HA12159
FM IF System for Use with the Dynas System

HITACHI

Preliminary
Rev. 0
Mar. 1992

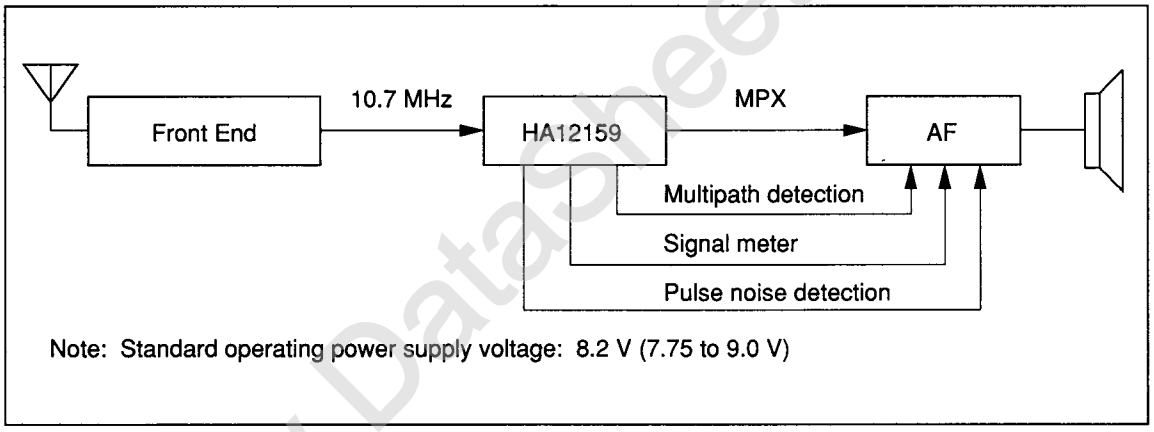
The HA12159 is an FMIF IC that incorporates a new technique that radically improves the sensitivity and selectivity of FM receivers. With the HA12159, FM stations that previously could not be received can now be heard clearly. The "Dynas" system was developed by H.U.C. Electronik GmbH, and a license from that company is required for the use of the HA12159.

Functions

- IF signal processing
- Mute function
- Adjacent interference detection
- Signal meter driver

Features

- Selectivity improvement: about 30 dB
- Sensitivity improvement: about 5 dB



Car Radio System Using the HA12159

Absolute Maximum Ratings (T_a = 25°C)

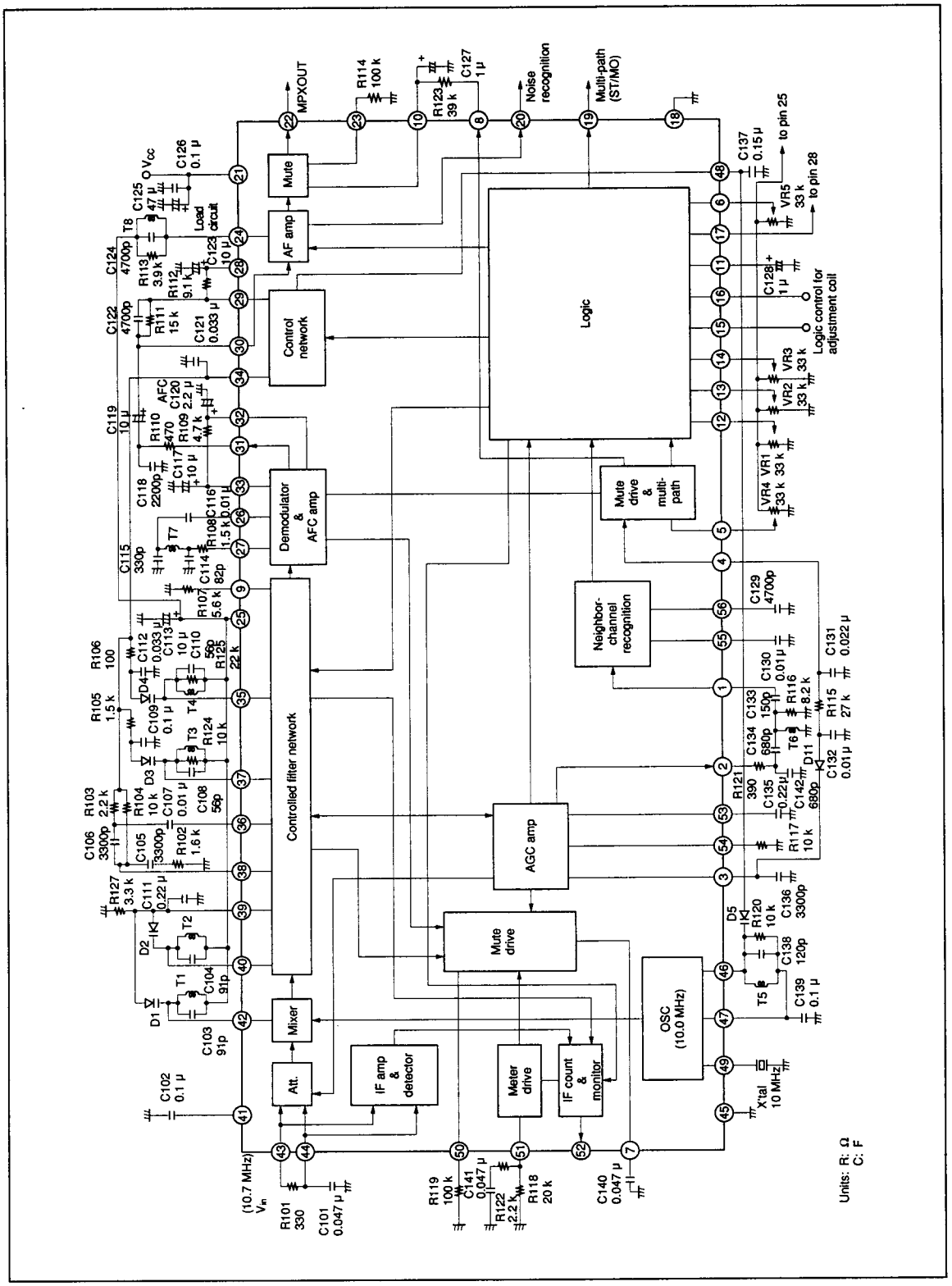
Item	Symbol	Rated Value	Units
Power supply voltage	V_{CC}max	16	V
Power dissipation	P_T[Note]	600	mW
Operating temperature	T_{opr}	–40 to +85	°C
Storage temperature	T_{stg}	–50 to +125	°C

Note: Rated value when T_a = 85°C

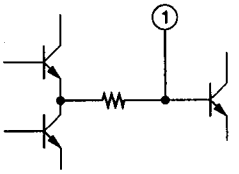
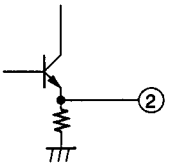
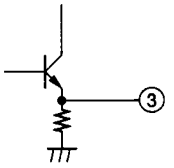
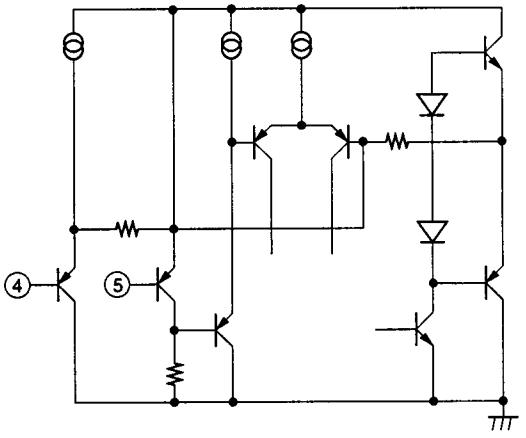
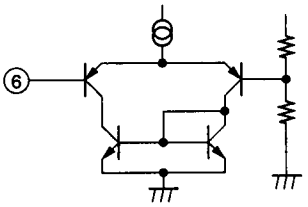
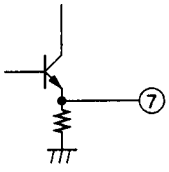
Note: Hitachi may need to contact customers concerning the number of units to be delivered in cases where H.U.C. Electronik GmbH has contacted Hitachi.

Hitachi semiconductor

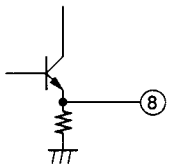
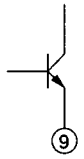
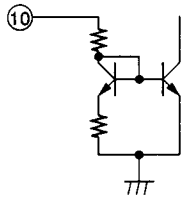
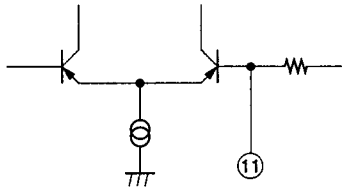
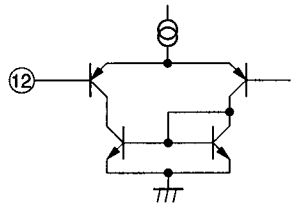
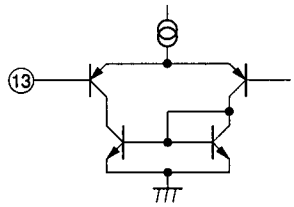
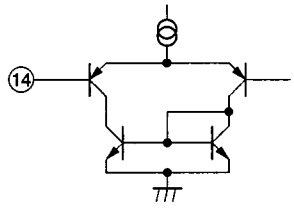
Block Diagram



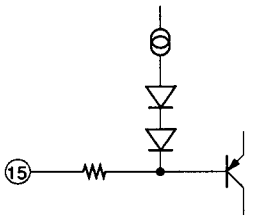
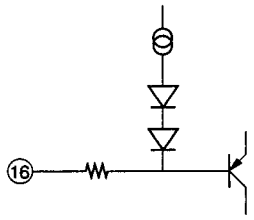
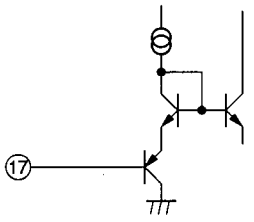
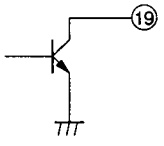
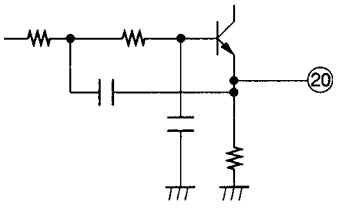
Pin Assignments

Pin No.	Name	Function	Equivalence Circuit
1	N•Ch In	Neighboring channel recognition input	
2	AGC Det Out	AGC detector output	
3	AGC Det	AGC detector	
4	MD In	Mute drive input	
5	V_{TH} Mute	Mute drive threshold voltage	
6	V_{TH} MP	Multipath threshold voltage	
7	SD Out	SD Detector output	

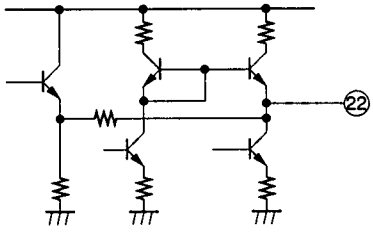
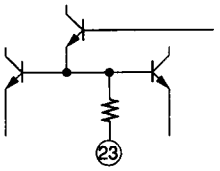
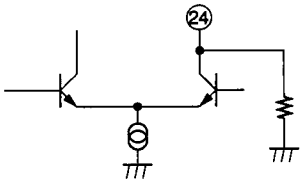
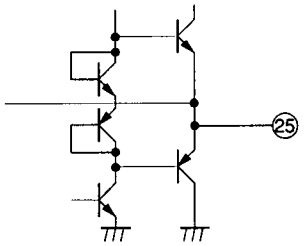
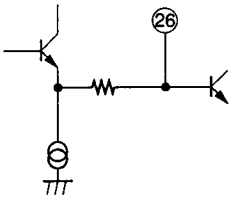
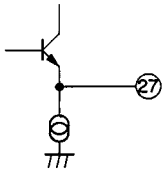
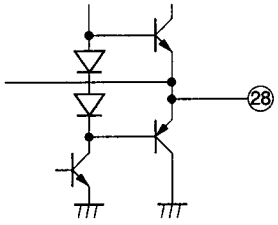
Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
8	Mute Out	Mute drive output	
9	Bias	—	
10	Mute In	Mute control input	
11	OSC1	Logic oscillator input	
12	V_{TH} NC1	NC1 threshold voltage	
13	V_{TH} NC2	NC2 threshold voltage	
14	V_{TH} NC3	NC3/NC4 threshold voltage	

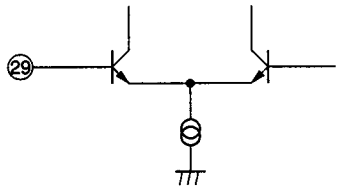
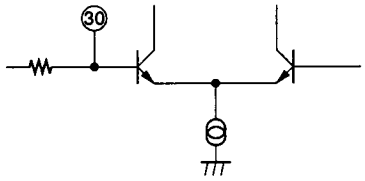
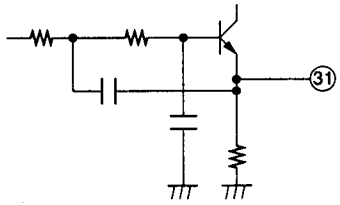
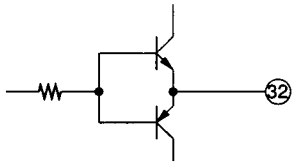
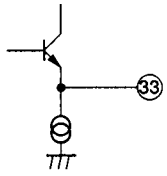
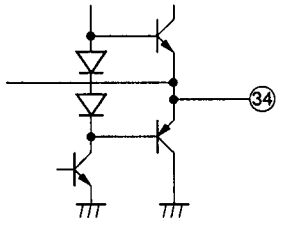
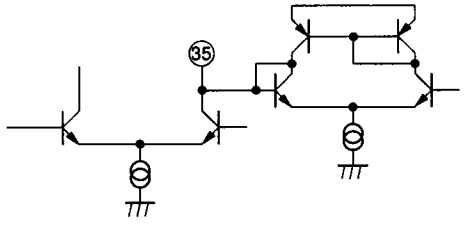
Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
15	Adj	Coil 1 adjustment logic control	
16	IF Count Request	IF count request/Force to NC0 mode	
17	Iinj	IIL injection current supply	
18	GND	—	
19	MP Out	Multipath output	
20	NPN Out	Noise canceller pulse noise output	
21	V_{CC}	Power supply	

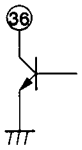
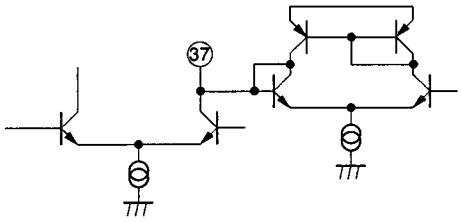
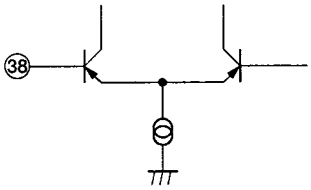
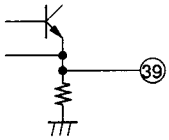
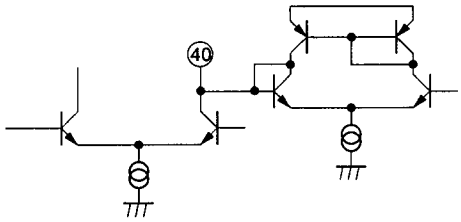
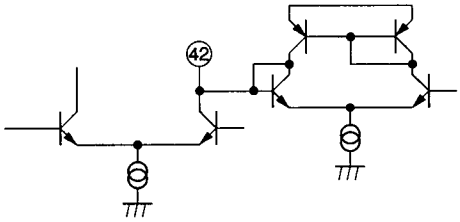
Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
22	AF Out	Audio output	
23	Mute ATT	Mute attenuation adjustment	
24	57K	57 kHz tuning circuit	
25	V_{ref1}	Voltage stabilization (5.7 V)	
26	PS In	Demodulator phase shifter input	
27	PS Out	Demodulator phase shifter output	
28	V_{ref2}	Voltage stabilization (3.2 V)	

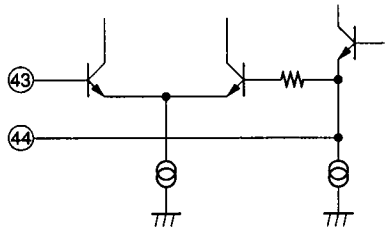
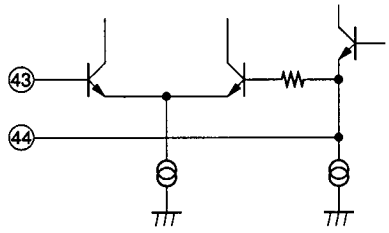
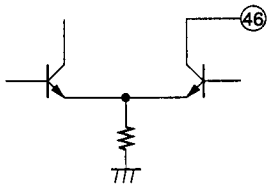
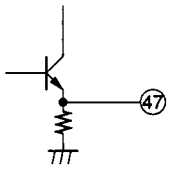
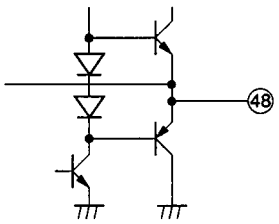
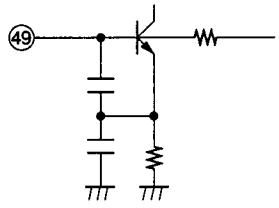
Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
29	CN In	Control network input	
30	AF In	AF amp input	
31	Demo Out	Demodulator output	
32	AFC	AFC voltage output	
33	V_{REF3}	AFC stabilization voltage	
34	CN Out	Control network output	
35	T4 Out	4th filter (700 kHz)	

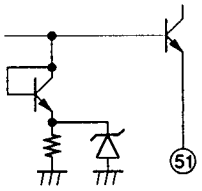
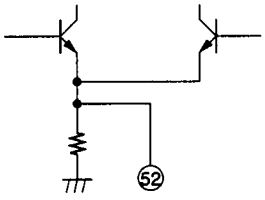
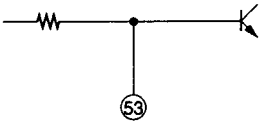
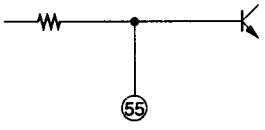
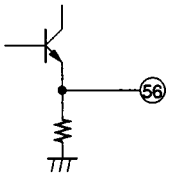
Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
36	L•P	Low pass filter control	
37	T3 Out	Third filter (700 kHz)	
38	Buff In	Control signal buffer input	
39	Buff Out	Control signal buffer output	
40	T2 Out	Second filter (700 kHz)	
41	Bias	RF V_{CC}	
42	T1 Out	Mixer output	

Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
43	V_{in}	Input	
44	Bypass	Input current bypass	
45	GND	RF GND	
46	P.S	Phase shifter	
47	Bypass	Oscillator bypass	
48	CN Out2	Phase shifter control network output	
49	OSC2	Mixer oscillator (10 MHz)	

Pin Assignments (cont)

Pin No.	Name	Function	Equivalence Circuit
50	Bias	SD bias	
51	tM	Signal meter	
52	IF Count Out	IF count and IF monitor	
53	AGC	AGC	
54	AGC	AGC start point	
55	N•Ch Det	Neighboring channel detector	
56	N•Ch	Neighboring channel LP filter	

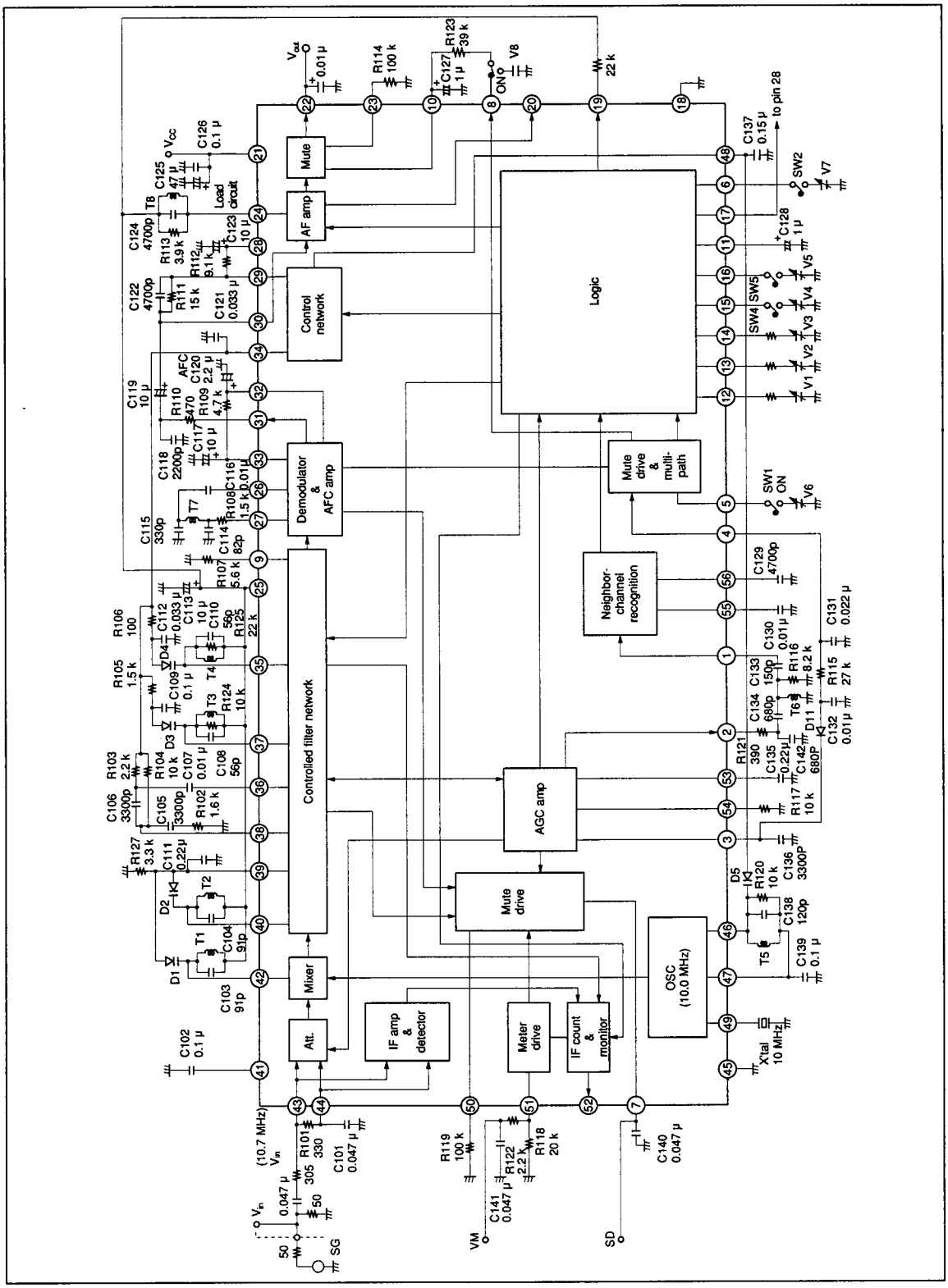
Electrical Characteristics

(T_a = 25°C, V_{CC} = 8.2 V, fc = 10.700 MHz, V_{in} = 100 dBμ, fm = 1 kHz, Δf = ±22.5 kHz dev.)

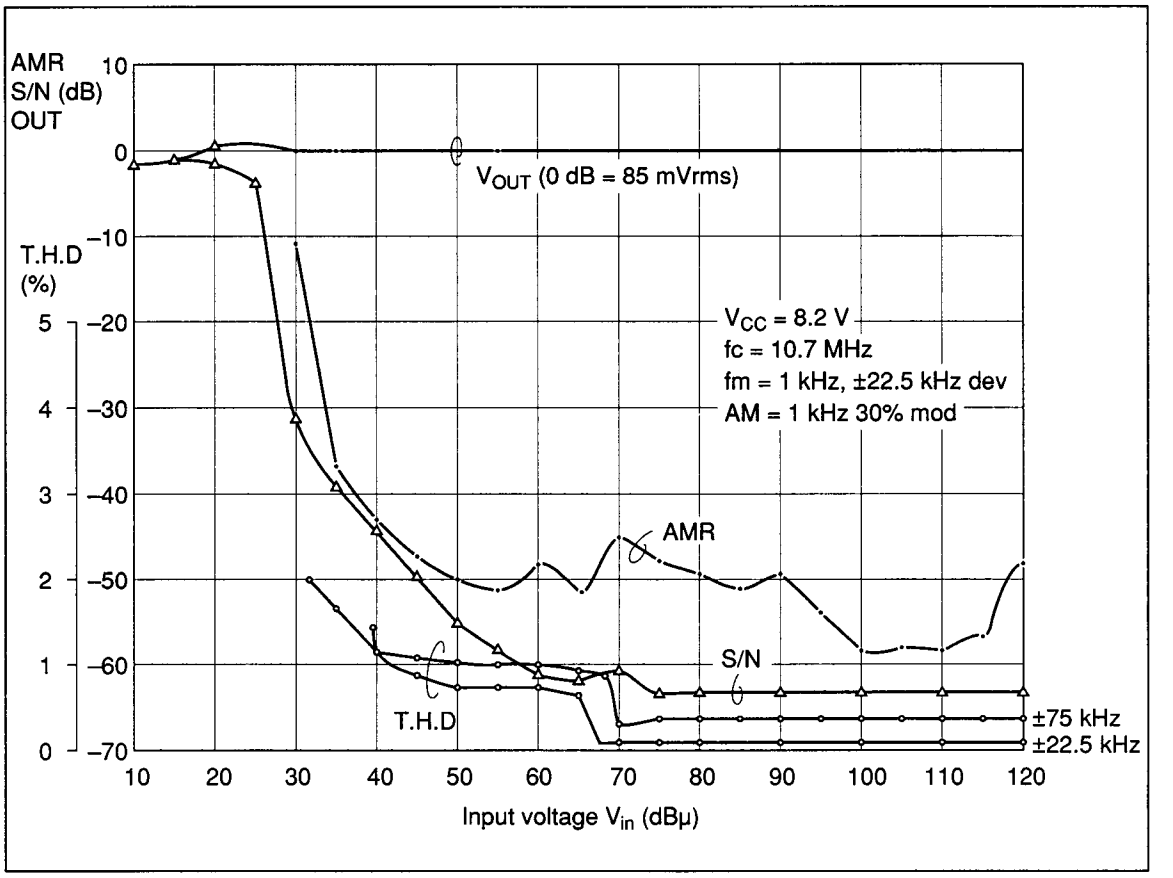
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Audio output voltage	V_{out}	—	85	—	mVrms	
Harmonic Distortion	T•H•D (1)	—	0.15	—	%	
	T•H•D (2)	—	0.40	—	%	Δf = ±75 kHz dev.
Signal to noise ratio	S/N	—	63	—	dB	
Mute attenuation	Mute ATT (1)	—	–7.5	—	dB	V8 = 0.8 V, SW3 ON
	Mute ATT (2)	—	–23	—	dB	V8 = 2 V, SW3 ON
	Mute ATT (3)	—	–37	—	dB	V8 = 5 V, SW3 ON
Meter drive voltage	$V_{M(1)}$	—	0	—	V	No input
	$V_{M(2)}$	—	1.6	—	V	V_{in} = 70 dBμ
	$V_{M(3)}$	—	5.5	—	V	V_{in} = 120 dBμ
Quiescent current	I_{CC}	—	55	—	mA	No input
SD drive voltage	SD (1)	—	5.1	—	V	No input
	SD (2)	—	0	—	V	V_{in} = 70 dBμ
SD bandwidth	SD (BW)	—	115	—	kHz	
OSC voltage	OSC	—	2.2	—	Vp-p	
IF count output voltage	IF out	—	880	—	Vp-p	
Filter tuning voltage	$V_{T(AC)}$	—	105	—	mVp-p	
AGC voltage	AGCsens	—	54	—	dBμ	
Usable sensitivity	US	—	27	—	dBμ	S/N = 30 dB
Pin 15 threshold voltage	$V_{15(1)}$	—	—	1.7	V	V_{in} = 100 dBμ, SW4 ON NC2 → Normal
	$V_{15(2)}$	2.9	—	—	V	Normal → NC4
Pin 16 threshold voltage	$V_{16(1)}$	—	—	1.7	V	V_{in} = 50 dBμ, SW4 ON NC0 → Normal
	$V_{16(2)}$	2.9	—	—	V	Normal → IF count request
Tracking range	BW (NC4-1)	—	78	—	kHz dev	fm = 1 kHz, V_{in} = 62 dBμ SW4 ON, V5 = 5 V
	BW (NC4-2)	—	29	—	kHz dev	fm = 10 kHz, V_{in} = 62 dBμ SW4 ON, V5 = 5 V

Note: T7 detector coil adjustment: Adjust T7 so that the AFC voltage (the voltage between pins 32 and 33) is 0 V.

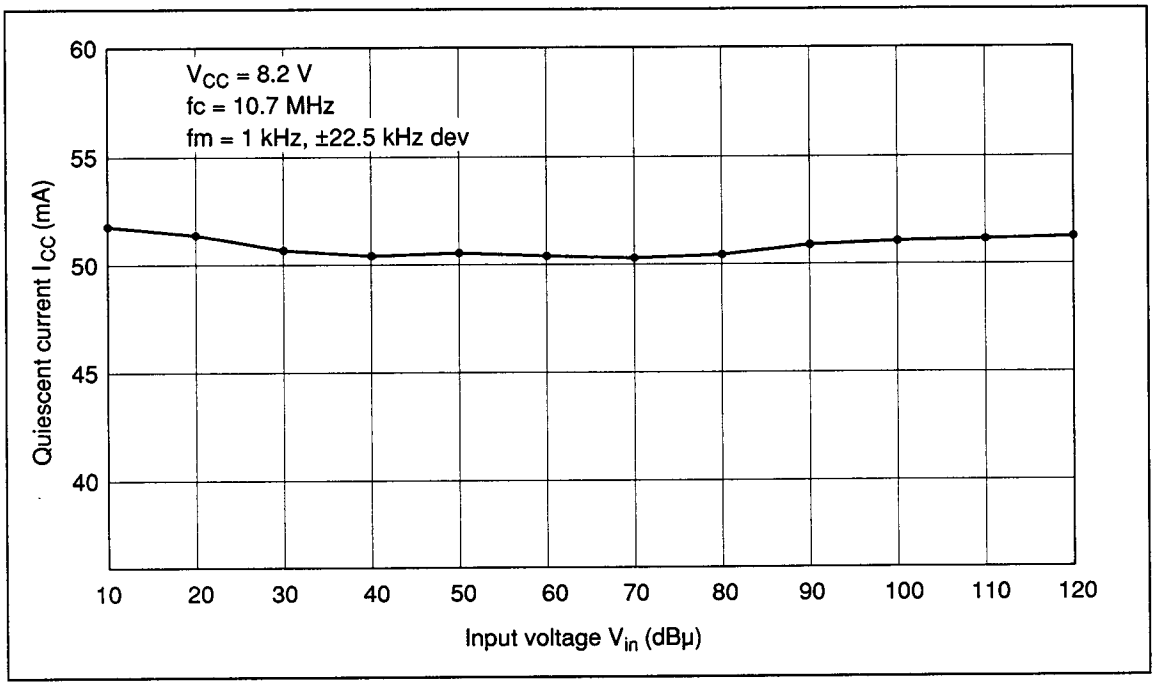
Test Circuit



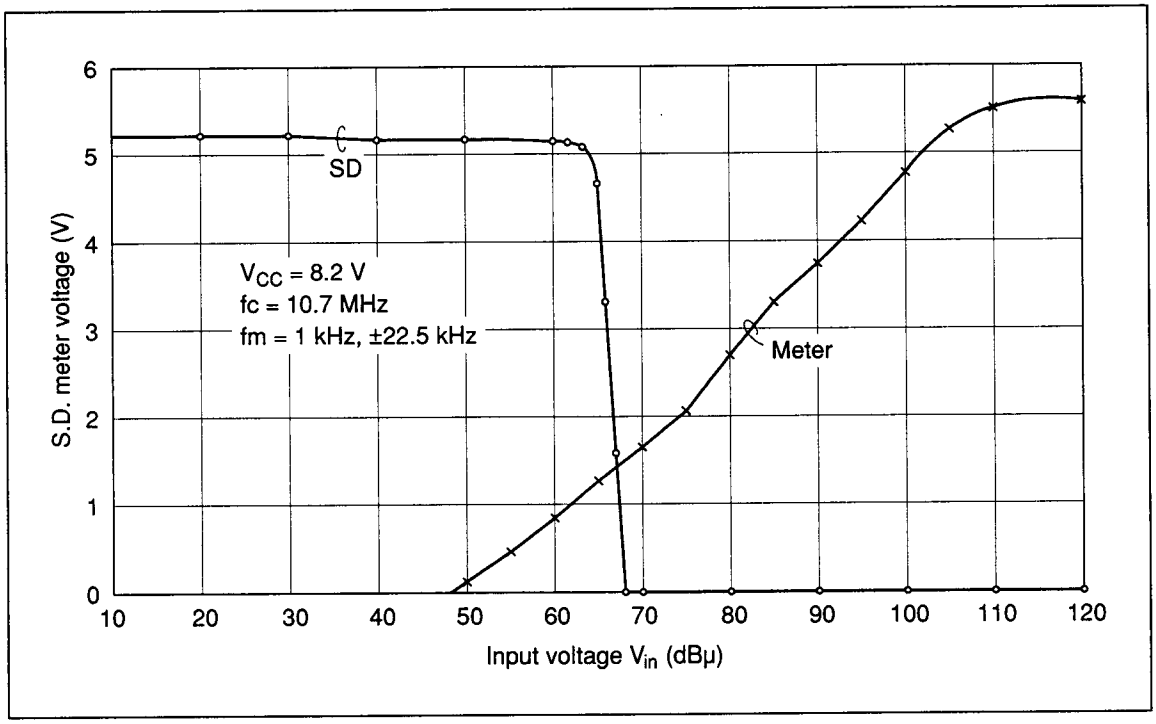
Input Characteristics



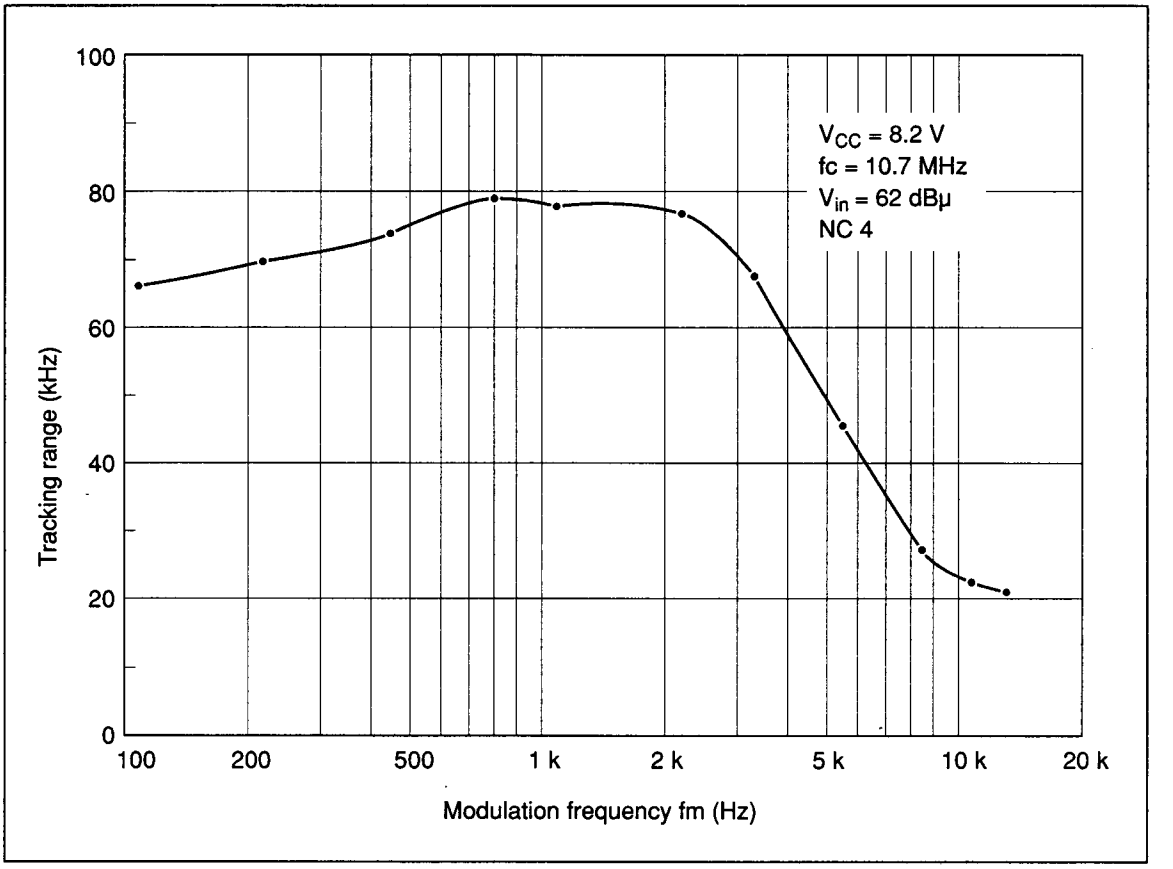
Quiescent Current vs. Input Voltage Characteristics



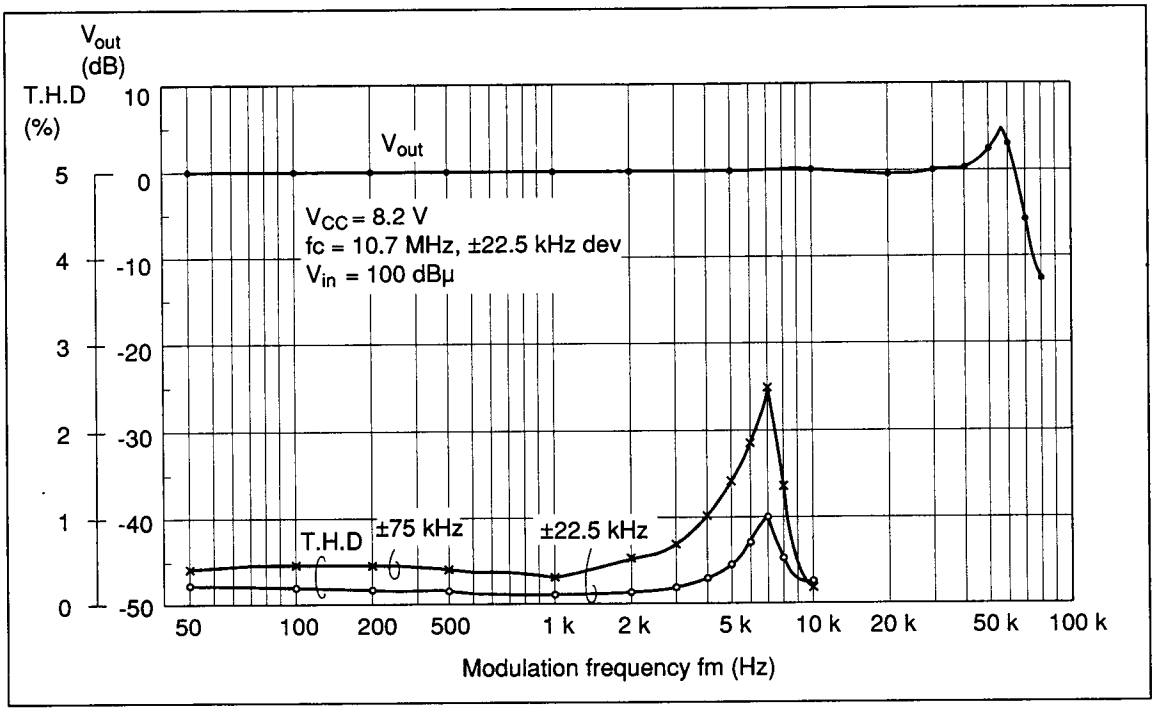
S.D. Meter Voltage vs. Input Voltage Characteristics



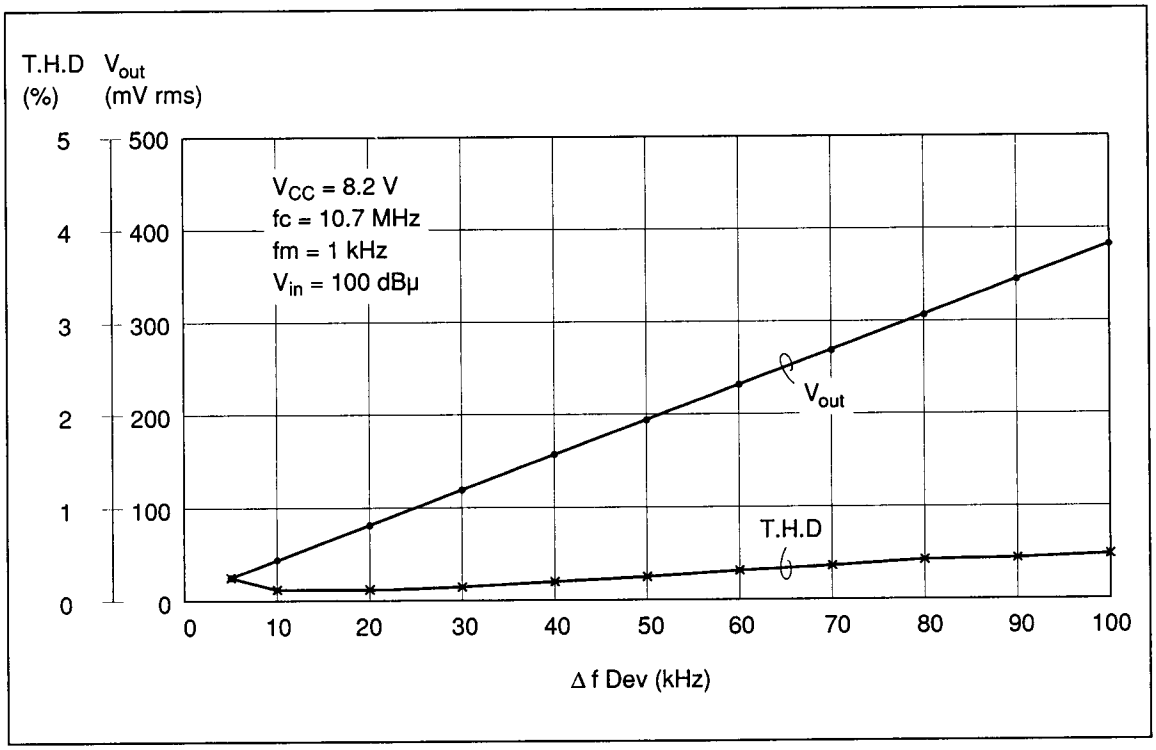
Tracking Range vs. Modulation Frequency Characteristics



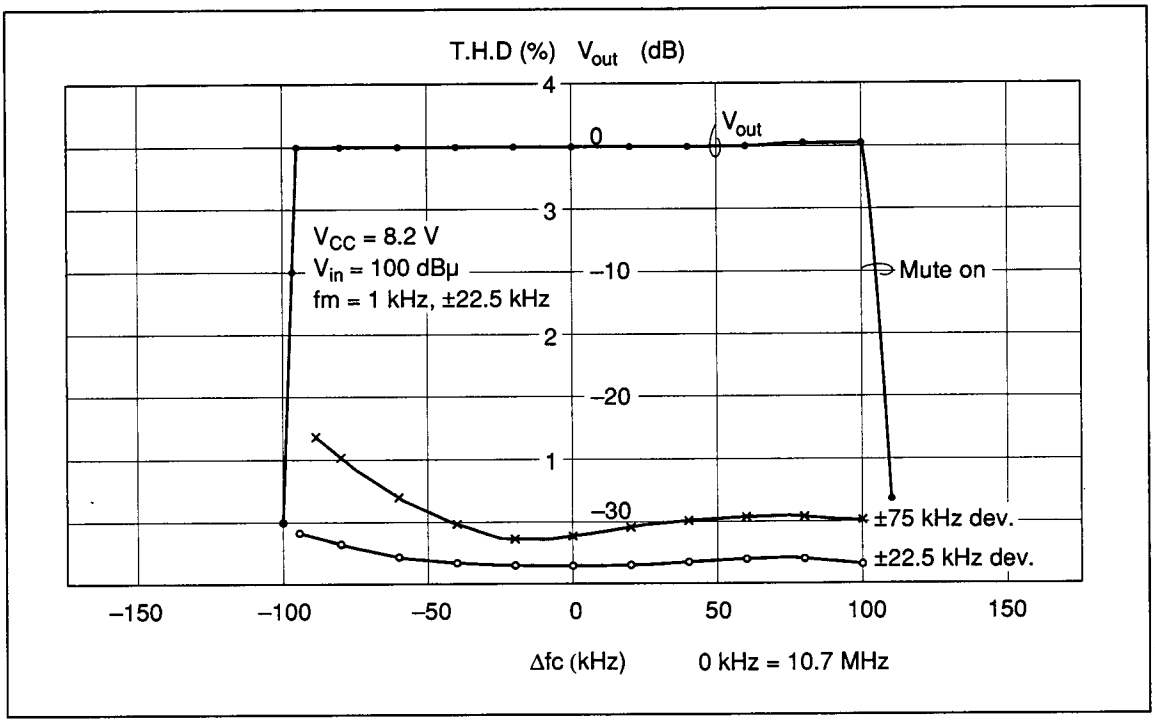
Harmonic Distortion and Output Voltage vs. Modulation Frequency Characteristics



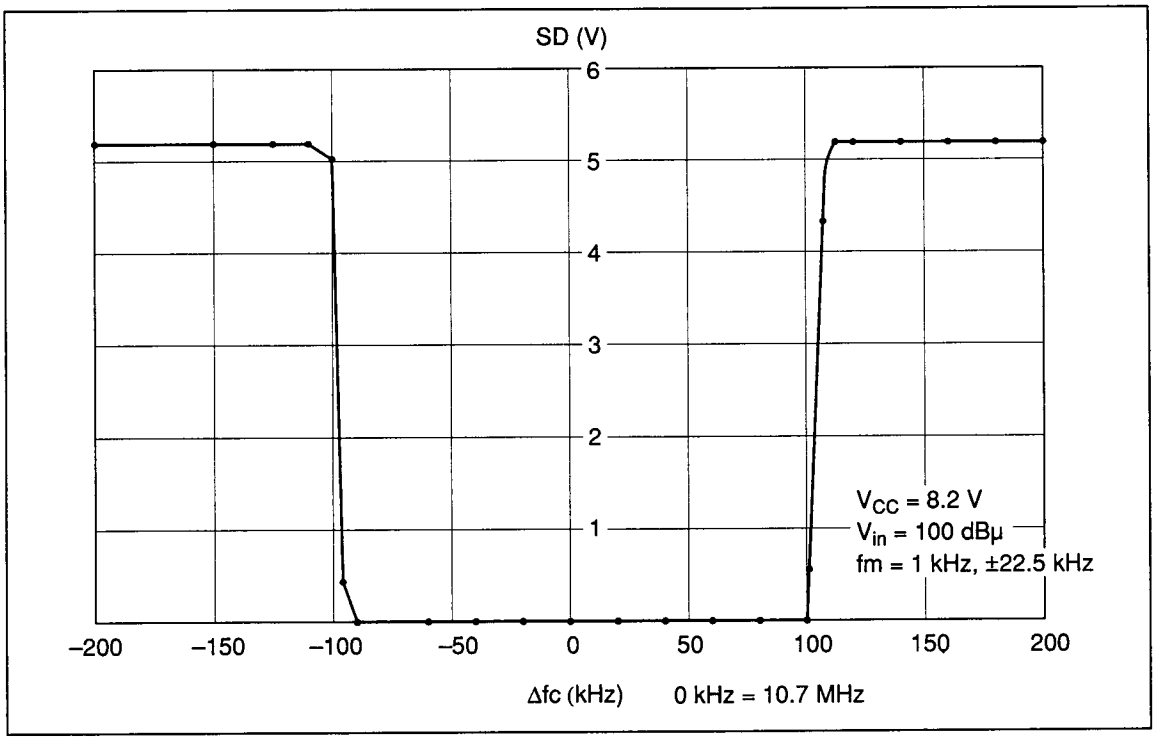
FM Modulation Factor Characteristics



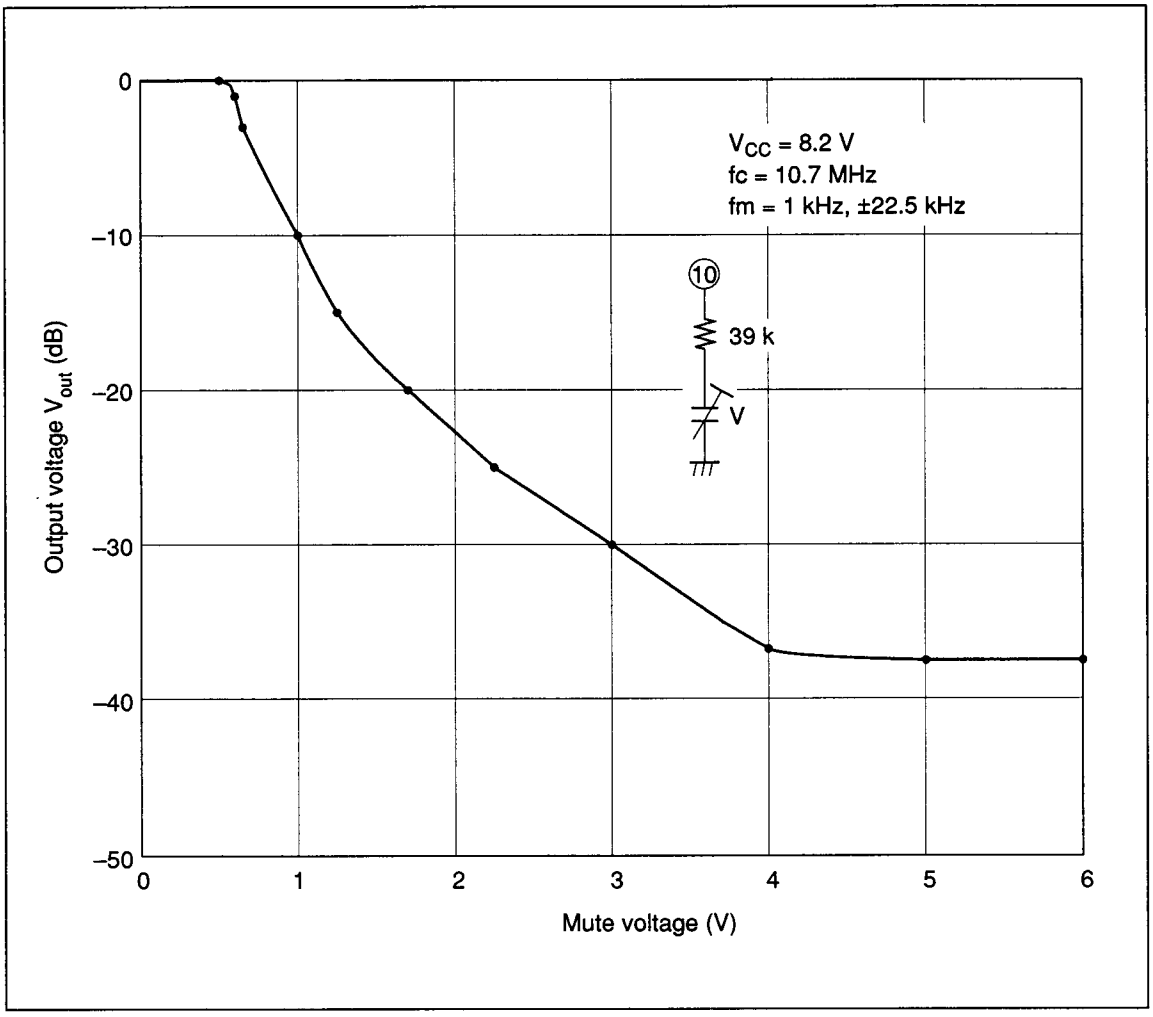
Detuning Frequency Characteristics (1)



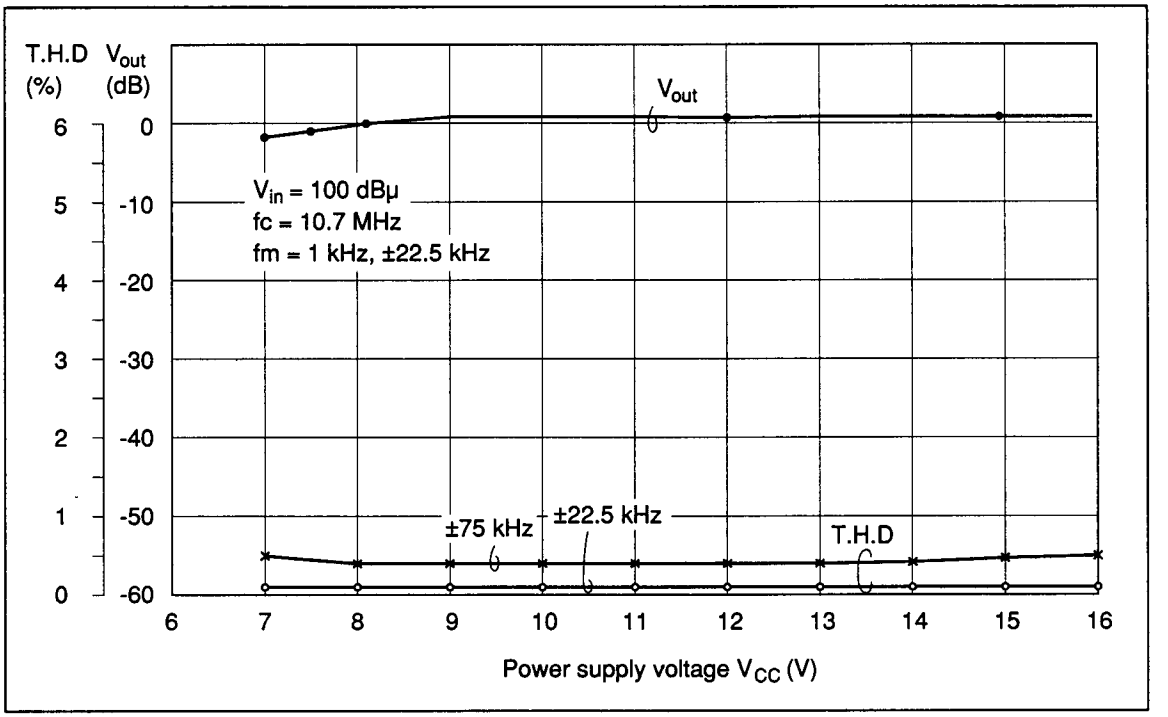
Detuning Frequency Characteristics (2)



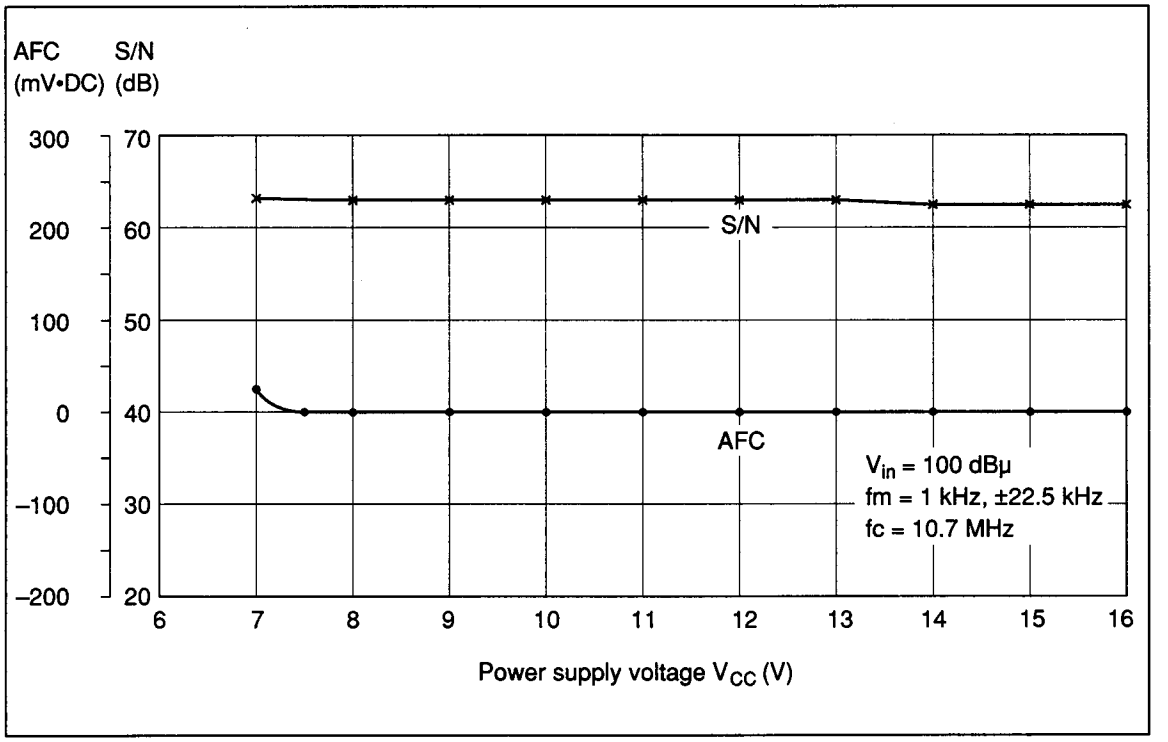
Output Voltage vs. Mute Voltage Characteristics



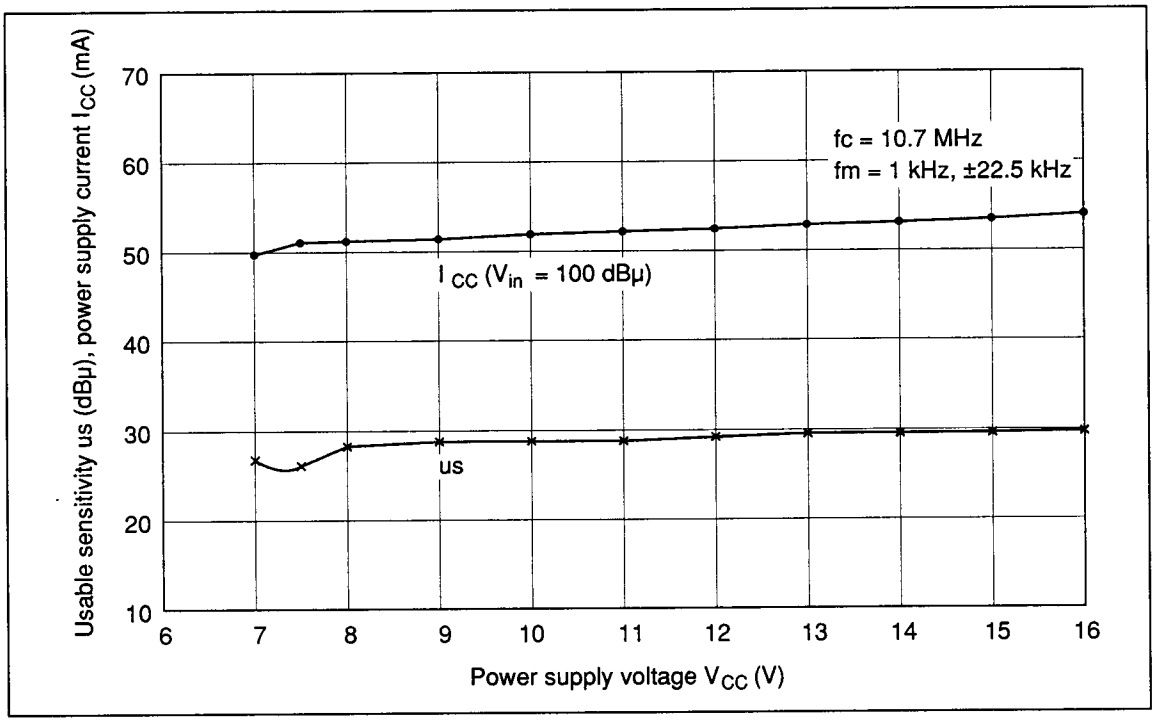
Power Supply Voltage Characteristics (1)



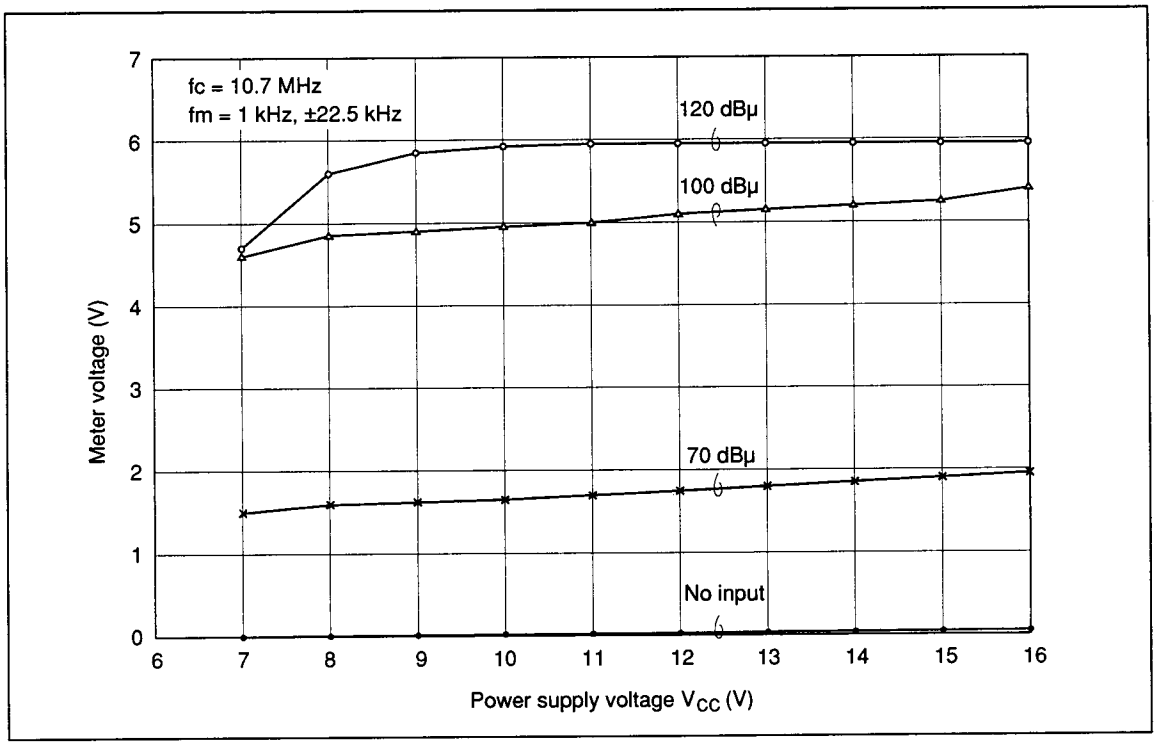
Power Supply Voltage Characteristics (2)



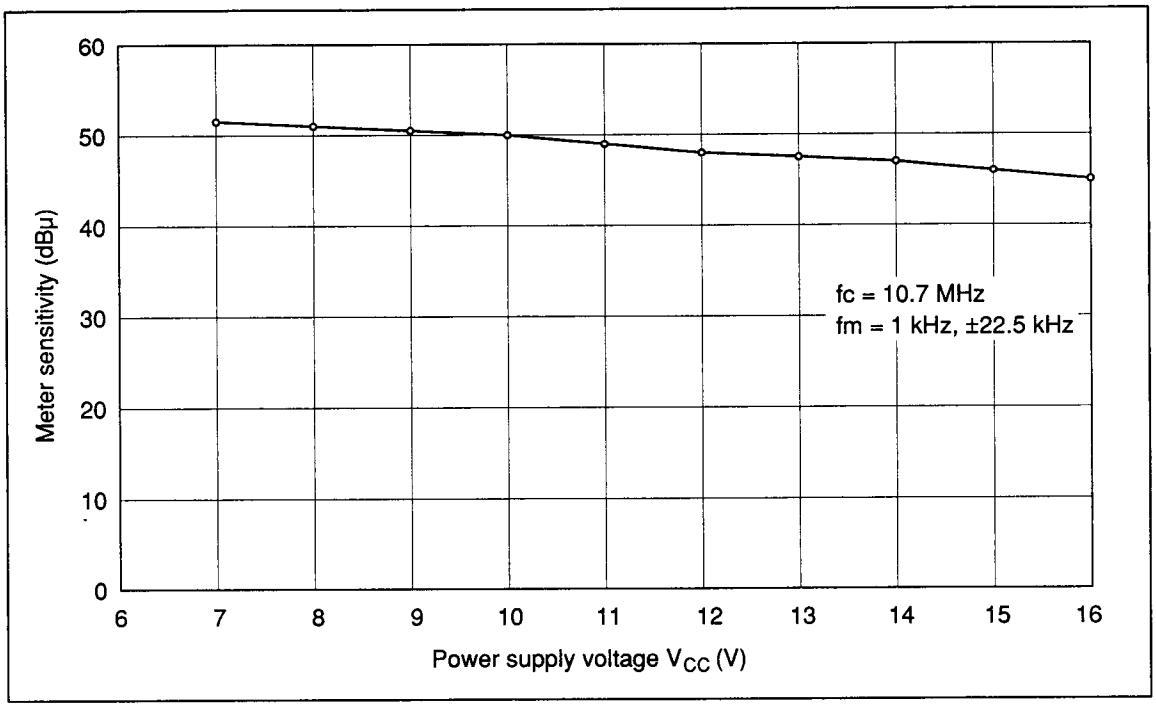
Power Supply Voltage Characteristics (3)



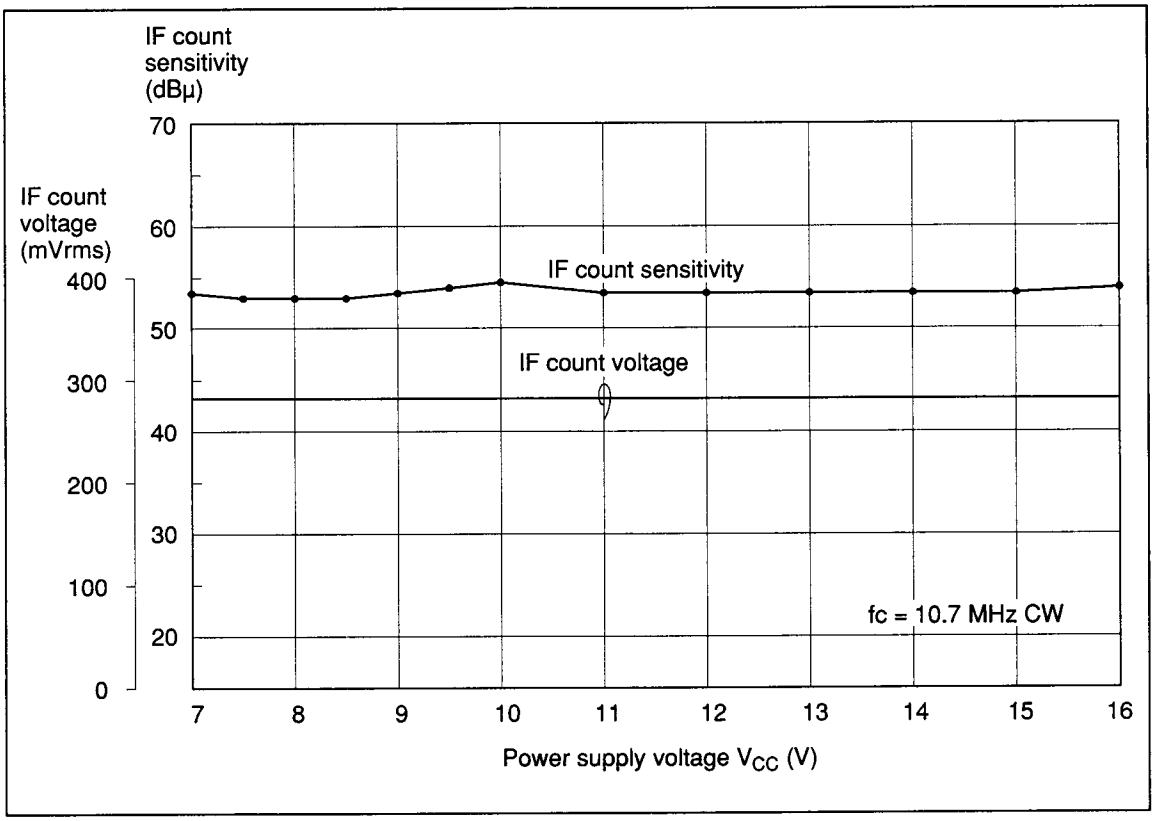
Power Supply Voltage Characteristics (4)



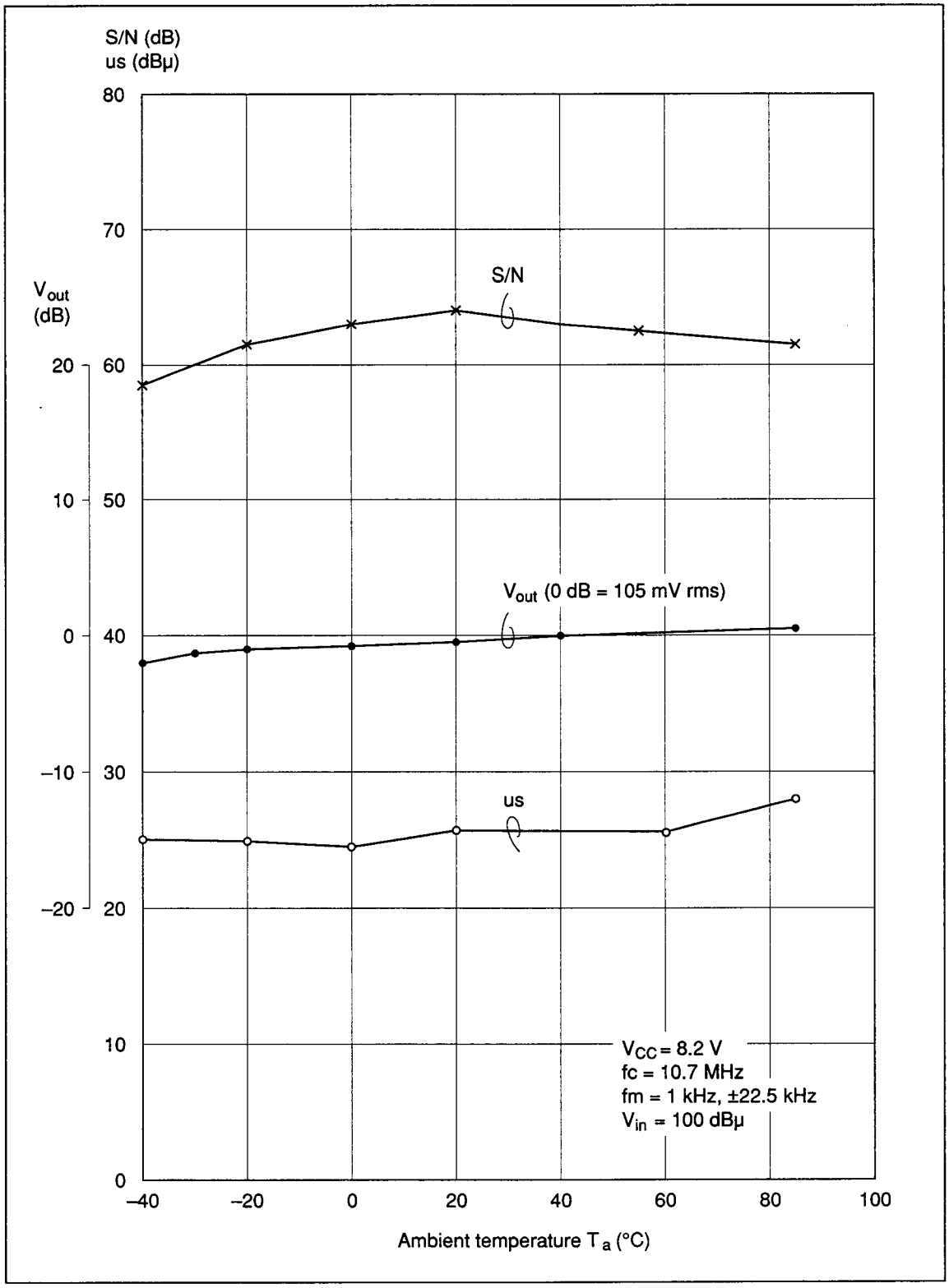
Power Supply Voltage Characteristics (5)



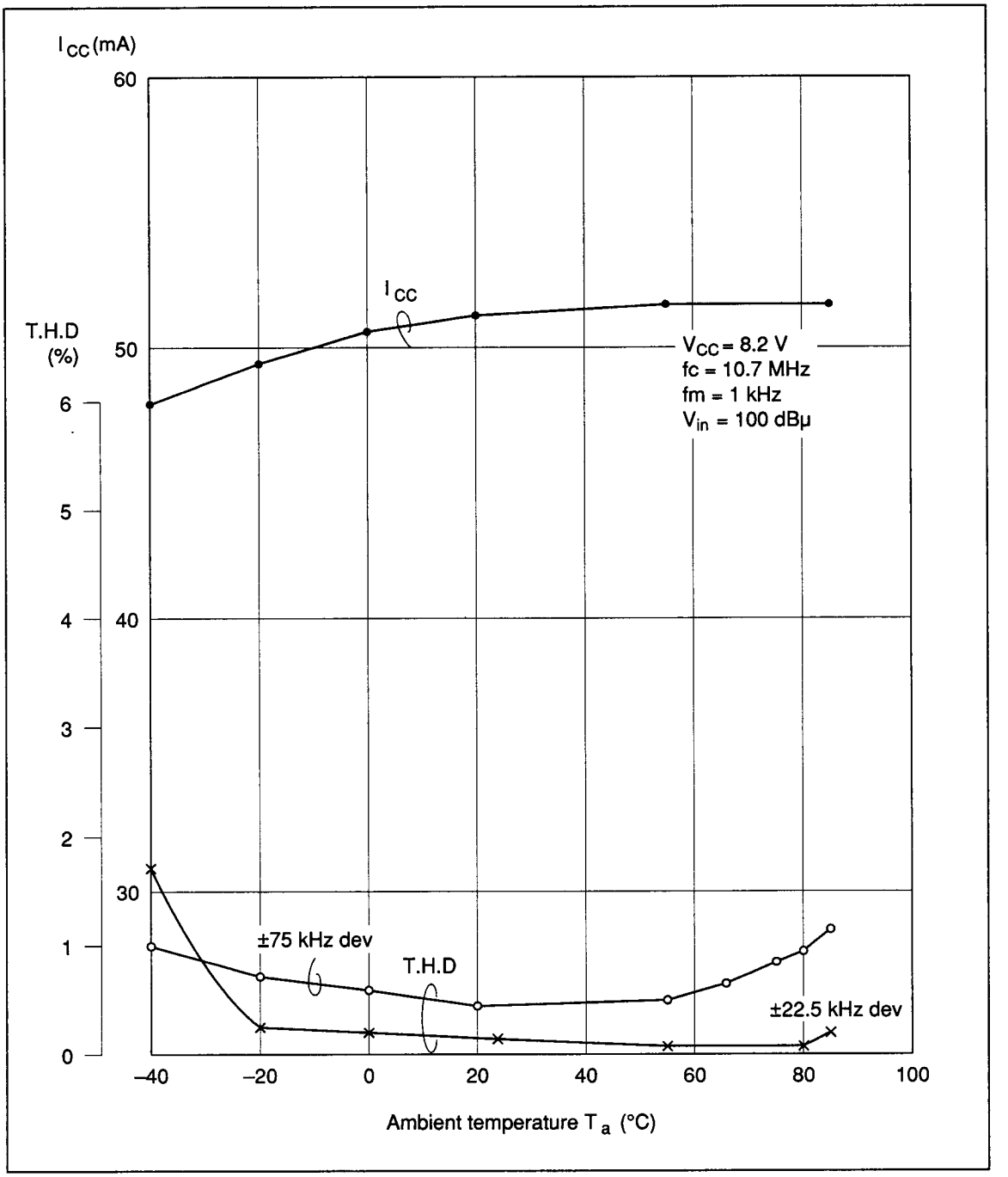
IF Count Sensitivity and Power Supply Voltage Characteristics



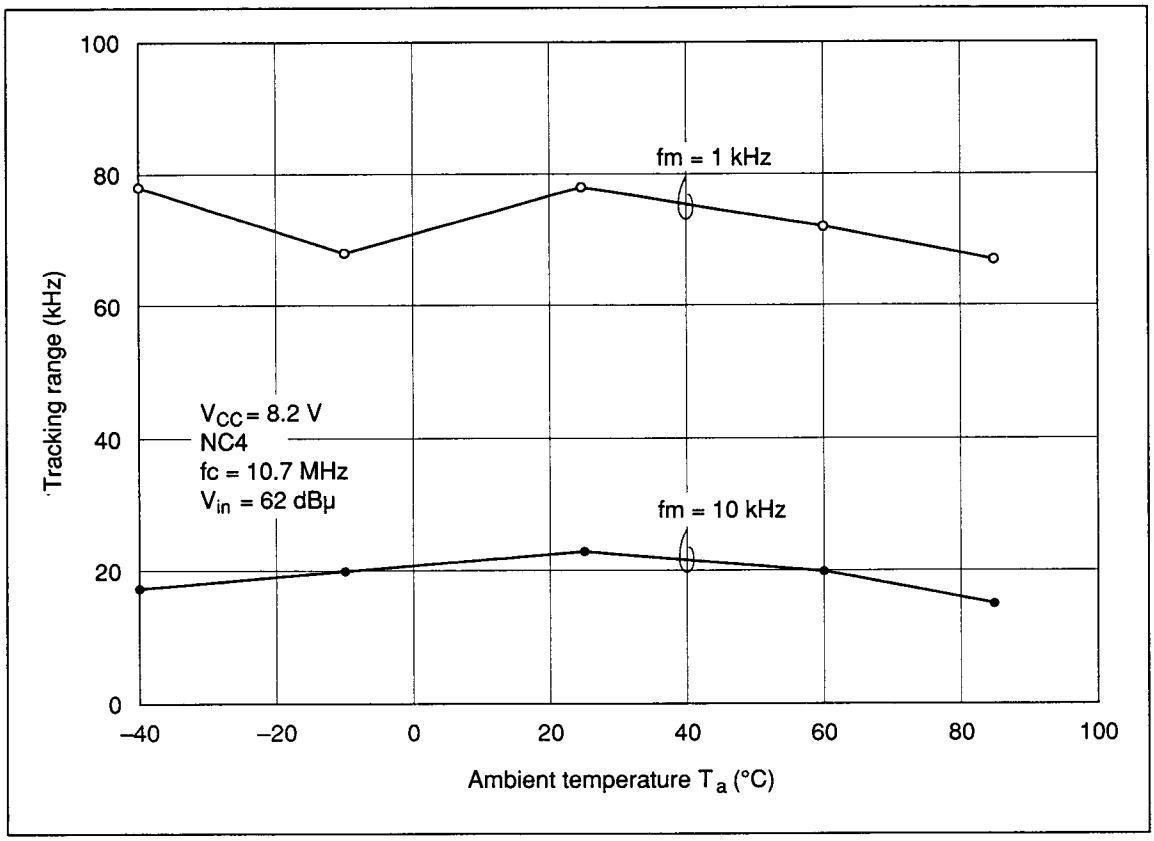
Temperature Characteristics (1)



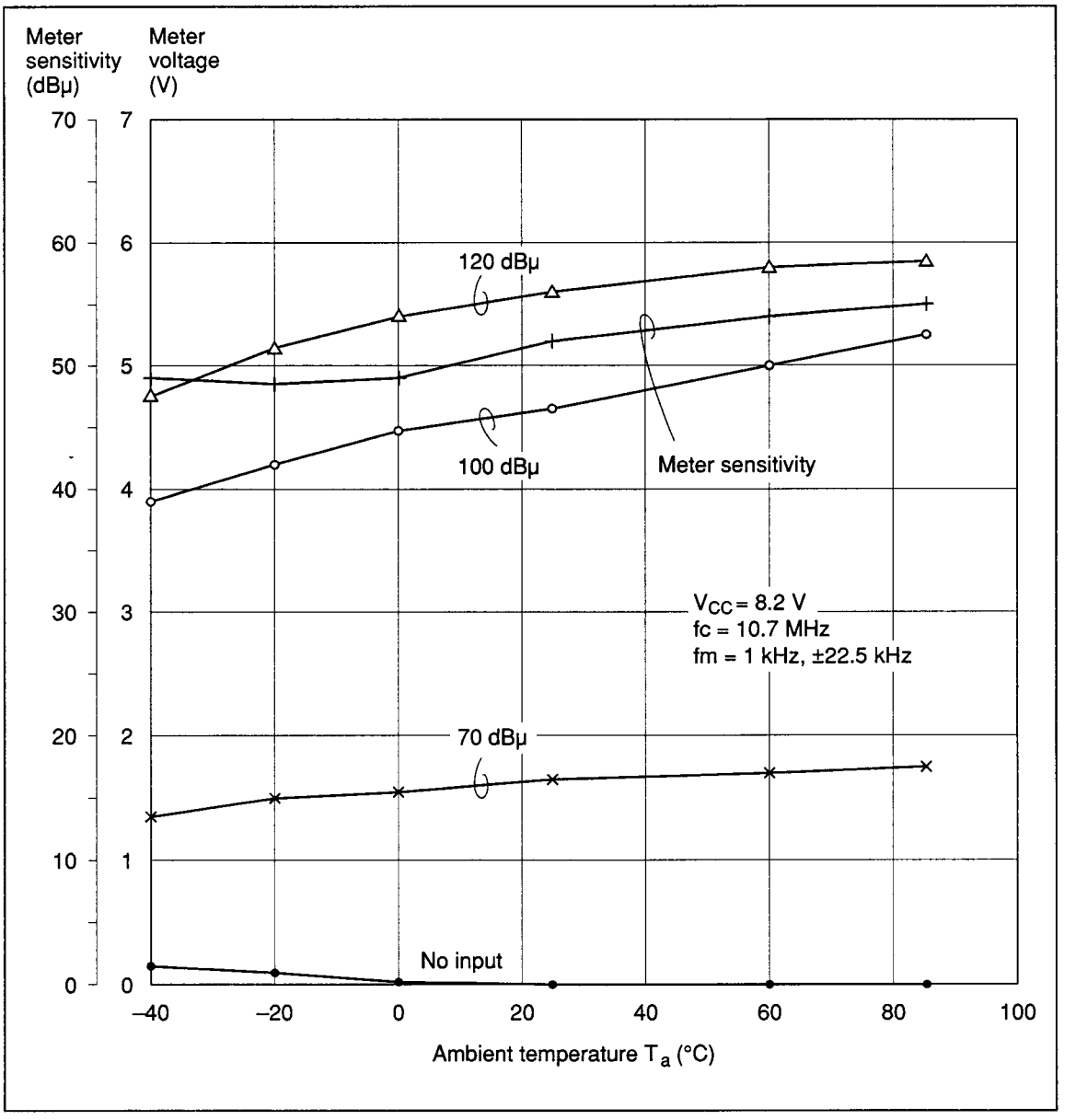
Temperature Characteristics (2)



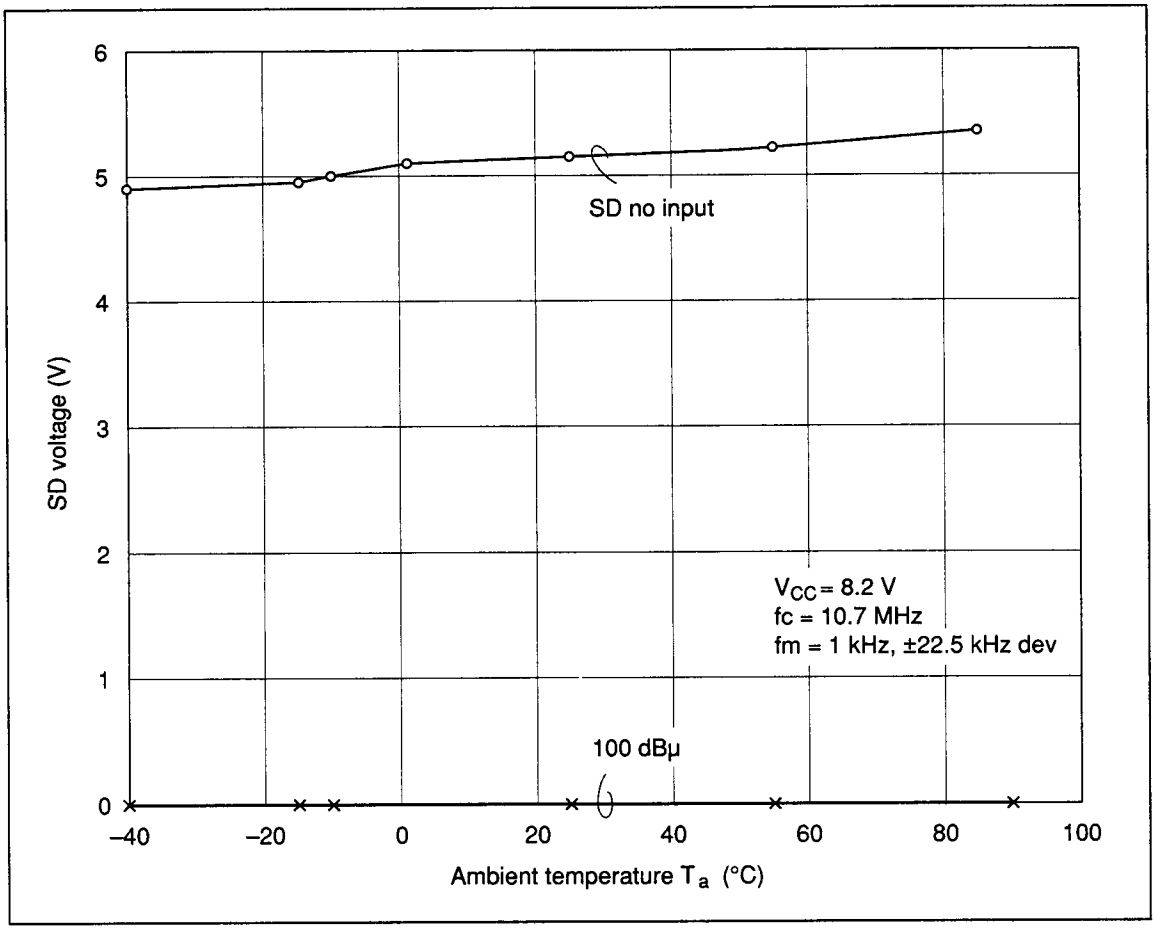
Tracking Range vs. Ambient Temperature Characteristics



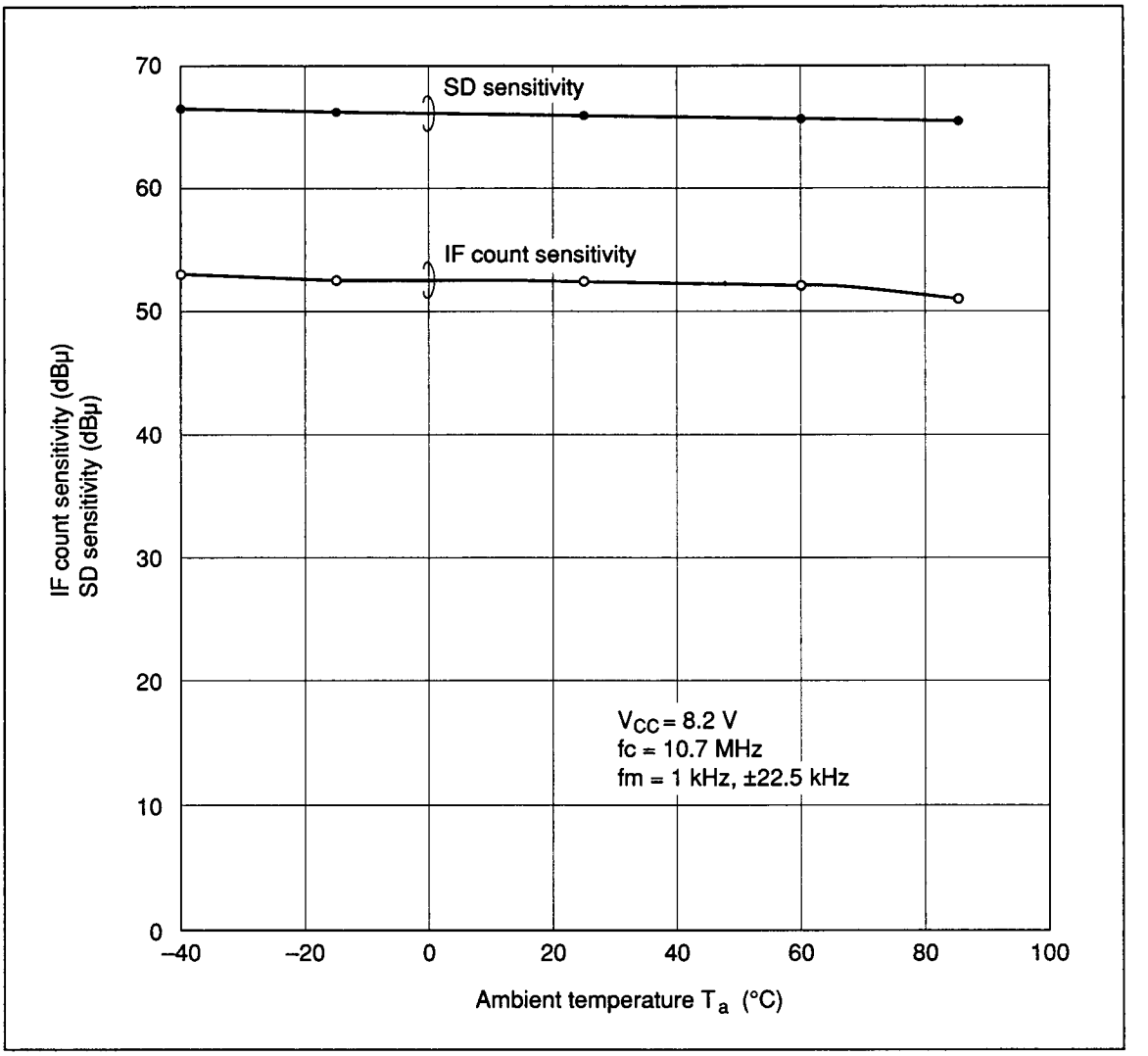
Meter Sensitivity and Meter Voltage vs. Ambient Temperature Characteristics



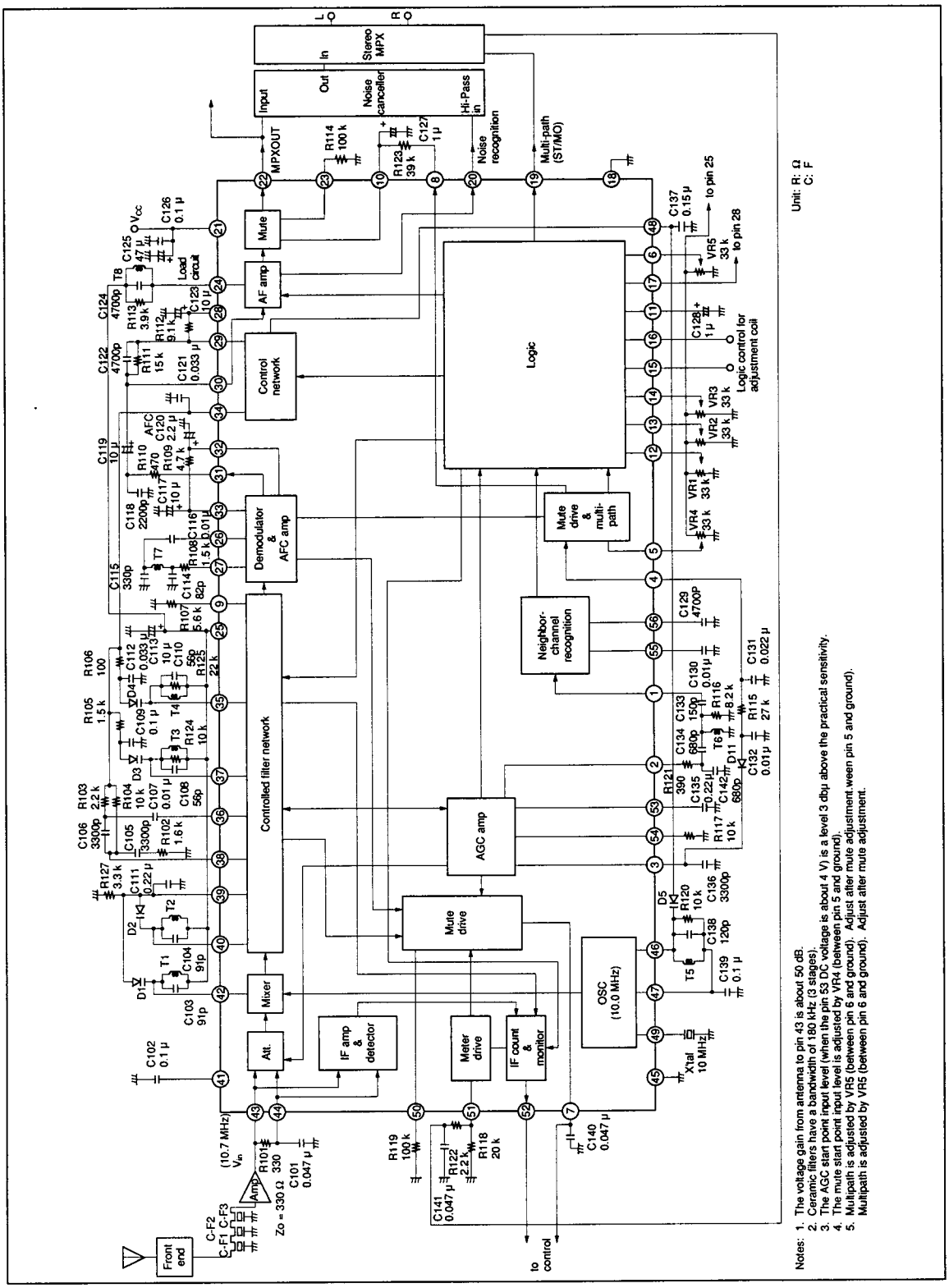
SD Voltage vs. Ambient Temperature Characteristics



IF Count Sensitivity and SD Sensitivity vs. Ambient Temperature Characteristics



Circuit Example



Notes:
1. The voltage gain from antenna to pin 43 is about 50 dB.
2. Ceramic filters have a bandwidth of 180 kHz (3 stages).
3. The AGC start point input level (when the pin 53 DC voltage is about 4 V) is a level 3 dbμ above the practical sensitivity.
4. The mute start point input level is adjusted by VR4 (between pin 5 and ground).
5. Multipath is adjusted by VR5 (between pin 6 and ground). Adjust after mute adjustment.ween pin 5 and ground).
   Multipath is adjusted by VR5 (between pin 6 and ground). Adjust after mute adjustment.

Filter Coil Adjustment (T1 to T5)

1. Adjustment in the NC4 Mode

- Adjustment conditions

  Conditions:

  — fc = 98 MHZ (USA) or fc = 83 MHZ (Japan), with an input level signal (with the pin 53 voltage less than 3 V) such that the AGC does not operate when the signal is unmodulated.

  — Set pin 15 to 5 V, and observe the 700 kHz output waveform from pin 52.

  — Adjust pin 14 to 0.3 V.

- Adjust T1 to T4, and maximize the pin 52 output voltage. At this point, adjust the oscilloscope so that the pin 52 waveform takes 8 gradations.

- Next, turn the T1 core in the inward direction (moving the tuning point lower), and set the pin 52 waveform to have an amplitude of 4 gradations.

- Next, turn the T2 core in the outward direction (moving the tuning point higher), and set the pin 52 waveform to have an amplitude of 2.5 gradations, as opposed to the previous 4 gradations.

- Next, input fc as above except with a 1 kHz modulation frequency and a V_{in} of 10 dBμ. Adjust T1 so that the tracking range has a ±6 kHz deviation.

2. Phase Shift Coil T5 Adjustment

- Adjustment Conditions

  — Use an fc as above except with an input level of 20 dBμ.

  — Set pin 15 to 5 V, and observe the pin 52 output waveform with an oscilloscope.

- Set the modulation frequency fm to be between 6 and 10 kHz with Δf = ±20 kHz, and minimize the AM modulation on the pin 52 output waveform.

- Next, set the modulation frequency to 15 kHz with Δf = ±20 kHz, and adjust the pin 52 output waveform AM modulation to be symmetrical from left to right. (See figure 1.)

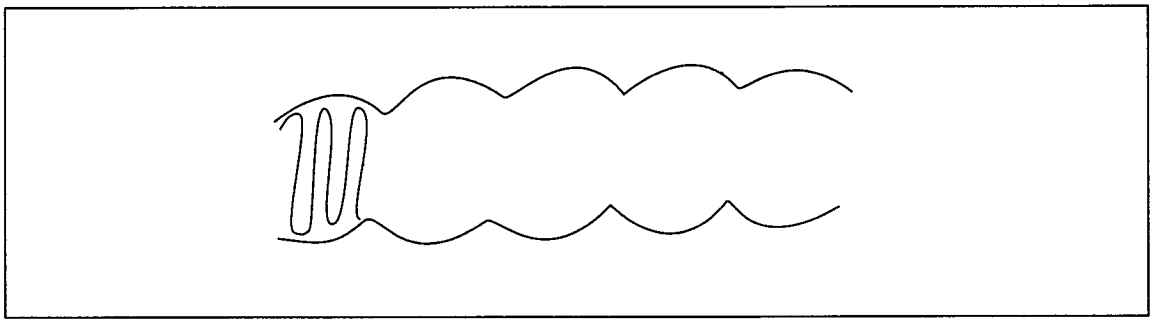


Figure 1 The Pin 52 Output Waveform

Adjacency Detection Threshold Adjustment (pins 12 to 14)

1. Input Conditions

- Desired signal: Carrier frequency 98 MHz, V_{in} = 20 dBμ, fm = 1 kHz, Δf = ±22.5 kHz.
- Interference signal: Carrier frequency 98.1 MHz, Vin = 20 dBμ, fm = 400 Hz, Δf = ±22.5 kHz.

  Carrier frequency 97.9 MHz, V_{in} = 20 dBμ, fm = 400 Hz, Δf = ±22.5 kHz.

2. Adjustment

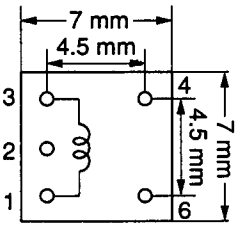
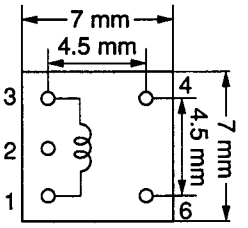
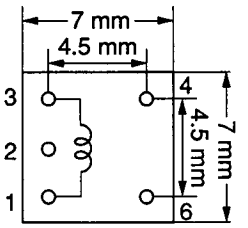
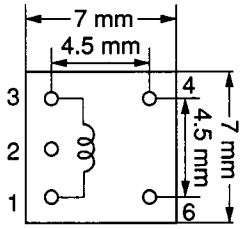
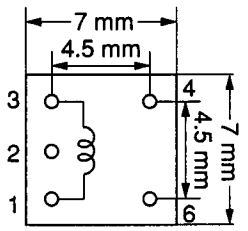
- Set the pin 12, pin 13, and pin 14 voltages to be 0.3 V.
- Adjust T6 so that the peak occurs at the tuning point of the adjacency detection high pass filter (between pins 1 and 2).
- Increase the input level of the interference signal, and then reduce it to just below the input level where the output waveform distortion increases. When the voltage on pin 12 is increased, adjacency detection turns on (the circuit enters NC1 mode) and the pin 12 voltage becomes about 4.9 V.
- Next, Increase the level of the interference signal, and then reduce it to just below the input level where the output waveform distortion increases. When the voltage on pin 13 is increased, adjacency detection turns on (the circuit enters NC2 mode) and the pin 13 voltage becomes about 4.9 V.
- Next, increase the level of the interference signal, and then reduce it to just below the input level where the output waveform distortion increases. Increase the pin 14 voltage. Now, increase the interference signal and confirm that the output waveform distortion does not increase.
- Perform the above adjustment for interference signals of both 98.1 and 97.9 MHz, and set the pin 12 to 14 threshold voltages on the high side.

Forced Mode Settings

Pin No.	NC2*1	NC4*1	NC0	IF Counter*2
15	0 V	5 V	Open	Open
16	Open	Open	0 V	5 V

Notes: 1. The IF output (700 kHz) in NC2 and NC4 modes is output from pin 52.
2. The IF output (10.7 MHz) in IF counter mode is output from pin 52.

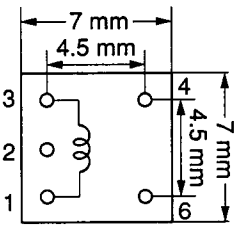
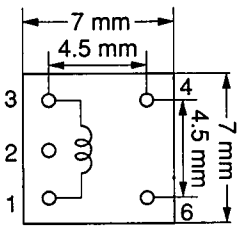
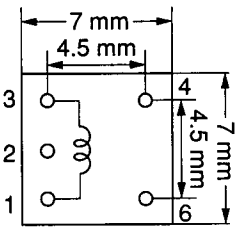
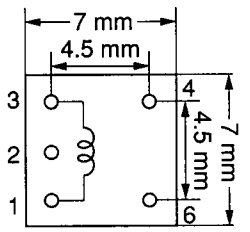
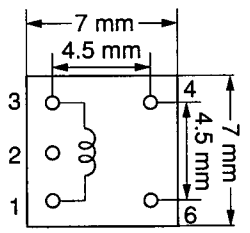
1. Coil Specifications (TOKO Co. Ltd)

Coil No.	Coil Specifications		Pin Arrangements (bottom view)	
T1 to T4	L: 150 µH, Qu > 130 269BRS-0510Z	(700 kHz)		Height: 9 mm
T5	L: 1.45 µH, Qu > 35 291ANS-6576Z	(10 MHz)		Height: 9 mm
T6	L: 8.2 mH, Qu > 70 269LNS-0499Z	(100 kHz)		Height: 9 mm
T7	L: 150 µH, Q > 70 L7NRS-2272Z	(700 kHz)		Height: 9 mm
T8	L: 2 mH, Q > 100 269LNS-0500Z	(57 kHz)		Height: 9 mm

2. Variable Capacitance Diodes

D1 to D4: Hitachi HVR 320
D5: Hitachi HVR 17

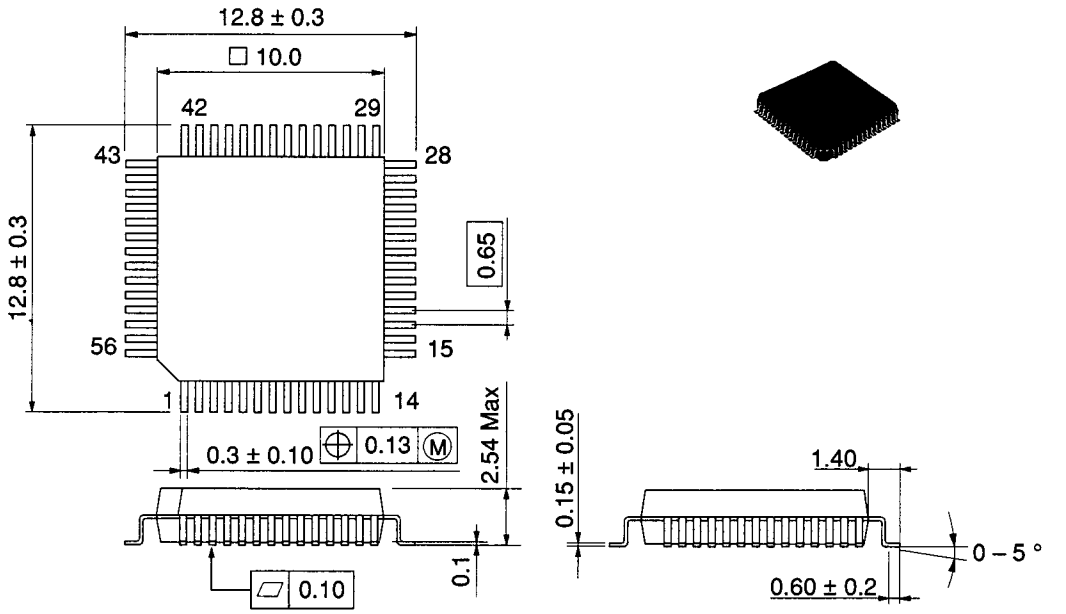
1. Coil Specifications (Mitumi Co. Ltd)

Coil No.	Coil Specifications		Pin Arrangements (bottom view)	
T1 to T4	L: 170 μH, Qu > 130 YI-0261	(700 kHz)		Height: 12 mm
T5	L: 1.45 μH, Qu > 35 YI-0384	(10 MHz)		Height: 9 mm
T6	8.2 mm, Qu > 70 YI-0383	(100 kHz)		Height: 12 mm
T7	150 μH, Q > 80 YI-0382	(700 kHz)		Height: 9 mm
T8	2 mH, Q > 60 MB-0087-1	(57 kHz)		Height: 9 mm

Package Dimensions

Units: mm

• FP-56



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