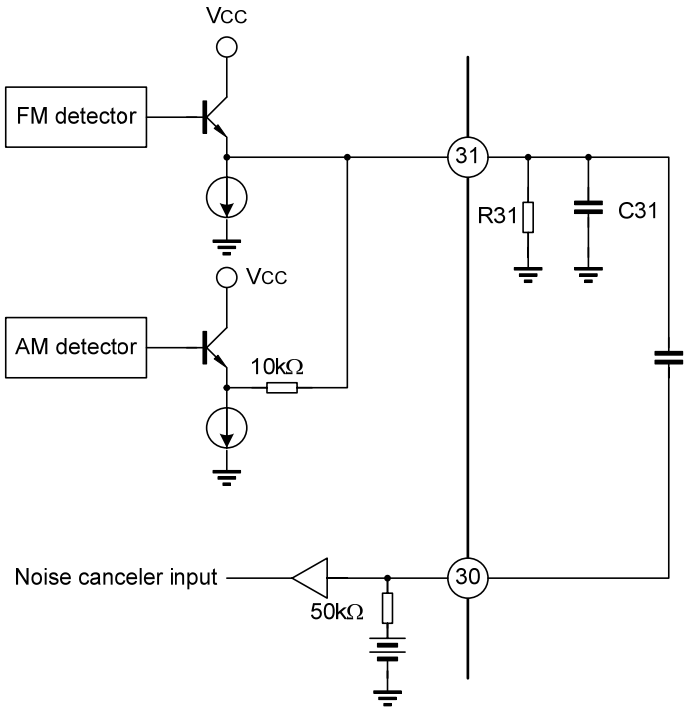


Figure 7

AM stereo system pins is shown in Figure 8

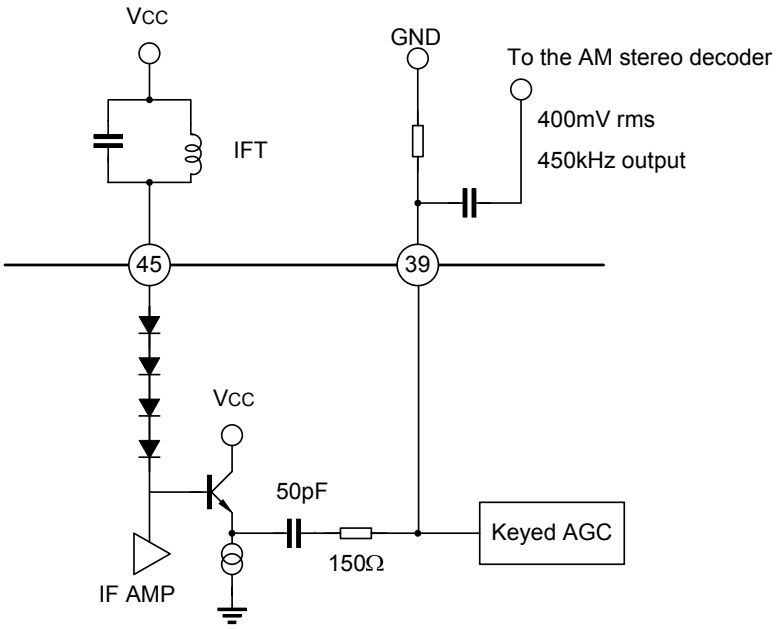


Figure 8

AM low band cut adjustment method

The AM low band frequency characteristics can be adjusted with C42, which is inserted between pin 42 and Vcc. Since the detector is designed with Vcc as the reference, C42 must be connected to Vcc, shown in figure 9.

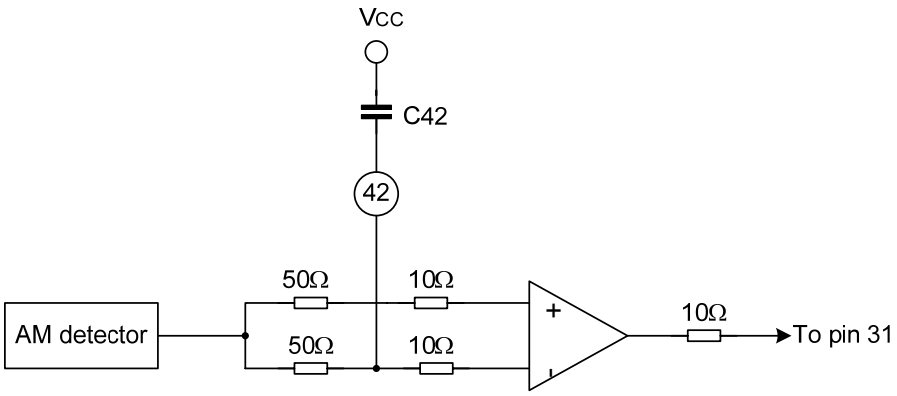


Figure 9

Pilot canceller adjustment (pins 17 and 18)

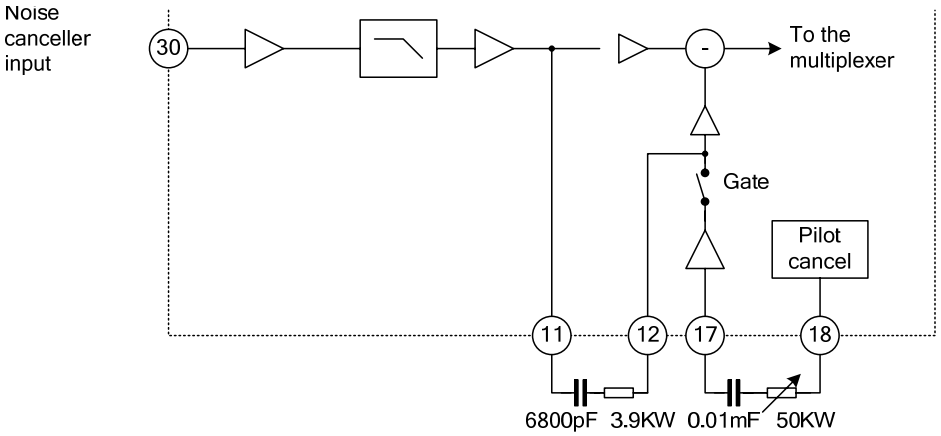


Figure 10

The pilot canceller signal waveform (pin 19) is a 19 kHz signal that not contains third harmonic as shown in figure 10. Since this signal has the same phase as the pilot signal, no capacitor is required between pin 18 and ground. Since it has no third harmonic component, excellent pilot cancellation can be acquired in both the left and right channels by adjusting with a variable resistor.

Separation adjustment (pin 19)

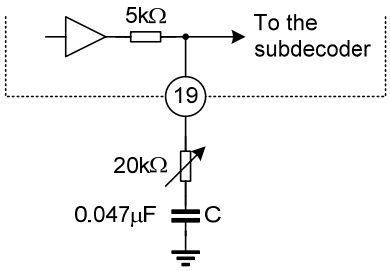


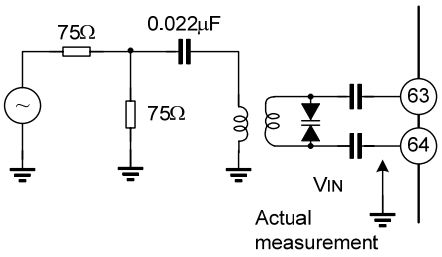
Figure 11

The separation is adjusted by modifying the input level to the subdecoder with the variable resistor connected to pin 19. Since only the sub-modulation level is changed by changing the variable resistor setting, the monaural (main) output level is not changed. Furthermore, degradation of high band separation in the decoder can be avoided if the impedance of the external capacitor (C) in the subchannel frequency band (23 to 53 kHz) is made sufficiently smaller than the variable resistor.

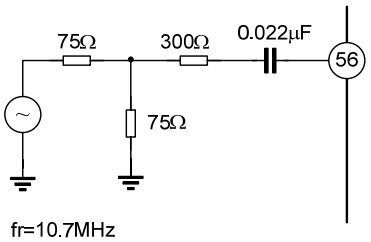
INPUT CIRCUITS FOR EACH STAGE

FM

Mixer input

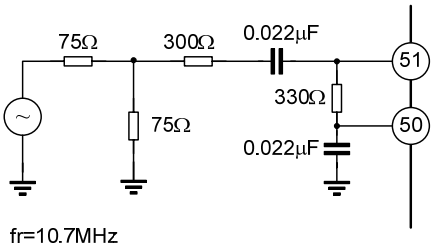


First IF input



fr=10.7MHz

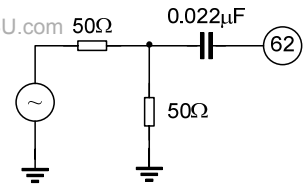
IF input



fr=10.7MHz

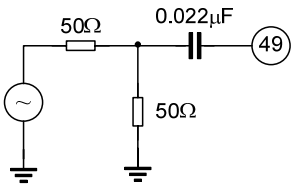
AM

First mixer input



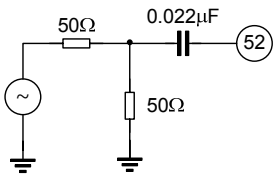
fr=RF

Second mixer input



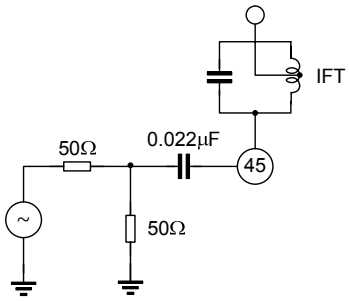
fr=10.71MHz(f2nd osc+0.45MHz)

IF input



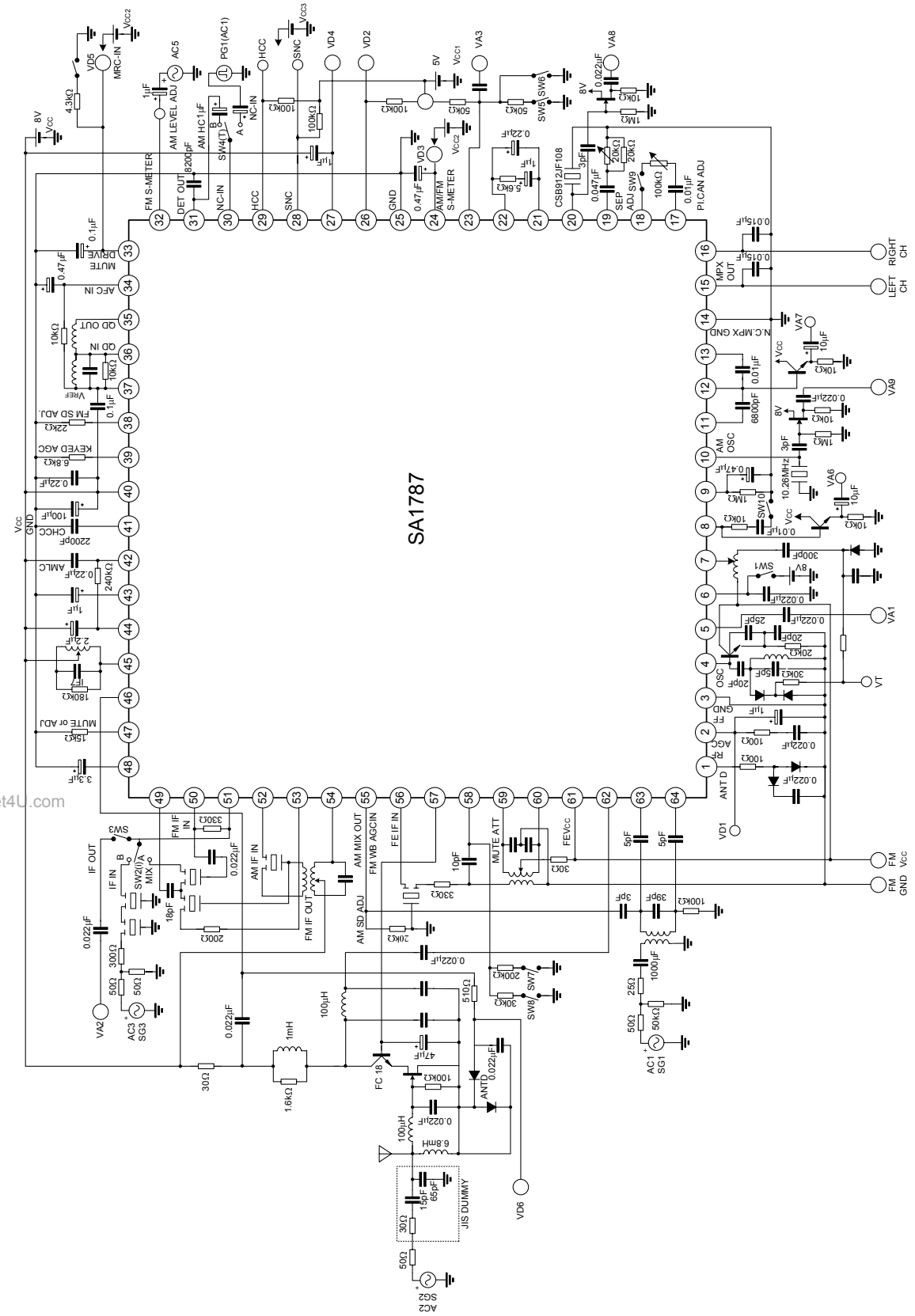
fr=450kHz

Del input

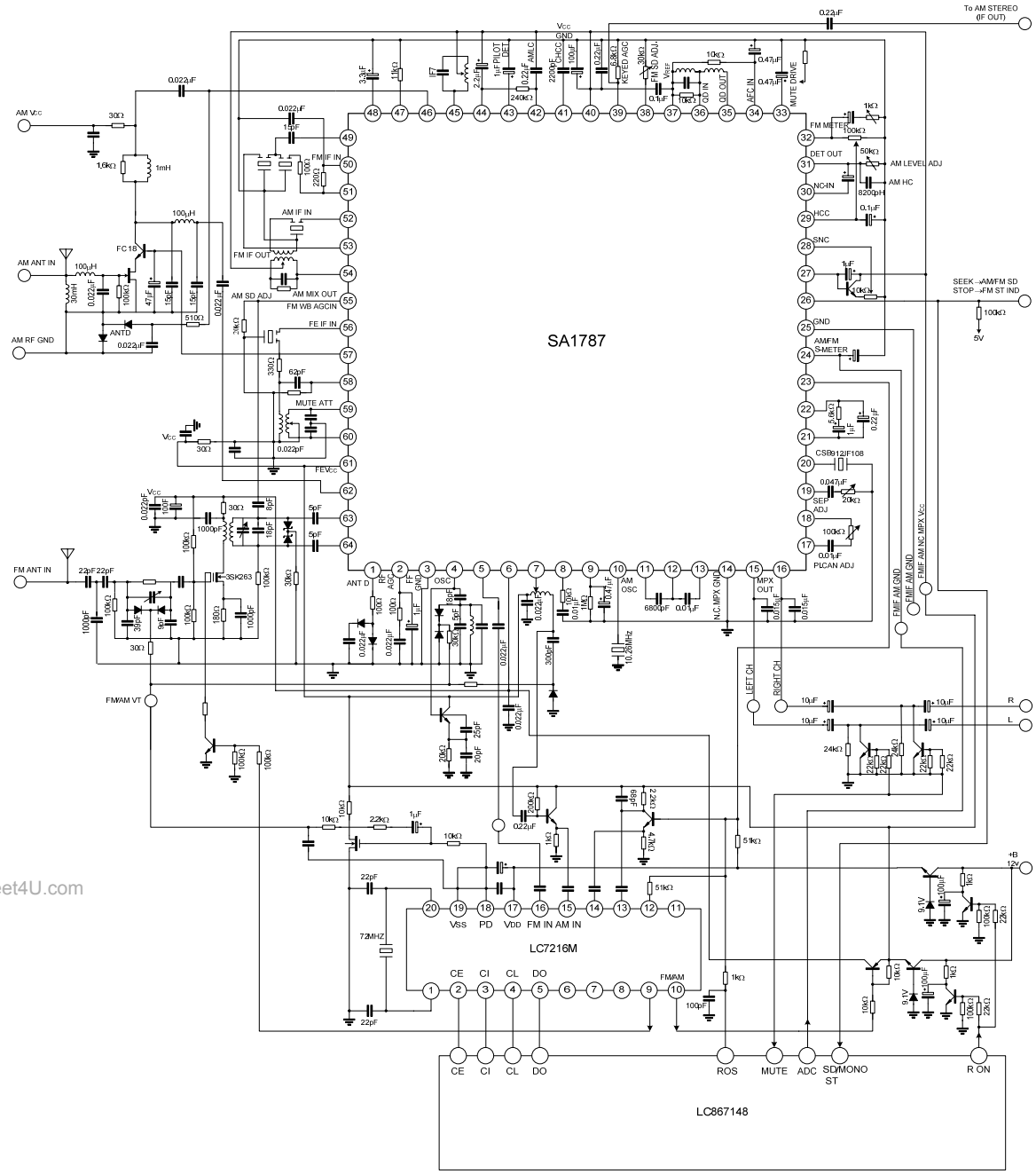


fr=450kHz

TEST CIRCUIT

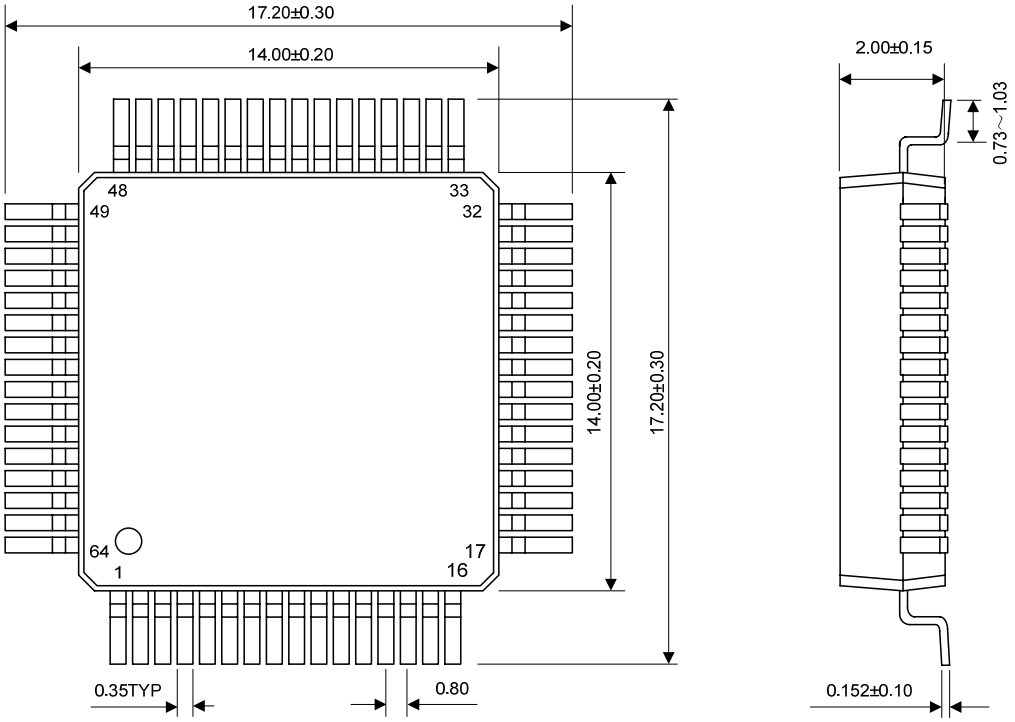


TYPICAL APPLICATION CIRCUIT



PACKAGE OUTLINE

QFP-64-14x14-0.8 UNIT: mm



Note: Silan reserves the right to make changes without notice in this specification for the improvement of the design and performance. Silan will supply the best possible product for customers.