



FM IF System for Car Radios

Overview

The LA1143 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
- AF preamplifier
- Signal meter output
- Muting at detuning
- Quadrature detector
- AFC output
- AGC output
- Muting at small input

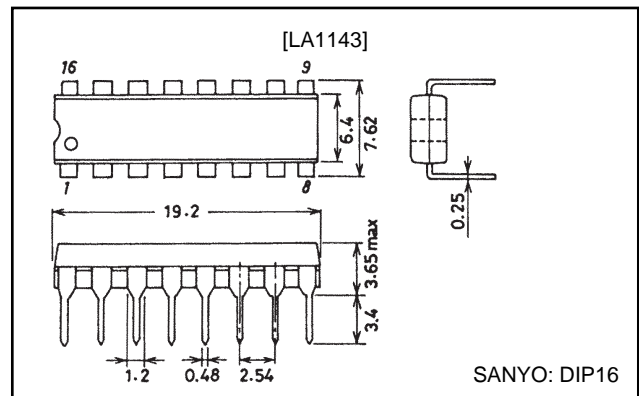
Features

1. Versatile mutings
 - 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 (25 dBμ typ. with muting off) provides a good 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 LA3373).
7. Clamped ($\pm V_{BE}$) AFC output, bandwidth adjustable.
8. Delayed AGC output for front end circuit.

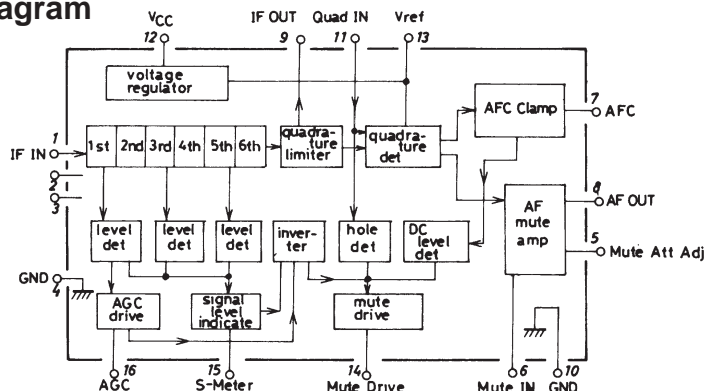
Package Dimensions

unit: mm

3006B-DIP16



Equivalent Circuit Block Diagram



LA1143

Specifications

Maximum Ratings at $T_a=25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC\ max}$	Pin 12	16	V
Maximum supply current	$I_{CC\ max}$	Pin 12	40	mA
Allowable power dissipation	$P_{d\ max}$	$T_a=25^\circ\text{C}$	640	mW
		$T_a=70^\circ\text{C}$	460	mW
Input voltage	V_{IN}	Pin 1 to 2	± 1	Vp-p
Flow-in current	I_2	Pin 2	± 0.2	mA
	I_3	Pin 3	± 0.2	mA
	I_6	Pin 6	2	mA
Flow-out current	I_5	Pin 5	1	mA
	I_{13}	Pin 13	2	mA
	I_{14}	Pin 14	2	mA
	I_{15}	Pin 15	1	mA
	I_{16}	Pin 16	1	mA
Operating temperature	T_{opr}		-20 to +70	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

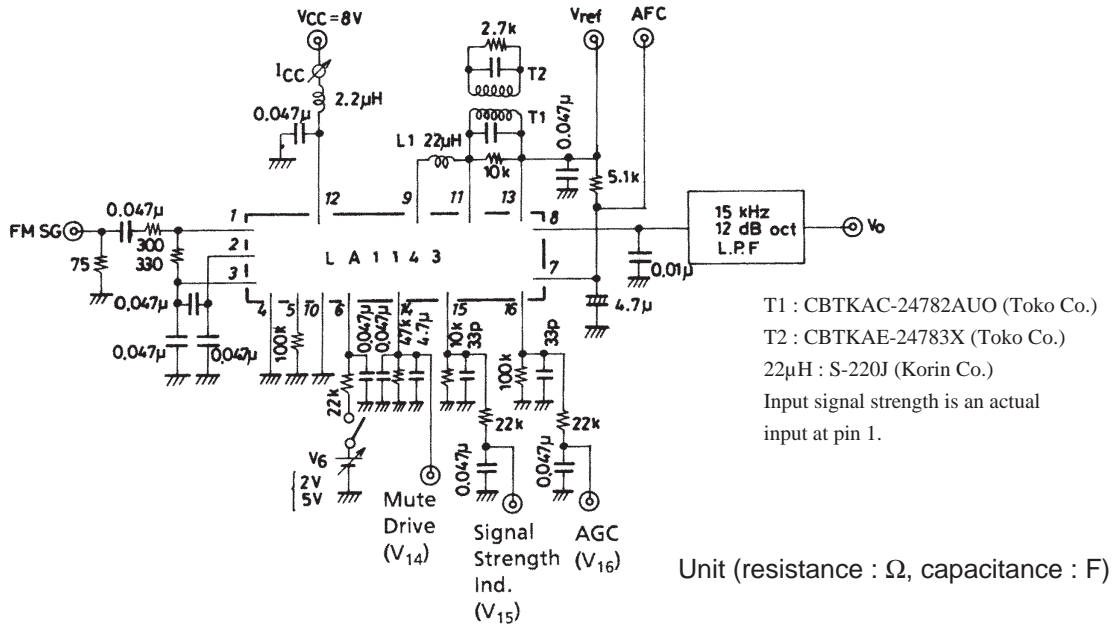
Operating Condition at $T_a=25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		8	V
Operating voltage range	$V_{CC\ op}$		7.5 to 16	V

Operating Characteristics at $T_a=25^\circ\text{C}$, $V_{CC}=8\text{V}$, $f=10.7\text{MHz}$, See specified Test Circuit.

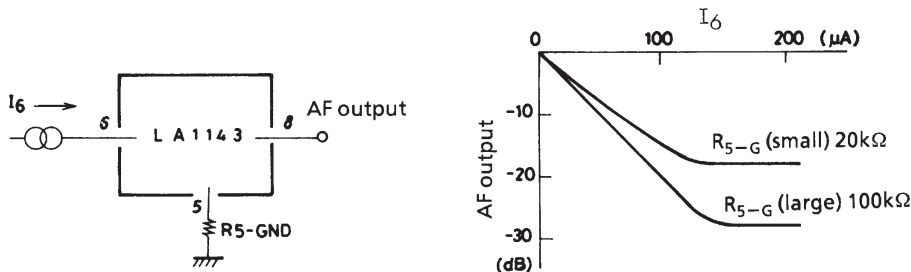
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}	Quiescent	15	21	27	mA
Current drain	I_{CC}	$V_{IN}=100\text{dB}\mu$	20	25	30	mA
Demodulation output	V_O	$V_{IN}=100\text{dB}\mu, 400\text{Hz}, 100\% \text{ mod.}$	200	260	320	mVrms
Total harmonic distortion	THD	$V_{IN}=100\text{dB}\mu, 400\text{Hz}, 100\% \text{ mod.}$		0.05	0.2	%
Signal to noise ratio	S/N	$V_{IN}=100\text{dB}\mu, 400\text{Hz}, 100\% \text{ mod.}$	72	78		dB
Input limiting voltage	$V_{IN(lim)}$	$V_O : 3\text{dB down}, 400\text{Hz } 100\% \text{ mod.}$		25	29	dB μ
Muting sensitivity	$V_{IN(mute)}$	$V_{14}=2.0\text{V}$	22	26	35	dB μ
Muting attenuation (1)	Mute(ACC)	$V_6=2.0\text{V} (22\text{k}\Omega), V_{IN}=100\text{dB}\mu, 400\text{Hz } 100\% \text{ mod.}$	10	15	20	dB
Muting attenuation (2)	Mute(ACC)	$V_6=5.0\text{V} (22\text{k}\Omega), V_{IN}=100\text{dB}\mu, 400\text{Hz } 100\% \text{ mod.}$	24	28	32	dB
Muting bandwidth	BW(mute)	$V_{IN}=100\text{dB}\mu, V_{14}=2.0\text{V}$	140	210	370	kHz
AM rejection ratio	AMR	$V_{IN}=100\text{dB}\mu, \text{FM } 400\text{Hz } 100\% \text{ mod.}$ AM 1kHz 30% mod.	50	63		dB
Muting drive output	V_{14-0}	Quiescent	3.5	4.2	5.0	V
Muting drive output	V_{14-100}	$V_{IN}=100\text{dB}\mu$	0	0	0.3	V
Signal meter output (1)	V_{15-0}	Quiescent	0	0.1	0.3	V
Signal meter output (2)	V_{15-50}	$V_{IN}=50\text{dB}\mu$	0.8	1.4	2.0	V
Signal meter output (3)	V_{15-70}	$V_{IN}=70\text{dB}\mu$	1.6	2.4	3.2	V
Signal meter output (4)	V_{15-100}	$V_{IN}=100\text{dB}\mu$	4.5	5.3	6.0	V
AGC output (1)	V_{16-0}	Quiescent	3.5	4.1	4.5	V
AGC output (2)	V_{16-100}	$V_{IN}=100\text{dB}\mu$	0	0.02	0.3	V
Offset voltage (1)	V_{7-13}	Quiescent, pin 7 to 13	-0.25	0	+0.25	V
Offset voltage (2)	V_{8-13}	Quiescent, pin 8 to 13	-0.5	0	+0.5	V

AC Test Circuit



Muting Characteristic

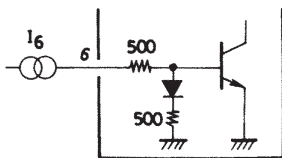
The muting operation in the LA1143 is performed by an AF preamplifier, the gain of which varies continuously with control current, and a muting drive circuit which supplies the control current. The gain of the AF preamplifier decreases with increasing gain control current applied to pin 6. However, the gain does not decrease further when the control current reaches approximately 120μA or more. 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 500Ω 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 pin 6 through a high resistance (up to 20kΩ).

The muting drive output comes in three types :

- 1) Hole detector output which develops a voltage when C/N (carrier-to-noise ratio) lowers under weak signal input condition.
- 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 detuning operation.



Unit (resistance : Ω)

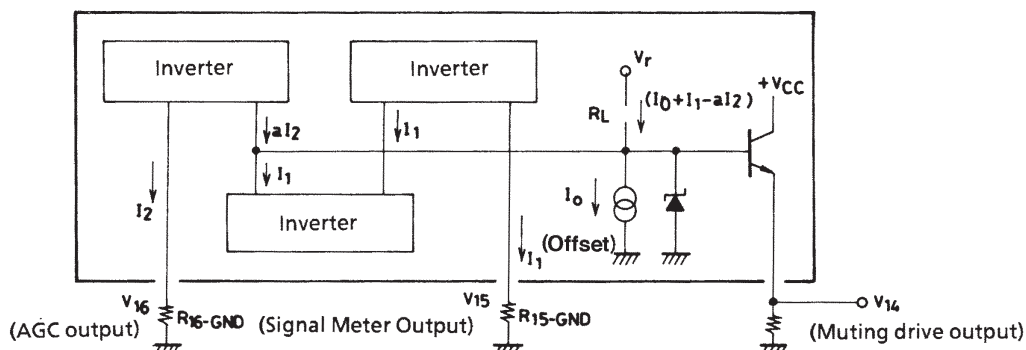
All these outputs are led to an OR circuit and the processed output is developed at pin 14. Of the above muting drive outputs, descriptions on the hole detector output and the bandwidth limited muting drive

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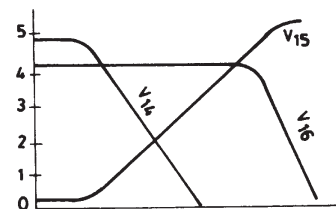
output will be omitted, since they are the same as those used in conventional quadrature detector ICs (such as LA1230, LA1231N).

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



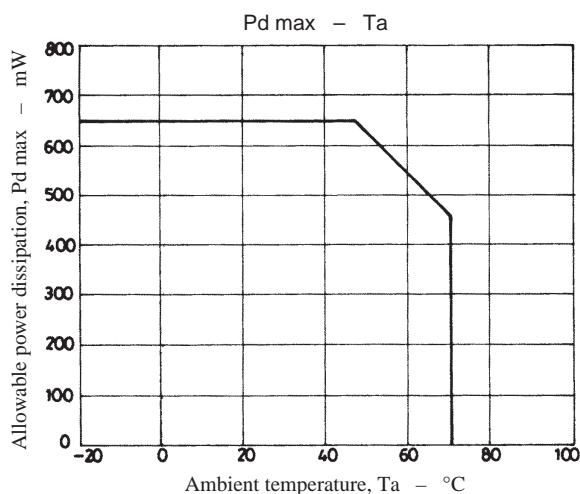
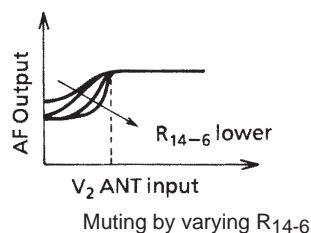
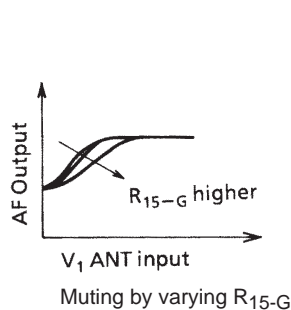
By referring to the illustration, V_{14} is given by the formula : $V_{14} = V_T - (I_0 + I_1 - aI_2)R_L - V_{BE}$.

Conditions are : $V_T \approx 4.9V$, $I_0 \approx 0.2mA$, $a \approx 2$, $R_L = 22k\Omega$, $V_{BE} \approx 0.6V$, $I_1 = V_{15}/R_{15-G}$, $I_2 = V_{16}/R_{16-G}$, 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 LA1143 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 $120\mu A$ even though 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 $22k\Omega$.



Proper cares in using LA1143

1. The detector transformers should be designed to develop a quadrature signal (pin 11) of higher than 175mVrms (about 105dB μ) 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. Do not connect a capacitor directly between pin (16) and ground. If the signal intensity of IF input varies in the vicinity of 90dB μ , the voltage at pin (16) 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.

For detailed data and sample application circuits, refer to the catalog of the LA1140.

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