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SANYO Semiconductors

DATA SHEET



LV25700PM

Bi-CMOS IC

For Car Radio

Single chip Tuner IC

Overview

The LV25700PM is a tuner IC for car radio, which incorporates an AM/FM Tuner, PLL, AM/FM Noise Canceller (NC), FM Stereo-decoder (MPX), Multipath-noise Rejection Circuit (MRC), and RDS Demodulator Logic-controller. The basic performance is based on the LV25210, and both adjustment-free operation and software control of the IF band variable filter are possible.

This IC enables easy configuration of a low-cost, high performance analog tuner for OEM.

Functions

- AM/FM + FE + PLL + IF + NC + MPX + MRC + RDS Demodulator + Logic-controller

Features

- World-wide compatible tuners
World-wide compatible tuners can be configured and supplied with a single tuner IC.
FM is compatible with U.S., European, Japanese and Weather bands, while AM is compatible with LW, MW and SW.
High performance image cancel mixer incorporated in FM MIX.
PLL fast locking, RDS demodulator and AM/FM noise canceller incorporated
- Self-contained type IF band variable filter incorporated
Detects any neighboring interfering FM stations and the modulation index, and enables various bandwidth settings of the IF bandpass filter by using the software incorporated in the IC.

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- Auto alignment EEPROM not necessary. It is incorporated inside the IC
FM RF, VCO, Null-voltage, Mute-on, Mute-ATT, SNC, HCC, Separation, S-meter, AM/FM AGC sensitivity, AM/FM IF gain, SD sensitivity, I²C bus compatible
* This IC can be supplied in the adjusted state. Some adjustments are necessary depending on the specifications and external components.
- Other functions
Neighboring interference (Quality Out) RDS AF-search support
I²C communication bus

Specifications

Absolute Maximum Ratings at Ta = 25°C, GND = 0V

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V _{CC_H} max		8.7	V
	V _{CC_L} max		5.7	V
	V _{DD} max		6.5	V
	V _{DDBUS} max		6.5	V
Maximum input current	V _{IN} max		6.5	V
Maximum output current	V _O max		6.5	V
Allowable power dissipation	Pd max	(Ta ≤ 85°C)	1040	mW
Operating temperature	Topr		-40 to +85	°C
Storage temperature	Tstg		-40 to +150	°C

Recommended Operating Conditions at Ta = 25°C, GND = 0V

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V _{CC_H}	PIN 1, 2, 15, 68, 80	8.0	V
	V _{CC_L}	PIN 53, 74	5.0	V
	V _{DD}	PIN 35	5.0	V
	V _{DDBUS}	PIN 34	5.0	V

Recommended Operating Conditions at Ta = 25°C, GND = 0V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Operating supply voltage range	V _{DD}	PIN 35	4.5	5.0	5.5	V
	V _{DDBUS}	PIN 34 (*1)	3.0	5.0	5.5	V
	V _{COP_H}	PIN 1, 2, 15, 68, 80	7.5	8.0	8.5	V
	V _{COP_L}	PIN 53, 74	4.5	5.0	5.5	V
Logic operation, memory hold voltage range	V _{DDLOGIC}	PIN 35	3.5		5.5	V
Internal supply	V _{REG}	PIN 36 V _{DDLOGIC} > 3.5V (*2)		3.0		V
Input High level voltage	V _{IH}	PIN 31, 32, 33	0.8V _{DDBUS}		V _{DDBUS}	V
Input Low level voltage	V _{IL}	PIN 31, 32, 33	0		0.2V _{DDBUS}	V
Input amplitude voltage	V _{IN}	PIN 39	0.5		1.5	Vrms
Input frequencies	F _{IN}	PIN 39		20.5		MHz
Input High level current	I _{IH} (1)	PIN 39, V _I = V _{DD} = 5.0V	2.0	5.0	15.0	μA
	I _{IH} (2)	PIN 31, 32, 33 V _I = V _{DD} = V _{DDBUS} = 5.0V			3.0	μA
Input Low level voltage	I _{IL} (1)	PIN 39, V _I = V _{DD} = V _{SS}	2.0	5.0	15.0	μA
	I _{IL} (2)	V _I = V _{SS}			3.0	μA
Hysteresis width	V _H	PIN 31, 32, 33	0.1V _{DDBUS}	0.2V _{DDBUS}		V
Output High level voltage	V _{OH} (1)	PIN 26, 27, 28, 29, 30 I _O = -1mA, V _{DD} = V _{DDBUS}	V _{DD} -1.0			V
	V _{OH} (2)	PIN 38 I _O = -200μA, V _{DD} = V _{DDBUS}	V _{REG} -1.0			V
	V _{OH} (3)	PIN 21, 22 I _O = -500μA, V _{DD} = V _{DDBUS}	V _{DD} -1.0			V

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Output Low level voltage	V _{OL} (1)	PIN 26, 27, 28, 29, 30 I _O = -1mA, V _{DD} = V _{DDBUS}			1.0	V
	V _{OL} (2)	PIN 38 I _O = -200μA, V _{DD} = V _{DDBUS}			1.0	V
	V _{OL} (3)	PIN 21, 22 I _O = -500μA, V _{DD} = V _{DDBUS}			1.0	V
	V _{OL} (4)	PIN 31, 32 I _O = -5mA, V _{DD} = V _{DDBUS}			1.0	V
Output off leak current	I _{off} (1)	PIN 26, 27, 28, 29, 30, 31, 32	-3		+3	μA
	I _{off} (2)	PIN 21, 22	-100		+100	nA
RESET application time at power on.	t _{POR}	PIN 33	50			ms
RESET application time at instantaneous power failure.	t _{PDR}	PIN 33	50			ms
Oscillation stabilization time after RESET input is completed	t _{CKR}	PIN 36 (*2)	80			ms

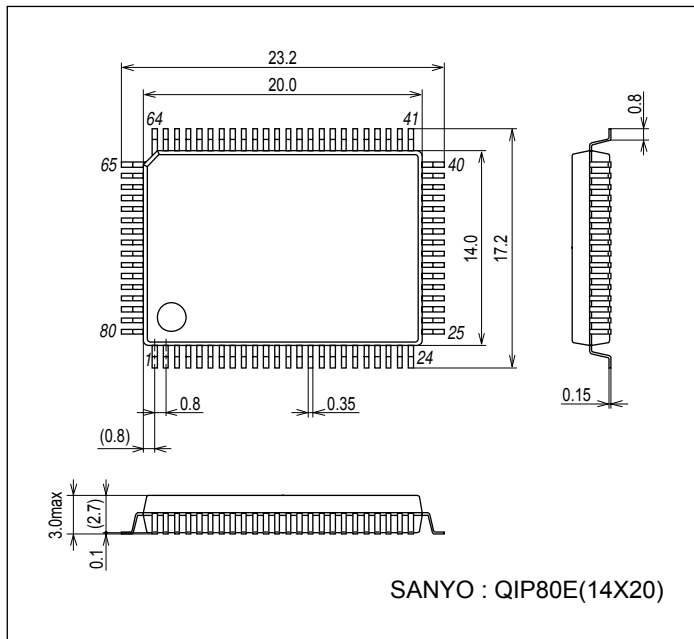
(*1): Use with V_{DD} < V_{DDBUS} is prohibited.

(*2): External access to LV25700, other than RESET or power supply, that results in V_{REG} = V_{DDLOGIC} during RESET application and until XIN oscillation stabilizes (t_{CKR}), should wait until the t_{CKR} time elapses after RESET is released.

Package Dimensions

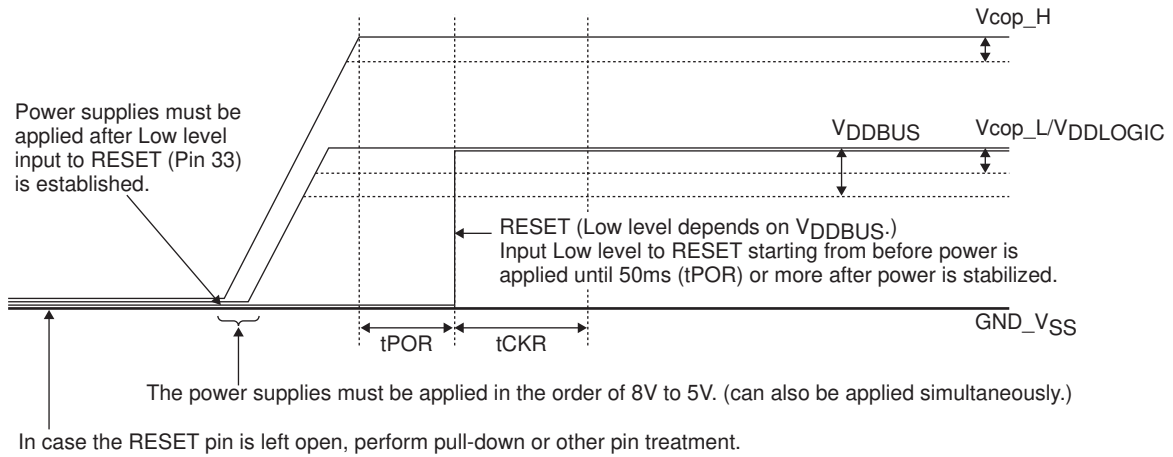
unit : mm (typ)

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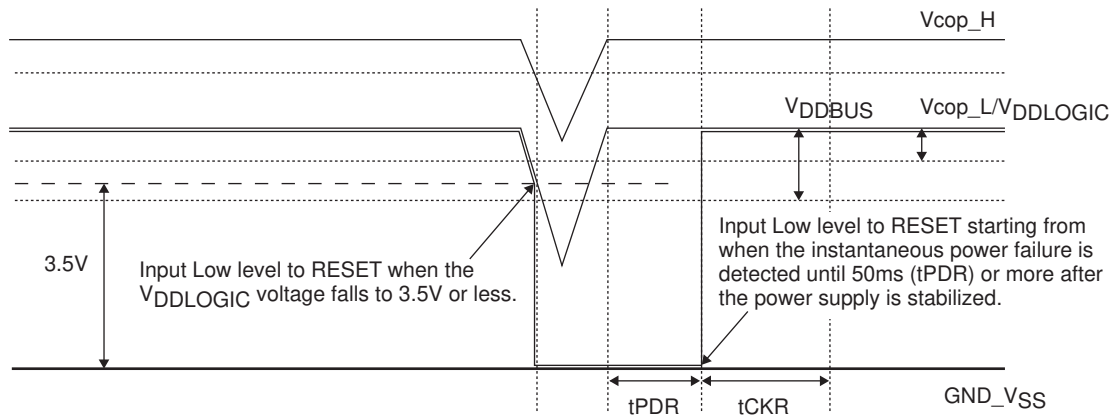


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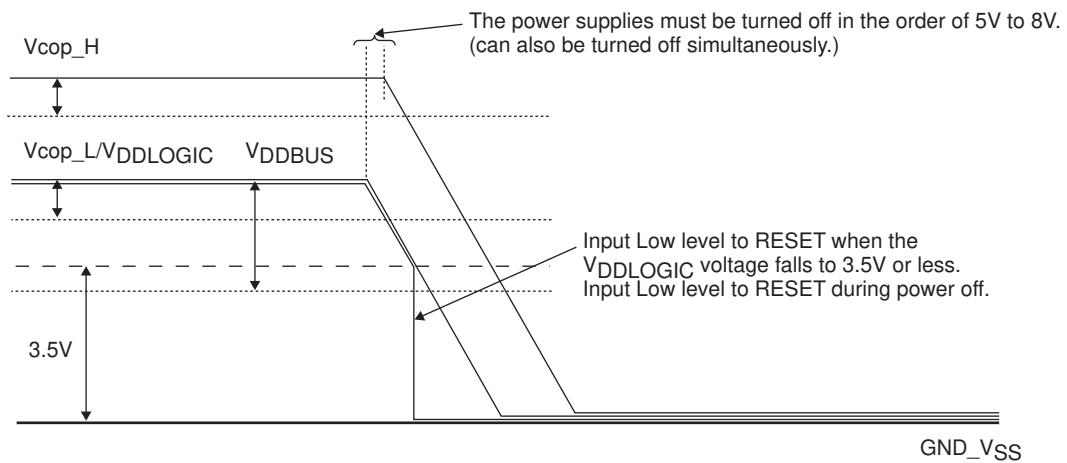
Reset Timing at Power-ON



Reset Timing at Instantaneous Power Failure



Reset Timing at Power-OFF



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AC Characteristics

Operating Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 8.0\text{V}$, $V_{DD} = 5.0\text{V}$, unless otherwise specified. Ratings for publications

* : These measurements are made using the Yamaichi Electronics IC51-0804-819-2 IC socket. An IHF bandpass filter is used as the audio filter.

[FM Characteristics] FM Front End Mixer Input

Parameter	Symbol	Conditions	min	typ	max	Unit
Current drain-8V	$I_{CCO}F-8V$	No input, FM mode I1+I2+I15+I68+I80	60	73	85	mA
Current drain-5V	$I_{CCO}F-5V$	No input, FM mode I35+I53+I74	37	45	52	mA
Demodulation output	V_{O-FM_1}	98.1MHz, 60dB μ V, 1kHz, 100%mod, pin 49	400	550	700	mVrms
Detection output	V_{O-FM_2}	98.1MHz, 60dB μ V, 1kHz, 100%mod, pin 60	280	380	480	mVrms
Channel balance	CB	98.1MHz, 60dB μ V, 1kHz, pins 49 and 50	-1	0	1	dB
Total harmonic distortion	THD-Fm mono (1)	98.1MHz, 60dB μ V, 1kHz, 100%mod, pin 49		0.2	1	%
Total harmonic distortion	THD-Fm mono (2)	98.1MHz, 60dB μ V, 1kHz, 150%mod, pin 49		0.3	2.5	%
Signal to noise ratio (MONO)	S/N-FM-MONO	98.1MHz, 60dB μ V, 1kHz, 100%mod, pin 49	60	70		dB
Signal to noise ratio (ST)	S/N-FM-ST	98.1MHz, 60dB μ V, 1kHz, 100%mod, pin 49, L+R = 90%, pilot = 10%	58	65		dB
AM suppression ratio	AMR	98.1MHz, 60dB μ V, 1kHz, 100%mod, 30% in AM mode, fm = 400Hz, pin 49	58	67		dB
Muting attenuation (1)	Att-1	98.1MHz, 60dB μ V, 1kHz, with V64 = 0→2V, pin 49 attenuation (Mute ATT SW = 0)	-30	-25	-20	dB
Muting attenuation (2)	Att-2	98.1MHz, 60dB μ V, 1kHz, with V64 = 0→2V, pin 49 attenuation (Mute ATT SW = 2)	-23	-18	-13	dB
Muting attenuation (3)	Att-3	98.1MHz, 60dB μ V, 1kHz, with V64 = 0→1V, pin 49 attenuation (Mute ATT SW = 2)	-11	-6	-1	dB
Separation	Separation	98.1MHz, 60dB μ V, mod = 100%, pilot = 10%, pin 49 output ratio Separation control adj	27	43		dB
Stereo ON level	ST-ON	Pilot demodulation at which V27 < 0.5V is established	1.5	3.8	5.5	%
Stereo OFF level	ST-OFF	Pilot demodulation at which V27 < 3.0V is established	1.2	3.2		%
Main distortion factor	THD-Main L	98.1MHz, 60dB μ V, L+R = 90%, pilot = 10%, pin 49		0.5	1.2	%
SNC output attenuation	AttSNC	98.1MHz, 40dB μ V, L-R = 90%, pilot = 10%, pin 49 (L→R)	5	10	15	dB
HCC output attenuation	FM HCC	98.1MHz, 60dB μ V, 10kHz, modulation = 30% reference, input level at which the output is down by -3dB	24	30	36	dB μ V
Input limiting voltage	Vi-lim	98.1MHz, 60dB μ V, 30%mod, MIX input at which the input reference output is down by -3dB, V42 = 0V, V29 = 0V, with MUTE = OFF	-6	-1	4	dB μ V
Muting sensitivity	Vi-mute	MIX input level at V64 = 0.7V, non-mod	0.1	5	9.9	dB μ V
SD sensitivity	SD-senFM	MIX input level at which SD pin is ON, shifter- adj, non-mod	20	25	30	dB μ V
IF count sensitivity	IF-count-sens. FM	IF count sensitivity at MIX input, non-mod			20	dB μ V

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Parameter	Symbol	Conditions	min	typ	max	Unit
S-meter DC output	VSMFM-1	No input, pin 44 DC output non-mod			0.5	V
	VSMFM-2	10dB μ V, pin 44 DC output non-mod		0.85		V
	VSMFM-3	30dB μ V, pin 44 DC output non-mod, S-meter shift-adj	1.8	1.85	1.9	V
	VSMFM-4	50dB μ V, pin 44 DC output non-mod		3.0		V
	VSMFM-5	80dB μ V, pin 44 DC output non-mod			4.5	V
S-meter AC pin DC output	VSMFM-A1	No input, pin 57 DC output non-mod			0.45	V
	VSMFM-A2	10dB μ V, pin 57 DC output non-mod		0.63		V
	VSMFM-A3	30dB μ V, pin 57 DC output non-mod	1.15	1.45	1.75	V
	VSMFM-A4	50dB μ V, pin 57 DC output non-mod		2.45		V
	VSMFM-A5	80dB μ V, pin 57 DC output non-mod			4.5	V
S-meter inclination standard - 1	S-curve1	Which was obtained by deducting (VSMFM-2) from VSM (VSMFM-3)	0.85	1.0	1.4	V
S-meter inclination standard - 2	S-curve2	Which was obtained by deducting (VSMFM-3) from VSM (VSMFM-4)	0.8	1.15	1.5	V
Mute drive output	VMUTE-60	60dB μ V, pin 64 output DC output non-mod		0.15	0.3	V
Noise convergence - 1	FM NOISE-20	60dB μ V.98.1MHz, 30%mod, input reference, output level of the input -20dB μ V, MUTE = OFF (42pin = GND)	-12	-7	-3	dB
N-AGC ON input	VNAGC	98.1MHz, non-mod, MIX input level at which pin 13 becomes 0.6V or more	64	69	74	dB μ V
W-AGC ON input	VWAGC	98.1MHz, non-mod, pin 44 = 0V applied (Keyed on), MIX input level at which pin 13 becomes 0.6V or more	80	88	96	dB μ
Image obstruction ratio	IRR	Removal amount of 108.1M +21.4MHz (when IRR-DAC is used)	40			dB
SD bandwidth	BW-mute	98.1MHz, non-mod, 60dB μ V, Bandwidth at which SD pin is turned ON	70	100	130	kHz
Conversion gain (MIX+1 st IF AMP)	A.V.	98.1MHz, 60dB μ V, non-mod, FECF output	93	97	101	dB μ V

[FM IF Filter characteristics] FM IF input

Parameter	Symbol	Conditions	min	typ	max	Unit
IF variable filter gain	FIL-Gain	10.7MHz, non-mod, 70dB μ V, pin 44-S-meter voltage (FILTER TEST MODE). Narrow-Fix		1.9		V
IF variable filter narrow-band characteristics	FIL-BW-N	10.7MHz \pm 30kHz, non-mod, 70dB μ Pin 44 S-meter voltage (Filter test mode). Narrow-Fix mode. Difference from Pin 44 voltage at 10.7 MHz		0.3		V
IF variable filter wide-band characteristics	FIL-BW-W	10.7MHz \pm 80kHz, non-mod, 70dB μ Pin 44 S-meter voltage (Filter test mode). Wide-Fix mode. Difference from Pin 44 voltage at 10.7 MHz			0.5	V

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[NC block] NC input (pin 59), S-meter AC input (pin 57)

Parameter	Symbol	Conditions	min	typ	max	Unit
FM NC gate time	FM τ GATE	NC input, pulse cycle = 1kHz, 44pin = 2V applied, pulse width = 1 μ s, at 200mVp-o pulse input (after MPX-VCO adjustment), measurement at pin 24.	36	40	44	μ s
FM NC noise sensitivity	SN-DETOUT	NC input (pin 59), 44pin = 2V applied, measure the pulse input level at which the noise canceller starts operation, pulse cycle = 1kHz, pulse width = 1 μ s	95	130	165	mVp-o
FM NC noise sensitivity	SN-Vsm	S-meter (AC) input (pin 57), 44pin = 0V applied, measure the pulse input level at which the noise canceller starts operation, pulse cycle = 1kHz, pulse width = 1 μ s		90		mVp-o
AM NC gate time	AM τ GATE (1)	S-meter (AC) input (pin 57), pulse cycle = 1kHz, pulse width = 1 μ s, measurement at pin 24. 44pin = 1.5V	270	390	510	μ s
AM NC noise sensitivity	SN	S-meter (AC) input (pin 57), measure the pulse input level at which the noise canceller starts operation, pulse cycle=1kHz, pulse width=1 μ s		220		mVp-o

[Multipath-noise rejection circuit] MRC input (pin 58)

Parameter	Symbol	Conditions	min	typ	max	Unit
MRC output	VMRC	Pin 56 voltage when 3.5 V is applied to V44	2.7	2.95	3.2	V
MRC operation level	MRC-ON	SG (AG5) out level when pin 44 = 3.5V and pin 56 = 2.6V, f = 70kHz	110	155	220	mVrms

[AM characteristics] AM AMANT input

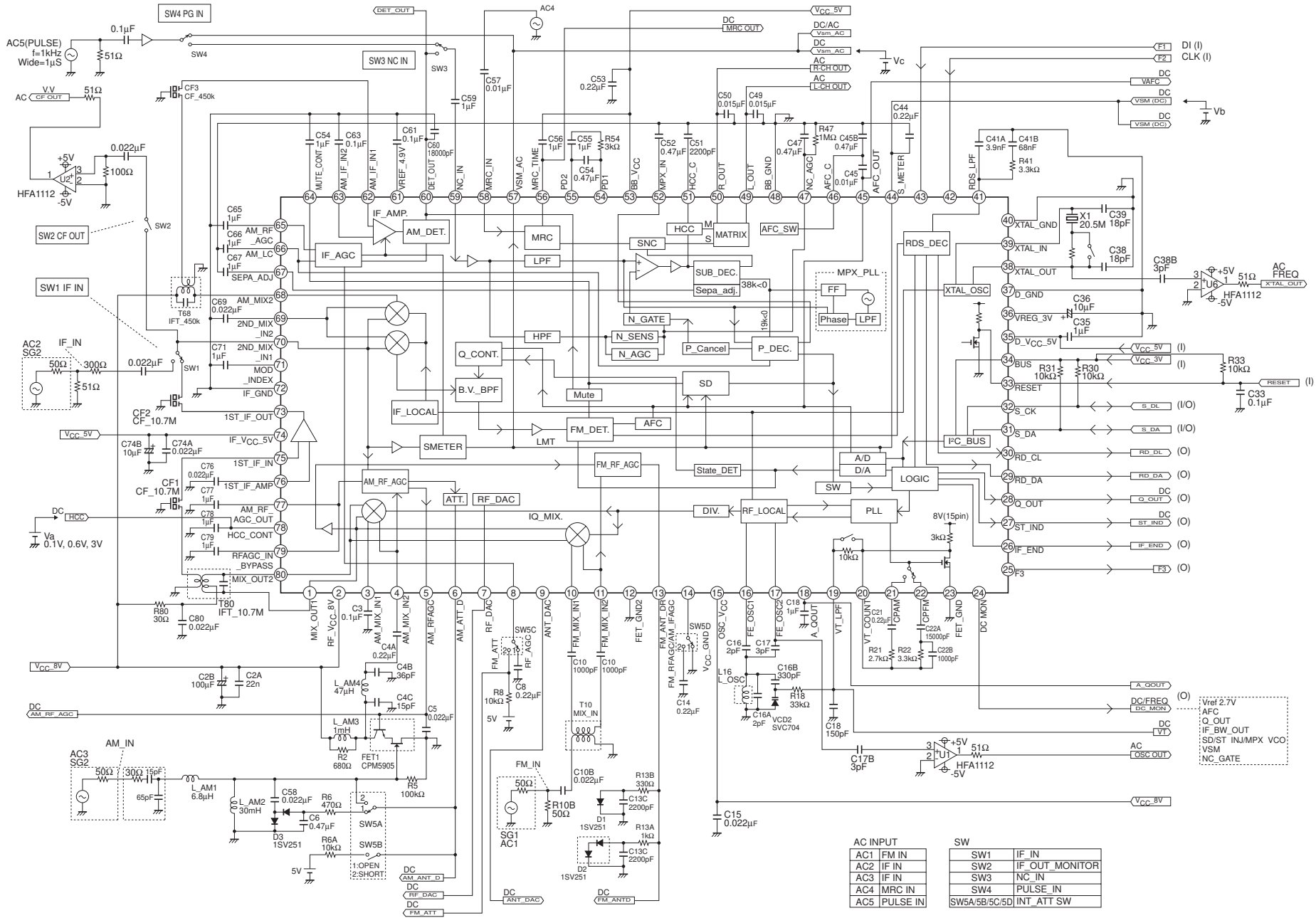
Parameter	Symbol	Conditions	min	typ	max	Unit
Practical sensitivity	S/N-30	1MHz, 30dB μ V, fm = 1kHz, 30%mod, pin 49	20			dB
Detection output	Vo-AM	1MHz, 74dB μ V, fm = 1kHz, 30%mod, pin 49	130	180	250	mVrms
AGC-F.O.M	V AGC-FOM	1MHz, 74dB μ V, output reference, input width at which the output decreases by 10dB, pin 49	52	56	60	dB
Signal-to-noise ratio	S/N-AM	1MHz, 74dB μ V, fm = 1kHz, 30%mod	51	60		dB
Total harmonic distortion ratio - 1	THD-AM-1	1MHz, 74dB μ V, fm = 1kHz, 80%mod		0.3	1	%
Total harmonic distortion ratio - 2	THD-AM-2	1MHz, 120dB μ V, fm = 1kHz, 80%mod		0.5	1.5	%
AM HCC output attenuation	AM HCC	1MHz, 74dB μ V, fm = 3kHz, 30%mod, V78 = 3V \rightarrow 0.6V, 25 pin	-13	-9	-5	dB
S-meter DC output	VSMAMDC-1	No input, 44 pin DC output	0	0.1	0.5	V
	VSMAMDC-2	1MHz, 30dB μ V, non-mod, 44 pin DC output	0.7	1.3	1.9	V
	VSMAMDC-3	1MHz, 120dB μ V, non-mod, 44 pin DC output	2.4	3.0	4.2	V
S-meter AC output	VSMAMAC-1	1MHz, -20dB μ V, fm = 1kHz, 80%mod, 57 pin DC output		0	0.5	mVrms
	VSMAMAC-2	1MHz, 74dB μ V, fm = 1kHz, 80%mod, 57 pin DC output	90	140	180	mVrms
Wide band AGC sensitivity	W-AGC.AM	1.4MHz, input at V6 = 0.7V	86	92	98	dB μ V
SD sensitivity	SD-sen.AM	1MHz, ANT input level at which the SD pin is turned ON	25	30	35	dB μ V
IF count sensitivity	IF-count-sens. AM	IF count sensitivity, 1MHz, non-mod			22	dB μ V

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Pin Function

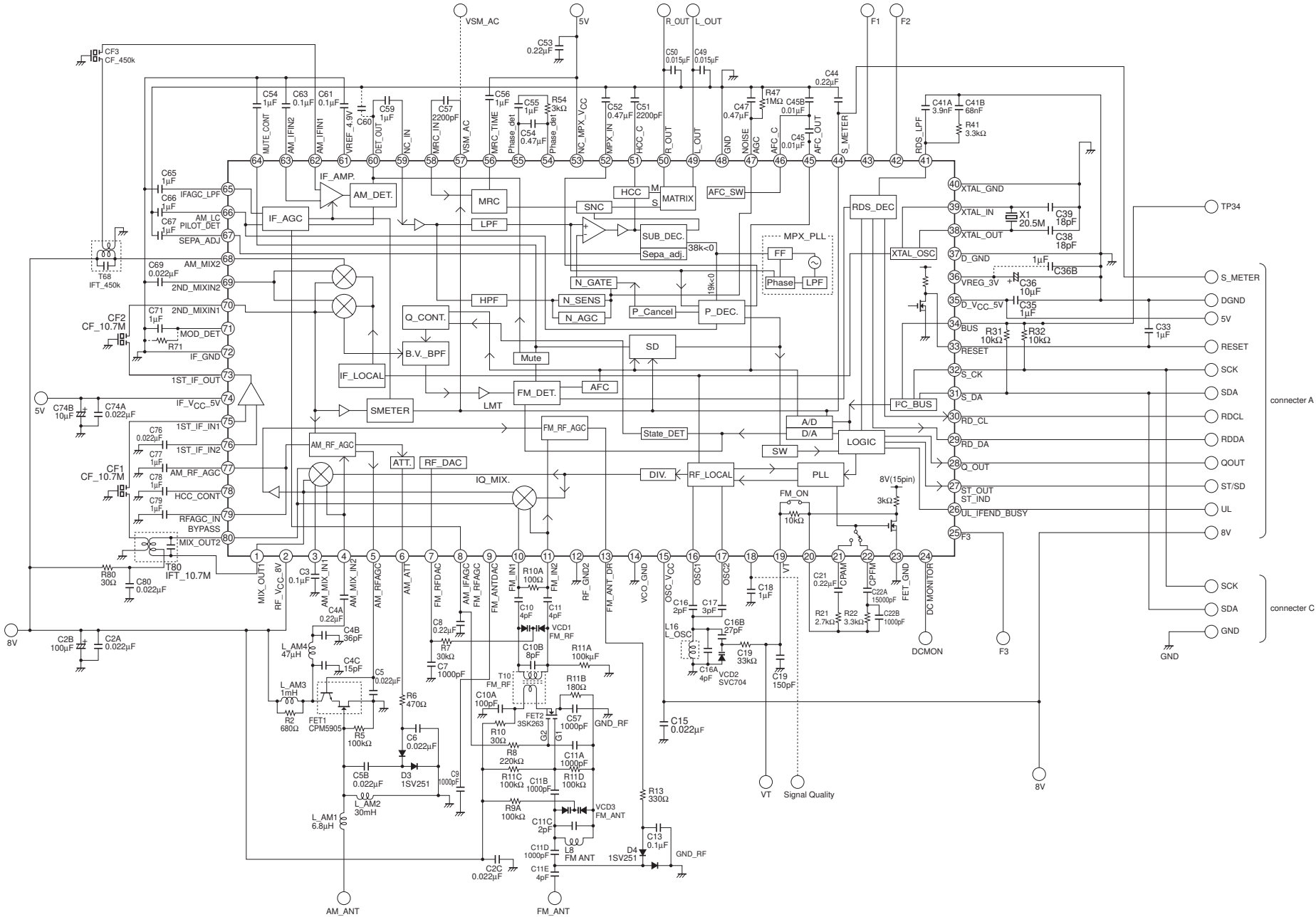
Pin No.	Function name	Block
1	MIX-OUT1	FE
2	RF-V _{CC} _8V	---
3	AM-MIX-IN2	AM
4	AM-MIX-IN1	AM
5	AM-RFAGC	AM
6	AM-ATT	AM
7	FM-RFDAC	FE
8	AM-IFAGC/FM-RFAGC	AM/FM
9	FM-ANTDAC	FE
10	FM-IN1	PLL
11	FM-IN2	PLL
12	RF-GND2	PLL
13	FM-ANT-D	FE
14	VCO-GND	---
15	OSC-V _{CC}	---
16	AM/FM-OSC(B)	FE
17	AM/FM-OSC(C)	FE
18	SIGNAL QUARITY	IF
19	VT	PLL
20	AM/FM FET	PLL
21	CPAM	PLL
22	CPFM	PLL
23	FET GND	PLL
24	DC MONITOR	MPX
25	F3	LOGIC
26	UL/IFEND/BUSY	LOGIC
27	SD_OUT/ST_IND	---
28	Q_OUT	MPX
29	RD_DA	LOGIC
30	RD_CL	LOGIC
31	S_DA	LOGIC
32	S_CK	LOGIC
33	RESET	LOGIC
34	BUS(TP34)	LOGIC
35	D_V _{CC} _5V	---
36	VREG_3V	---
37	D_GND	---
38	XTAL_OUT	X'tal
39	XTAL_IN	X'tal
40	XTAL_GND	---

Pin No.	Function name	Block
41	RDS_LPF	IF
42	F2	LOGIC
43	F1	LOGIC
44	S-METER	IF
45	AFC-OUT.	IF
46	AFC-C	IF
47	Noise-AGC	NC
48	GND	---
49	MPX Lch-OUT	MPX
50	MPX Rch-OUT	MPX
51	CHCC	MPX
52	MPX_IN	MPX
53	NC-MPX-V _{CC}	---
54	Phase_dat	MPX
55	Phase_dat	MPX
56	MRC-TIME	MRC
57	VSM-AC	IF
58	MRC-IN	MRC
59	NC-IN	NC
60	DET-OUT	IF
61	VREG49	AM/FM
62	AM-IF-IN1	AM
63	AM-IF-IN2	AM
64	MUTE-CONT	IF
65	IFAGC-LPF	FE
66	AM_LC/Pilot-Det.	AM
67	Sep.-ADJ	MPX
68	AM-MIX2	AM
69	2 nd -MIXIN2	AM
70	2 nd -MIXIN1	AM
71	Mod.-DET	NC
72	IF-GND	---
73	1 st -IF-OUT	FM
74	IF-V _{CC} -5V	---
75	1 st -IF-IN1	FE
76	1 st -IF-IN2	FE
77	AM-RF-AGC	AM
78	HCC-CONT	AM/FM
79	RFAGC-IN BYPASS	FE
80	MIX-OUT2	FE



L/25700PM

Performance Emphasis (FM FET specifications)



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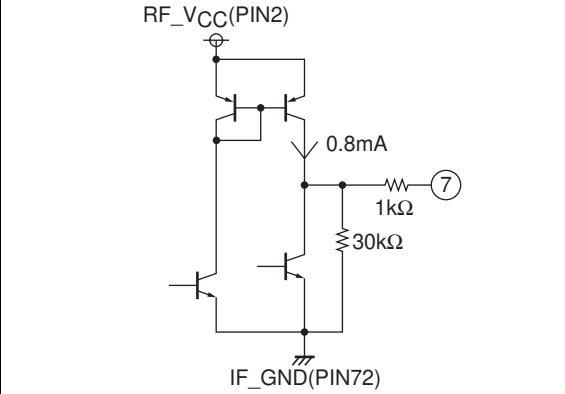
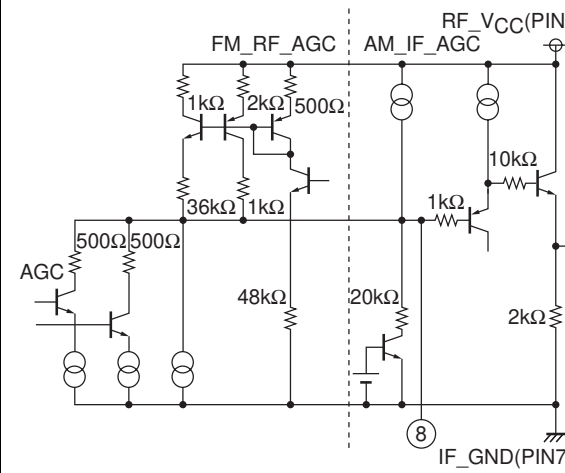
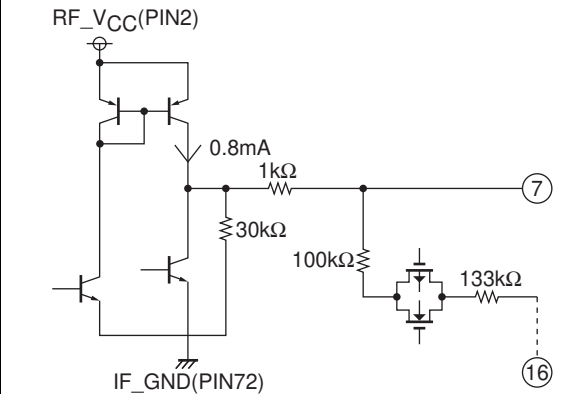
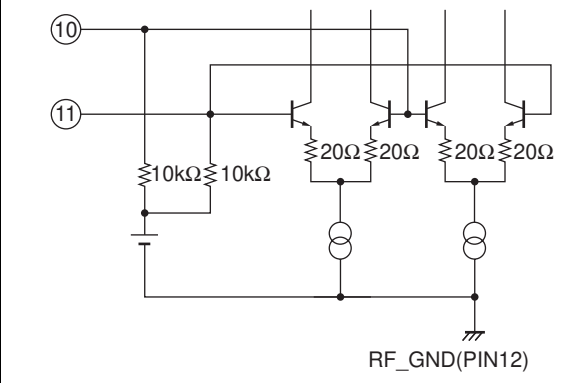
Pin Discription

Pin name	Function	Discription	Internal Equivalent Circuit
1 80	MIXER OUT1 MIXER OUT1	FM/AM MIX OUT (common)	
2	RF V _{CC}		V _{CC} = 8V
3 4	AM MIXER input 1 AM MIXER input 2	AM MIX IN Input impedance = 10kΩ	
5	AM RF AGC	RF AGC rectifier capacitor Determination of distortion ratio during low-frequency modulation Increase C5; Distortion → improved Response → slow Decrease C5; Distortion → worse Response → quick	
6	AM ANT ATT	For pin diode drive I ₆ = 8mA ANT damping current	

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Pin name	Function	Discription	Internal Equivalent Circuit
7	FM-RF-DAC	FM RF tuning DAC	
8	AM IF AGC FM RF AGC	<p>IF AGC voltage: DC smoothing capacitor pin</p> <p>FM RF AGC voltage: Voltage = Hi (around 8V) with AGC OFF. The voltage lowers when a level is inserted into the AGC circuit. AGC is applied at the voltage of $V_{CC}-V_{be}$.</p>	
9	FM-ANT-DAC (IRR-DAC)	<p>FM ANT tuning DAC</p> <p>Can be used as an IRR-DAC selected with a changeover switch.</p>	
10 11	FM MIXER IN1 FM MIXER IN2	FM MIX input	
12	RF GND2	(FE, FM, AM)	RF GND

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Pin name	Function	Discription	Internal Equivalent Circuit
13	Antenna Damping Drive pin	Pin 13: Antenna damping current flows when the RF AGC voltage becomes $V_{CC} - V_{be}$.	
14	VCO_GND		GND
15	OSC V _{CC}	(OSC)	$V_{CC} = 8V$
16 17	OSC1 OSC2	OSC pin	
18	SIGNAL QUARITY (UNDESIRE DET)	DC smoothing is performed by the output impedance and external capacity. Note that too large capacity will reduce the responsiveness of the IF filter as the voltage of this pin is also used to control the IF filter.	

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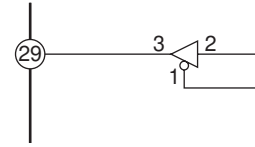
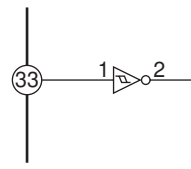
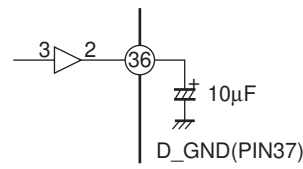
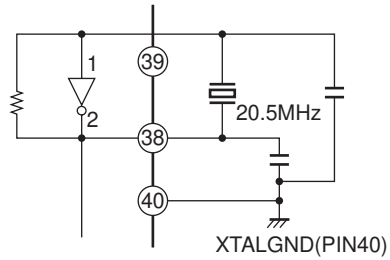
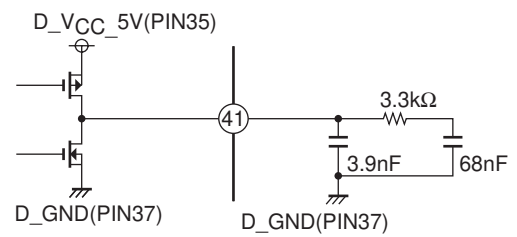
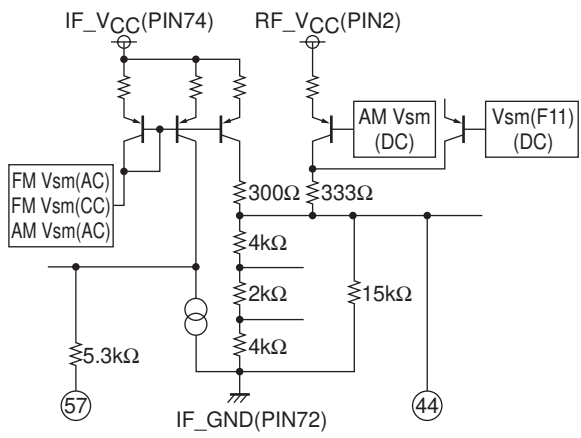
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Pin name	Function	Discription	Internal Equivalent Circuit
19 20 21 22 23	VT LPFD CPAM CPFM FET_GND	<p>LPFD: Internal FET drain output pin for PLL This pin is combined with CPM/CPAM pins to form a low pass filter for PLL.</p> <p>CPFM, CPAM: Charge pump output pins These pins are placed in high-impedance state in BACKUP mode, at power-on-reset time, and in PLL stop state.</p>	
24	DC MONITOR	<p>Adjustment mode Internal signal output monitor pin See BIT specifications.</p> <p>Normal mode: This pin outputs the SD signal.</p>	
25 26 42 43	F3 UL/IFEND/BUSY F2 F1	<p>F3 This pin must be left open. Output port</p> <p>UL/IFEND/BUSY: These pin generates the signal that identifies the Radio PLL-Unlock, IF count end, or I²C BUS Busy state.</p> <p>F1, F2 These pins must be left open. Default pull-down ON.</p>	
27 28 31 32	SD_OUT/ST_IND Q_OUT S_DA S_CK	<p>SD_OUT/ST_IND SD, ST_IND signal output pin QOUT</p> <p>Quality-out signal output pin SDA, SCK</p> <p>I²C interface pins. Both are of open drain type. External pull-up resistors are needed. Use the same power supply for the pull-up resistors and Pin 34 BUS. These pins are set to an input port at RESET time.</p>	

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Pin name	Function	Discription	Internal Equivalent Circuit
29 30	RD_DA RD_CL	RDS demodulator signal output pins Output Low when the RDF is OFF.	 <p style="text-align: center;">RD_DA,RD_CL pin</p>
33	RESET	System reset pin A low-level to this pin resets the system and PC starts executing the program from address 0. When power is turned on, it is necessary to apply low-level to this pin for 50ms or more after the 8V/5V power supply is stabilized (leaving this pin open is inhibited). See the RESET timing diagrams.	
34 35 37	BUS D_VCC_5V D_GND	Power/GND pins • BUS: Power supply for the main microcontroller interface pins. • DVCC5V, GDND: Main operating power supply	
36	VREG_3V	Internal operating low-voltage output pin Connect a bypass capacitor to this pin.	
38 39 40	XTAL_OUT XTAL_IN XTAL_GND	Pins connected to the 20.5MHz oscillating element XTAL_GND: X'tal oscillator circuit GND	 <p style="text-align: center;">XTALGND(PIN40)</p>
41	RDS_LPF	Low pass filter for RDS VCO Used to form an external low pass filter	
44	AM/FM S_METER (DC)	Current drive type S-meter output Pin 44: Eliminates the AC component by external capacity. Pin 57: Leaves the AC components (Pin for NC noise extraction and for neighboring interfering noise extraction)	

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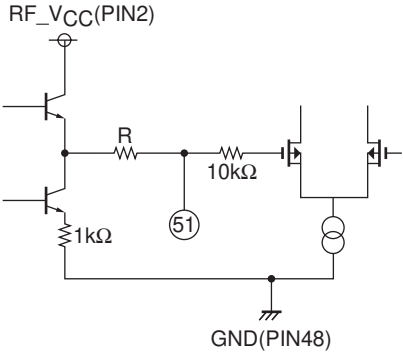
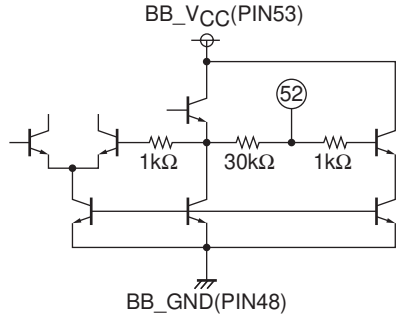
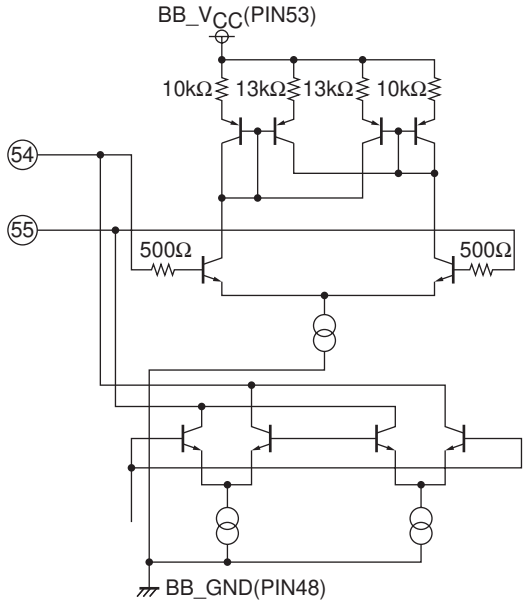
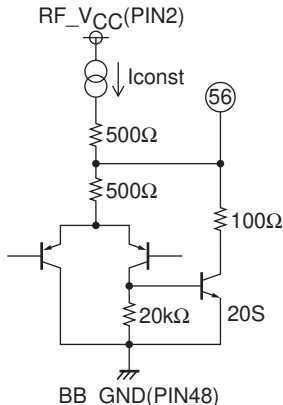
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Pin name	Function	Discription	Internal Equivalent Circuit
45	AFC_OUT	Null voltage As compared with internal 2.7V regulator.	
46	AFC_C	At reception SW-ON Shorts between pin 45 and AFC capacity. (series, small capacity shorted) At RDS SW-OFF Opens between pin 45 and AFC capacity. (series, small capacity + large capacity configuration)	
47	NOISE AGC MOS: NCAGCO		
48	GND	(NC, MPX, MRC)	GND
49 50	MPX output (LEFT) MPX output (RIGHT)	MPX outputs Impedance changed over with the de-emphasis changeover. Low = 3.3kΩ High = 5.0kΩ (50/75μs changeover with the external capacity of 0.015μs)	

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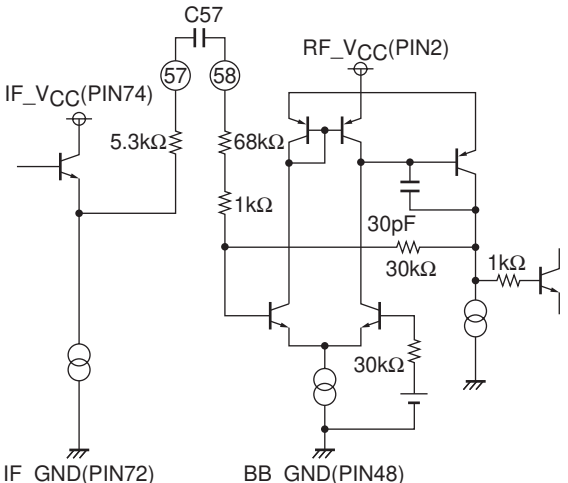
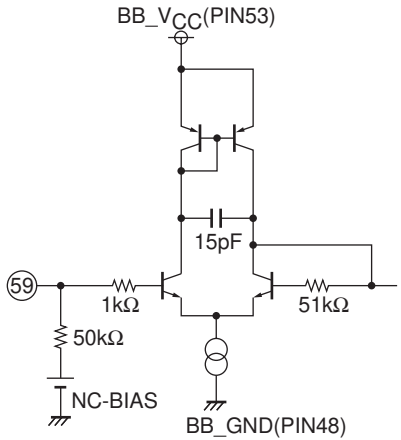
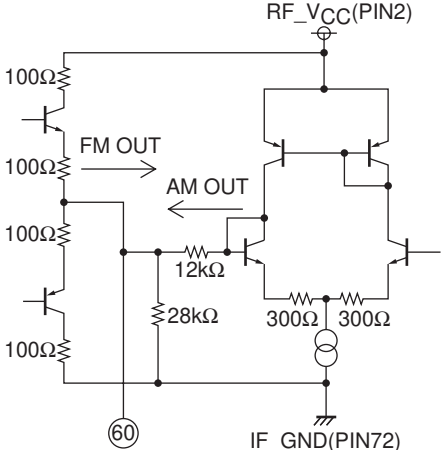
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Pin name	Function	Discription	Internal Equivalent Circuit
51	HCC capacitor pin	<p>With pin 51 external capacity and internal resistor R, high-cut frequency characteristics are set.</p> <p>Internal resistance can be changed over with 3 bits (10kΩ, 30kΩ, 50kΩ, 70kΩ, 90kΩ, 110kΩ, 130kΩ, 150kΩ) (HCC cut off)</p>	
52	MPX PLL input	<p>LPF formed with internal resistance 30kΩ and pin 34 external capacity</p> <p style="text-align: center;">↓</p> <p>HPF formed by subtracting the above LPS passage signal from the Composite signal.</p> <p style="text-align: center;">↓</p> <p>Supply to MPX PLL circuit</p>	
53	NC MPX V _{CC}	(NC, MPX, MRC)	V _{CC} = 5V
54 55	Phase-Comparator for MPX		
56	MRC TIME	<p>The time constant for the Multipath-Noise Detector is determined with the following:</p> <p>100Ω resistor and external capacity during discharge</p> <p>IConstant and external capacity during charge.</p> <p>IConstant can be changed over with 2bits (MRC time constant).</p>	

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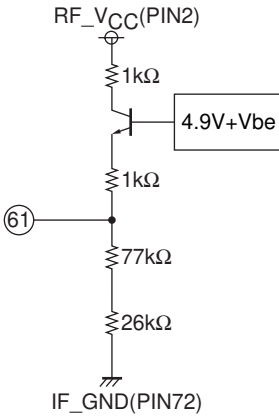
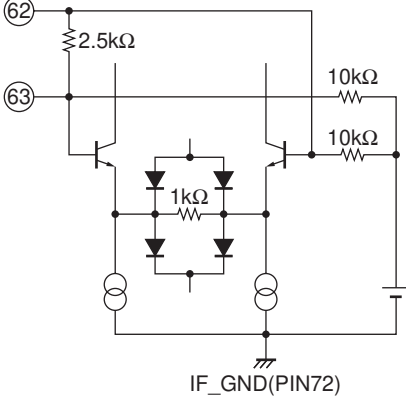
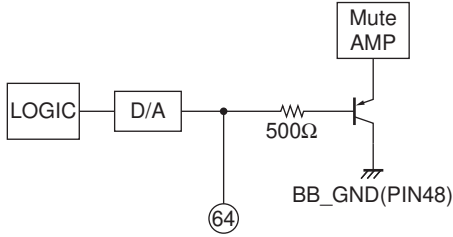
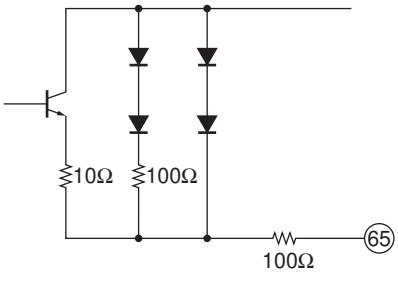
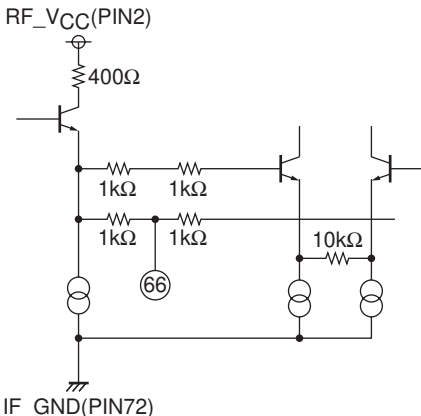
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Pin name	Function	Discription	Internal Equivalent Circuit
57 58	Vsm AC MRC input		
59	Noise canceller input	Noise Canceller Input Input impedance 50kΩ	
60	FM/AM DET OUT	AM/FM detection output Output impedance Low impedance in the FM mode 12kΩ in the AM mode	

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Pin name	Function	Discription	Internal Equivalent Circuit
61	VREF 4.9V	Reference voltage	
62 63	AM IF AMP input1 AM IF AMP input2	AM 450kHz AMP input Input impedance = 2kΩ	
64	MUTE CONT	Noise convergence adjustment Mute OFF function MUTE is turned OFF when pin 64 is short-circuited with GND.	
65	IF AGC LPF	Time constant changeover at Seek switch diode	
66		Frequency characteristics of unnecessary voice band of 100Hz or less is changed to produce the clear sound in the AM mode.	

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Pin name	Function	Discription	Internal Equivalent Circuit
67	SEPA ADJ	The input level of sub-decoder is varied through BIT control. (The output level of MONO and MAIN remains unchanged.) (Separation Control)	
68	AM 2 nd MIXER output	The mixer coil connected to the pin 68 mixer output must be wired to V _{CC} = 8V.	
69 70	FM 2 nd MIXER input1 FM 2 nd MIXER input2	FM 2 nd MIXER 10.7MHz → 450kHz FM AMP (10.7MHz) AMP for S-meter voltage AM MIXER input AMP for AM Noise AGC pickup	
71	Modulation INDEX	Set the detection output level as DC output. C71 is the smoothing capacitor.	
72	IF GND	(IF)	IF GND

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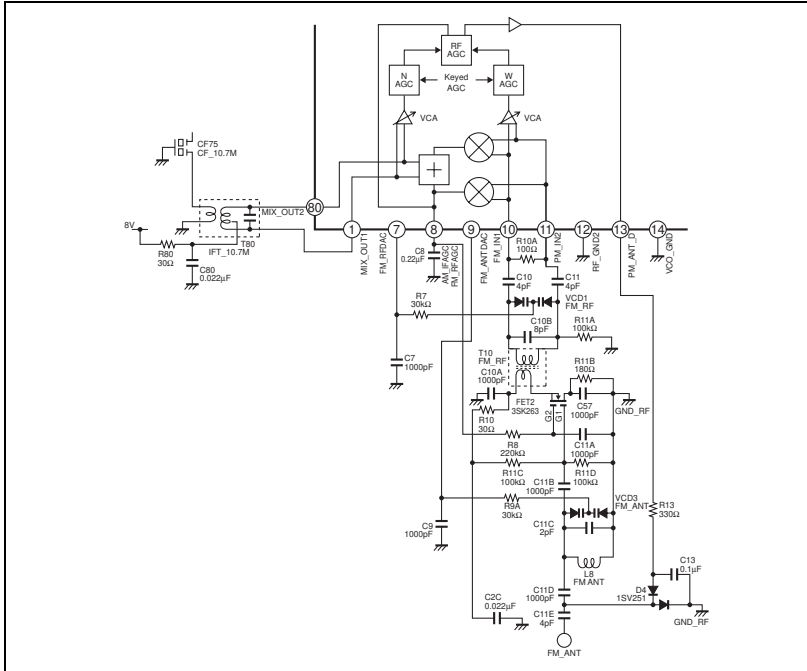
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Pin name	Function	Discription	Internal Equivalent Circuit
73	AM/FM 1st IF MIXER AMP output	Output impedance = 330Ω	
74	IF V _{CC}	(IF)	V _{CC} = 5V
75 76	AM/FM 1st IF MIXER AMP input	AM/FM 450kHz AMP Input impedance = 330Ω	
77	AM RF AGC	RF AGC rectifier capacitor Determination of the distortion ratio during low-frequency modulation Increase C77: Distortion → improved Response → slow Decrease C77: Distortion → worse Response → quick * Same as pin 79.	
78	HCC control input pin	With the Pin 78 input voltage, attenuation of the high pass component is controlled. ↓ At weak input, high pass is cut to reduce the noise feeling. • Same control for FM/AM HCC. • The f-characteristics are set by changing over the external capacity (Pin 51) and internal resistor. • Threshold can be controlled with 5 bits. (FM/AM HCC DAC).	
79	AM RF AGC BYPASS	RF AGC rectifier capacitor Determination of the distortion ratio during low-frequency modulation Increase C77: Distortion → improved Response → slow Decrease C77: Distortion → worse Response → quick * Same as pin 77.	
80	MIXER OUT2	* See pin 1 description.	

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FM/AM level Diagram

FM FE



RF AGC

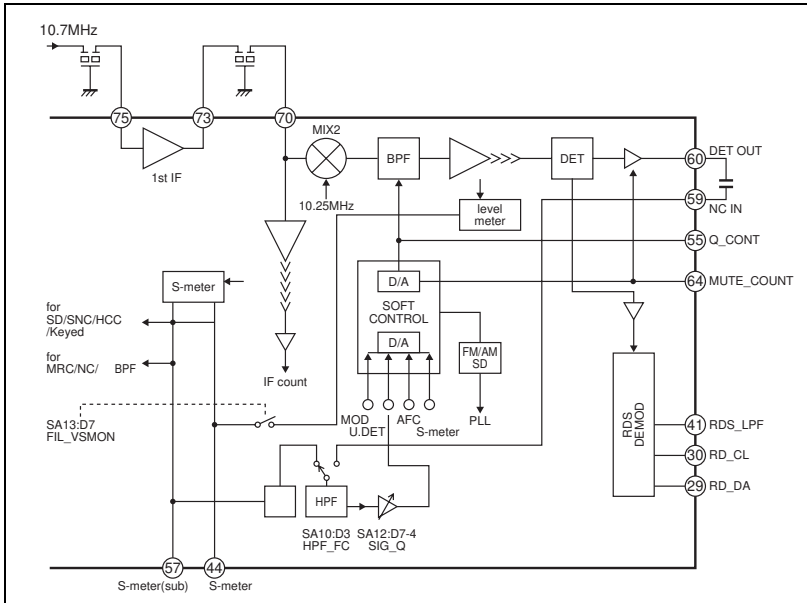
- Narrow AGC pick up
MIX OUT(4bit adj)
- Wide AGC pick up
MIX IN (10,11pin)(4bit adj)
- Keyed AGC
Controls narrow and wide AGC (4-bit adjustment) using the S-meter (Pin 44).

MIX

Image rejection Mixer(4bit adj)

1st IF (10.7MHz)

FM IF



- S-meter (10.7MHz)
- 2nd IF (450kHz)
- BPF (40kHz to 180kHz automatic control)
Detection path
→ S-meter sub/Det out/AFC modulation index
- S-meter for BPF (dedicated to filter adjustment)
- IF count freq (10.7MHz)
- IF Limiter AMP
- Band SD
- Soft Mute
- RDS Decoder

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FM IF Filter (BPF)

1. Detection

The following types of detection are performed, and when there is a response to any detection, the IF filter bandwidth is reduced.

When there is no response, the bandwidth remains wide. (-3dB BW: 40 to 180kHz)

- (1) Modulation index detection: Detects the modulation index of the FM DET OUT block
- (2) Neighboring interference detection: Detects neighboring interference
- (3) AFC detection: Detects the AFC voltage of the FM DET block

2. Control

The sensitivity of each of the above detection functions is adjusted by BIT. Control is self-contained within AKAGI. The control voltage is generated from neighboring interference detection, modulation index detection, and AFC detection.

Thus, ultimately the IF filter band is adjusted using a single control voltage.

This control voltage varies only the IF filter band.

The control voltage can be fixed from the main microcontroller, so the 40 to 180kHz band can also be adjusted by main microcontroller control. (Fine adjustment is possible in approximately 50 steps.)

(1) IF filter modulation index detection

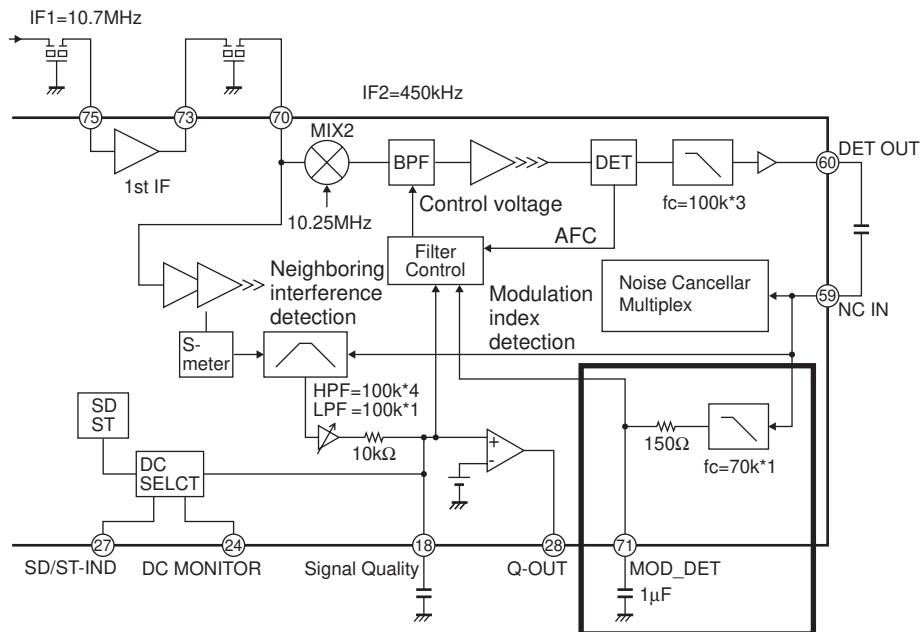
Detection output: Detects the audio signal level from NCIN (Pin 59)

LPF $f_c = 70\text{kHz}$ (1st order). The low pass filter is fixed inside the IC.

IC internal control is performed so that the modulation index detection function operates at a certain electric field strength or less. (The electric field threshold value can be changed by BIT.)

When modulation index detection operates, the IF filter bandwidth is reduced.

The modulation index detection function does not perform control to widen the IF filter bandwidth.



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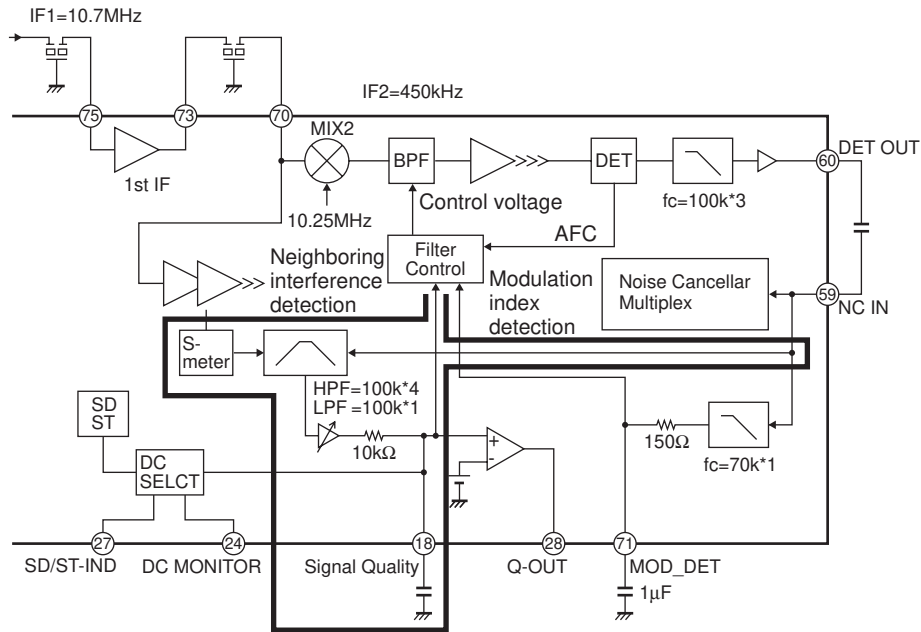
(2) IF filter neighboring interference detection

There are two detection block systems. The S-meter AC component is detected in the weak electric field (S-meter voltage = 2V or less), and neighboring interference is detected from DET OUT in the medium electric field or more (S-meter voltage = 2V or more).

The detection path is changed inside the IC according to the electric field.

S-meter AC component detection only or DETOUT block detection path only can also be changed by BIT at all electric fields.

The BPF consists of a HPF with $f_c = 100\text{kHz}$ (4th order) and an LPF with $f_c = 100\text{kHz}$ (1st order). The HPF can be selected from 50 or 100kHz, and the LPF f_c can be lowered by adding a capacity to the S-meter AC (Pin 57).

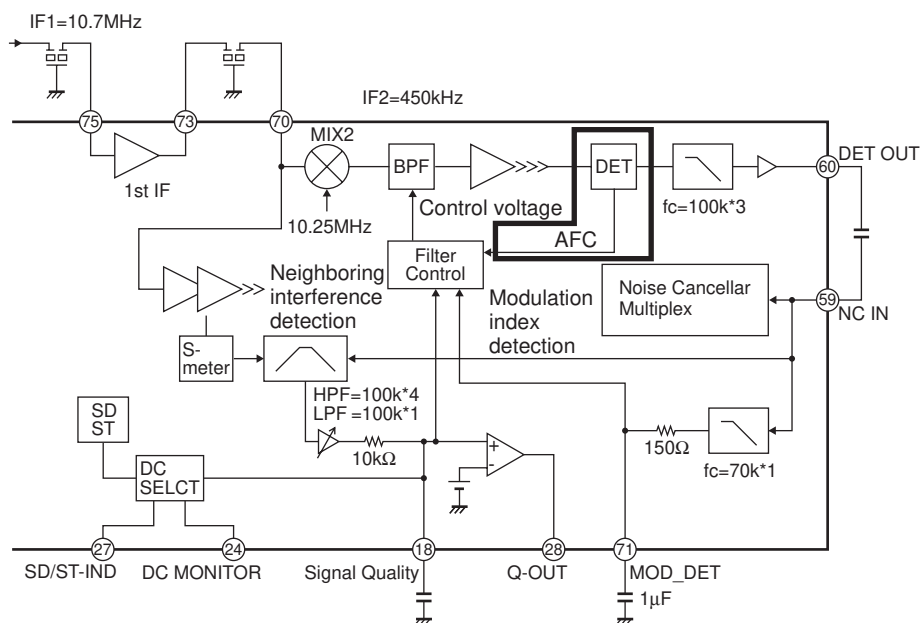


(3) IF filter AFC detection

The IF filter band is controlled by changing the AFC voltage (Pin 45).

The AFC voltage is generated by converting the frequency offset relative to the IF frequency (450kHz) to a voltage. Neighboring interference detection responds even when the desired signal and the interference signal are the same level, but AFC detection responds when the interference signal level is higher than that of the desired signal.

Therefore, AFC detection is used in an auxiliary manner for portions that cannot be detected by the neighboring interference detection path.



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Signal Quality

Signal quality uses the same path as neighboring interference detection. (The path can be changed by BIT.)

- Detection block (Smeter_AC/DETOUT) switching inside the IC according to the electric field
- Smeter_AC detection fixed at all electric fields
- DETOUT detection fixed at all electric fields

There are two output systems as follows:

- The neighboring interference detection voltage is compared by the comparator to generate the quality output (Q-OUT: Pin 28).
- The neighboring interference detection voltage is output in a linear manner (Signal Quality: Pin 18).

Signal Quality (Pin 18) performs DC smoothing using the output impedance ($1k\Omega$) and an external capacity. This pin voltage is also used to control the IF filter, so care must be taken as the IF filter response will become slow if the capacitance value is too large.

The S-meter path performs detection from before the BPF (IF filter), so there is no difference in the quality output due to filter band fluctuation.

The DET OUT (Pin 59) path performs detection from after the BPF (IF filter), so filter band fluctuation produces a difference in the quality output.

(The multipath signal is detected by Smeter_AC, so differences do not easily occur in Q-OUT.)

