HA16841MA

IF, Base-Band Signal Processing IC for Cordless Telephone

Description

The HA16841MA is an IF, Base-Band signal processing IC which is optimal for use in cordless telephones. In addition to an FM IF amplifier, it also integrates a data filter, a receiver amplifier, and a compander function for noise reduction on a single chip, thus enabling a significant reduction in total parts count.

Features

- Optimal for system miniaturization, including thickness reduction, due to the basic linear functions being integrated on a single chip, and packaging in a miniature surface mount package.
- Reduced power consumption during standby mode possible, since the FM IF system and compander system have independent power supplies.
- Low voltage operation possible (FM IF system: 2.2 to 6.5 V, Compander system: 2.7 to 6.5 V)
- Low power consumption (Typically 10 mA with all blocks on)
- The BTL circuit of the receiver amplifer is capable of driving miniature ceramic receivers directly, and even can drive the hac receiver.
- Either a coil or a ceramic discriminator may be used in the FM detector phase shifting circuit.
- S meter circuit with wide linearity range. (70 dB typ)

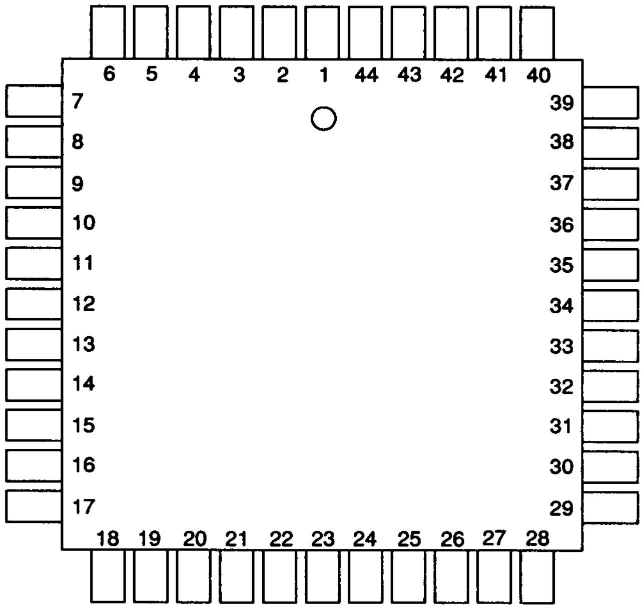
Functions

FM IF System	Mixer, IF amp, Squelch trigger, and S meter
Compander	Compressor and expander
Data Filter	Filter amp, comparator with hysteresis
Receiver Amplifier	Ceramic receiver driver (BTL amp)

Packaging Information

Part No.	Package
HA16841MA	MP-44S

Pin Arrangement



(Top view)

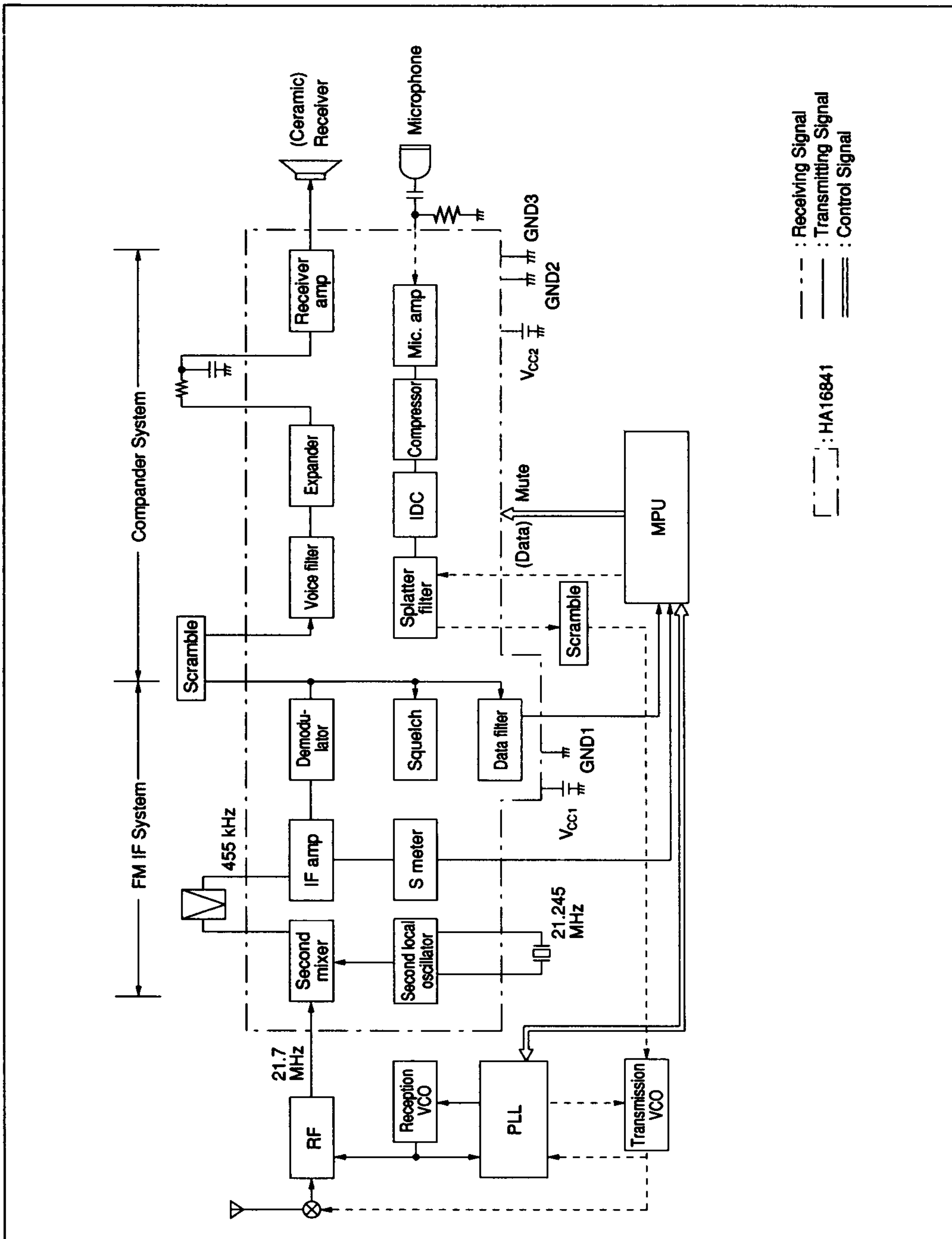
Pin Functions

Pin No.	Function		Block
1	LPF output		COMPRESSOR
2	LPF input		
3	Compressor output		
4	Data input		
5	Compressor detection		
6	AC cut		
7	Mic. amp output		
8	Mic. amp input		
9	GND3		SW. ETC.
10	V_{ref}		
11	Meter output		
12	V_{CC2}		
13	LOGIC SW	Comp/Exp mute	
14		Compander through	
15	Data filter 1 (+) input		DATA FILTER
16	Data filter 1 (–) input		
17	Data filter 1 output		
18	Data filter 2 (+) input		
19	Data filter 2 (–) input		
20	Comparator input		
21	Comparator output		
22	Scan control		SQ AMP
23	Squelch input		
24	Noise amp output		
25	Noise amp input		
26	Audio amp output		EXPANDER
27			
28	GND2		
29	Audio amp input		
30	Expander output		
31	Expander detection		
32	Expander input		
33	IF detection output		IF AMP DETECT
34	IF detection		
35	IF amp output		

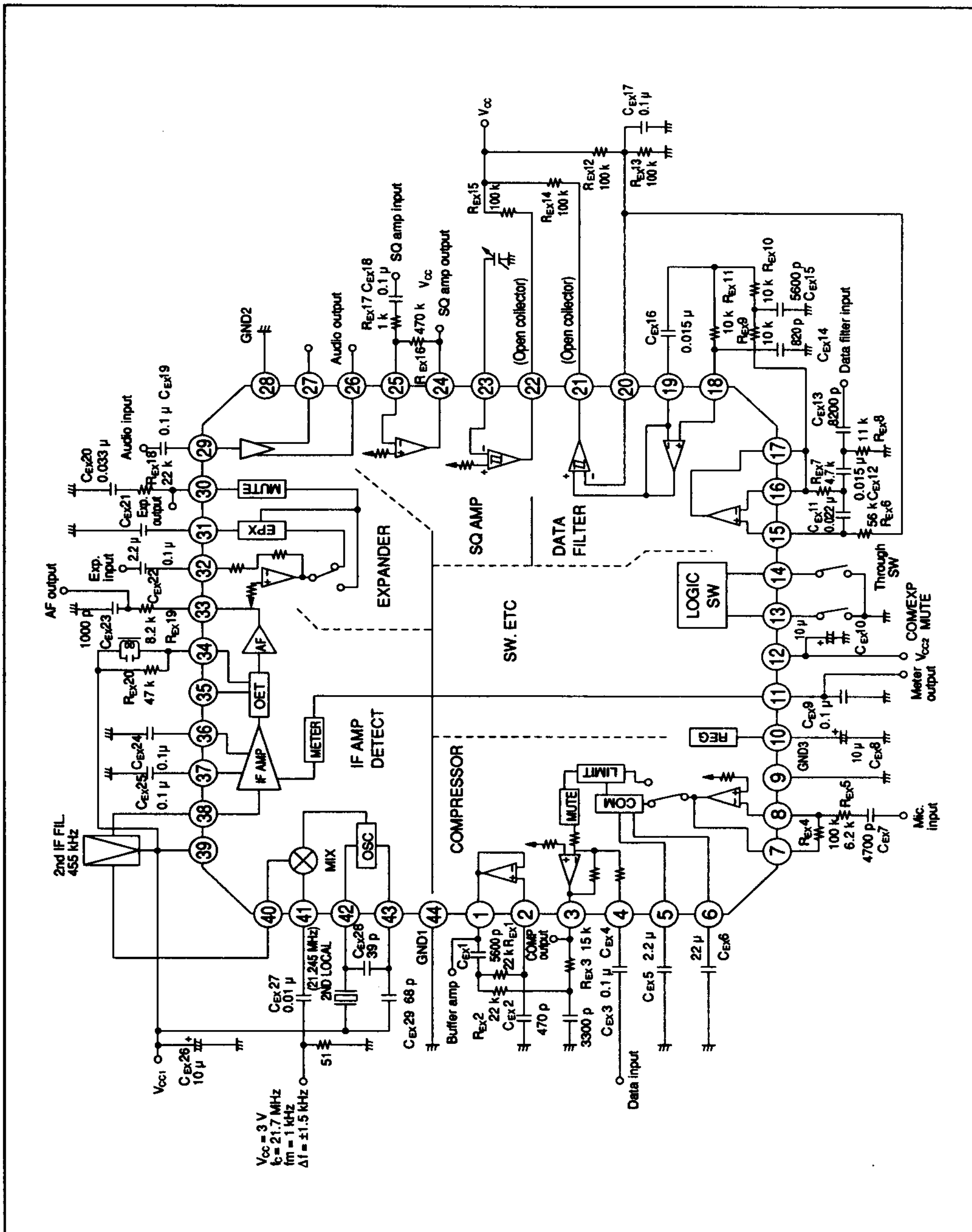
Pin Functions (cont)

Pin No.	Function	Block
36	DC feedback decoupling	IF AMP DETECT
37		
38	IF amp input	
39	V_{CC1}	
40	Mixer-out ceramic filter (455 kHz)	
41	RF input (21.7 MHz)	
42	Local oscillator X'tal (21.245 MHz)	
43		
44	GND1	

Cordless Telephone Handest Block Diagram



System Block and Standard External Components Diagram



Function Descriptions

Second Mixer

The local oscillator circuit is a Colpitts type oscillator, and oscillates due to positive feedback through the capacitance between pins 42 and 43. The oscillation frequency is determined by the x'tal oscillator connected between pin 42 and V_{CC1}. A double balance type mixer circuit is used, and the voltage gain (between pins 41 and 38) is typically 26 dB.

IF Amp/S Meter

The IF amp is a high gain DC direct coupled circuit, and also includes an amplitude limiter.

Also, the signal output from the IF amp is input to the S meter circuit, and is converted to a current proportional to the input field strength. This is finally output as the S meter voltage at pin 11, by passing the current through an internal resistance (68 kΩ, typ).

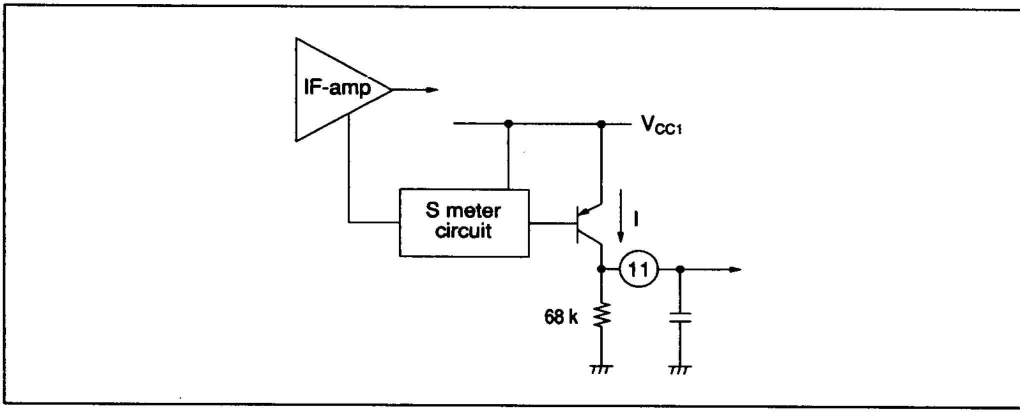


Figure 1

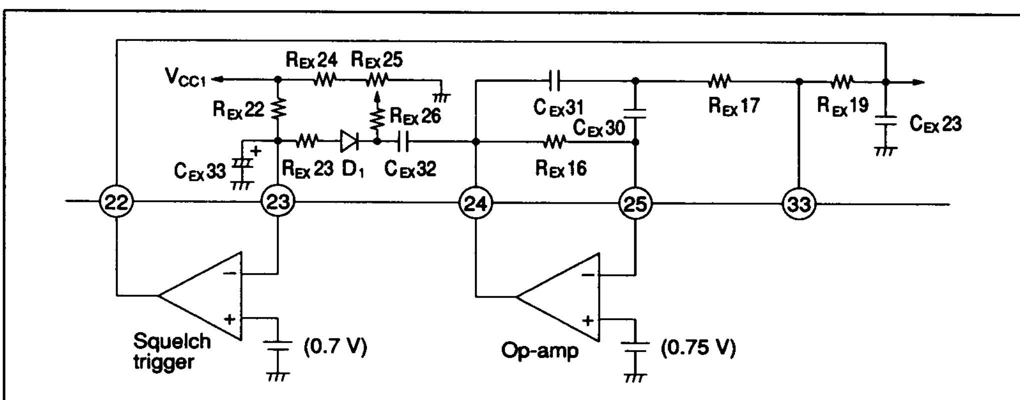


Figure 2

Squelch Circuit

A noise squelching circuit can be constructed using the built-in op-amp and squelch trigger circuit. The op-amp open loop gain is 50 dB, the characteristic frequency is 100 kHz, and it is a wide bandwidth amplifier. A sample circuit is shown in figure 2.

When the voltage on pin 23 is over about 0.7 V, the squelch amp output on pin 22 takes on a low level. This output is an open collector output.

Detection (demodulation)

Quadrature detection is used as the detection method. The IF amp output is phase shifted by 90°. Either an RCL parallel resonance circuit or a ceramic discriminator may be used as the phase shifter.

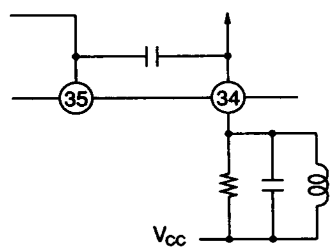


Figure 3 RCL Phase Shifter

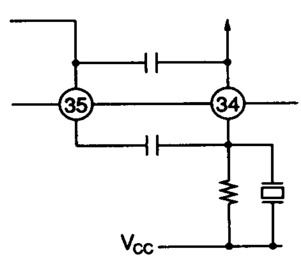


Figure 4 Ceramic Discriminator

Data Filter

The data filter is constructed from two active filters and a comparator with a hysteresis of 20 mV typ. This circuit is highly resistant to noise, and it outputs a signal with a 50% duty in response to the data signal input. Note that the comparator output, pin 21, is open collector.

Compressor

The voice signal is amplified by the Mic. amp, a circuit which also forms a differentiating circuit. The voltage gain can be adjusted by external components.

Data input is input from the post compressor circuit buffer pin, pin 4. If the MUTE switch is pressed during transmission of this data signal, unwanted voice signals will be cut.

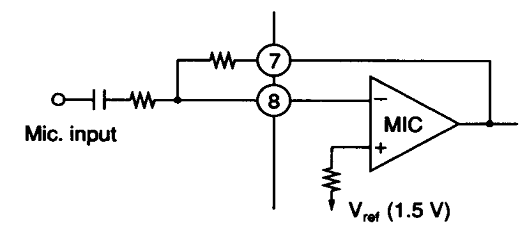


Figure 5

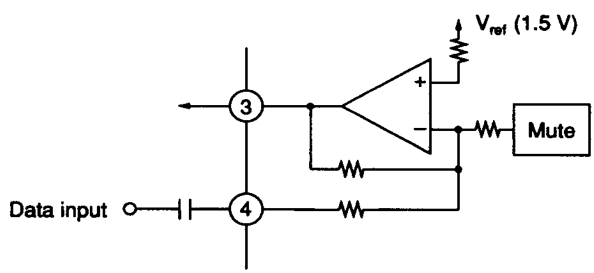


Figure 6

Expander/Receiver Amp

The demodulated signal is input to the expander (pin 32) and the data filter (pin 16). When the signal is a data signal, it is processed by the data filter and output to the MPU.

In the case of a voice signal, after being processed by the expander the signal is input to the receiver amplifier at pin 29.

Since the receiver amp is biased internally to V_{ref} (1.5 V), the signal is input through a capacitor. The output uses a BTL circuit which is capable of driving a miniature ceramic receiver directly. With a V_{CC} of 3 V, and at a frequency of 1 kHz, a dynamic range of typical 5 V_{P-P} can be assured, and adequate volume can be obtained.

Power Supply/SW

There are two power supply pins, V_{CC1} and V_{CC2}, and they are connected to the various blocks as follows.

V_{CC} 1	FM IF system, data filter
V_{CC} 2	Compander, speaker amp

Therefore, power consumption can be reduced by only providing power to V_{CC1} during standby, and apply power to both during communications. It is of course possible to use a single power supply to supply both V_{CC1} and V_{CC2}.

SW is used for the compander system mute and through functions, and functions according to the logic of table 1. Note that the high impedance state is logically equivalent to a high level.

Table 1

	Pin No.	Level H	Level L
Mute	13	OFF	ON
Through	14	OFF	ON

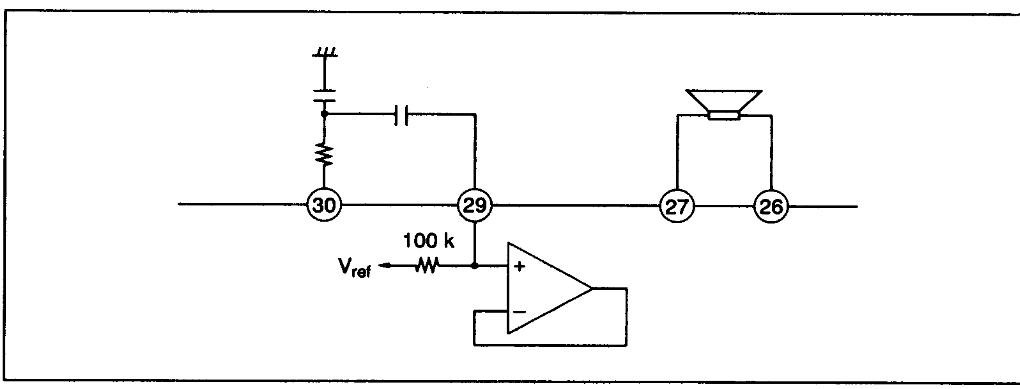


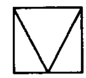
Figure 7

External Component Table

1. Crystal Oscillator

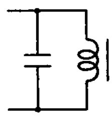
TOYOKOMU
TN4–30035
f_O = 21.245 MHz

2. Ceramic Filter



KYOCERA
KBF–455R–9A
f_O = 455 kHz

3. Detection Coil



MITSUMI
IFT–21k5–H
(R12–T–312A)
1–3 : 170T
Q_U = 65TYP
f_O = 455 kHz
C_O = 180 pF

4. Ceramic Discriminator

MURATA
CDB455C7
f_O = 455 kHz

5. External Capacitors

No.	Recom-mended Value(F)	Function	Effects: Larger than Recommended Value	Effects: Smaller than Recommended Value
$C_{EX}1$	5600 p	Low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$C_{EX}2$	4700 p			
$C_{EX}3$	3300 p	Frequency cut		
$C_{EX}4$	0.1 µ	Input DC cut	—	Frequency characteristics low band gain decreases
$C_{EX}5$	2.2 µ	Rectified detection	Detection time constant increases	Compressor characteristics: become unstable
$C_{EX}6$	22 µ	AC cut	Compressor time constant increases	Compressor cut off frequency increases
$C_{EX}7$	4700 p	Pre-emphasis	Furequency characteristics: low band gain increases	Furequency characteristics: low band gain decreases
$C_{EX}8$	10 µ	Reference stability	—	Cross talk increases
$C_{EX}9$	0.1 µ	S meter rectified detection	Detection time constant increases	S meter output becomes unstable
$C_{EX}10$	10 µ	Power supply pass capacitor	—	Influence of voltage variations increases
$C_{EX}11$	0.022 µ	Data filter high pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$C_{EX}12$	0.015 µ			
$C_{EX}13$	8200 p			
$C_{EX}14$	820 p	Data filter low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$C_{EX}15$	5600 p	Low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$C_{EX}16$	0.015 µ	Data filter low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$C_{EX}17$	0.1 µ	Bias stability	Time constant for power supply rise time increases	Influence of power supply noise level increases

No.	Recom-mended Value(F)	Function	Effects: Larger than Recommended Value	Effects: Smaller than Recommended Value
C_{EX}18	0.1 µ	Input DC cut	—	Frequency characteristics: low band gain decreases
C_{EX}19	0.1 µ	Input DC cut	—	Frequency characteristics: low band gain decreases
C_{EX}20	0.033 µ	De-emphasis	Frequency characteristics change	Frequency characteristics change
C_{EX}21	2.2 µ	Rectified detection	Detection time constant increases	Expander characteristics become unstable
C_{EX}22	0.1 µ	Input DC cut	—	Expander frequency characteristics change
C_{EX}23	1000 p	Detection output carrier attenuation	Load characteristics change	Load characteristics change
C_{EX}24	0.1 µ	IF amp DC feedback decoupling	—	IF gain decreases
C_{EX}25	0.1 µ			
C_{EX}26	10 µ	Power supply pass capacitor	Detection output increases	Detection output decreases
C_{EX}27	0.01 µ	Input DC cut	—	—
C_{EX}28	39 p	Local oscillator feedback circuit	Oscillator level increases	Oscillator level decreases
C_{EX}29	68 p		Oscillator level decreases	Oscillator level increases
C_{EX}30	4700 p	Op-amp frequency characteristics determination	Band pass center frequency decreases	Band pass center frequency decreases
C_{EX}31	4700 p		—	—
C_{EX}32	0.1 µ	Squelch detection circuit	—	—
C_{EX}33	4.7 µ		Squelch response decreases	—
C_D	56 p	Phase shift capacitor	IF amp S characteristics change	IF amp S characteristics change

6. External Resistors

No.	Recom-mended Value(Ω)	Function	Effects: Larger than Recommended Value	Effects: Smaller than Recommended Value
R_{EX}1	22 k	Low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
R_{EX}2	22 k			
R_{EX}3	15 k	Frequency cut		
R_{EX}4	100 k	Microphone amp gain determination	Amp gain increases	Amp gain decreases
R_{EX}5	6.2 k		Amp gain decreases	Amp gain increases
R_{EX}6	56 k	Data filter high pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
R_{EX}7	4.7 k			
R_{EX}8	11 k			

2

No.	Recommended Value(Ω)	Function	Effects: Larger than Recommended Value	Effects: Smaller than Recommended Value
$R_{EX}9$	10 k	Data filter low pass frequency characteristics determination	Cut off frequency decreases	Cut off frequency increases
$R_{EX}10$	10 k			
$R_{EX}11$	10 k			
$R_{EX}12$	100 k	Bias	Time constant for power supply rise time increases	Power dissipation increases
$R_{EX}13$	100 k			
$R_{EX}14$	10 k	Data filter pull-up resistance	—	Power dissipation increases
$R_{EX}15$	100 k			
$R_{EX}16$	470 k	Op-amp gain determination	Amp gain increases	Amp gain decreases
$R_{EX}17$	1 k		Amp gain decreases	Amp gain increases
$R_{EX}18$	22 k	De-emphasis	Frequency characteristics change	Frequency characteristics change
$R_{EX}19$	8.2 k	Detection output carrier attenuation	Frequency characteristics change	Frequency characteristics change
$R_{EX}20$	47 k (Coil) 2.4 k (Ceramic discrimi-nator)	Detection coil damping	Detection output increases	Detection output decreases
$R_{EX}21$	51	Oscilator impedance matching	—	—
$R_{EX}22$	150 k	Noise squelch detection and squelch Vth setting	Vth set value decreases	Vth set value increases
$R_{EX}23$	1 k		Squelch response decreases	Squelch stability becomes worse
$R_{EX}24$	33 k		Vth set value decreases	Vth set value increases
$R_{EX}25$	22 k		—	—
$R_{EX}26$	4.7 k		—	—

7. External Diodes

D_1 : 1S2076

Absolute Maximum Ratings (T_a = 25°C)

Item	Symbol	Rated Value	Units
Power supply voltage	V_{CC}	7.0	V
Power dissipation	P_T	350 Note	mW
Operating temperature	T_{opr}	–20 to +70	°C
Storage temperature	T_{stg}	–55 to +125	°C

Note: Ta ≤ 70 °C

Electrical Characteristics (V_{CC} = 3.0 V, T_a = 25°C)

	Item	Symbol	Min	Typ	Max	Units	Measurement Conditions	Notes
	Quiescent current	I_{CC1}	—	11	15.5	mA	No input, squelch on	
		I_{CC2}	—	11.5	16	mA	No input, squelch off	
IF AMP	Limiting sensitivity	V_{IN} (Lim)	—	15	22	dBμ	At the –3 dB point	1
	Detection output	V_o (AF)	150	230	310	mV	V_{IN} = 100 dBμ	
	Mixer gain	G (MIX)	18	22	26	dB	V_{IN} = 60 dBμ	
	Mixer input impedance	Zin (MIX)	2.2	3	3.8	kΩ	DC measurement	
	Mixer output impedance	Zout (MIX)	1.6	2.2	2.8	kΩ		
	IF input impedance	Zin (IF)	1.6	2.2	2.8	kΩ		
	Squelch hysteresis	HYST	25	50	75	mV		
	Squelch threshold value	Sth	—	0.7	—	V		
	Scan control high level	SH	V_{CC} –0.1	V_{CC}	—	V	Squelch input = 0 V	
	Scan control low level	SL	—	0.05	0.3	V	Squelch input = 2.5 V	
	Signal meter output	Sout 1	2.1	2.4	2.7	V	V_{IN} = 100 dBμ	
		Sout 2	1.2	1.5	1.8	V	V_{IN} = 50 dBμ	
		Sout 3	—	0.05	0.4	V	No signal	
	Filter amp gain	G (FIL)	42	46	—	dB	f = 10 kHz, V_{IN} 25 = 0.15 mVrms	
	Total harmonic distortion	THD	—	1.8	3	%	V_{IN} = 100 dBμ	
Compressor	Output reference level	V_{refc}	270	355	470	mVrms	V_{INC} = 14 mVrms (0 dB)*	2, 3
	Gain deviation	ΔGc1	–0.5	0	0.5	dB	V_{INC} = –20 dB*	
		ΔGc2	–1.0	0	1.0	dB	V_{INC} = –40 dB*	
	Through on/off difference	ΔGtc	–1.5	0	1.5	dB	V_{INC} = 0 dB*	
	Distortion factor	THDc	—	0.2	1	%		2
	Mute attenuation	Attc	60	76	—	dB		2, 3
	Crosstalk	CTc	—	–40	–30	dB	EXP. V_{INE} = 45 mVrms	2
	Buffer voltage gain	Gb	–0.5	0	–0.5	dB	Voc = 300 mVrms	
	Buffer distortion factor	THDb	—	0.1	1	%		
	Limiting voltage	Vlimc	1.25	1.45	1.6	V_{P-P}		

Notes: 1. fc = 21.7 MHz, fm = 1 kHz, Δf = ±1.5 kHz, and the detection coil adjusted for minimum distortion factor.
2. f = 1.0 kHz
3. *Using the CCITT recommended evaluation noise filter.

Electrical Characteristics (V_{CC} = 3.0 V, T_a = 25°C) (cont)

Item		Symbol	Min	Typ	Max	Units	Measurement Conditions	Notes
Expander	Output reference voltage	V_{refe}	60	80	100	mVrms	V_{INE} = 25 mVrms (0 dB)*	1, 2
	Gain deviation	ΔGe1	–0.5	0	0.5	dB	V_{INE} = –10 dB*	
		ΔGe2	–1	0	1	dB	V_{INE} = –20 dB*	
		ΔGe3	–1.5	0	1.5	dB	V_{INE} = –30 dB*	
	Through on/off difference	ΔGte	–1.5	0	1.5	dB	V_{INE} = 0 dB*	
	Audio voltage gain	GAU	37	40	43	dB	V_{IN} (29) → Vout (26, 27)	1
	Distortion factor	THDe	—	0.4	1.5	%	V_{INE} = 0 dB*	
	Mute attenuation	Atte	60	76	—	dB		1, 2
	Maximum output voltage	Voemax	1500	2000	—	mVrms	T.H.D = 10 % Vout (26, 27)	1
	Crosstalk	CTe	—	–70	–60	dB	COMP. V_{INC} = 14 mVrms*	1, 2
DATA FIL	Comparator H level	VcompH	V_{CC} –0.1	V_{CC}	—	V		
	Comparator L level	VcompL	—	0.05	0.3	V		
	Comparator output duty	Vduty	45	50	55	%	V_{IN} = 200 mVrms, f = 2.4 kHz	
	Comparator hysteresis width	ΔHYST	15	20	35	mV		
SW ETC	Regulator	Vreg	1.42	1.5	1.58	V		
	Source current	Iso	—	–1000	–500	µA	Vo ≥ 1.4 V	
	Threshold voltage	Vth	1.0	1.2	1.5	V	Pins 13, 14	
	Input L current	IL13	8	15	25	µA	Pin 13 V_{IN} = 0 V	
	Input L current	IL14	15	30	45	µA	Pin 14 V_{IN} = 0 V	
	Input H current	IH13	10	20	40	µA	Pin 13 V_{IN} = 1.6 V	
	Input H current	IH14	10	30	60	µA	Pin 14 V_{IN} = 1.6 V	

Notes: 1. f = 1.0 kHz
2. *Using the CCITT recommended evaluation noise filter.

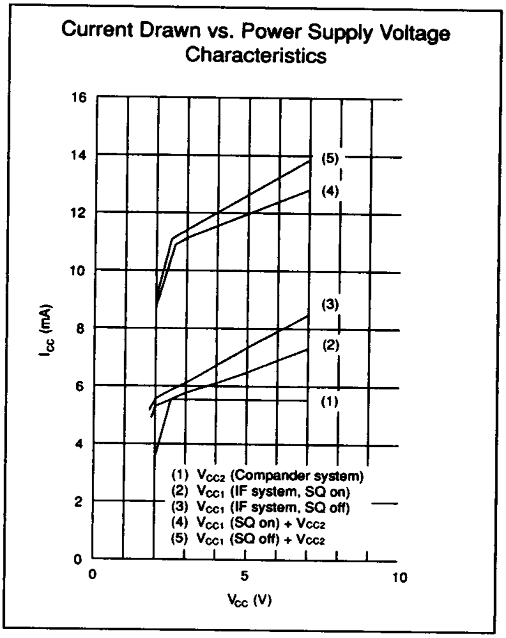


Figure 8

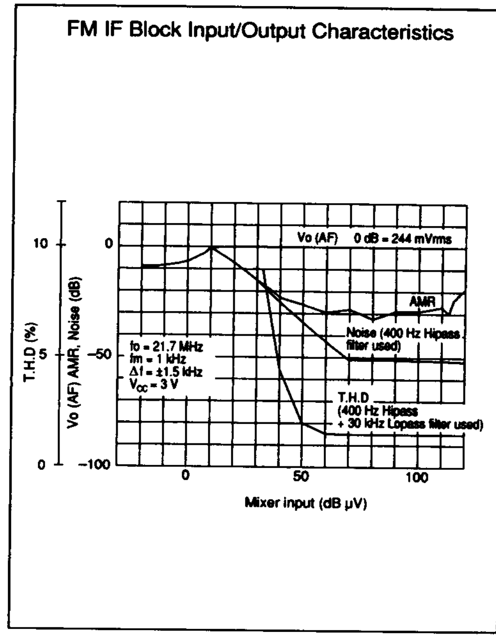


Figure 9

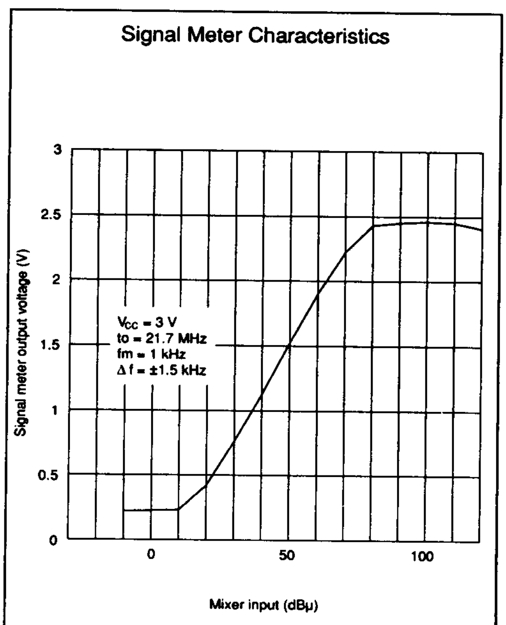


Figure 10

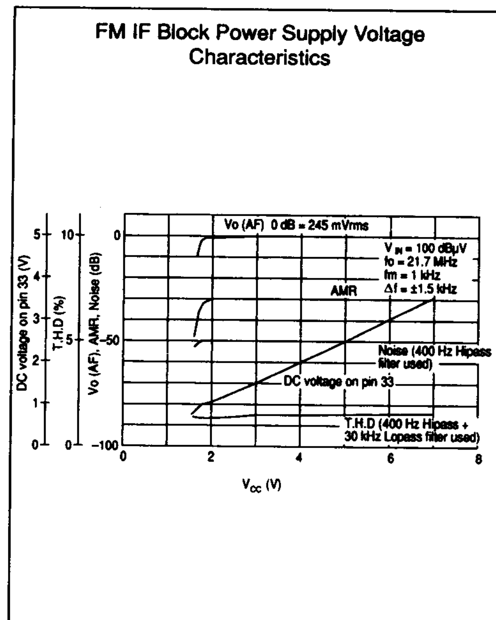


Figure 11

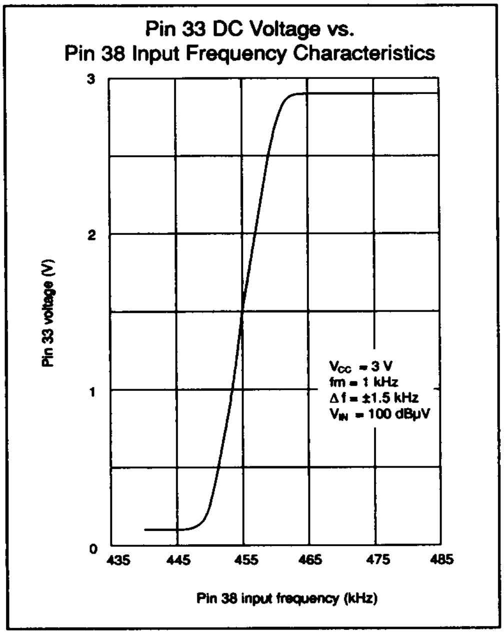


Figure 12

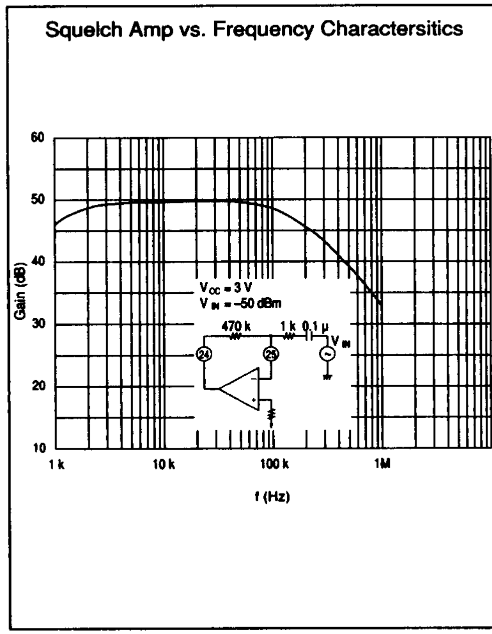


Figure 13

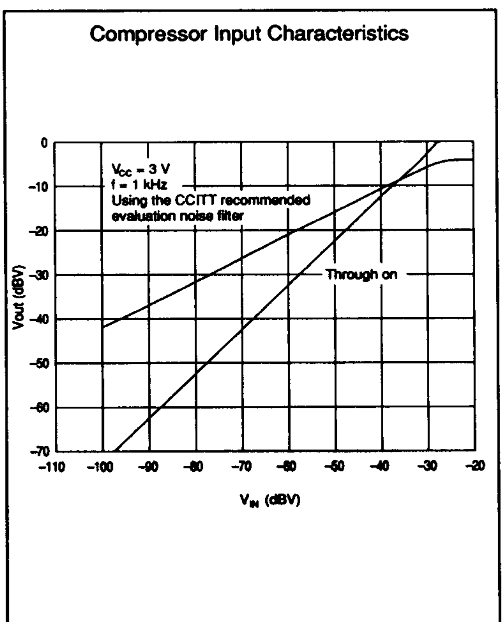


Figure 14

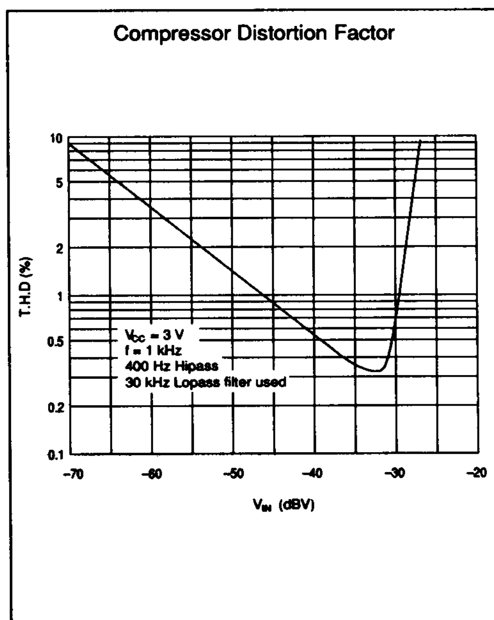


Figure 15

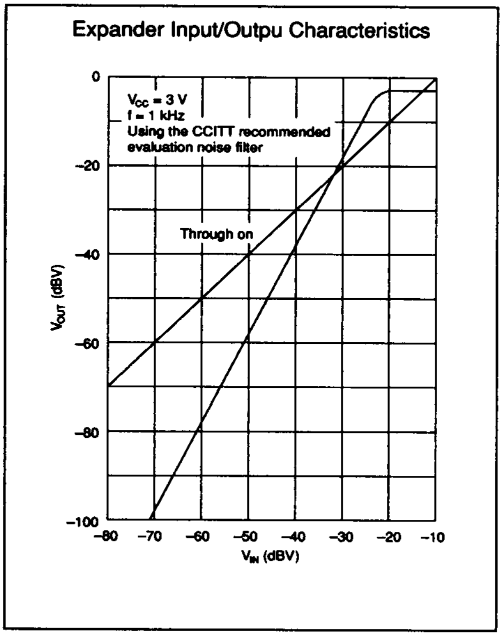


Figure 16

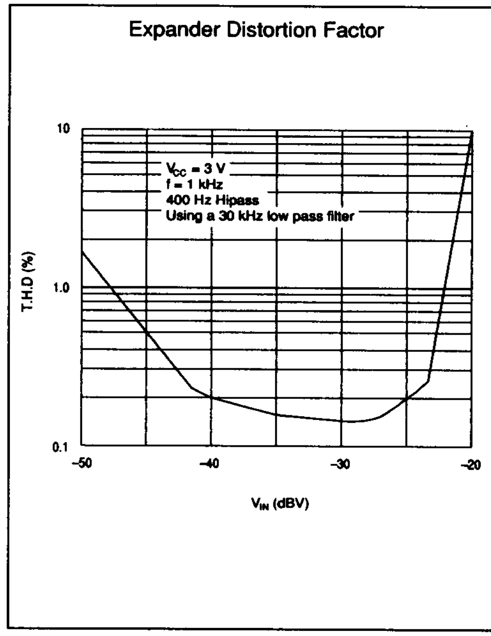


Figure 17

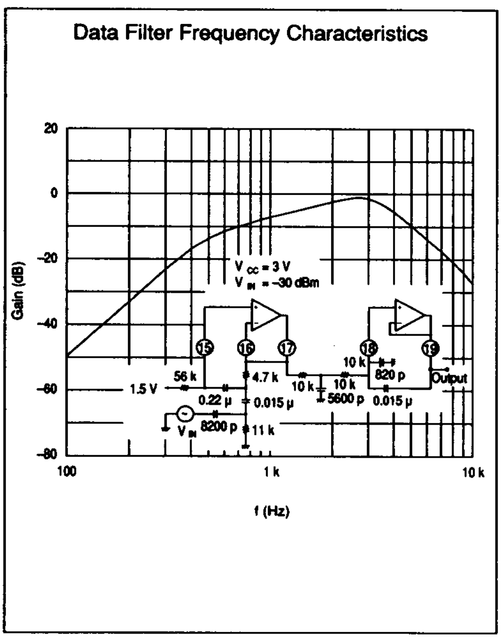


Figure 18

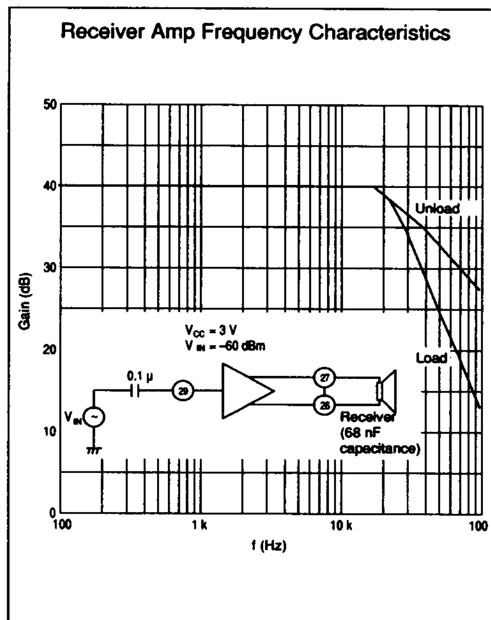


Figure 19