



SANYO Semiconductors

DATA SHEET

LA3370

Monolithic Linear IC
For Car Stereo
PLL FM Multiplex Stereo Demodulator

Overview

The LA3370 is a multiplex IC for FM car stereo, and it has the following 2 functions through its utilization of the IF meter output voltage, etc.

1. Stereo noise control (SNC) under which the noise particular to the FM stereo unit in the weak electric field is reduced smoothly.
2. High-cut control (HCC) under which the high frequency is smoothly attenuated. In addition, the LA3370 can be, due to its low distortion factor, an IC for multiplex stereo demodulator which is appropriate for the car component stereo unit.

Features

- Low distortion factor. (0.05% typ. 300mV input, mono)
- The ripple of power source can effectively be rejected. (35dB typ.)
- The range of voltage to be used is wide. ($V_{CC} = 6.5$ to 14V)
- The space factor is advantageous because of the single-end package.
- The printed circuit board can easily be prepared as 3mm pitch is used between the pins.

Functions

- Stereo noise control (SNC terminal)
Through controlling the quality of sound from stereo mode to monaural mode with the voltage applied to the control pin, the FM stereo noise in the weak electric field is reduced by this function.
- High-cut control function (HCC terminal)
The FM noise in the weak electric field is reduced through the attenuation of high frequency thereof. Such attenuation can be changed smoothly from "Normal" to "High Cut" by controlling the voltage applied to the control pin. The volume of "High Cut" can be selected by using an external capacitor.
- Stereo-monoaural automatic select
This selection has priority over the stereo noise control. Pilot input prioritized.
- Stoppage of VCO oscillation
When a voltage of 7.5V or higher is applied to the HCC terminal, the oscillation of VCO can be discontinued. In this case, the stereo lamp does not malfunction.
- With separation control terminal.

■ Any and all SANYO Semiconductor Co., Ltd. products described or contained herein are, with regard to "standard application" intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment, etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer, who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co., Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

SANYO Semiconductor Co., Ltd.

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC\text{ max}}$		16	V
Lamp driving current	I_L		40	mA
Allowable power dissipation	$P_d\text{ max}$	$T_a \leq 45^\circ\text{C}$	520	mW
Operating temperature	T_{opr}		-20 to +70	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

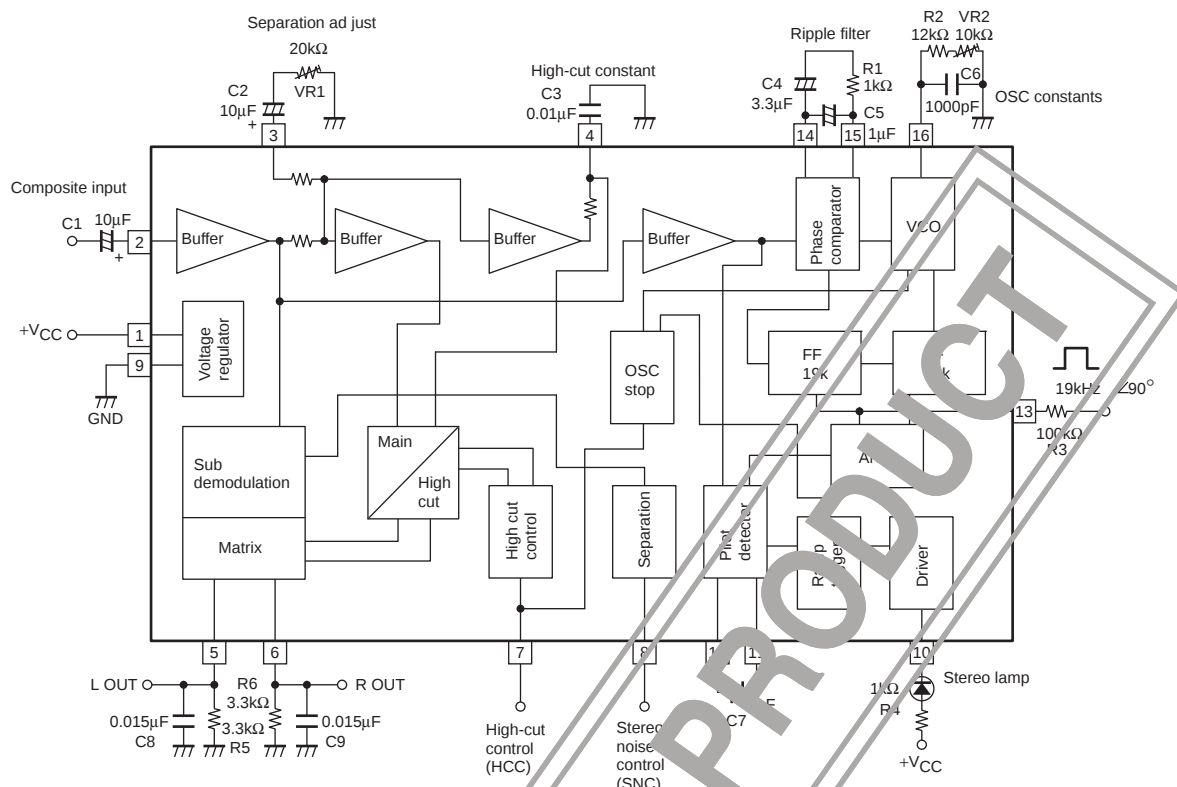
Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		6.5 to 14	V
Input signal voltage	V_{IN}		200 to 300	mV

Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 10\text{V}$, $V_{IN} = 300\text{mV}$, $f = 1\text{kHz}$, $L+R = 90\%$, $\text{pilot} = 10\%$ See specified Test Circuit.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}			21	27	mA
Channel separation	Sep		40	50		dB
Monaural distortion	mono THD	Mono = 300mV		0.05	0.2	%
Stereo distortion	ST THD	Main		0.05	0.2	%
Lamp turning-on level	V_L	$L+R = 90\%$, $\text{pilot} = 10\%$	60	85	120	mV
Hysteresis	hy			3	6	dB
Capture range	CR	Pilot = 30mV		± 3		%
Output signal level	V_O	Sub	140	200	280	mV
S/N ratio	S/N		70	78		dB
Input resistance	r_i			20		k Ω
SCA rejection	SCA _{rej}			80		dB
Allowable input voltage	V_{IN}	THD = 1%	700	800		mV
SNC output attenuation	$A_{tt\text{ SNC}}$	$V_8 = 0.6\text{V}$, $L-R = 90\%$, $\text{pilot} = 10\%$	-8.5	-3.0	-0.3	dB
SNC output voltage	$V_{O\text{ sub}}$	$V_8 = 0.1\text{V}$, $L-R = 90\%$, $\text{pilot} = 10\%$			5	mV
HCC output attenuation	$A_{tt\text{ HCC }1}$	$V_7 = 0.6\text{V}$, $L+R = 90\%$, $\text{pilot} = 10\%$	-15.0	-6.0	-0.5	dB
	$A_{tt\text{ HCC }2}$	$V_7 = 1\text{V}$, $L+R = 90\%$, $\text{pilot} = 10\%$	-2.0		0	dB
Power ripple rejection	Rr			35		dB
VCO stopping voltage	$V_{CO\text{ stop}}$			6.8		V
Channel balance	CH Ba			0.5	1.5	dB

Block Diagram and Sample Application Circuit



- SNC (stereo noise control) and HCC (high-cut control)

The LA3370 has SNC and HCC terminals for improved S/N ratios when operating in weak radio fields. By adjusting the SNC terminal, noises unique to stereo FM in weak fields can be reduced. The HCC terminals permits further improvement of effective S/N ratios by lowering the levels of FM noises in weak fields. (See Fig.2)

STEREO deteriorates approximately 21.7dB (compared to MONO) in weak radio fields (Fig.2). Generally, when S/N ratios deteriorate below 30 to 40dB, noises become quite noticeable. Section (1) shows ways to set SNC and HCC when radio field strengths are divided into regions A, B, and C (Fig.2). SNC is expected to function in region A, and HCC in region B. In region C, shallow noise reduction is effected in the IF stage.

(1) SNC (stereo noise control)

Stereo S/N ratios deteriorate 21.7dB below monaural but can be improved by varying stereo separation. S/N improvement becomes apparent only when the separation is 20dB or worse. In that case, the relation between separation and S/N improvement is shown in Fig.3.

SNC in the LA3370 improves S/N ratios in weak radio fields by varying separation. It varies subsignal demodulation level and controls separation. By using the IF stage signal meter level output as the source of the control signal, S/N ratios in region A of Fig.2 can be maintained at about 40dB or better. Ideal S/N enhancements should provide gradual switching over from stereo to monaural to maintain constant S/N ratios, starting from a point in region A for 40dB stereo S/N toward a point for 40dB monaural S/N. Methods to set the control level will be described later.

Fig.4 shows voltage applied to pin 8 (SNC terminal) of LA3370 versus separation characteristics (SNC characteristics). Pin 8 is also the base of a PNP transistor, so stereo mode is set when pin 8 is open and monaural mode is set when it is grounded. SNC terminal control is effective only when locked with pilot signals and when stereo indicator is lit. External circuit parameters can be chosen in large values that do not affect the IF stage meter output circuit because SNC control currents are small. This makes designing easy. (See Fig.5)

(2) Designing external circuits for SNC characteristics (characteristic setting by drawing)

We recommend the following as a way to adjust SNC characteristics to have smooth transition of separation from stereo monaural in region A of Fig.2.

Separation vs. S/N enhancement relation.....Refer to Fig.3.

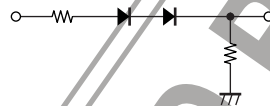
SNC pin voltage vs.separation characteristics.....Refer to Fig.4.

Antenna inputs vs. S/N improvement characteristics can be obtained from the drawing if the graph for IF stage signal meter output vs. antenna input and the graph for stereo S/N ratio vs. antenna input are known. From desired S/ N characteristics, SNC terminal voltage characteristics can also be obtained. Sample drawings are shown in Fig.6, where for simplicity's sake, SNC, IF meter, and stereo S/N characteristics have been approximated with straight lines.

For instance :

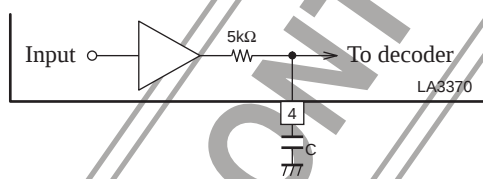
To obtain stereo S/N improvement characteristics from SNC characteristics, when (a) in the second quadrant of the chart represents bare SNC characteristics, point 1 projected to the third quadrant shows a 20dB separation and a 1dB S/N improvement. When projected from the first to the fourth quadrant, a point improved by 1dB in S/N over the stereo S/N line in the fourth quadrant corresponds to point 1. Similarly, point 2 on the SNC characteristics in the second quadrant corresponds to point 2 in the fourth quadrant. Point 3 in the second quadrant corresponds to point 3 in the fourth quadrant. Stereo S/ N improvement characteristics for each point are obtainable. Similarly, (b) characteristics in the second quadrant are projected to form (b) characteristics in the fourth quadrant, and (c) in the second quadrant to form (c) in the fourth quadrant, thus providing a way to diagram improvement characteristics.

In the resulting drawings, ideal S/N improvement characteristics are similar to (b) in the fourth quadrant, but corresponding SNC characteristics have to be (b) characteristics in the second quadrant which are difficult to realize. Among realistic characteristics, something like (c) appears to be satisfactory. The (c) SNC characteristics are obtained with a shift by two diodes together with a 1/ 2 bleeder.



(3) HCC (high-cut control)

In region B where S/N deteriorates to 40dB or worse even for monaural, the S/N as sensed by the human ear can be enhanced by suppressing levels at frequencies above approximately 7kHz. Treble region levels that follow meter voltages can be smoothly attenuated (high-cut control) by impressing IF stage signal meter output to the HCC pin (pin7) of the LA3370. Fig.7 shows MPX output frequency characteristics (monaural) provided by voltage impressed on pin 7. Frequency characteristics for a 100% high cut can be determined by an external capacitor connected to pin 4. An equivalent circuit is shown below where the designation is made by the 5k Ω and the C time constant. Approximate values provided by C as expressed in attenuation at 10kHz are listed in table below : right.



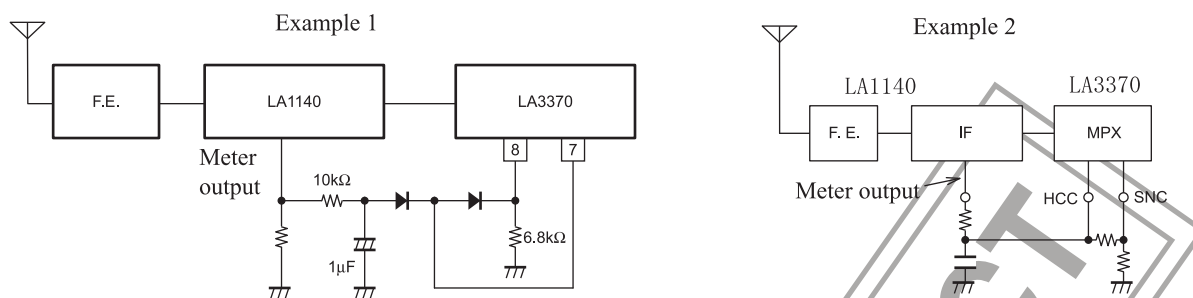
C [μF]	Attenuation at 10kHz (dB)
0.01	-11
0.033	-21
0.047	-25
0.068	-28

Fig. 8 shows the relation between voltages impressed on pin 7 and rates (%) of high cut (HCC). When IF meter output voltage characteristics and region B, S/N characteristics, of Fig. 2 have been obtained, S/N improvement by HCC can be drawn in a way similar to drawing SNC characteristics.

Fig.2 shows typical meter outputs of a quadrature detection IF amplifier IC. (Fig. 1 shows data for LA1140) HCC characteristics have been designated to permit region B improvements when the IC is directly connected to HCC (pin 7) terminal of the LA3370. The infinitesimal control currents at pin 7, similar to pin 8, do not affect meter outputs.

(4) SNC and HCC connection circuits when coupled with the IF stage.

Fig. 1 shows sample S/N characteristics via antenna inputs when SNC and HCC are connected with the IF stage by an external circuit.

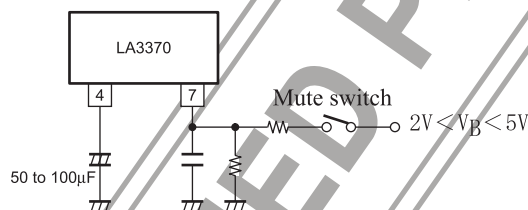


(5) S/N improvements in region C of Fig.1

Because S/N ratios deteriorate even further in the region C of Fig. 1, it is better to improve the S/N in this region with IF mutings. The LA1140 is available to linearly vary the IF muting. Employment of the LA3370 together with the LA1140 further enhances S/N improvement.

(6) Using the HCC terminal for muting

Muting in the neighborhood of 37dB are feasible by utilizing HCC functions as muting functions when used in home stereos and no need exists to suppress treble noises. Fade-in and fade-out of mutings, permitting delightful, shock-noise-free muting are possible by providing a time constant to the pin 7 control.



(7) VCO damping

VCO oscillations can be damped by applying a voltage not less than 7V to the HCC terminal (pin 7) to enter a monaural mode. At this time, both SNC and HCC are in an off mode. Fig. 9 shows flow-in current by voltages applied to pin 7.

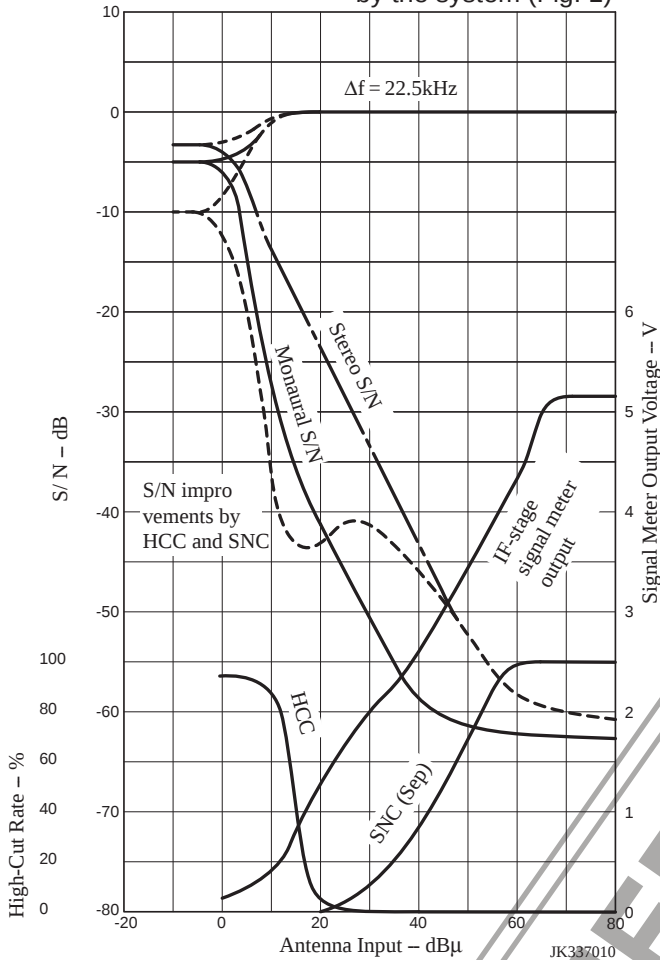
(8) Separation control terminal

Separation is controlled by controlling the main signal level.

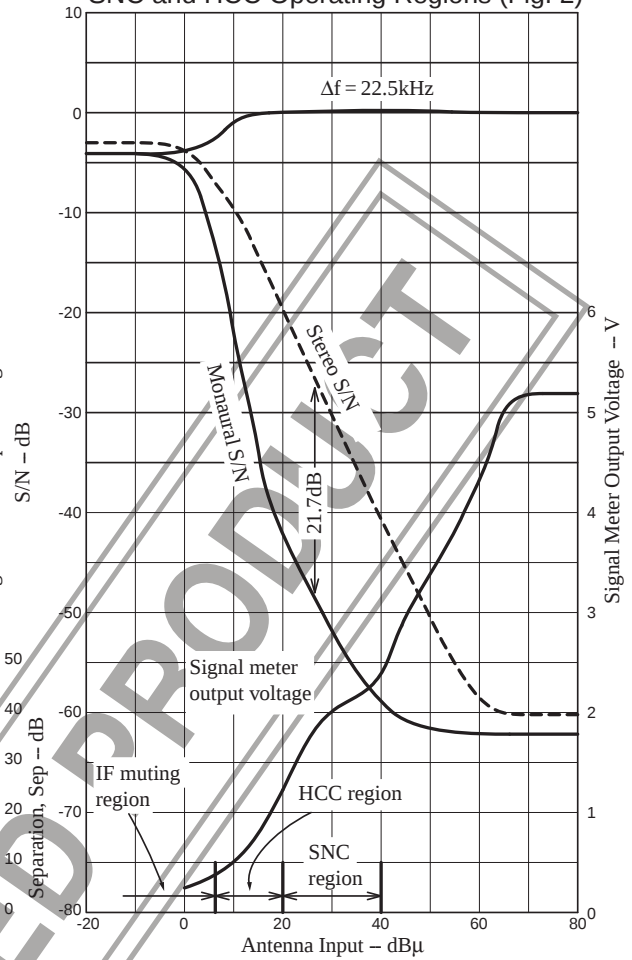
The controllable separation (ratio of sub signal to main signal) range of the input composite signal is approximately as follows :

$$m = \frac{\text{Sub signal level}}{\text{Main signal level}} \quad (\text{at peak level}) \quad 0.7 < m < 1.25$$

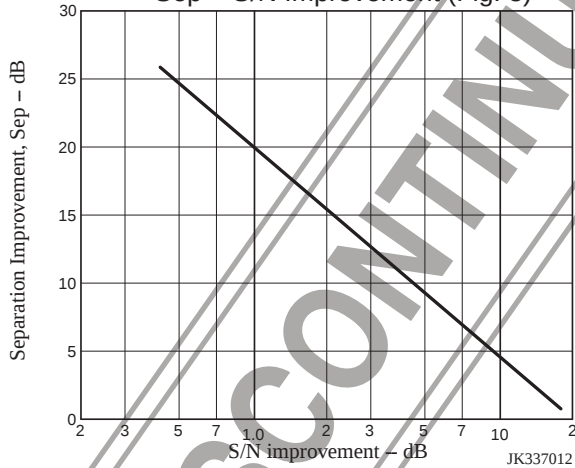
(9) For the application of LA1140+LA3370 and its characteristics, refer to the catalog of the LA1140 (No. EN729).

Sample weak radio field S/N improvements
by the system (Fig. 1)

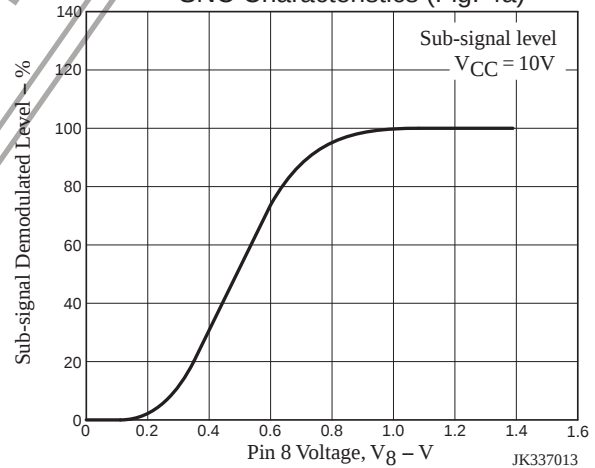
SNC and HCC Operating Regions (Fig. 2)



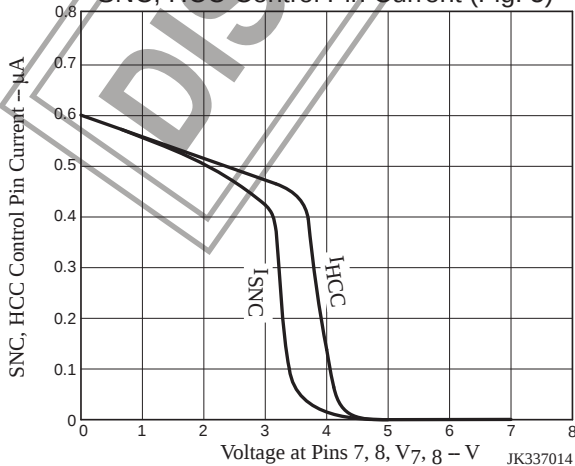
Sep - S/N Improvement (Fig. 3)



SNC Characteristics (Fig. 4a)



SNC, HCC Control Pin Current (Fig. 5)



SNC Characteristics (Fig. 4b)

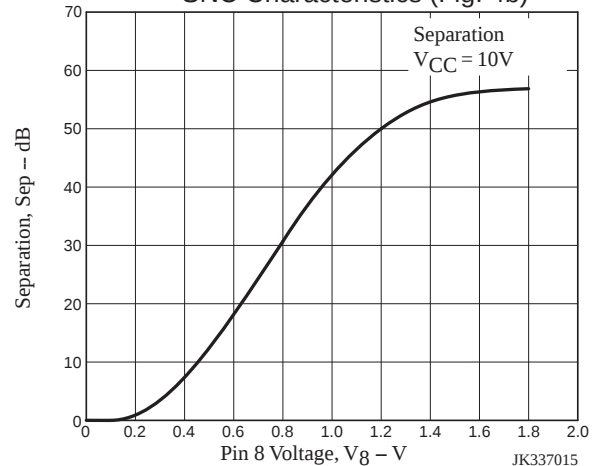
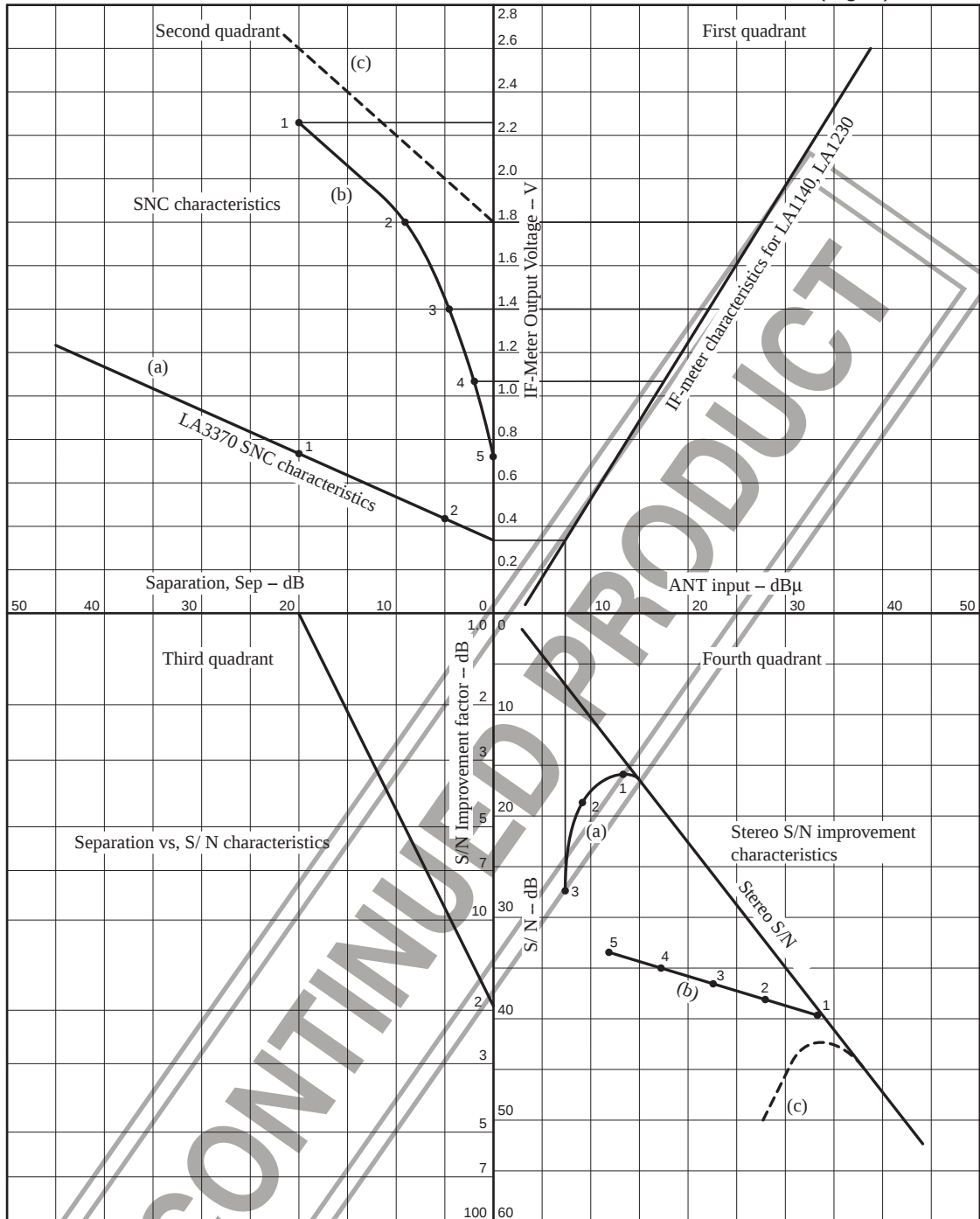
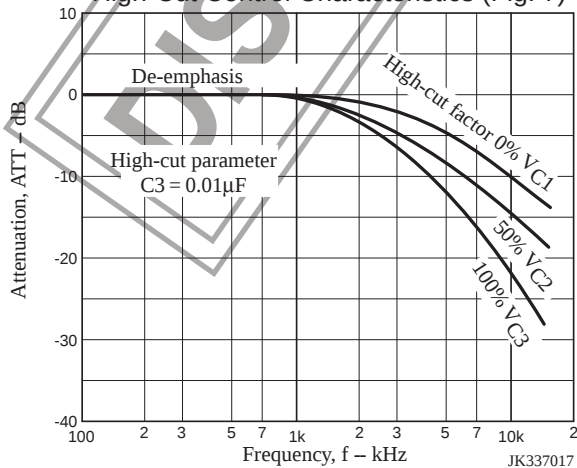


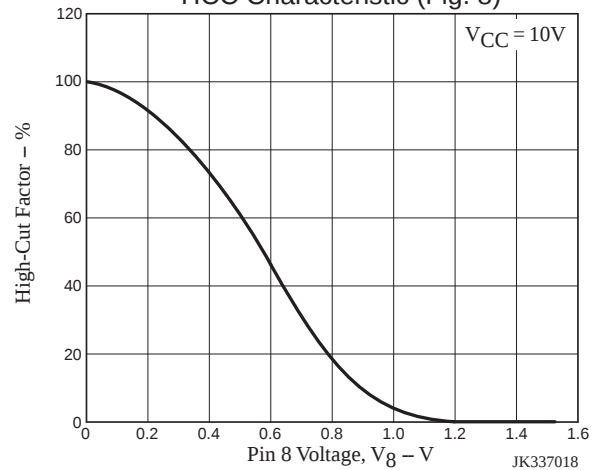
Chart to Obtain Stereo S/N Characteristics from SNC Characteristics (Fig. 6)



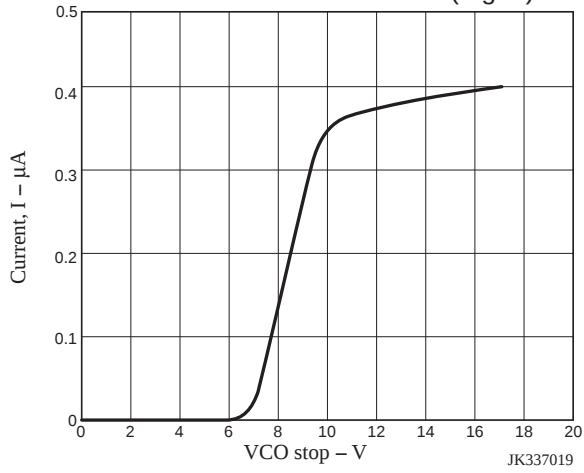
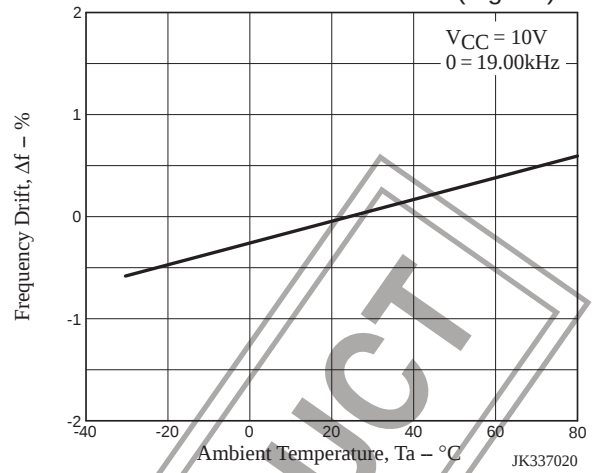
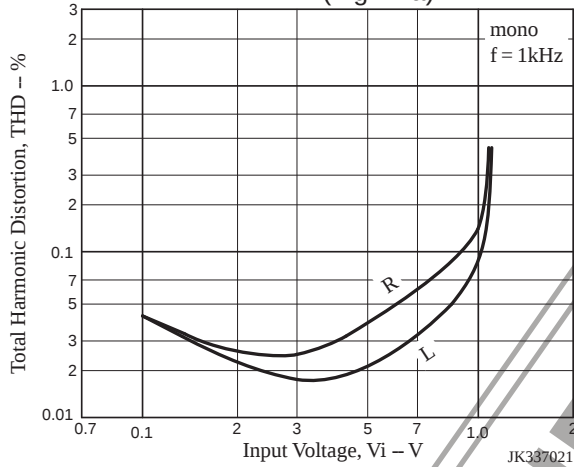
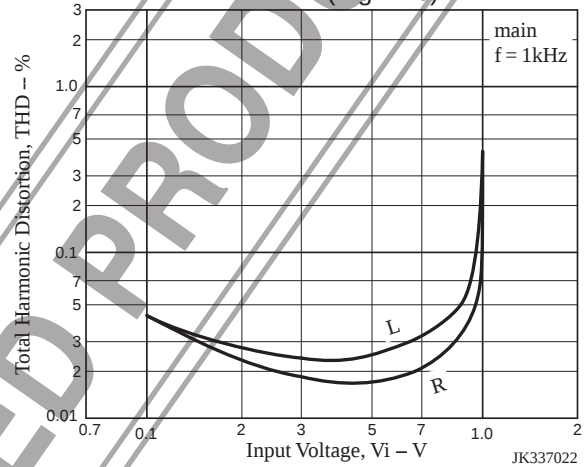
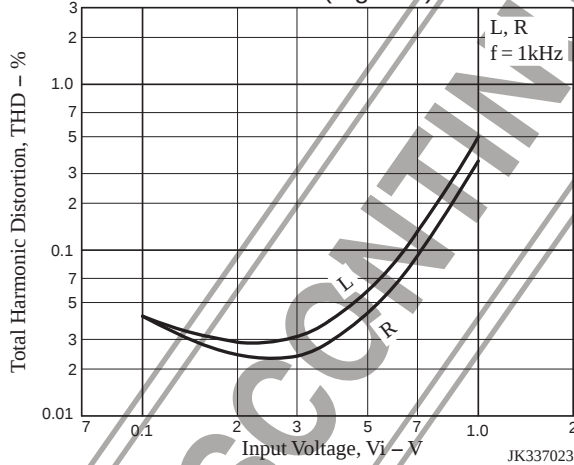
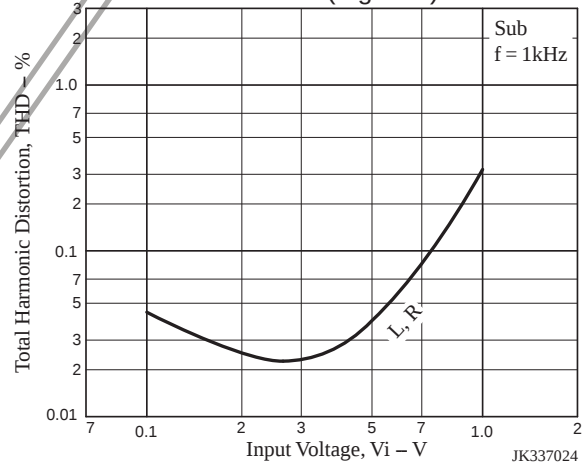
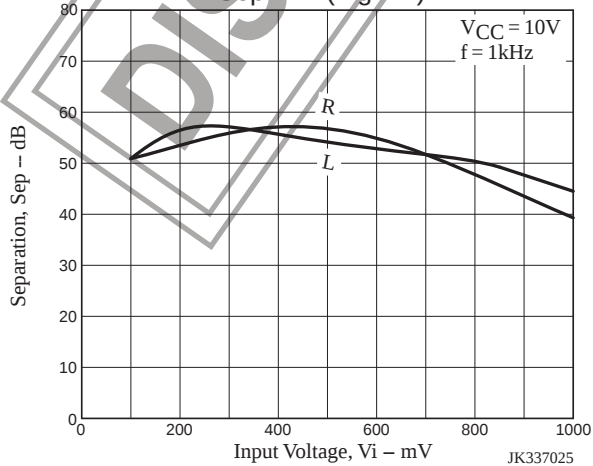
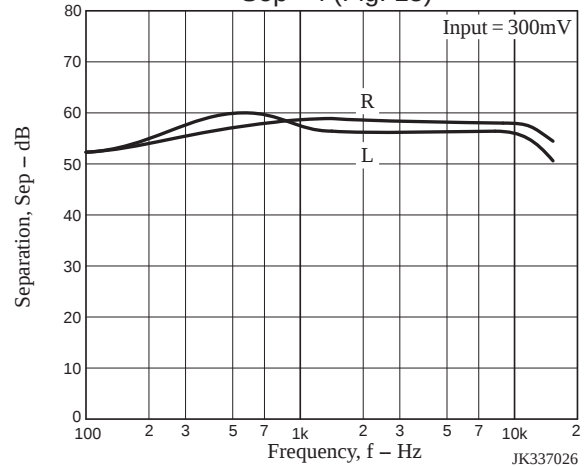
High-Cut Control Characteristics (Fig. 7)

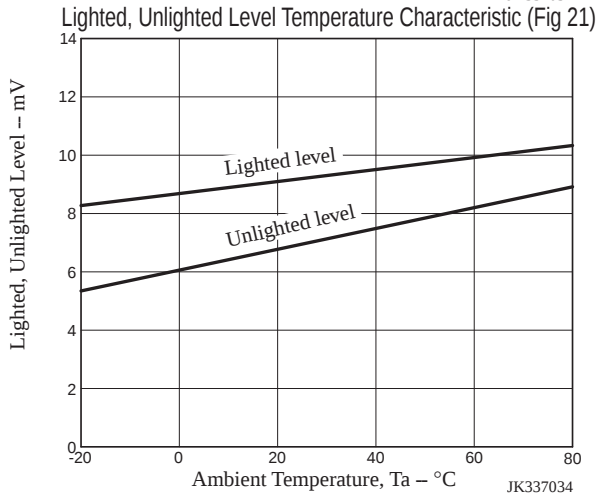
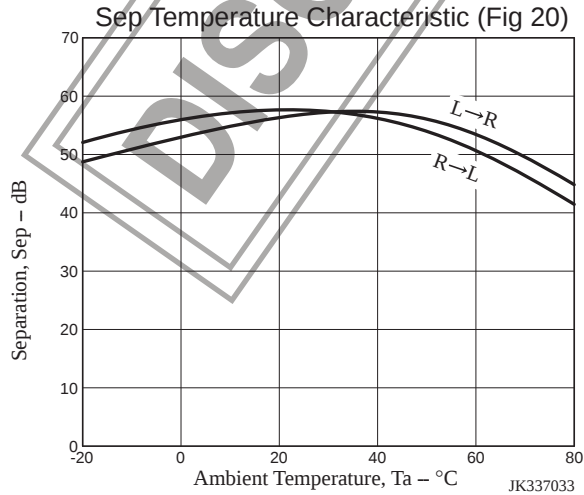
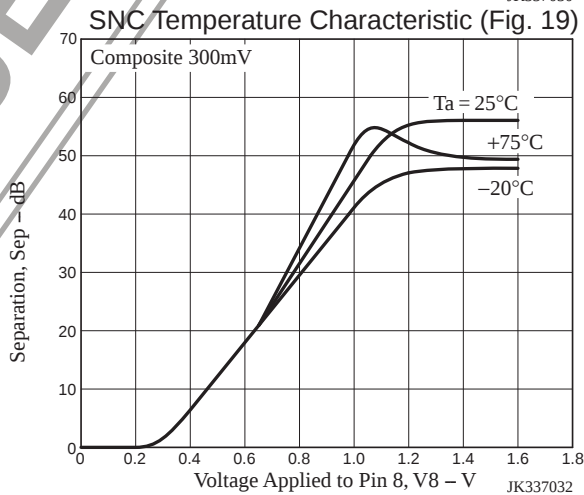
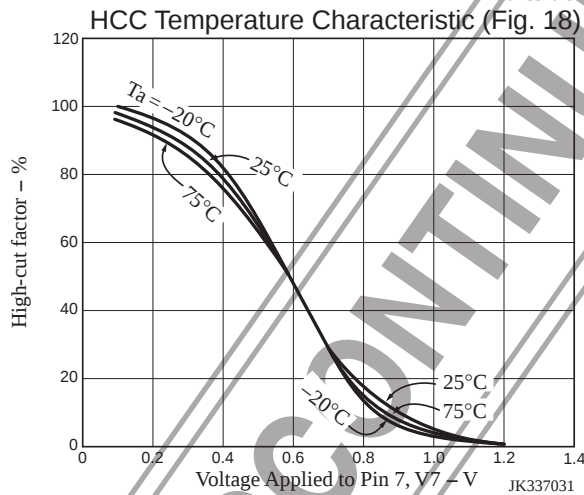
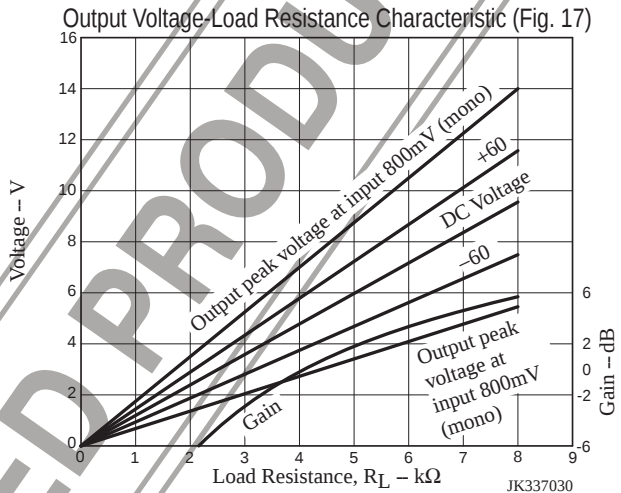
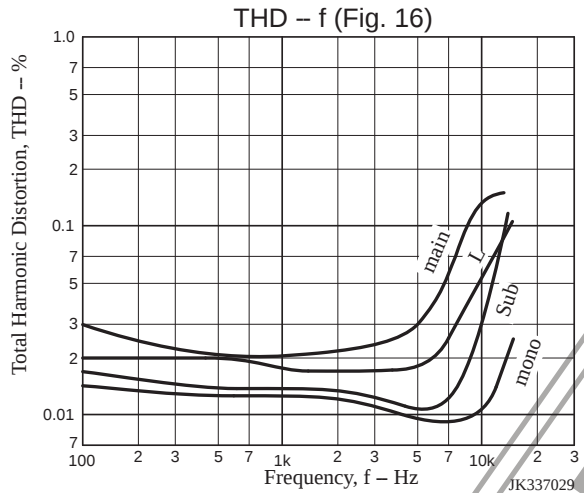
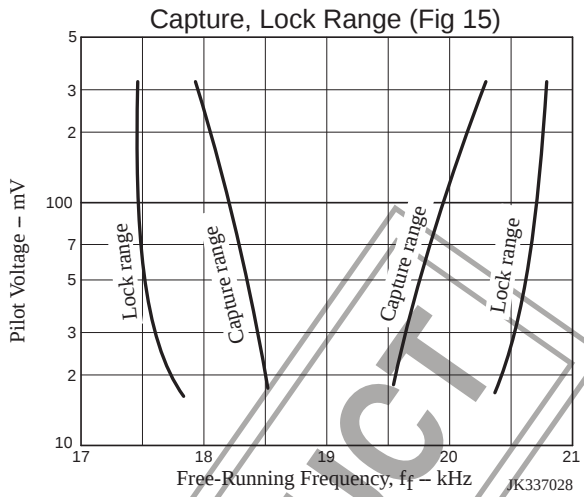
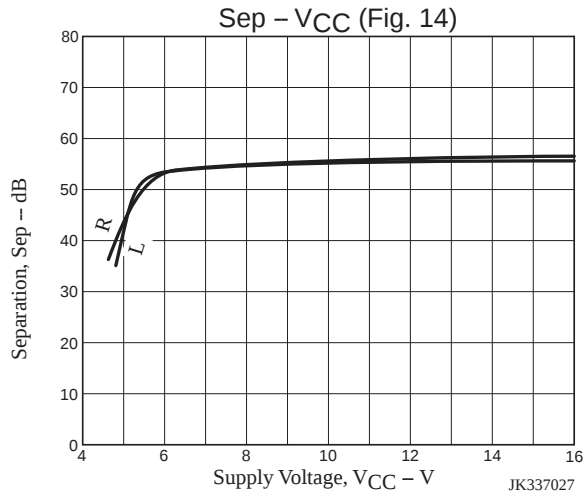


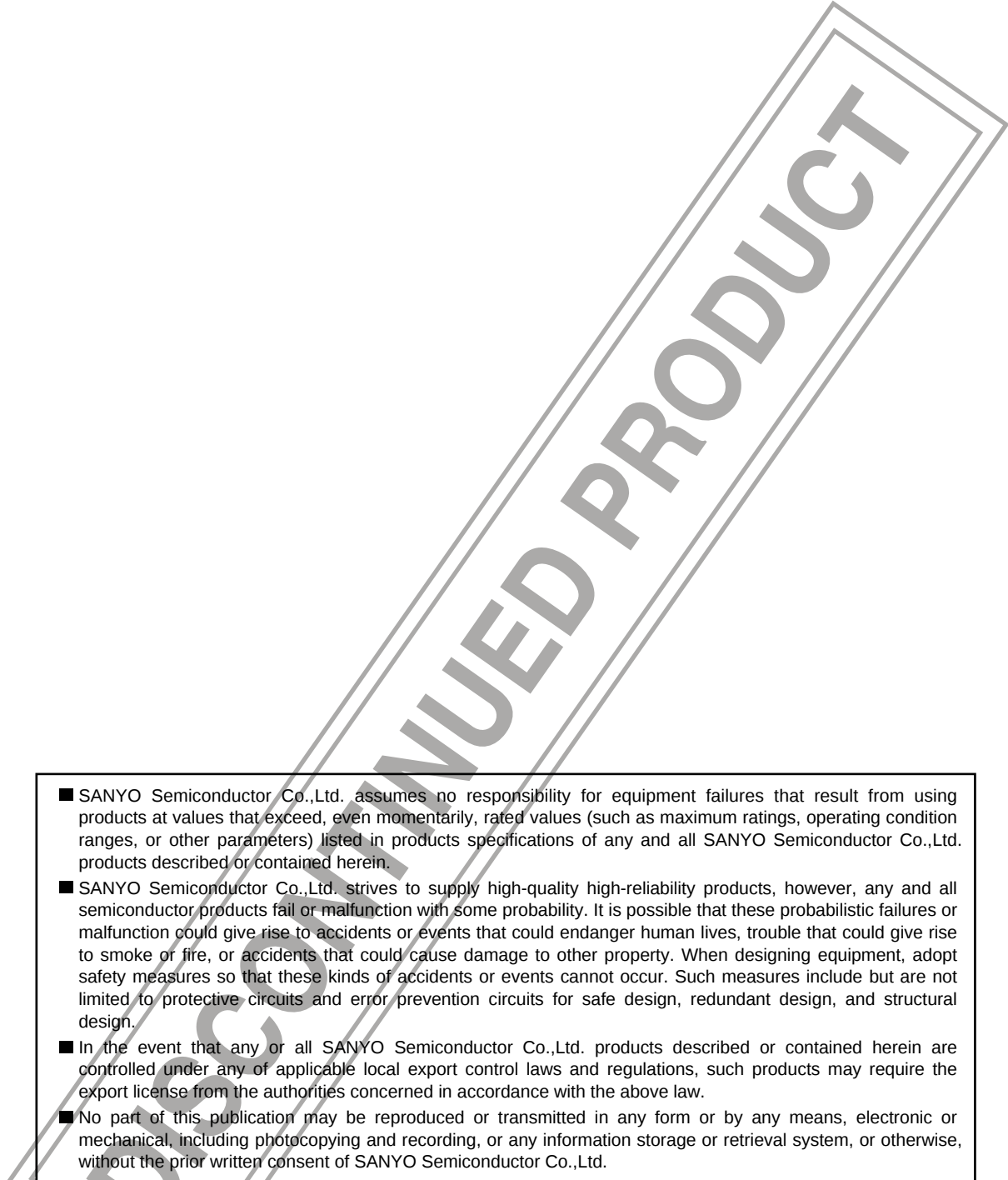
HCC Characteristic (Fig. 8)



JK337016

VCO Stop Function Control Terminal
Current Characteristics (Fig. 9)Free-Running Frequency Temperature
Characteristic (Fig. 10)THD - V_i (Fig. 11a)THD - V_i (Fig. 11b)THD - V_i (Fig. 11c)THD - V_i (Fig. 11d)Sep - V_i (Fig. 12)Sep - f (Fig. 13)



- 
- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
 - SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
 - In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
 - No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
 - Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
 - Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
 - Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of May, 2008. Specifications and information herein are subject to change without notice.