Ordering number : EN873F

Monolithic Linear IC

LA1235

FM IF System Applications

Overview

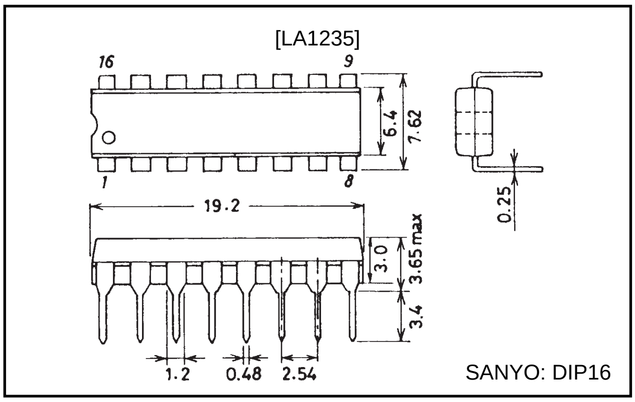
The LA1235 is a high integrated IC developed for use in high S/N, low distortion FM IF system applications. This IC features S/N=88dB, distortion factor=0.015% and has almost all functions required for FM tuner IF stage.

The IF amplifier and limiter stage consist of 6 stages of double ended differential amplifier having an excellent AMR, and this stage is followd by the signal meter driver which consists of 4 stages of level detector, thereby creating extended linearity up to strong input. The FM detector stage consists of a double balanced quadrature detector to which a low frequency preamplifire and a muting controller are attached. The muting drive stage consists of an OR circuit for weak signal muting drive output which detects signal intensity and detuning muting drive output which detects S curve DC output and enables the prevention of noise at the time of weak signal and detuning. Further, the weak signal muting drive output circuit contains a Schmitt circuit having hysteresis and enables the prevention of muting malfunction due to amplitude component at the time of weak signal. The AFC output and tuning meter drive stage is of current drive type which makes it possible to adjust AFC sensitivity and muting band width by means of an external resistor, and the built-in tuning meter null (short) circuit foreces the tuning meter to be [0] when th IF amplifier stops working. The IF amplifier stop circuit, being a circuit to stop the FM IF amlifier at the time of AM reception, makes it possible to decrease shock noise due to FM-AM receiving mode switchover.

Package Dimensions

unit: mm

3006B-DIP16



Functions

- IF amplifier, Limiter.
- Quadrature detection.
- AF preamplifier.
- Signal intesity muting drive output.
- Detuning muting drive output.
- AF signal muting circuit.
- Signal meter drive output.
- AFC, tuning meter drive output.
- IF amplifier stop circuit.
- Tunig meter null circuit.

Features

- High S/N (88dB typ.).
- Low distortion (0.015% typ.).
- Weak signal muting dirve output having hysteresis.
- Tuning mete null (short) circuit.
- Signal meter dirve output having wide dynamic range.
- High limiting sensitivity.
- Built-in constant-voltage regulated circuit (Operating voltage : 10 to 14V).

Specifications

Maximum Ratings at Ta=25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC}max	Pin 11	16	V
Input voltage	V_{IN}	Pins 1 to 2	±1	Vp-p
Supply current	I_{CC}	Pin 11	40	mA
Flow-in current	I_5	Pin 5	3	mA
Flow-out current	I_{10}	Pin 10	2	mA
	I_{13}		2	mA
Allowable power dissipation	Pd max		650	mA
Operating temperature	Topr		–20 to +70	°C
Storage temperature	Tstg		–40 to +125	°C

Recommended Operating Conditions at Ta=25°C

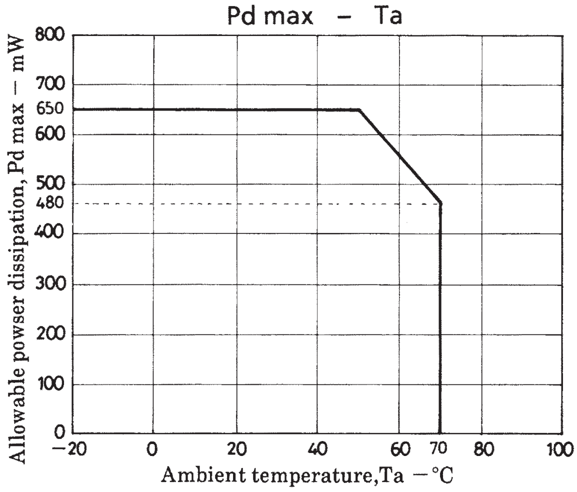
Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		10 to 14	V

Operating Characteristics at Ta=25°C, V_{CC}=12V, f=10.7MHz

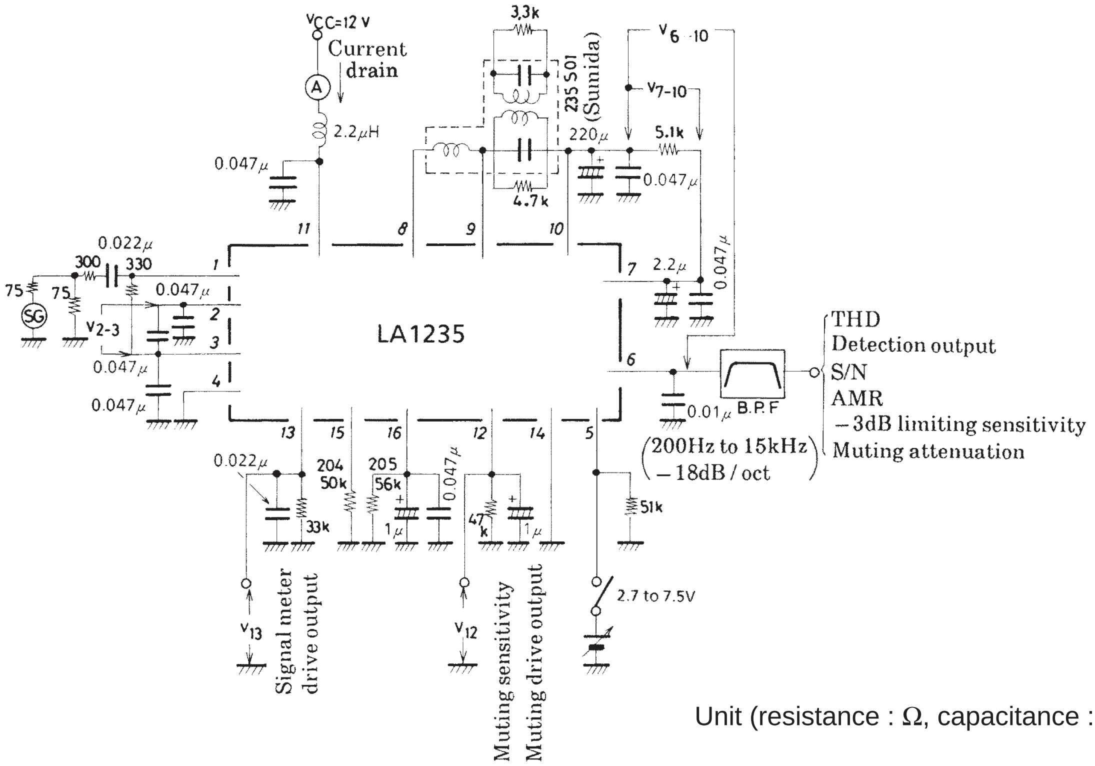
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}	Quiescent		21	30	mA
Current drain	I_{CC}	V_{IN}=100dBμ		22	31	mA
Detection output	V_O	V_{IN}=100dBμ, 400Hz, 100% mod.	310	430	590	mVrms
S/N		V_{IN}=100dBμ, 400Hz, 100% mod.	82	88		dB
–3dB limiting sensitivity	$V_{IN(lim)}$	V_O : –3dB, 400Hz, 100% mod.		25	31	dBμ
Muting sensitivity	$V_{IN(mute)}$	V_{12}=5.6V, R_{16}=56kΩ, R_{15}=50kΩ		40	50	dBμ
Muting attenuation	mute(att)	V_{IN}=100dBμ, 400Hz, 100% mod. V_5=3.5V	80	100		dB
Muting bandwidth	BW(mute)	V_{IN}=100dBμ, V_{12}=3V	120	200	330	kHz
Muting driving output	$V_{12(1)}$	Quiescent	5.6	6.2	6.8	V
	$V_{12(2)}$	V_{IN}=100dBμ		0	0.3	V
Total harmonic distortion	THD	V_{IN}=100dBμ, 400Hz, 100% mod.		0.015	0.05	%
AM supperssion ratio	AMR	V_{IN}=80dBμ, FM =400Hz, 100% mod, AM =1kHz, 30% mod.	45	60		dB
Signal meter driving output	$V_{13(1)}$	Quiescent		0	0.1	V
	$V_{13(2)}$	V_{IN}=35dBμ		0.1	0.5	V
	$V_{13(3)}$	V_{IN}=70dBμ	1.3	2.0	2.9	V
	$V_{13(4)}$	V_{IN}=100dBμ	2.2	3.5	5.0	V
Offset voltage	V_{6-10}	Quiescent, pin 6 to 10	–0.8	0	+0.8	V
	V_{7-10}	Quiescent, pin 7 to 10	–0.4	0	+0.4	V
Tuning meter null voltage	$V_{7-10(null)}$	V5=7.5V, pin 7 to 10	–50	+5	+50	mV
IF-off voltage	$I_{15(IF\ off)}$	V_{2-3}=1V	5.6		7.5	V

Reference Pin Voltage

Pin No.	Condition	Pin voltage (V)
V_1 V_2 V_3	Quiescent	2.6
V_6 V_7		6.2
V_8		5.9
V_{10} V_{12}		6.2
V_{13} V_{15} V_{16}		0



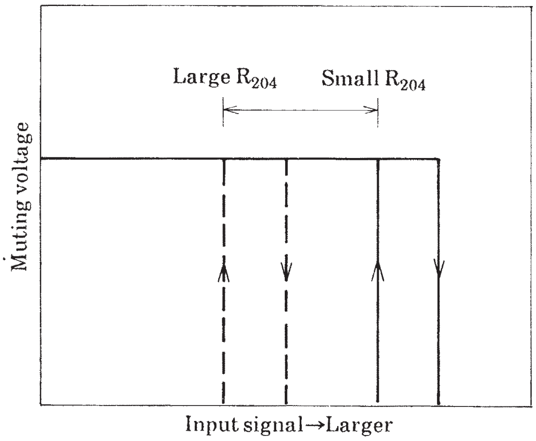
Test Circuit



Unit (resistance : Ω, capacitance : F)

- Setting of muting sensitivity, hysteresis width (Refer to the equivalent circuit block diagram and application circuit). Muting sensitivity and hysteresis width are set arbitarily by varying resistors R_{204} and R_{205} connected to pins 15 and 16, respectively. Muting sensitivity is set by varying R_{204} ; and if R_{204} is made larger, muting sensitivity will shift to the weak signal side. Hysteresis width is set by varying R_{205} ; and if R_{205} is made larger, hysteresis width will narrow. Next, how to set muting sensitivity is concretely described as follows. In case of using R_{204}=50kΩ (semifixed resistor) and R_{205}=56kΩ, the upper limit of current I_{16}, 50µA, delivered from the signal meter driver at which muting is turned ON is obtained from the first quadrant of Table for muting adjustable lower limit calculation. Muting is turned ON at I_{16}≤50µA. If I_{16}≤50µA, muting is already turned ON at a point of input being stronger than the setting input and it is impossible to adjust muting at the setting input. Therefore, I_{16}>50µA is required at the setting input. The input at which a sample with a small I_{16} output meets 50µA is obtained as V_{IN}=47dBµ. This input is the maximum value of muting sensitivity, that is to say, the lower limit at with muting can be set. The data for sample with a Small I_{16} shown in this Table is colose to the minimum value, but since samples with values less than this munimum value may occur, a margin of some dBµ must be allowed. From the above, the minimum value for muting setting (muting ON input) becomes 50dBµ for R_{204} (semifixed resistor)=50kΩ and R_{205}=56kΩ.

Muting sensitivity setting by means of R_{204}



Hysteresis width setting by means of R_{205}

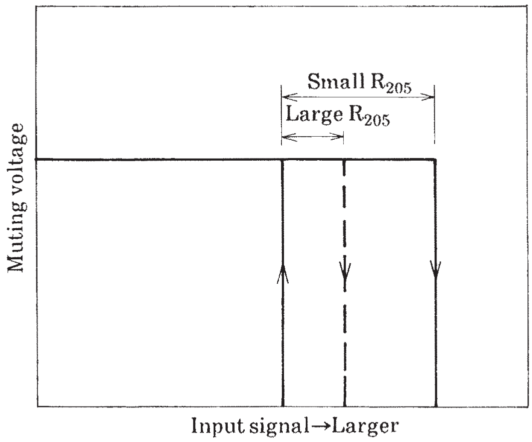
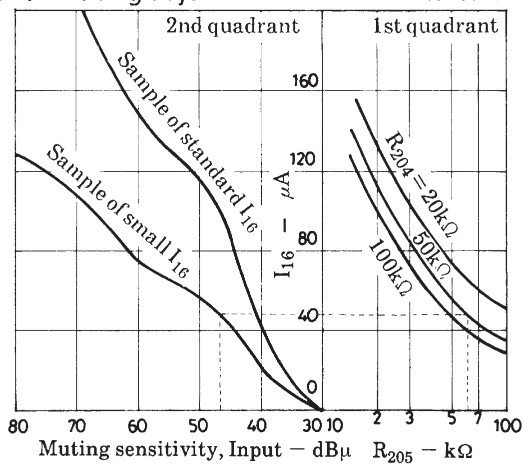
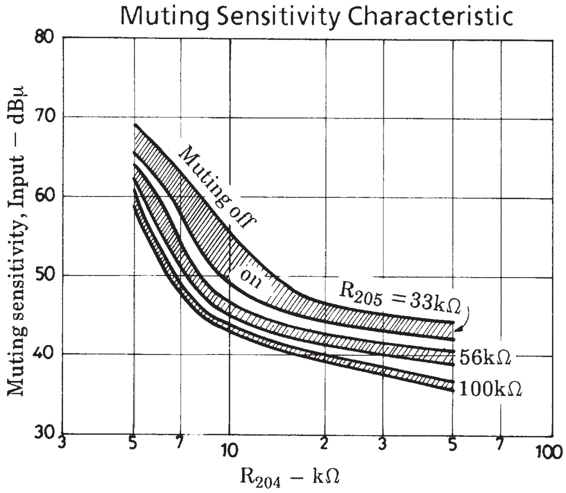


Table for muting adjustable lower limit calculation



Muting Sensitivity Characteristic



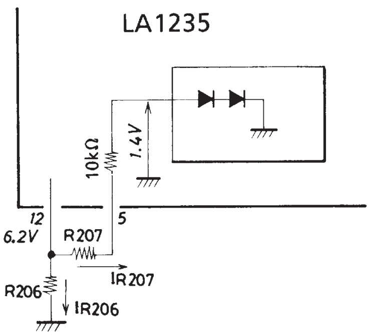
• Setting of muting circuit constnats

Drive current to be output at muting drive output pin 12 is 0.75mA typ., but approximately 0.4mA may be caused by variations in characteristic or changes in temperature (smaller at higher temperatures). It is desirable to design the circuit so that the total current to be output from pin 12 at the time of muting ON does not exceed 0.35mA. When driving the muting circuit of the LA1235, the muting drive current (input current at pin 5) must be considered besides this total output current. The muting drive current of the LA1235 is 0.2mA max.

Thus, the muting constants are obrained as follows. If the muting drive current is I_{R207}≥0.2mA, R_{207}≤14kΩ occurs and the total current It is shown by the following expression.

$$It=I_{R206}+I_{R207}=\frac{6.2V}{R_{206}}+\frac{4.8V}{R_{206}+10k\Omega}$$ (10kΩ : Input resistance at pin 5, Refer to the above figure.)

Muting Circuit

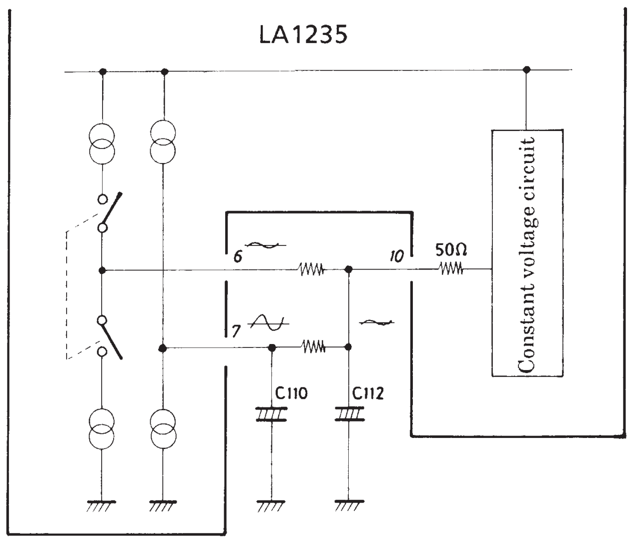


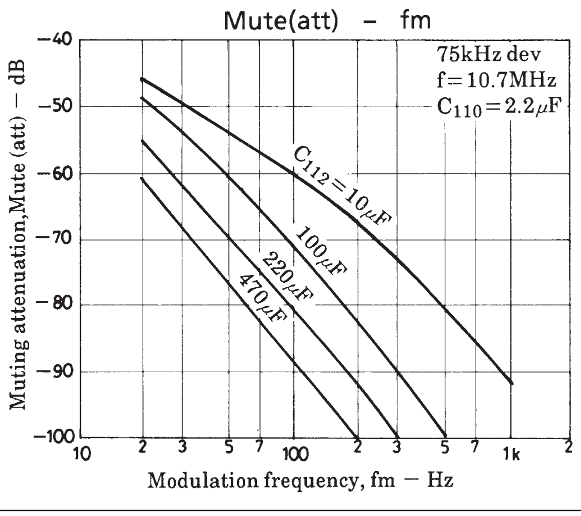
If R_{207}=10kΩ is taken with the variation s in voltage V_{12} at pin 12 and input resistance 10kΩ at pin 5 considered, R_{206}≈56.4kΩ is obtained, and then R_{206}=68kΩ and R_{207}=10kΩ are obtained.

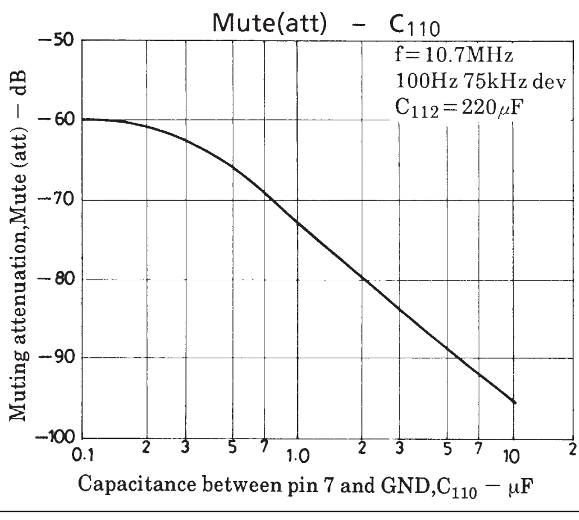
• Setting of C_{112} (Capacitance between pin 12 and ground)

C_{112} influences S/N and muting attenuation. S/N is improved 0.5 to 2.0dB by changing C_{112} from 1µF to 100µF. Muting attenuation becomes as shown in Mute (att) – fm (next page) characteristic. This phenomenon occurs because the output at pin 7 appears at pin 6 through pin 10 and capacitance C_{110} between pin 7 and ground also exerts influence. The relation between muting attenuation andC_{110} is such that if C_{110}=2.2µF and C_{112}=220µF, attenuation at modulation frequency 100Hz becomes –80dB.

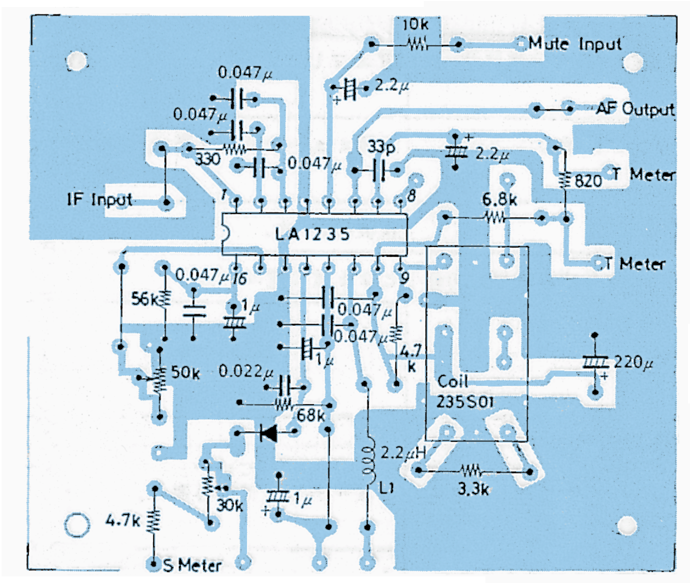
AF Output Circuit





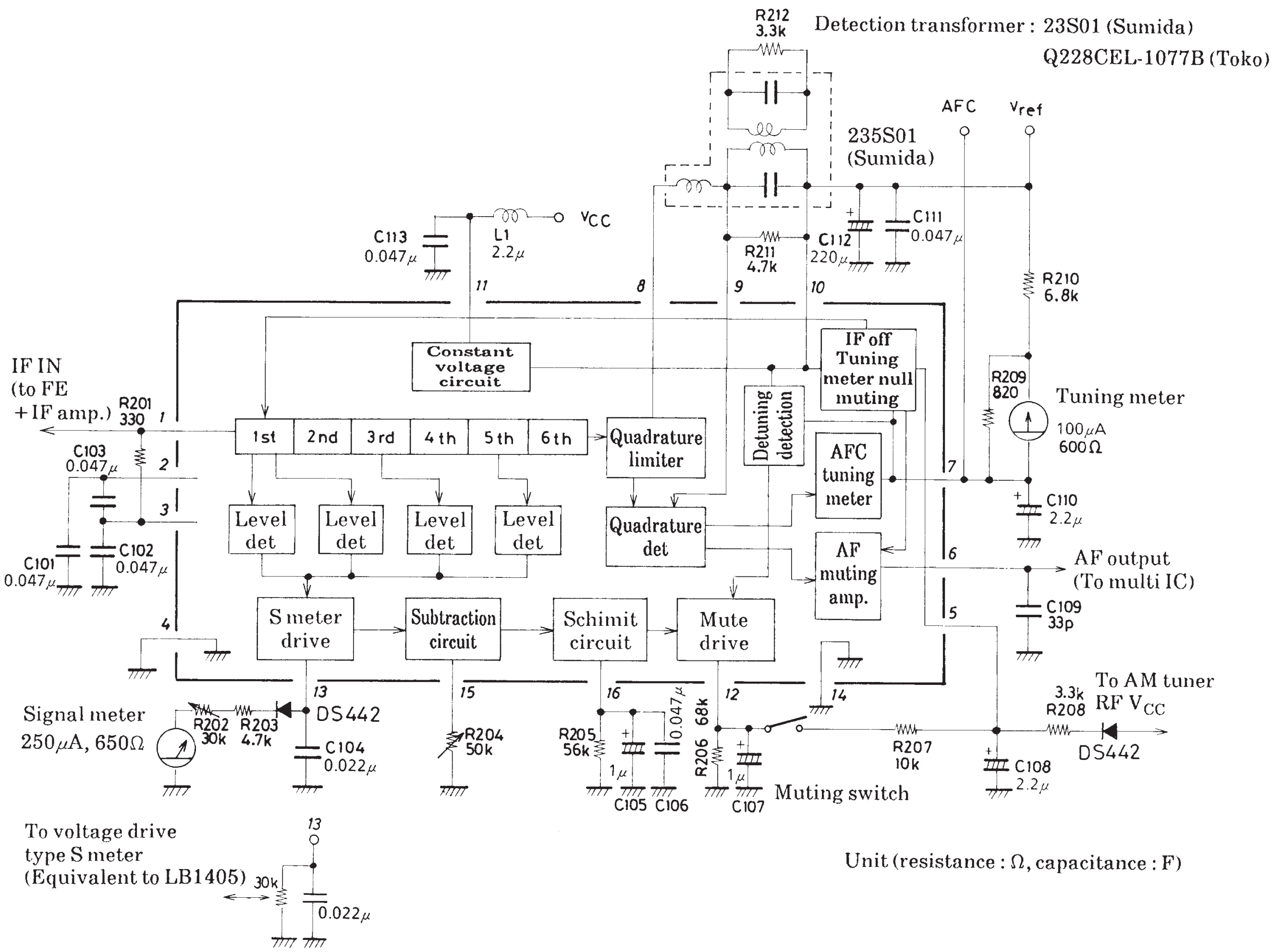


Sample Printed Circuit Pattern



(Cu-coated area 70×60mm²)

Equivalent Circuit Block Diagram and Sample Application Circuit



Description of external parts

Part No.	Function	Effect	
		If decreased	If increased
R201	Input resistance (Rg)	Causes matching wigh circuit of preceding stage.	
R202 R203	S meter adjust	Current drain increases. (Observe max. rating).	S meter pointer is off zero point. (In case of voltage drive type).
R204	Muting sensitivity adjust	Muting sensitivity shifts to weak input side.	
R205	Hysterisis adjunt	Large hysteresis.	Small hysteresis.
R206	Muting drive circuit load	Insufficient drive of detuning muting.	When driveing muting of LA3390 (MPX), make less than 200kΩ to prevent malfunction.
R207	Muting time constant	Abnormal detuning muting attenuation waveform and abnormal sound at the time of low frequency modulation.	Muting response delay.
R208	IF-off voltage applying resistnace	Large flow-in current at pin 5 (Observe max. rating).	IF-off does not occur. (IF-off voltage≥7.5V).
R209 R210	AFC, detuning muting band width, tuning meter deflection adjust	Large detuning muting bandwidth.	Small detuning muting bandwidth.
R211	Detection coil damping	Small detection output.	Large detection output.
R212	S curve linearity correction	Find such a value as to cause minimum distortion (THD).	
C101 C102 C103	IF amplifier bypass	Unstable IF amplifier.	
C104	S meter output bypass	IF system may be unstable.	
C105 C106	Muting drive output bypass	If low frequency AM compoent is generated in IF signal, weak signal muting flutters.	Muting response delay.
C107 C108	Muting drive output smooth	Abnormal detuning muting attenuation waveform and abnormal sound at the time of low frequency modulation.	Muting response delay.
C109	AF output LPF	Unstable IF system.	With MPX connected, separation worsens.
C110	AFC output LPF	Muting attenuation worsens and detuning muting bandwidth narrows.	Detunig muting response delay.
C111 C112	Constant voltage circuit smooth	S/N, muting attenuation worsen.	
C113	Power supply bypass	Unstable IF system.	
L1	Power supply choke	Unstable IF system.	

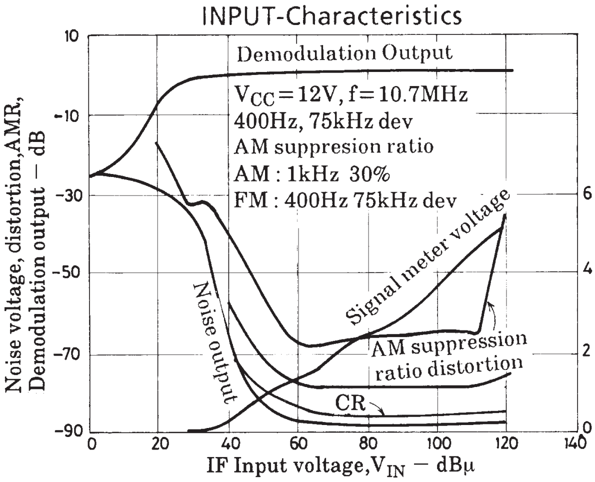
Proper cares in using IC

- Connect the ground side of bypass capacitors of pins 2, 3 to an area close to pin 4.
- Connect the ground side of bypass capacitors of pins 6, 7, 10, 13, 16 to an area close to pin 14.
- Use the shortest possible wires for detection coil-to-pins 8, 9, 10 connection.
- Pin 13, being used for signal meter drive output, can be also used multipath detection because IF signal envelope detected is output at this pin.

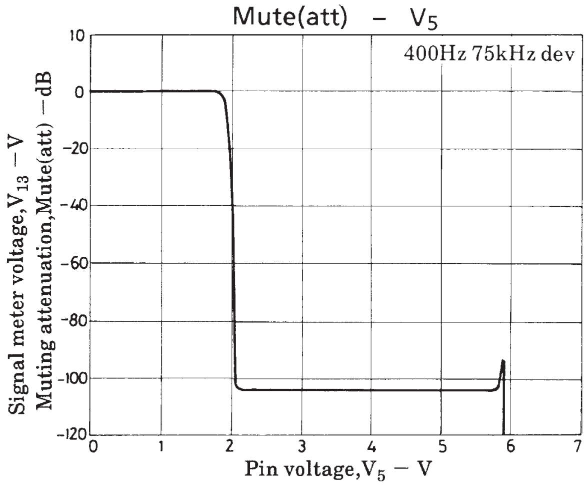
Coil specifications

Supplier	Coil name	Damping resistance		Remarks
		R211	R212	
Sumida	235S01	4.7kΩ	3.3kΩ	Containing fixed inductance 26μF.
	SNY-074-1919A	7.5kΩ	2.4kΩ	Containing fixed inductance 26μF. (Improvement in temperature characteristic).
Toko	Q228CEL-1077B	13kΩ	3.0kΩ	Containing fixed inductance

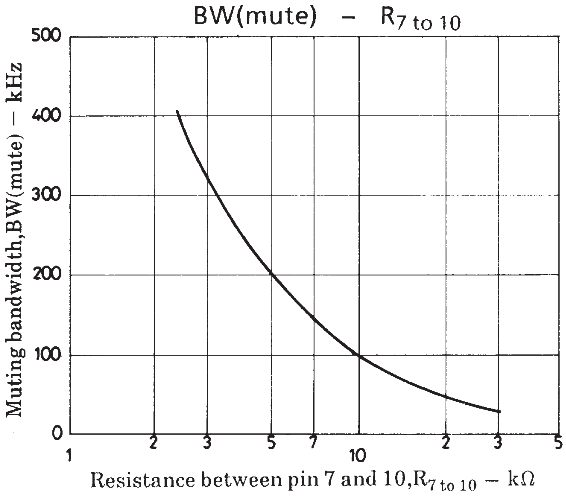
INPUT-Characteristics



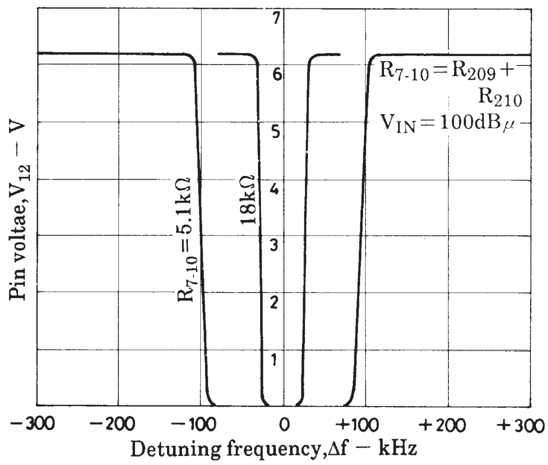
Mute(att) − V_5



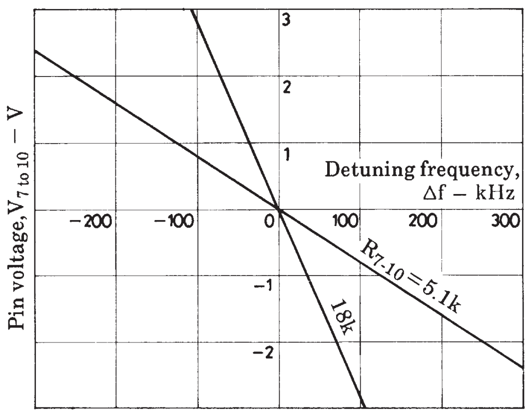
BW(mute) − $R_{7\ to\ 10}$



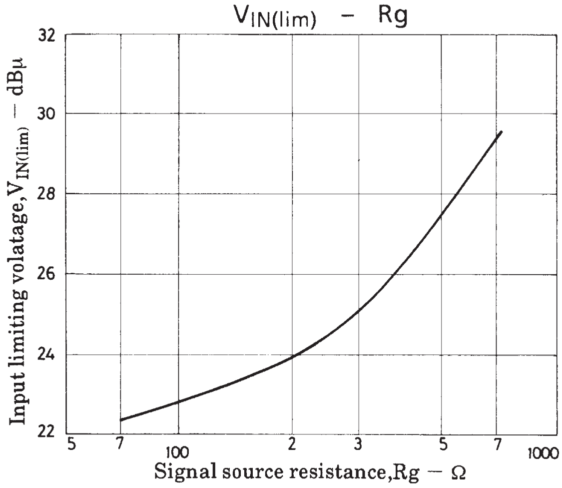
V_{12} − Δf

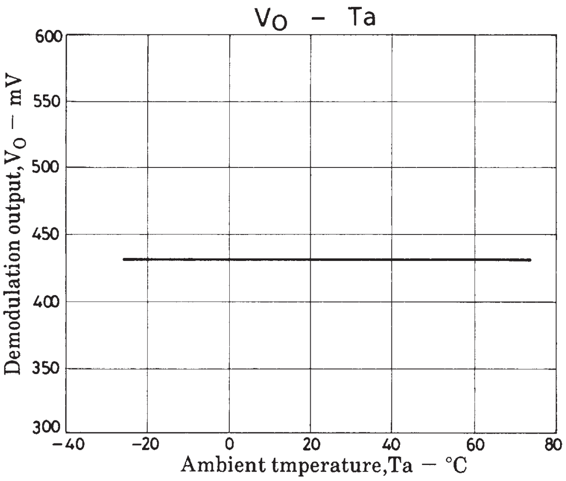


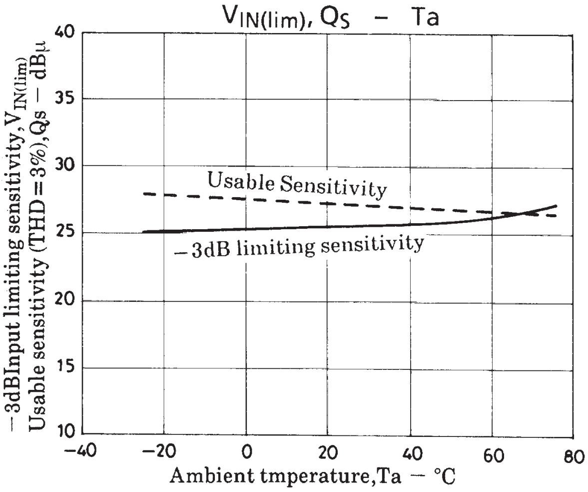
$V_{7\ to\ 10}$ − Δf

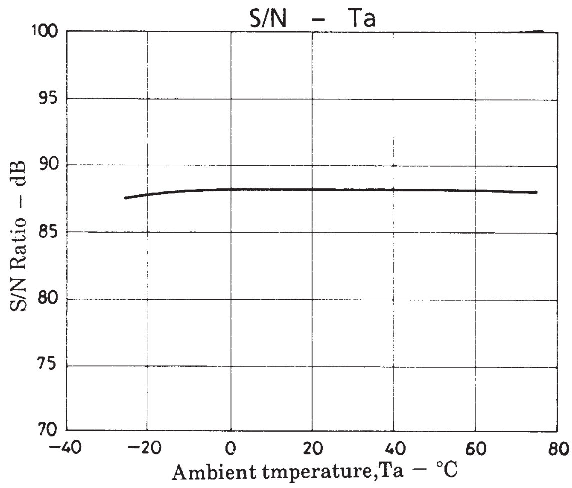


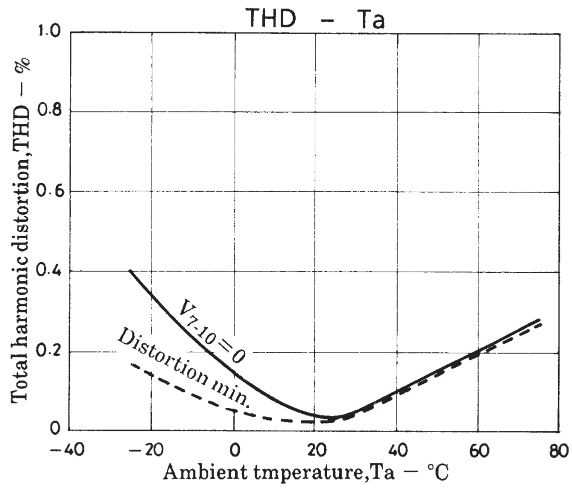
$V_{IN(lim)}$ − Rg

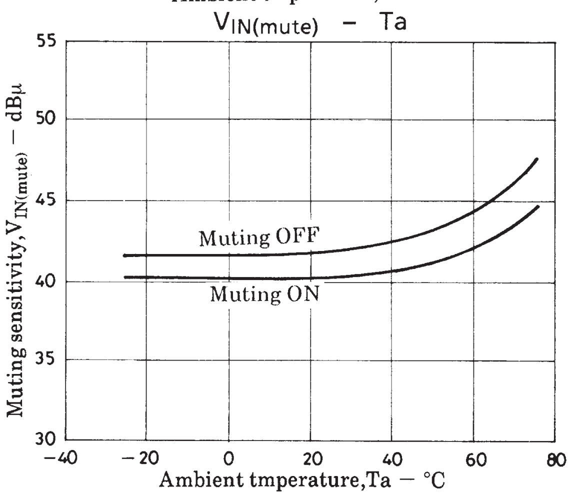


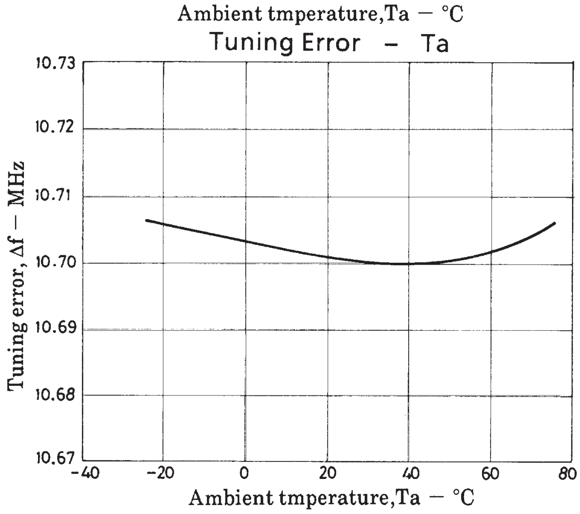

VO – Ta
Demodulation output,VO – mV
Ambient tmperature,Ta – °C

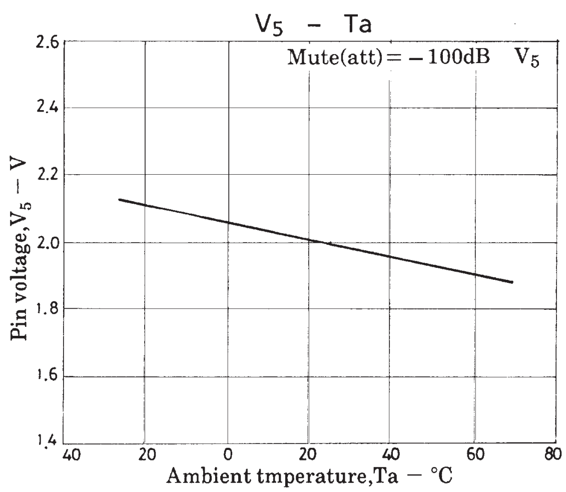

VIN(lim), QS – Ta
–3dBInput limiting sensitivity,VIN(lim)
Usable sensitivity (THD=3%),Qs – dBμ
Usable Sensitivity
–3dB limiting sensitivity
Ambient tmperature,Ta – °C

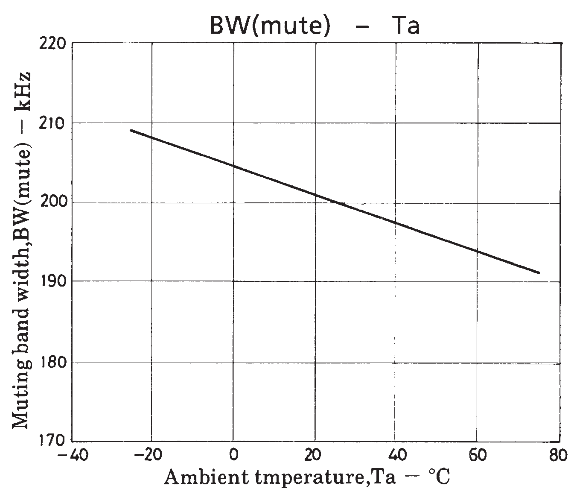

S/N – Ta
S/N Ratio – dB
Ambient tmperature,Ta – °C


THD – Ta
Total harmonic distortion,THD – %
V7-10=0
Distortion min.
Ambient tmperature,Ta – °C

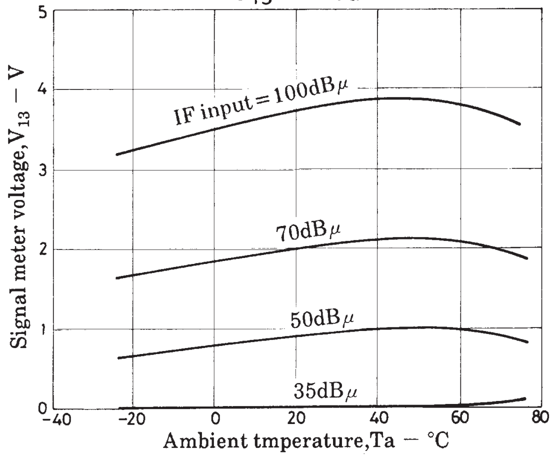

VIN(mute) – Ta
Muting sensitivity,VIN(mute) – dBμ
Muting OFF
Muting ON
Ambient tmperature,Ta – °C


Tuning Error – Ta
Tuning error, Δf – MHz
Ambient tmperature,Ta – °C

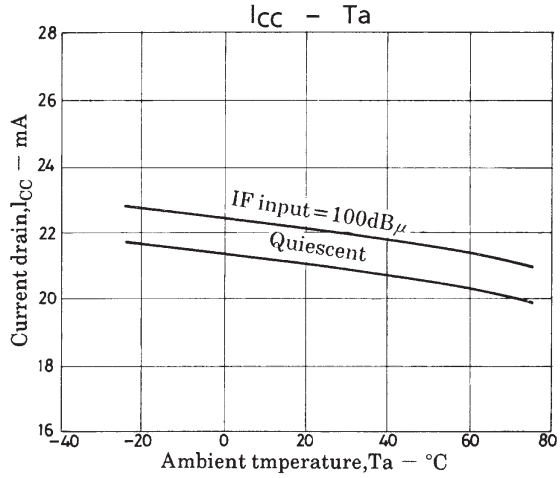

V5 – Ta
Mute(att)=–100dB V5
Pin voltage,V5 – V
Ambient tmperature,Ta – °C


BW(mute) – Ta
Muting band width,BW(mute) – kHz
Ambient tmperature,Ta – °C

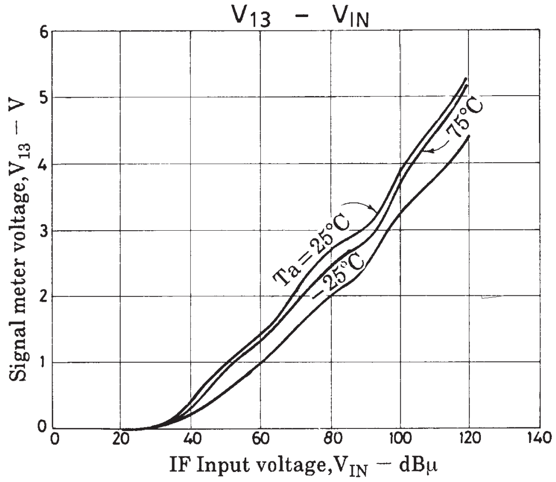
V_{13} – Ta



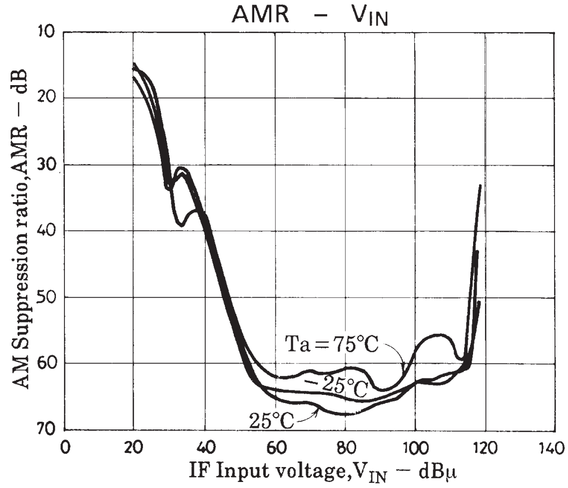
I_{CC} – Ta



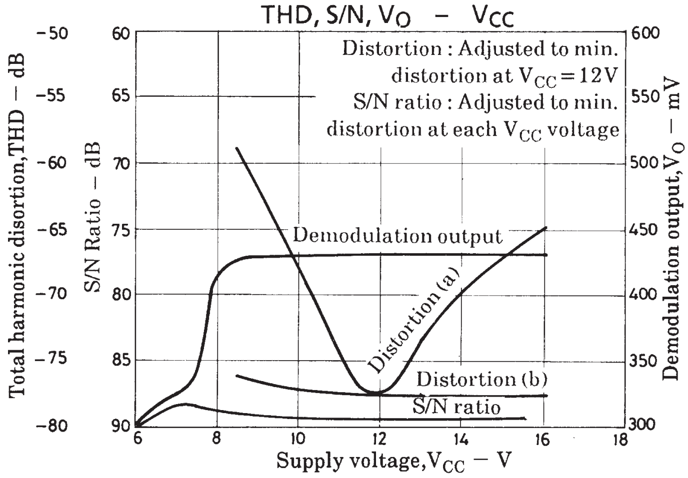
V_{13} – V_{IN}



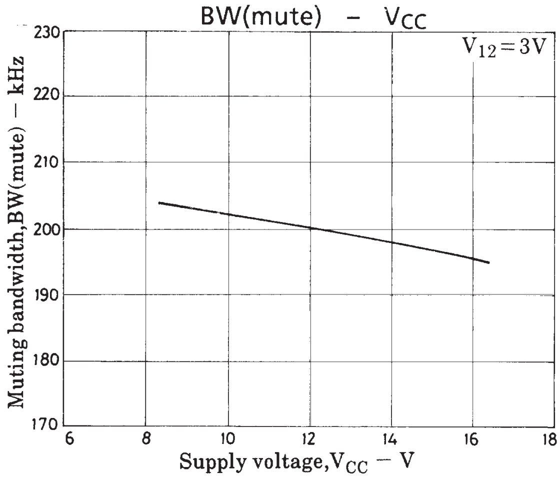
AMR – V_{IN}



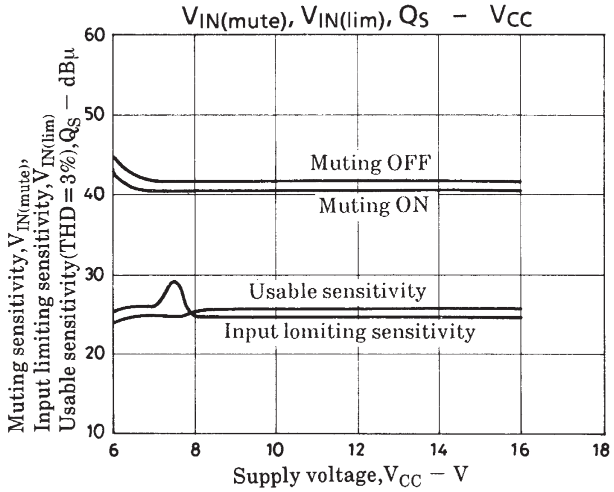
THD, S/N, V_O – V_{CC}



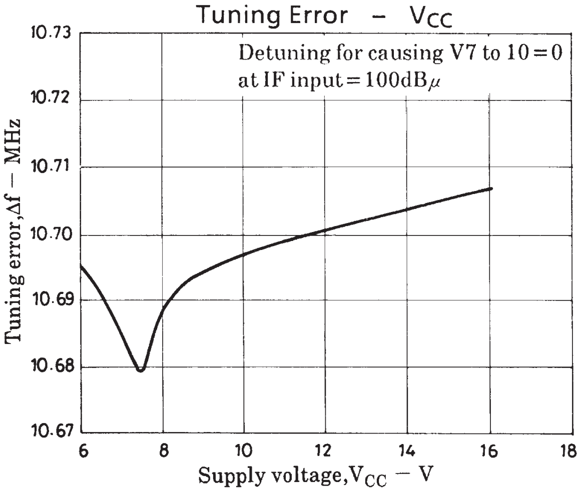
BW(mute) – V_{CC}

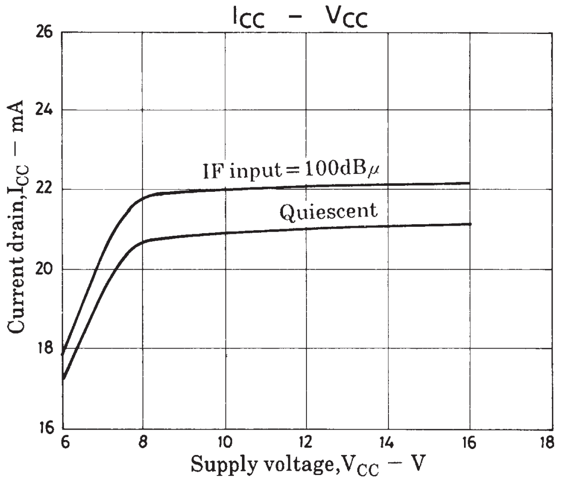


$V_{IN(mute)}$, $V_{IN(lim)}$, Q_S – V_{CC}



Tuning Error – V_{CC}

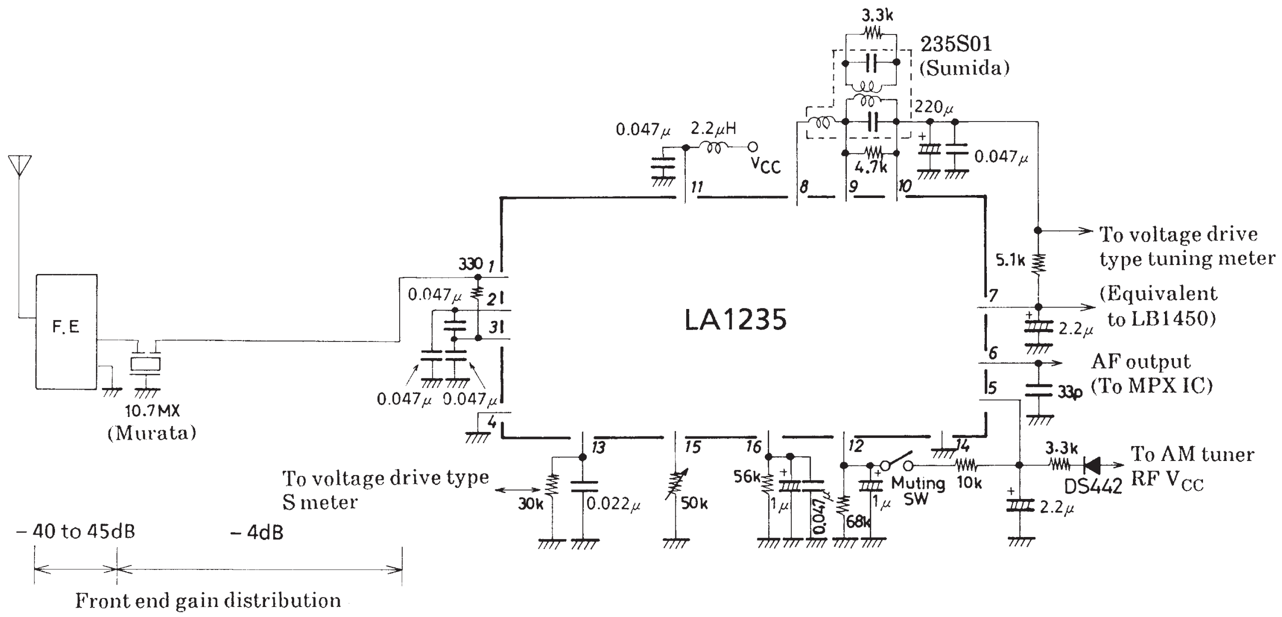




Cain distribution of application circuit

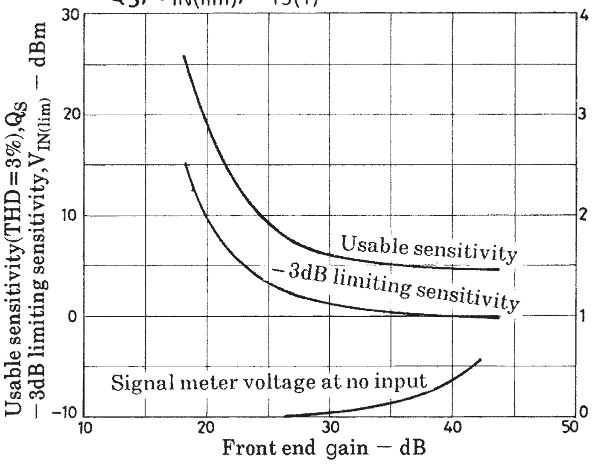
If IC anone is operated without front end, the tuning meter deflects toward plus side at the time of no input. This phenomenon is caused by the fact that the noise component to be applied to the quadrature multiplication circuit is not syummetric with respect to 10.7MHz but is shifted toward lower frequency side because the frequency characteristic of IF amplifier attenuates at high frequencies and the phase shift circuit is of low-pass type. If the formt end is attached and the noise which passes through the narrowband filter of IF stage and spreads symmetrically with respect to 10.7MHz is stronger than the noise generated inside the IC, the tuning meter reads 0.As the gain of the front end is decreased, input limiting sensitivity and usable sensitivity worsen abruptly. This phenomenon is caused by the fact that since the tuning meter is set to 0 at the time of no input the tuning point of the quadrature circuit must be shifted toward lower frequency side than 10.7MHz and the demodulation output waveform is deformed asymmetrically at an input in the vicinity of usable sensitivity. However, if the gain of the front end is too increased, the signal meter poiter does not return to zero point at the time of no signal.

Sample Application Circuit

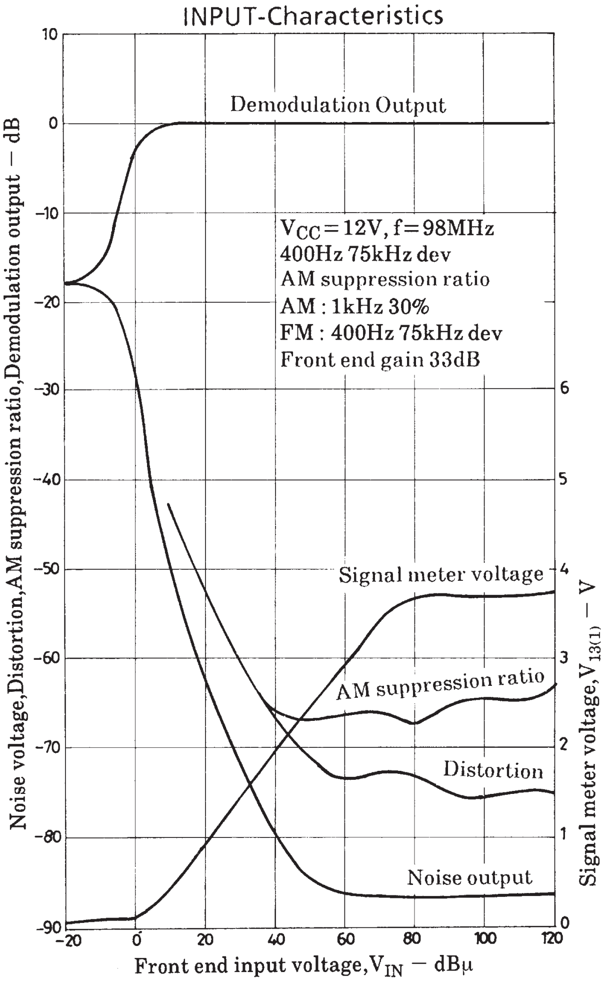


Unit (resistance : Ω, capacitance : F)

Qs, VIN(lim), V13(1) – Front End Gain



INPUT-Characteristics



This catalog provides information as of October, 1997. Specifications and information herein are subject to change without notice.