

**SANYO**

No.729E

LA1140

FM IF SYSTEM FOR CAR USE

The LA1140 is an IF system IC designed for FM car stereo receivers. It features versatile muting characteristics and allows receiver designers to realize the muting performance according to their design concept. Since the muting characteristics can be varied with a switch or a semi-fixed resistor, DX-Local switching will be accomplished with ease.

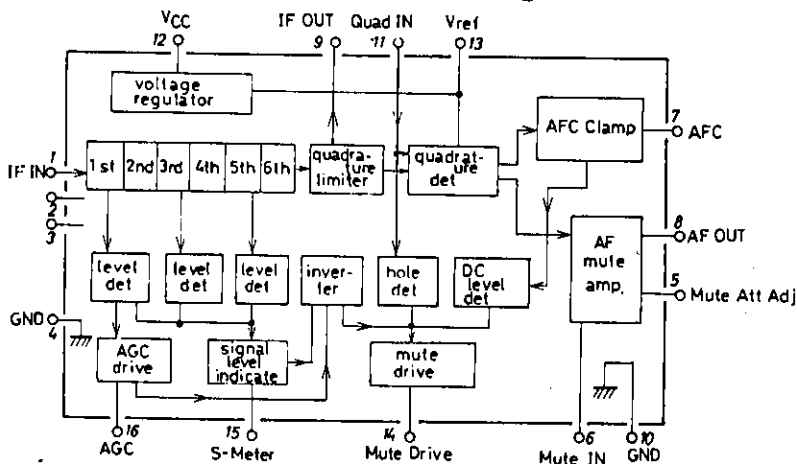
**Functions**

- . IF amplification/limiter
- . AFC output
- . Muting bandwidth
- . Quadrature detector
- . Signal meter output
- . Muting under weak signal strength
- . AF preamplifier
- . AGC output

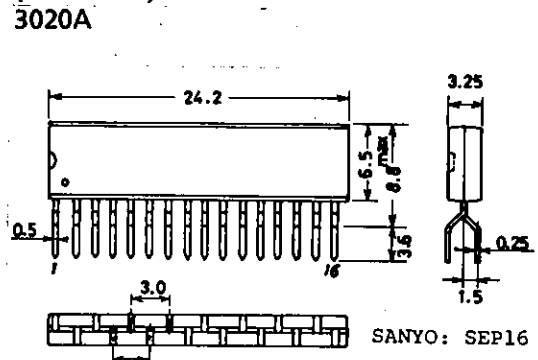
**Features**

1. Versatile muting
  - a) When muting operation is performed under a weak signal strength, an attenuation slope of the audio output against the input signal strength variations can be set at any given value.
  - b) Maximum muting attenuation can be selected to be approximately 6 to 40dB.
  - c) Input signal strength level which actuates the muting circuit can be set freely.
2. High limiting sensitivity (25dBu typ. with muting off) provides a fine quieting characteristic.
3. High S/N (78dB typ.)
4. Low distortion (0.05% typ.) available, if used with double-tuned circuits.
5. Good AMR (63dB with 6 stages of differential IF amplifiers).
6. Signal meter drive output proportional to the input signal strength in dB (suitable to control multiplex IC LA3370).
7. Clamped ( $\pm V_{BE}$ ) AFC output, bandwidth adjustable.
8. Delayed AGC output for front end circuit.
9. Small space factor due to single-ended package employed.
10. 3mm pitch of pin terminals permitting ease-to-write PC board pattern.

**Equivalent Circuit Block Diagram**



**Package Dimensions (unit: mm)**



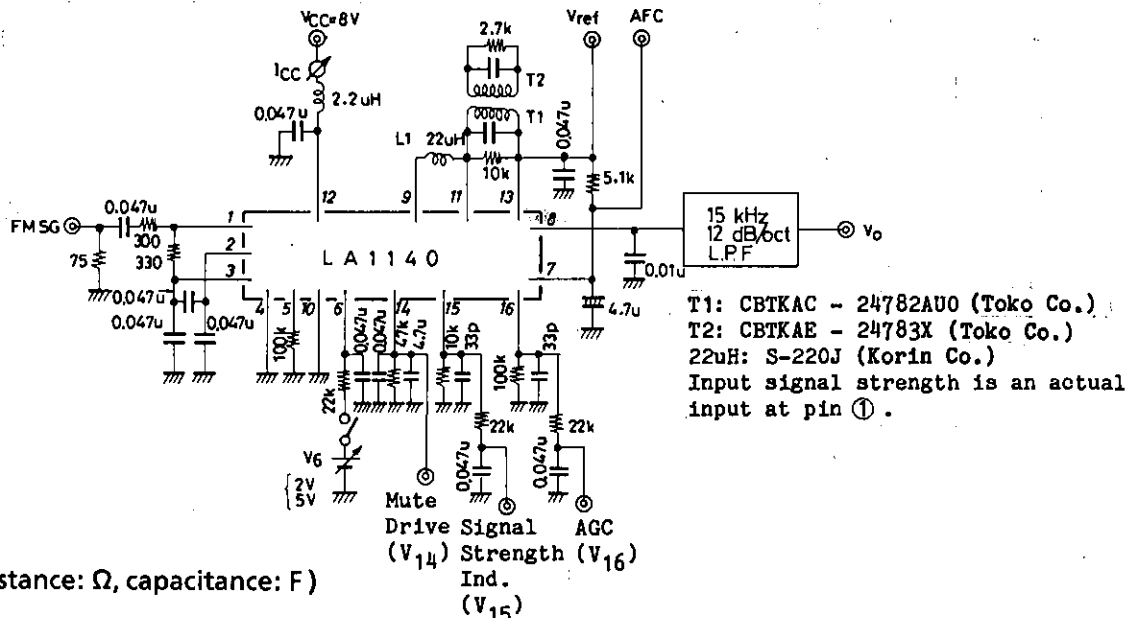
LAL140

Maximum Ratings at Ta=25°C				unit
Maximum Supply Voltage	V <sub>CC</sub> max	Pin12	16	V
Maximum Supply Current	I <sub>CC</sub> max	Pin12	40	mA
Allowable Power Dissipation	Pd max	Ta=25°C	640	mW
		Ta=70°C	460	mW
Input Voltage	V <sub>i</sub>	Pin1 to 2	±1	Vp-p
Flow-in Current	I <sub>2</sub>	Pin2	±0.2	mA
	I <sub>3</sub>	Pin3	±0.2	mA
	I <sub>6</sub>	Pin6	2	mA
Flow-out Current	I <sub>5</sub>	Pin5	1	mA
	I <sub>13</sub>	Pin13	2	mA
	I <sub>14</sub>	Pin14	2	mA
	I <sub>15</sub>	Pin15	1	mA
	I <sub>16</sub>	Pin16	1	mA
Operating Temperature	T <sub>opr</sub>		-20 to +70	°C
Storage Temperature	T <sub>stg</sub>		-40 to +125	°C

Operating Conditions at Ta=25°C				unit
Recommended Supply Voltage	V <sub>CC</sub>		8	V
Operating Voltage Range	V <sub>CC</sub> op		7.5 to 16	V

Operating Characteristics at Ta=25°C, V <sub>CC</sub> =8V, f=10.7MHz, See specified Test Circuit.				min	typ	max	unit
Quiescent Current	I <sub>cco</sub>	Quiescent	15	21	27	mA	
Current Dissipation	I <sub>CC</sub>	v <sub>i</sub> =100dBu	20	25	30	mA	
Demodulation Output	V <sub>o</sub>	v <sub>i</sub> =100dBu, 400Hz 100%mod.	200	260	320	mVrms	
Total Harmonic Distortion	THD	v <sub>i</sub> =100dBu, 400Hz 100%mod.	0.05	0.2		%	
S/N	S/N	v <sub>i</sub> =100dBu, 400Hz 100%mod.	72	78		dB	
Input Limiting Voltage	V <sub>i</sub> (lim)	v <sub>o</sub> : 3dB down, 400Hz 100%mod.	25	29		dBu	
Muting Sensitivity	V <sub>i</sub> (Mute)	V <sub>14</sub> =2.0V	22	26	32	dBu	
Muting Attenuation (1)	Mute(A <sub>CC</sub> )	V <sub>6</sub> =2.0V(22kohms),	10	15	20	dB	
		v <sub>i</sub> =100dBu, 400Hz 100%mod.					
Muting Attenuation (2)	Mute(A <sub>CC</sub> )	V <sub>6</sub> =5.0V(22kohms),	24	28	32	dB	
		v <sub>i</sub> =100dBu, 400Hz 100%mod.					
Muting Bandwidth	BW(Mute)	v <sub>i</sub> =100dBu, V <sub>14</sub> =2.0V	140	210	370	kHz	
AM Rejection Ratio	AMR	v <sub>i</sub> =100dBu, FM 400Hz	50	63		dB	
		100%mod., AM 1kHz 30%mod.					
Muting Drive Output	V <sub>14-0</sub>	Quiescent	3.5	4.2	5.0	V	
Muting Drive Output	V <sub>14-100</sub>	v <sub>i</sub> =100dBu	0	0	0.3	V	
Signal Meter Output (1)	V <sub>15-0</sub>	Quiescent	0	0.1	0.3	V	
Signal Meter Output (2)	V <sub>15-50</sub>	v <sub>i</sub> =50dBu	0.8	1.4	2.0	V	
Signal Meter Output (3)	V <sub>15-70</sub>	v <sub>i</sub> =70dBu	1.6	2.4	3.2	V	
Signal Meter Output (4)	V <sub>15-100</sub>	v <sub>i</sub> =100dBu	4.5	5.3	6.0	V	
AGC Output (1)	V <sub>16-0</sub>	Quiescent	3.5	4.1	4.5	V	
AGC Output (2)	V <sub>16-100</sub>	v <sub>i</sub> =100dBu	0	0.02	0.3	V	
Offset Voltage (1)	V <sub>7-13</sub>	Quiescent, pin7 to 13	-0.25	0+0.25		V	
Offset Voltage (2)	V <sub>8-13</sub>	Quiescent, pin8 to 13	-0.5	0 +0.5		V	

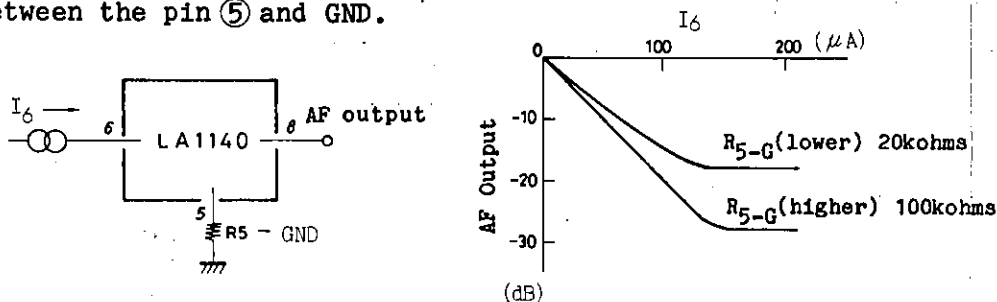
AC Test Circuit



Muting Characteristic

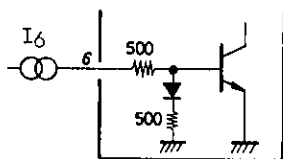
The muting operation in the LA1140 is performed by an AF preamplifier, the gain of which varies continuously with control current, and a muting drive output circuit which supplies the control current.

The gain of the AF preamplifier decreases with increasing gain control current applied to the pin ⑥. However, the gain does not decrease further when the control current reaches approximately 120uA or greater. The lower limit of the gain under this condition depends upon a resistor connected between the pin ⑤ and GND, and the higher the resistance the lower the gain (the higher the attenuation). Thus the maximum muting attenuation will be set by connecting the resistor between the pin ⑤ and GND.



Since the muting control input pin ⑥ is connected to the base of the emitter-grounded transistor (through a protection resistor of 500ohms in series), the voltage between pin ⑥ and GND is about 0.6V when the control current is applied. In actual cases, the muting operation is accomplished by applying a voltage drive type muting drive output (pin ⑭) to the pin ⑥ through a high resistance (up to 20kohms).

The muting drive output comes in three types:

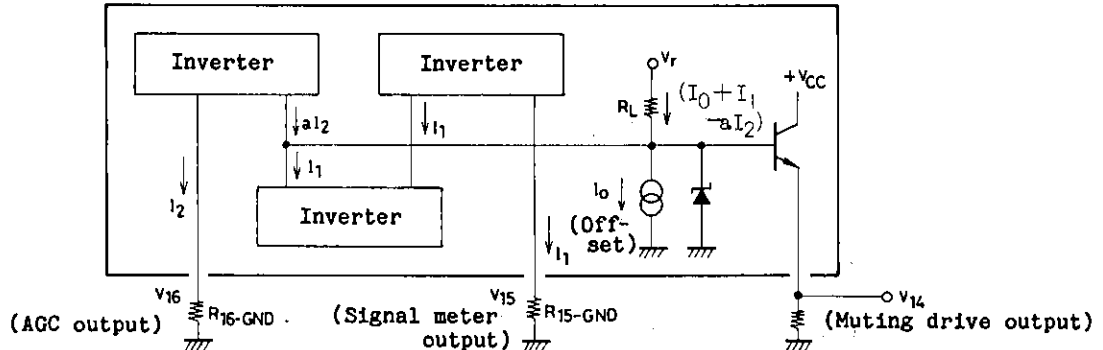


Unit (resistance:  $\Omega$ )

- 1) Hole detector output which develops a voltage when C/N (carrier-to-noise ratio) lowers under weak signal input conditions.
- 2) A reversed output of the signal strength indicating output (output at pin ⑮)
- 3) A bandwidth limited muting drive output which develops a voltage when the AFC output becomes higher than  $\pm V_{BE}$  during tuning-off operation.

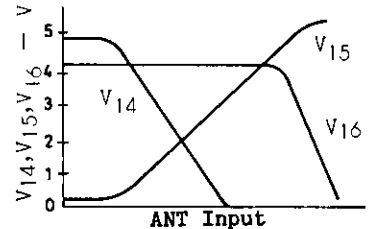
All these outputs are led to an OR circuit and the processed output is developed at pin 14. Of the above muting drive outputs, descriptions on the hole detector output and the bandwidth limited muting drive output will be omitted, since they are the same as those used in conventional quadrature detector ICs (such as LA1230, LA1231N).

The inverted output of the signal strength indication output is obtained as illustrated below.



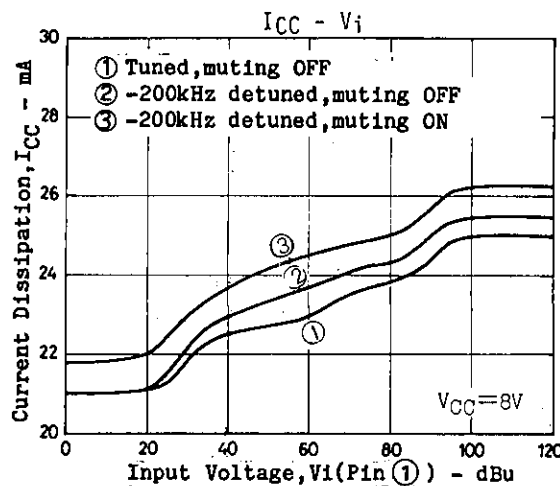
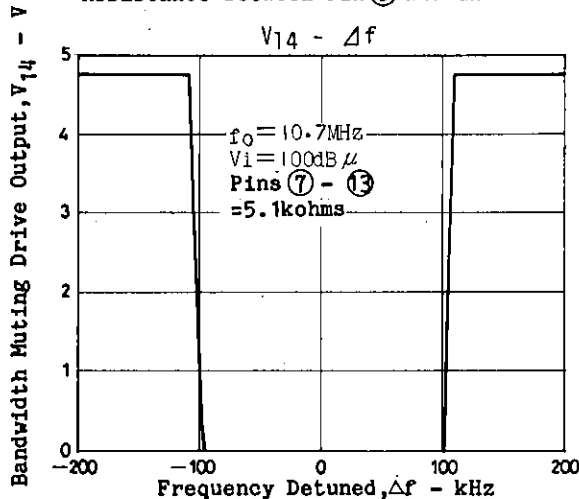
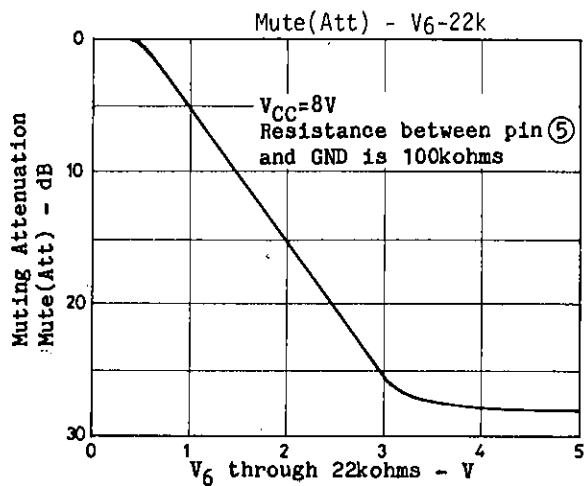
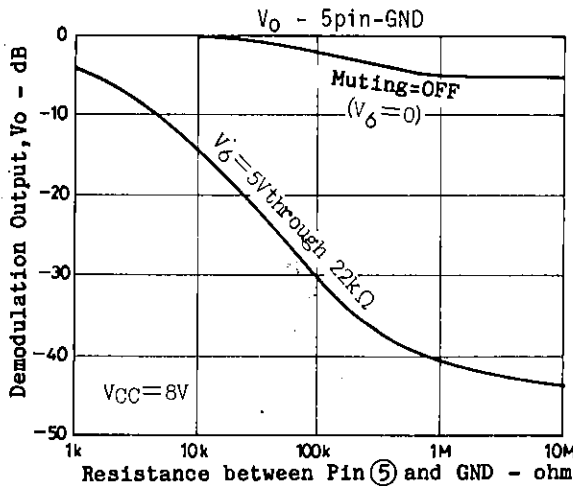
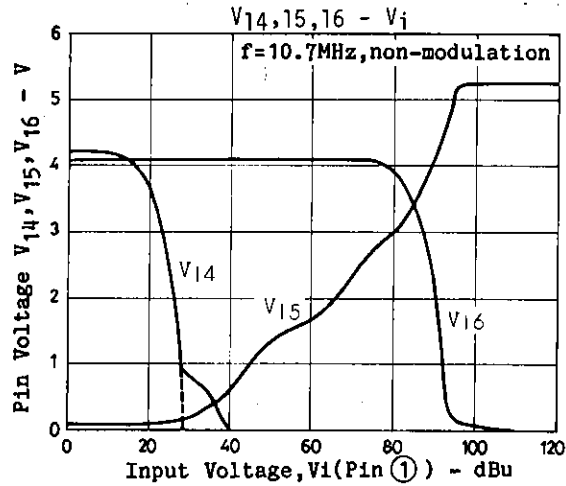
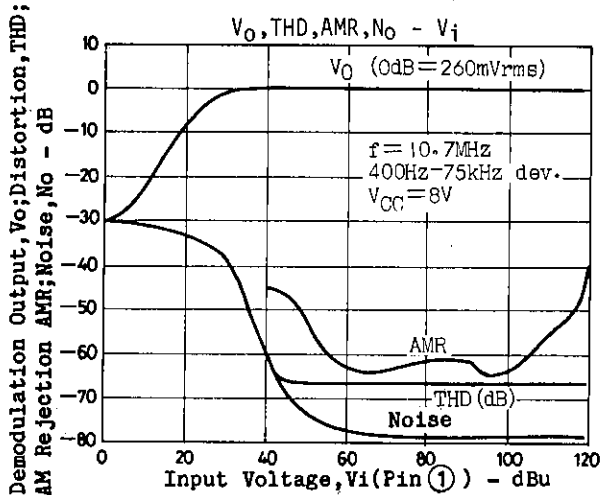
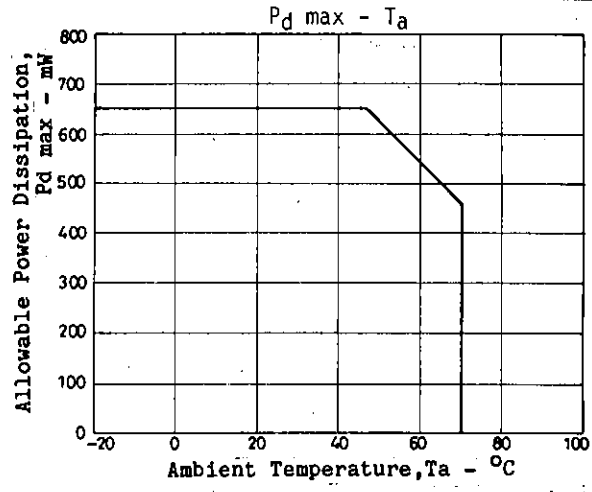
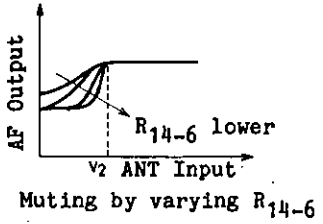
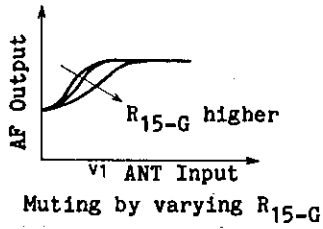
By referring to the illustration,  $V_{14}$  is given by the formula:  $V_{14} = V_r - (I_0 + I_1 - aI_2)R_L - V_{BE}$ .

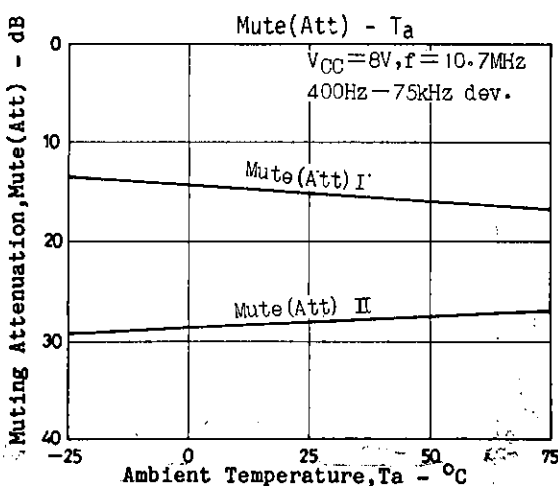
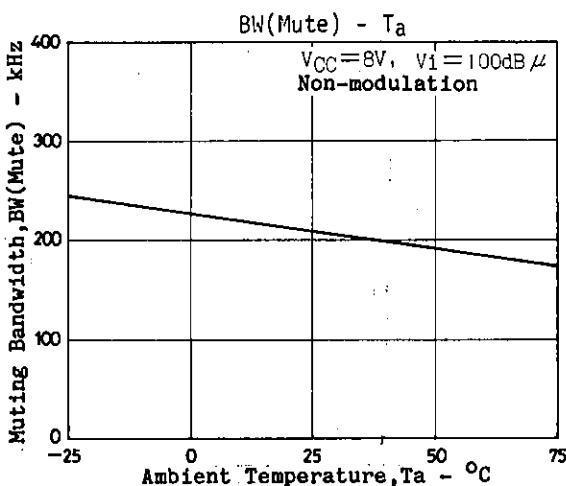
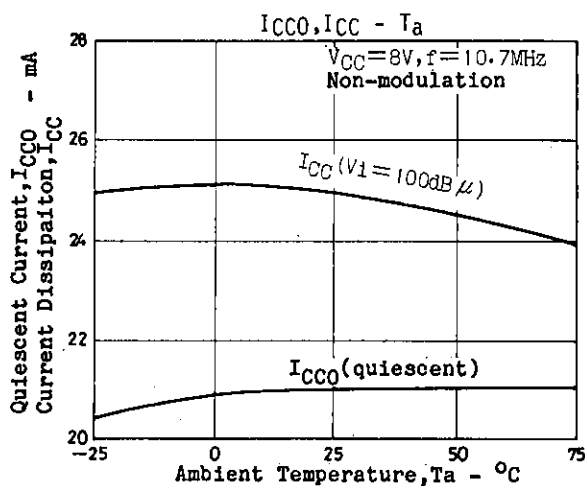
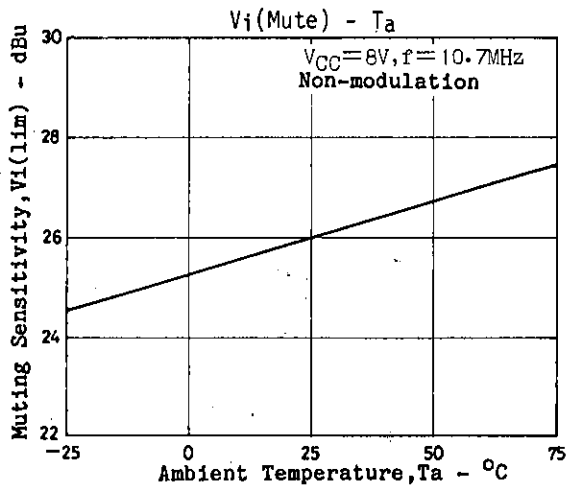
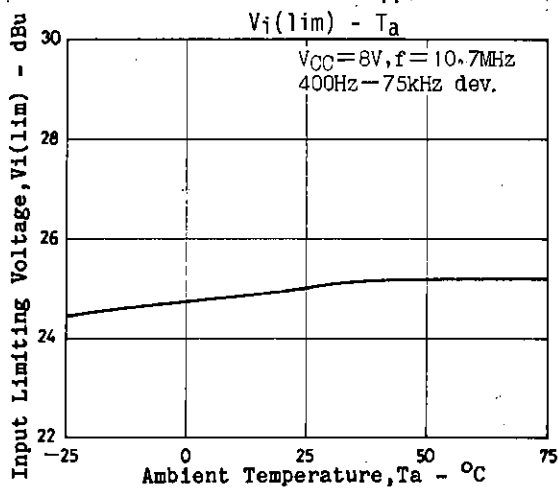
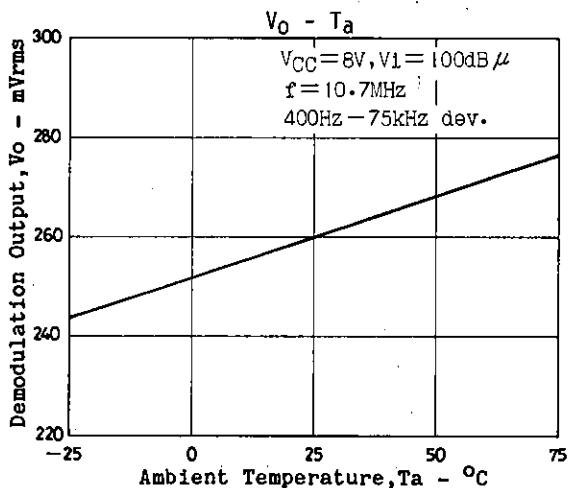
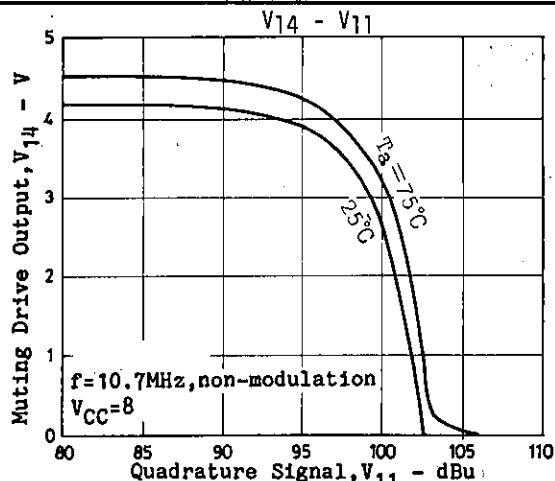
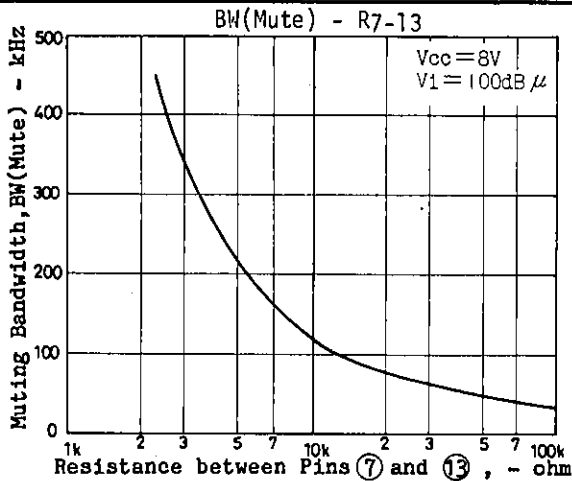
Conditions are:  $V_r \approx 4.9V$ ,  $I_0 \approx 0.2mA$ ,  $a \approx 2$ ,  $R_L = 22k\Omega$ ,  $V_{BE} \approx 0.6V$ ,  $I_1 = V_{15}/R_{15-G}$ ,  $I_2 = V_{16}/R_{16-G}$ , where  $V_{16}$  is a constant equal to 4.1V (typ) for medium or lower signal input levels, where the muting drive output is required. Since the  $V_{15}$  increases proportionally to the increase of the input signal strength,  $I_1$  will also increase. Therefore the  $V_{14}$  will decrease with increasing signal strength.

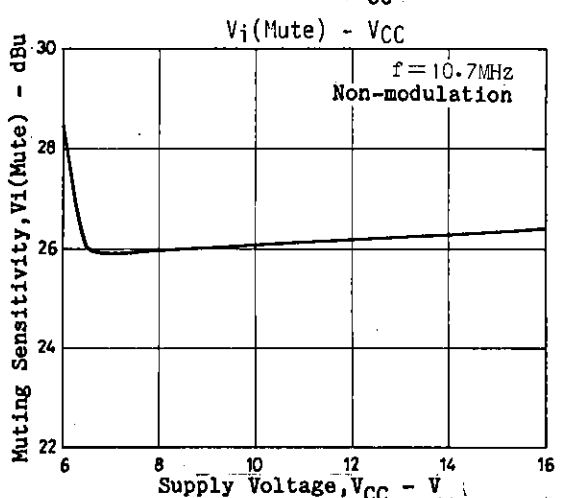
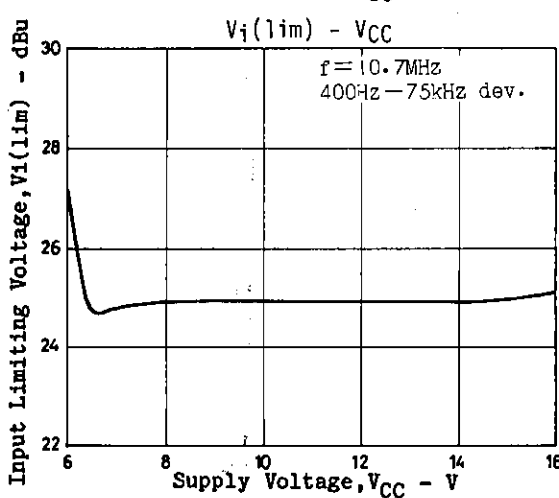
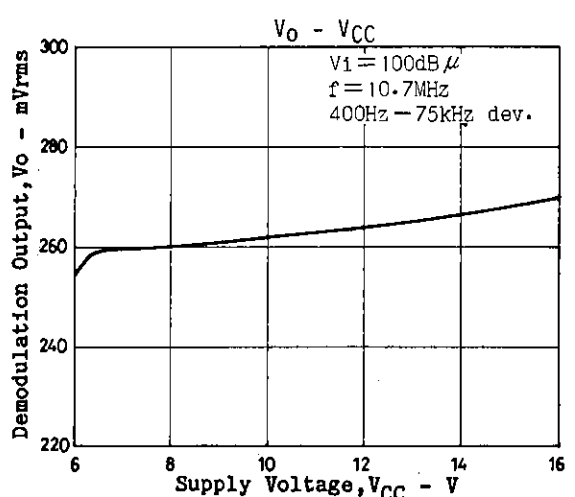
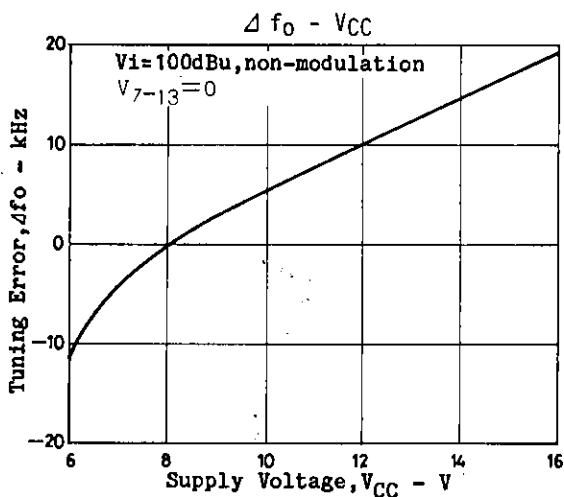
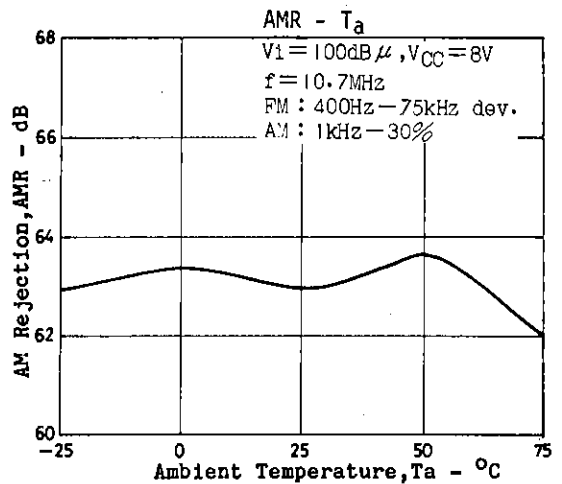
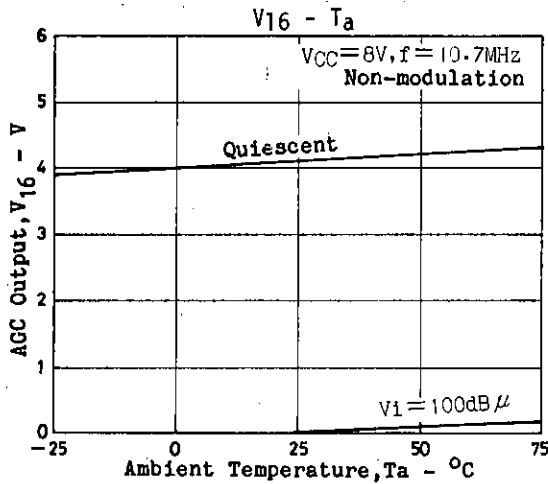
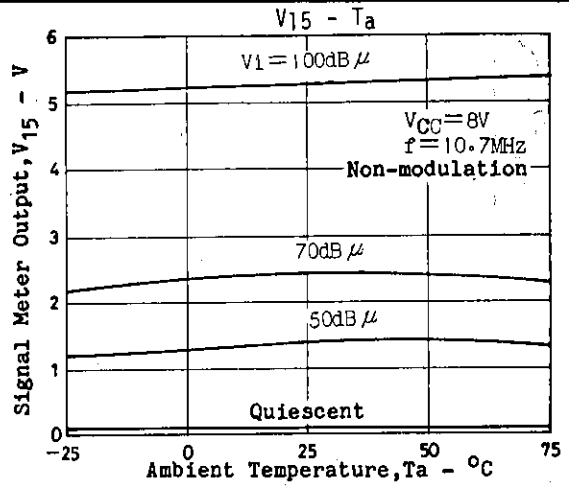
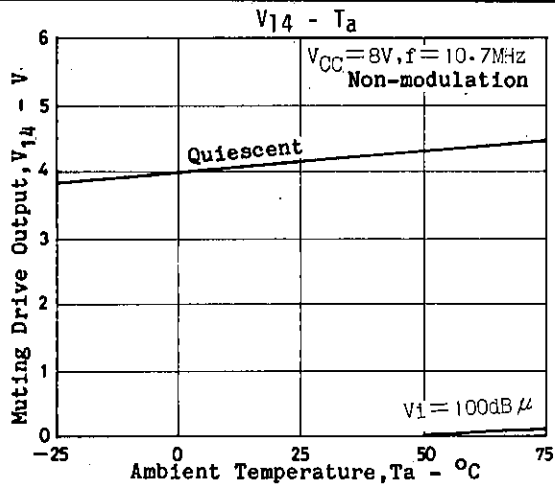


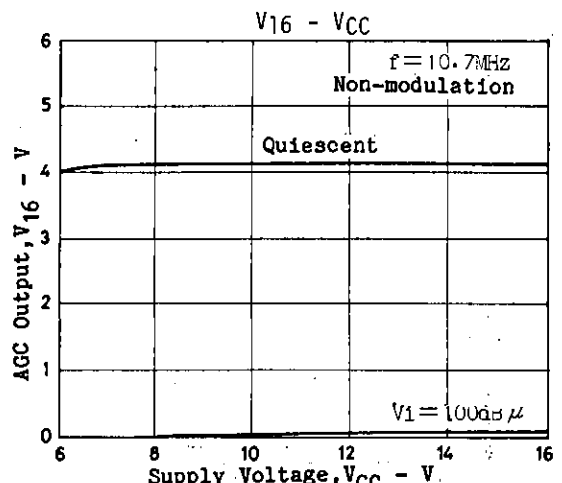
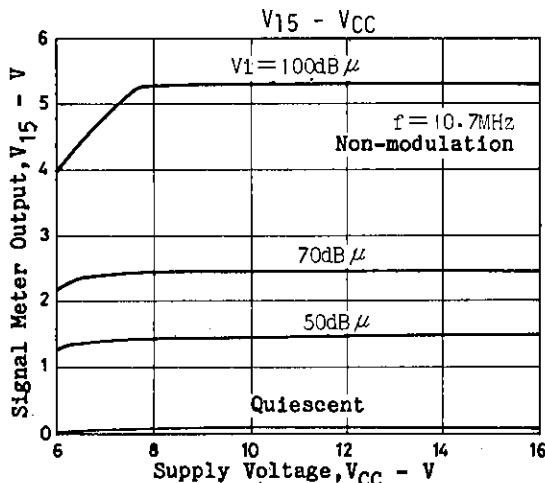
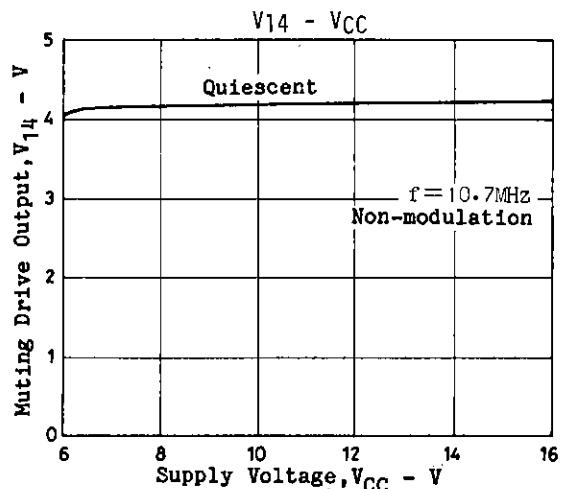
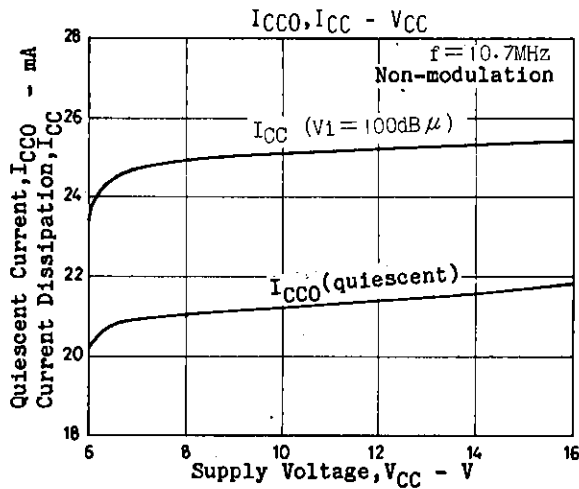
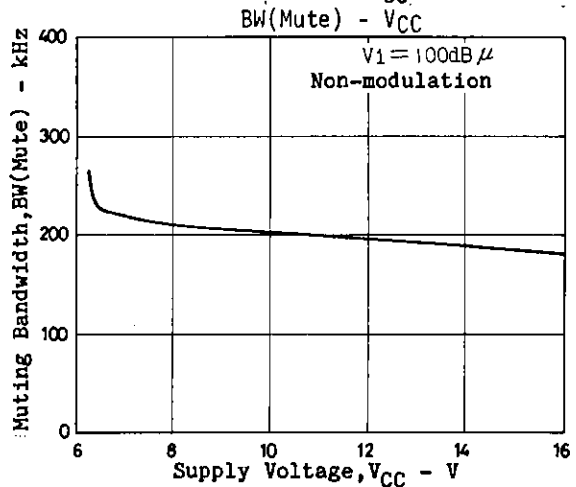
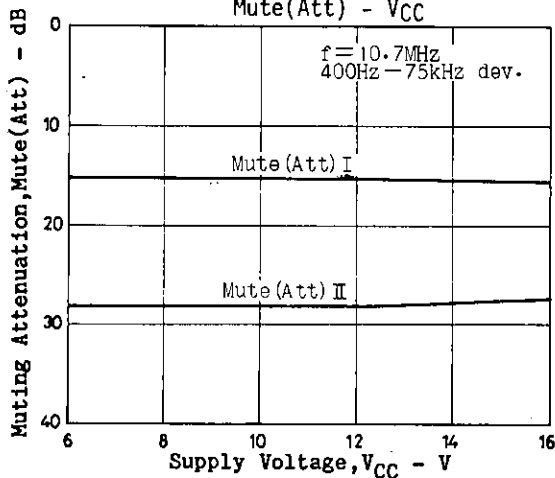
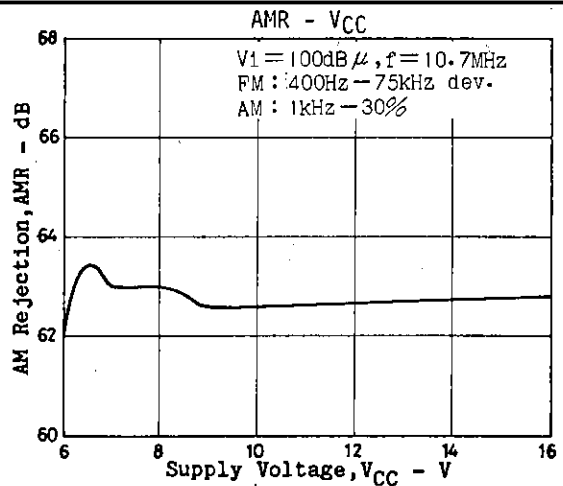
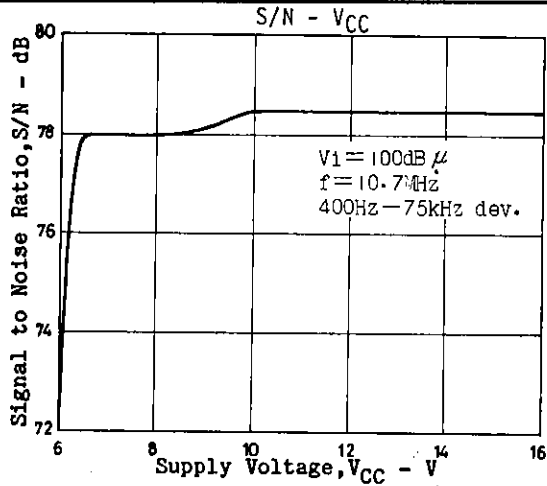
Thus the required muting drive output can be obtained by selecting proper values of  $R_{15-G}$  and  $R_{16-G}$ . For example, the muting drive output moves toward strong input signal level if the  $R_{16-G}$  is decreased, or the muting drive output becomes zero due to the offset current  $I_0$  under a weak signal input condition, if the  $R_{16-G}$  is increased to infinity (namely pin 16 is opened). However the muting drive output caused by a hole detector still exists in this case. Increasing  $R_{15-G}$  decreases the slope of the curve for the muting drive output vs. antenna signal input level, or decreasing the  $R_{15-G}$  increases the slope of the curve. Furthermore, varying the value of a resistor connected between the muting drive output (pin 14) and the muting control input (pin 6) changes the value of the muting control current required to obtain the same muting drive output, accordingly a slope of curve for muting attenuation vs. antenna signal input level is also changed. These characteristics investigated by using an actual receiver are shown on the curves below.

The general method to adjust the muting circuit of the LA1140 is: to set the signal input level required to actuate the muting circuit with the  $R_{16-G}$ , to adjust the slope of the curve for the muting attenuation vs. antenna signal input with the  $R_{15-G}$ , and to adjust the maximum muting attenuation (determined by setting the noise level at no signal) with the  $R_{5-G}$ . The slope of the curve for the muting attenuation vs. antenna signal input level can also be adjusted by the resistor connected between pins 14 and 6 in addition to  $R_{15-G}$ , however, selecting a resistor too high does not allow the muting control current flowing into pin 6 to reach 120uA even through the maximum muting drive output ( $V_{14}$ ) is applied, namely the muting attenuation does not reach its maximum value. Accordingly a recommended value of the resistor between pins 14 and 6 is about 22kohms.







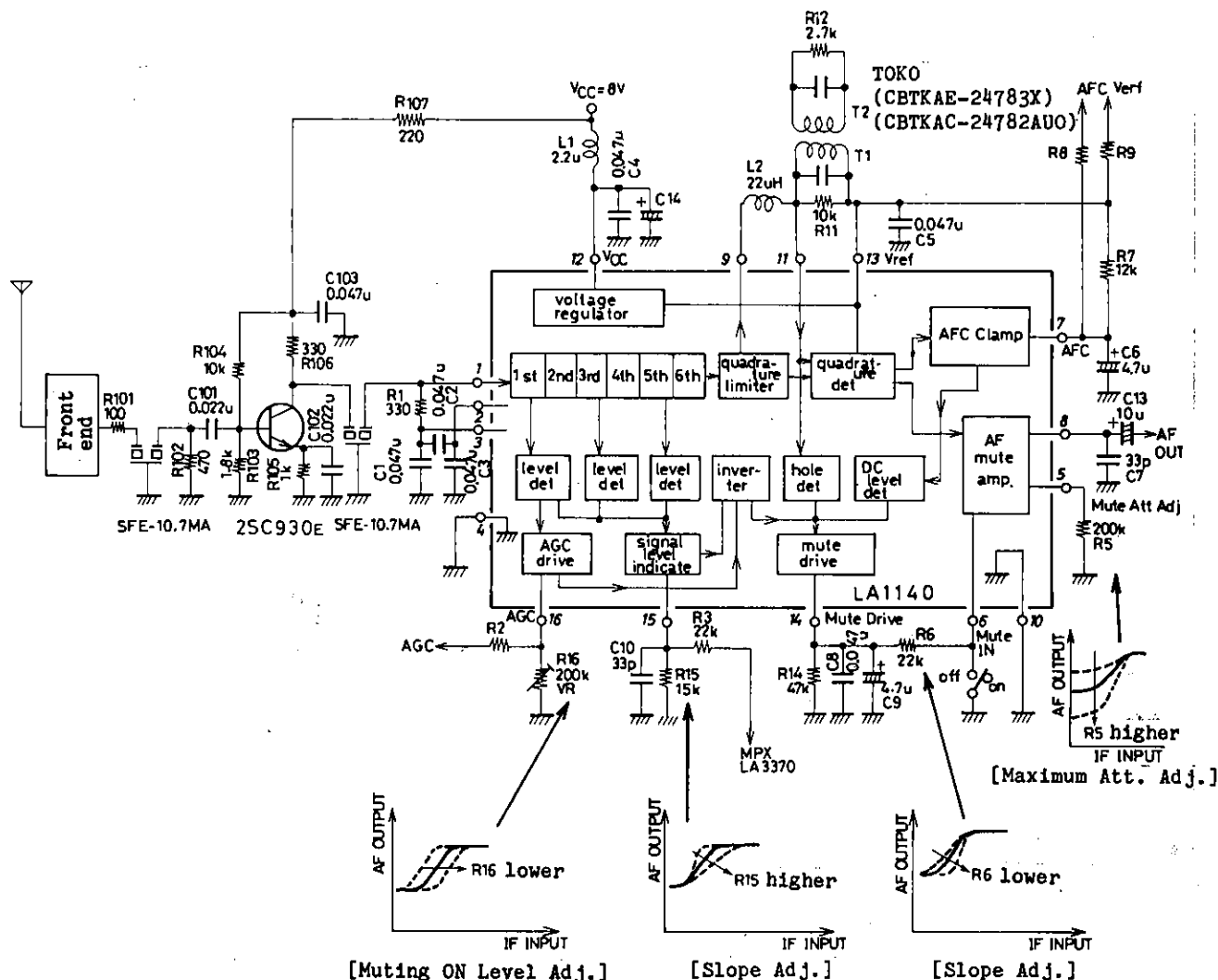




**Proper cares in using LA1140**

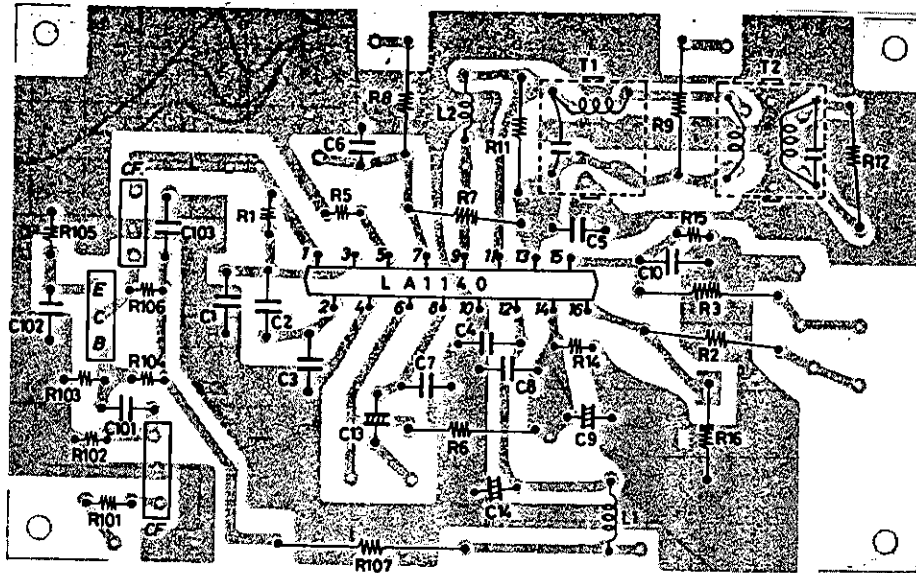
- 1) The detector transformers should be designed to develop a quadrature signal (pin ①) of higher than 175mVrms (approximately 105dBu) under high antenna signal input. If the quadrature signal strength is less than 125mVrms, the muting drive output can not decrease to zero even in a strong signal strength. Furthermore, when the quadrature signal strength lies between 125mV and 175mV, the muting drive output may move from zero to plus under high temperature conditions.
- 2) When designing a PC board, special care should be given to the ground pattern layout by referring to that of the recommended PC board example as shown on the next page.
- 3) Do not connect a capacitor directly between pin ⑬ and ground. If the signal intensity of IF input varies in the vicinity of 90dBu, the voltage at pin ⑬ varies. Thus, charging/discharging current flows into the capacitor and goes to the muting drive output (pin ⑭) through the inverter inside the IC, thereby causing the muting to malfunction.

**Sample Application Circuit 1**



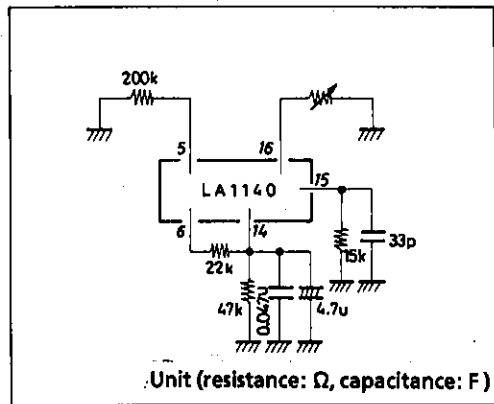
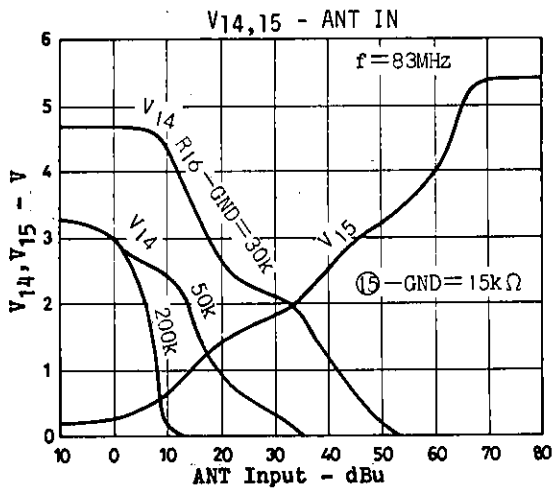
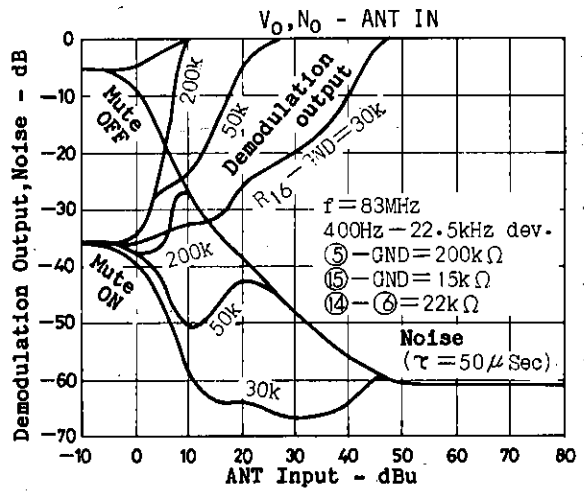
Unit (resistance: Ω, capacitance: F)

Sample Printed Circuit Pattern

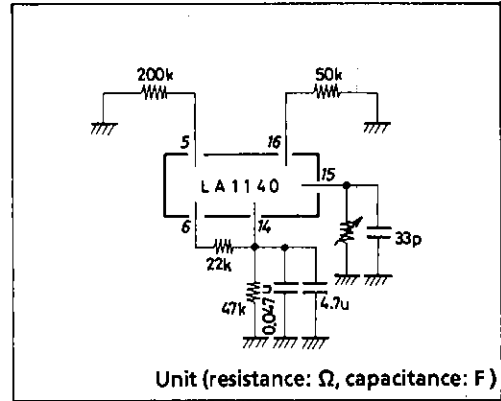
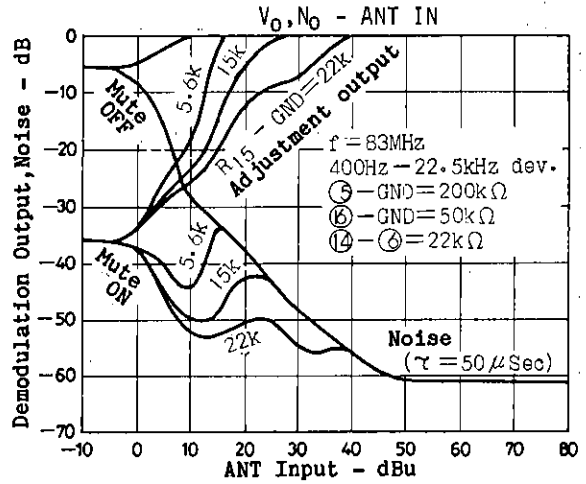
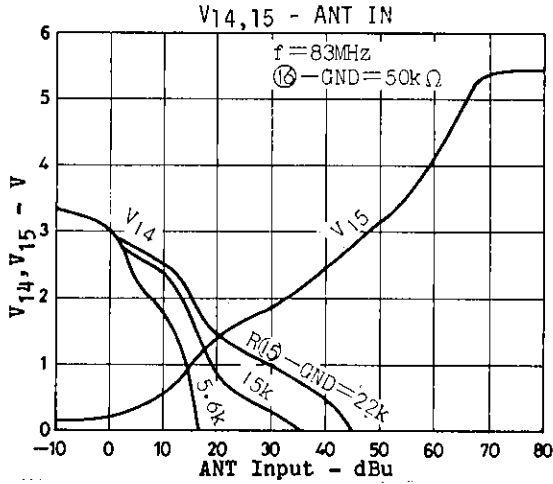


(Cu-foiled side 45x75mm<sup>2</sup>)

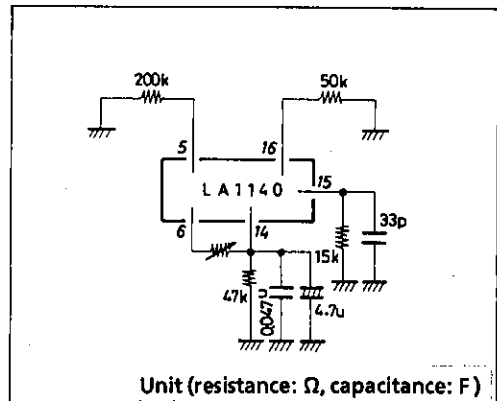
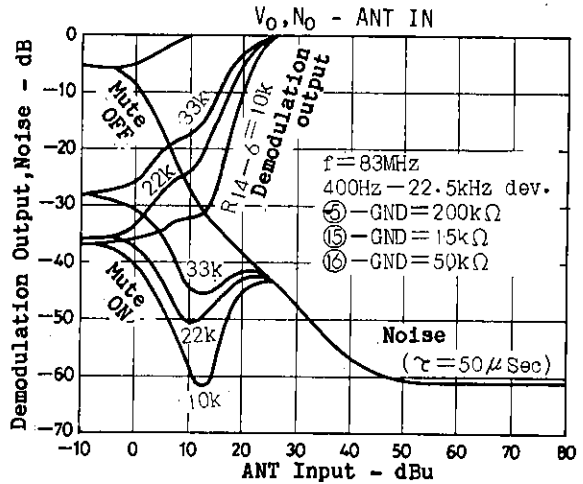
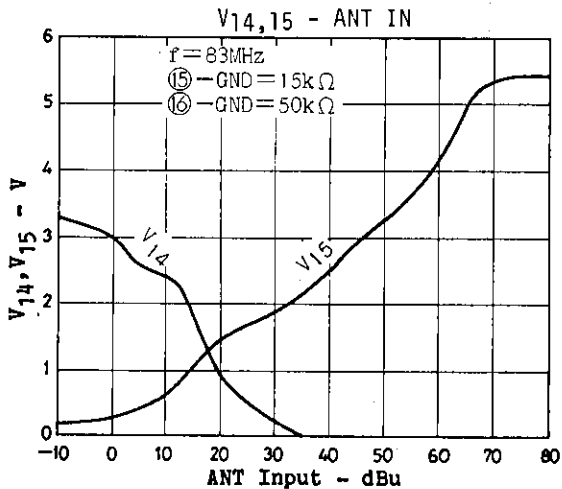
- Variations of muting characteristics with a resistor connected between the pin 16 and GND varied. (Muting threshold level adjustment)



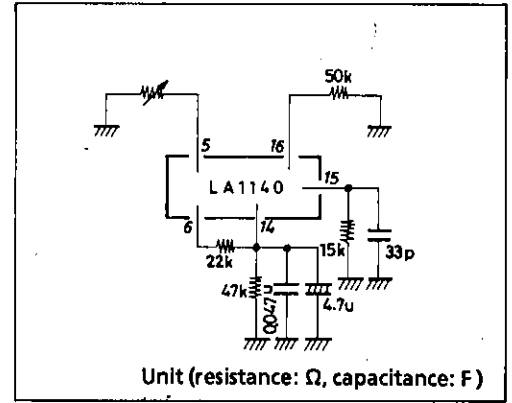
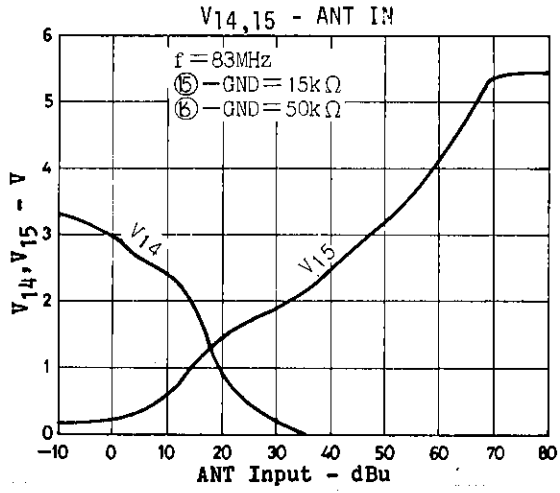
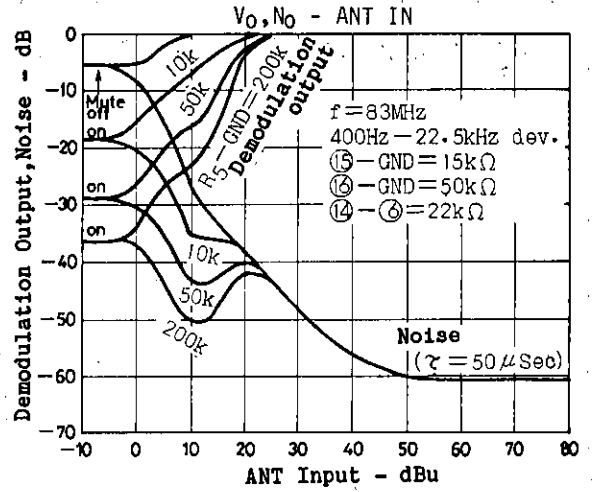
- Variations of muting characteristics with a resistor connected between pin ⑮ and GND varied. (Slope adjustment 1 of the curve for muting attenuation vs. antenna signal input level)



- Variations of muting characteristics with a resistor connected between pins ⑭ and ⑥ varied. (Slope adjustment 2 of the curve for muting attenuation vs. antenna signal input level)

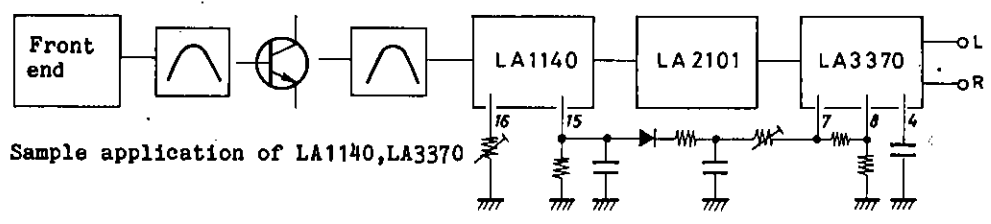


- Variations of muting characteristics with a resistor connected between pin 5 and GND varied. (Adjustment of the maximum muting attenuation)



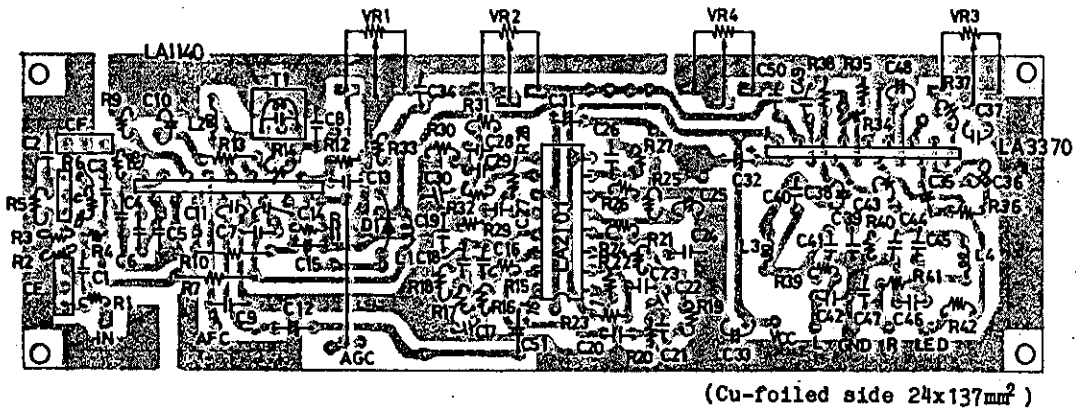
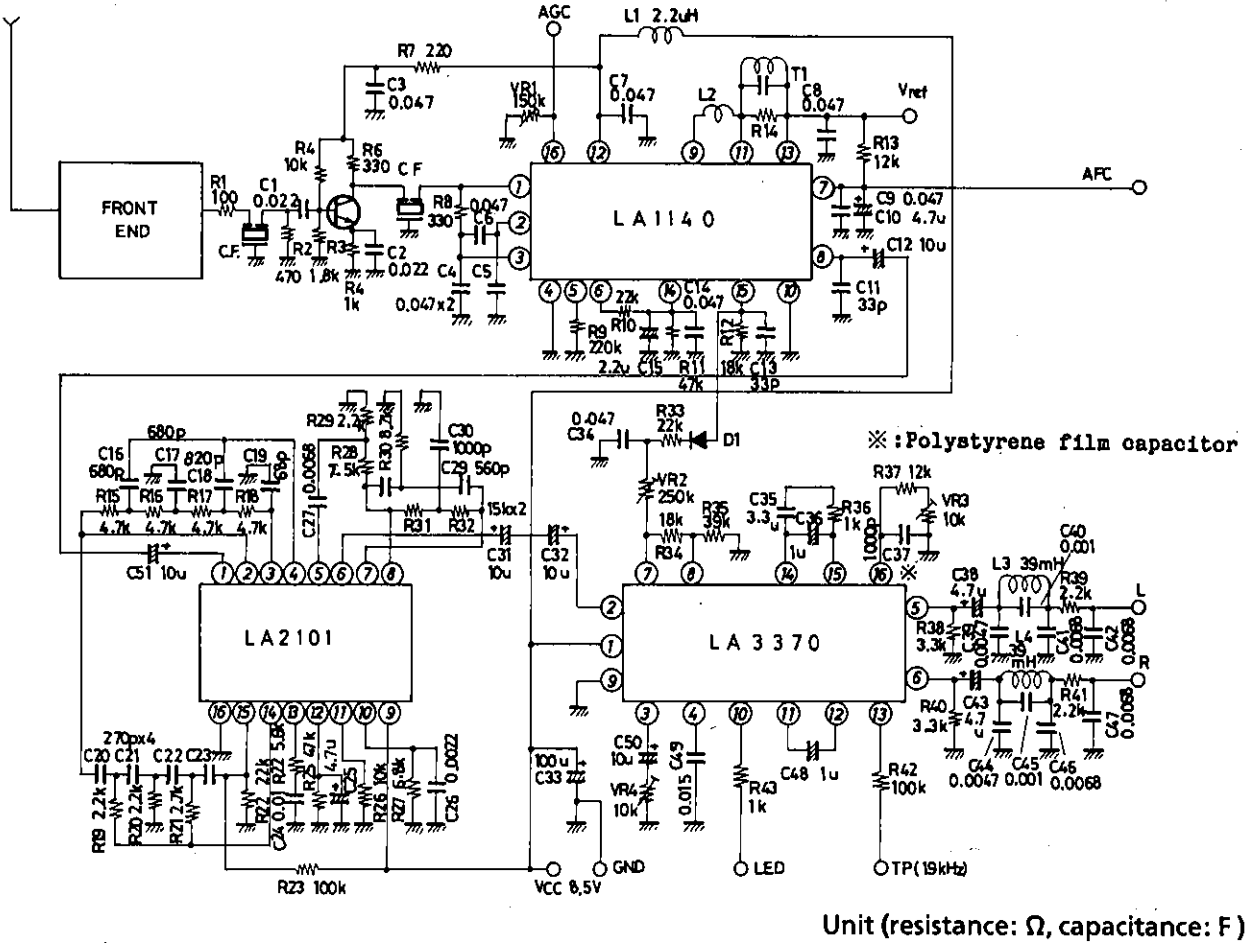
**Sample Application Circuit 2: High Frequency Section of Car Radio and Car Stereo with Noise Canceller and FM Stereo Multiplexer**

Almost all noise under a medium and lower input signal strength can be rejected by processing the muting characteristic of the LA1140, the stereo noise control (SNC) characteristic and the high cut control characteristic of the LA3370. These examples are as follows:

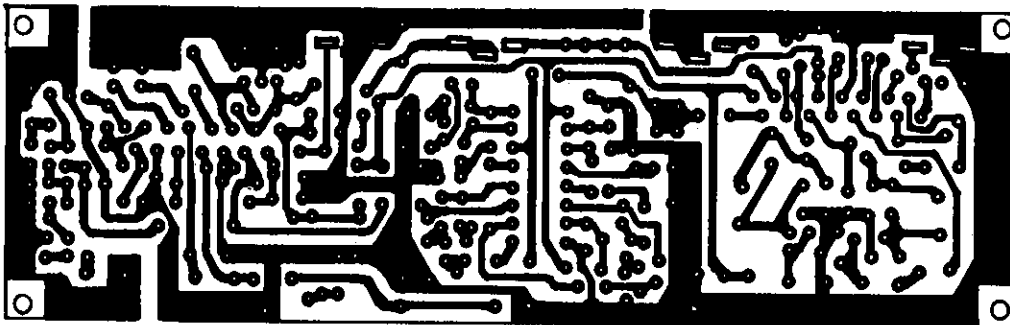


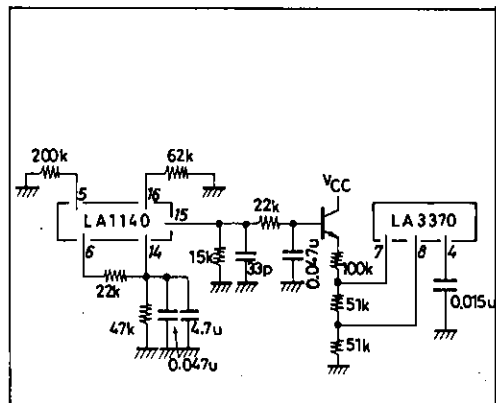
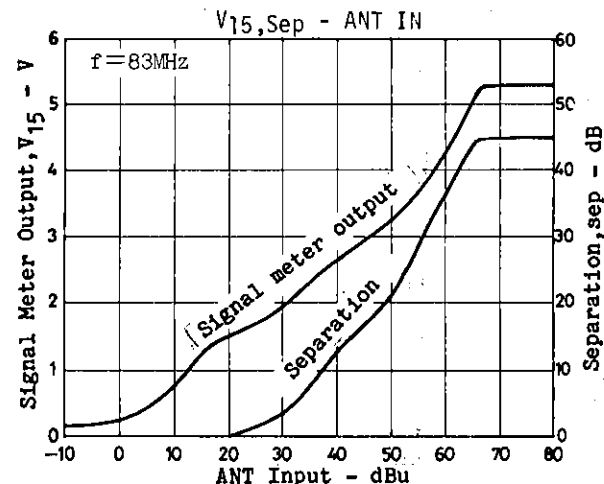
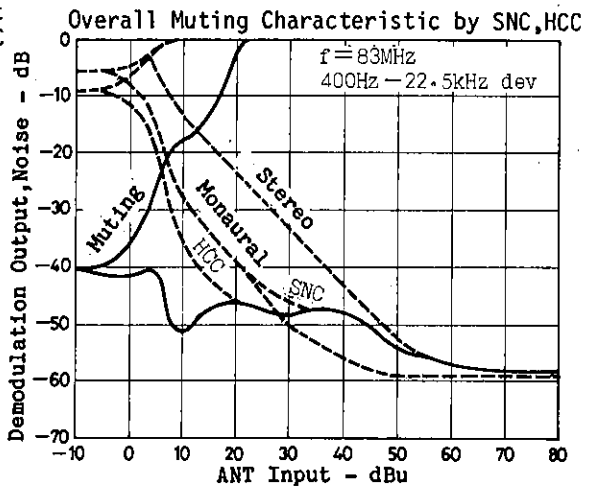
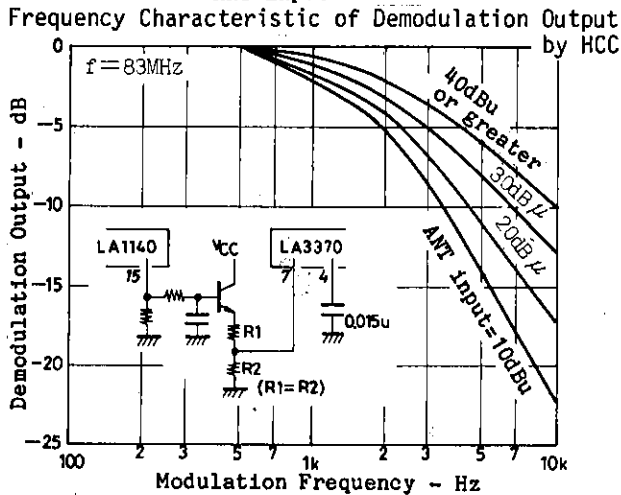
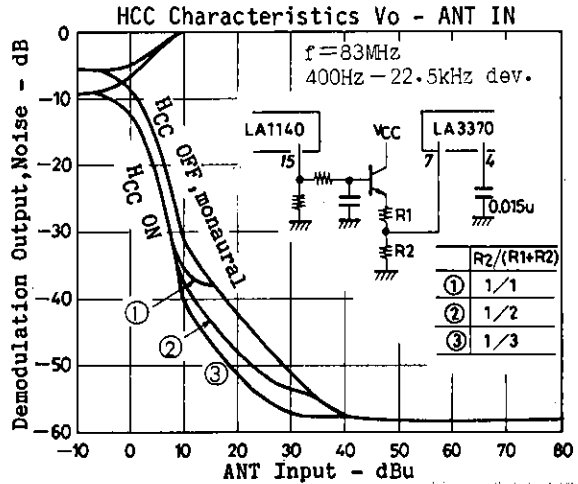
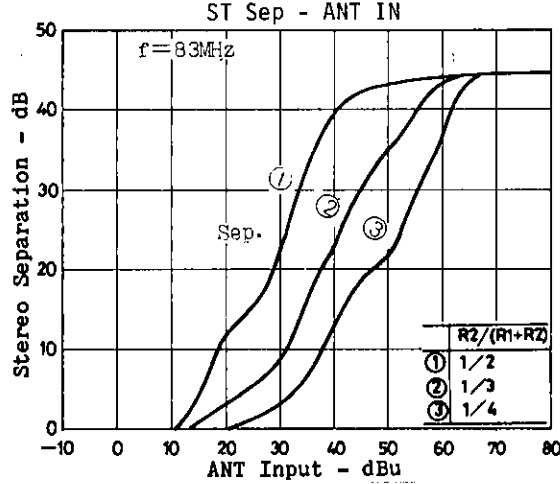
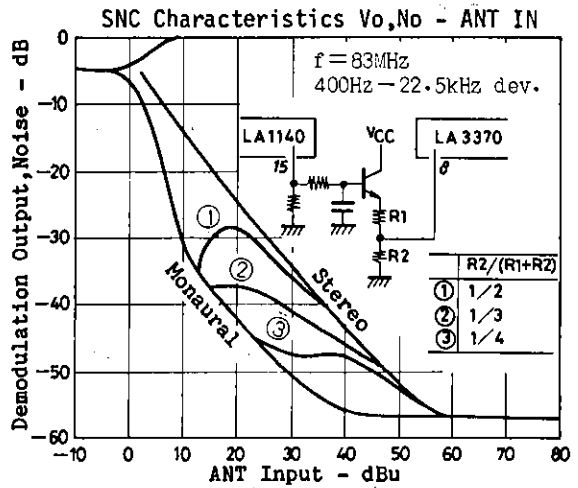
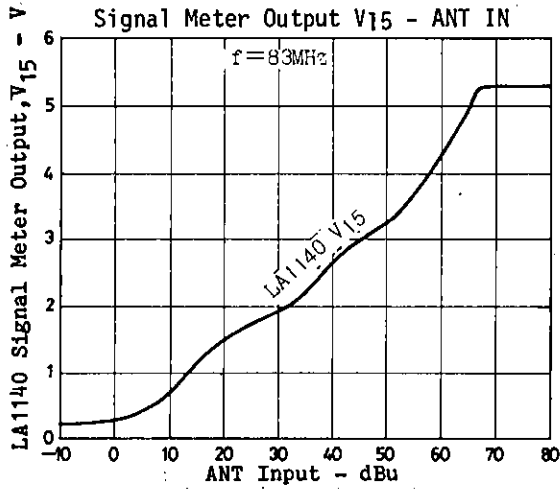
# LA1140

## Circuit Diagram



## Parts Assignment





Unit (resistance:  $\Omega$ , capacitance: F)

Item	Manufacturer	Type Number	Package	Fixed Inductor	Damping Resistor	Note
Double Tuning	Toko	Pri. CBTKAC-24782AU0	10mm sq.	22uH	10kohms	
		Sec. CBTKAE-24783X	10mm sq.		2.7kohms	
	Sumida	Pri. 0232-702-066	7mm sq.	22uH	10kohms	
		Sec. 0232-702-067	7mm sq.		2.7kohms	
Single Tuning	Toko	119AC-14086Z	7mm sq.	22uH	10kohms	
		MTKAC-25639Z	10mm sq.	22uH	10kohms	
	Korin	57-1011-01	7mm sq.	22uH	22kohms	*:Included
		59-1167-04	10mm sq.	(22uH*)	5.6kohms	
	Sumida	24M-190-268	7mm sq.	22uH	5.6kohms	
		24M-190-267	10mm sq.	22uH	5.6kohms	
Sankyo	DC-11	7mm sq.	(22uH*)	10kohms	*:Included	

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