

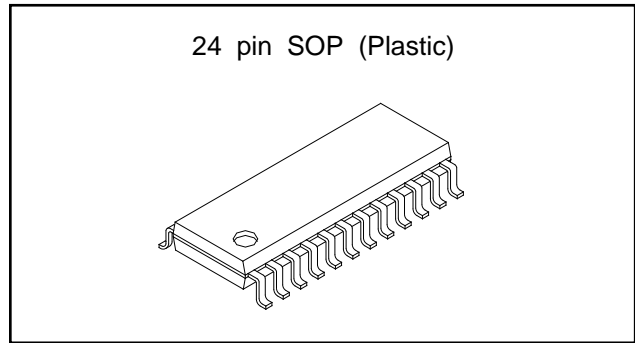
TV RF MODULATOR/PLL

Description

Fully synthesized I<sup>2</sup>C controlled UHF/VHF TV RF Modulator compatible with PAL and NTSC video formats.

Features

- Minimal adjustment of external components
- For use on VHF and UHF TV Frequencies
- Video RF carrier frequency programmable in 125 kHz steps
- ATT Driver
- I<sup>2</sup>C control of:
  - a. Video RF Carrier Frequency
  - b. Sound Carrier Frequency
  - c. Modulation Depth ( $\pm 2.5\%$  Typ.)
  - d. FM Deviation ( $\pm 7\%$  Typ.)
  - e. P/S ratio ( $\pm 1$  dB Typ.)
  - f. Nicam output enable to sleep
  - g. Video RF carrier enable to sleep
- On chip Regulator 3.1 V



Applications

- PAL and NTSC System VCR
- Satellite Receiver
- Set Top Box

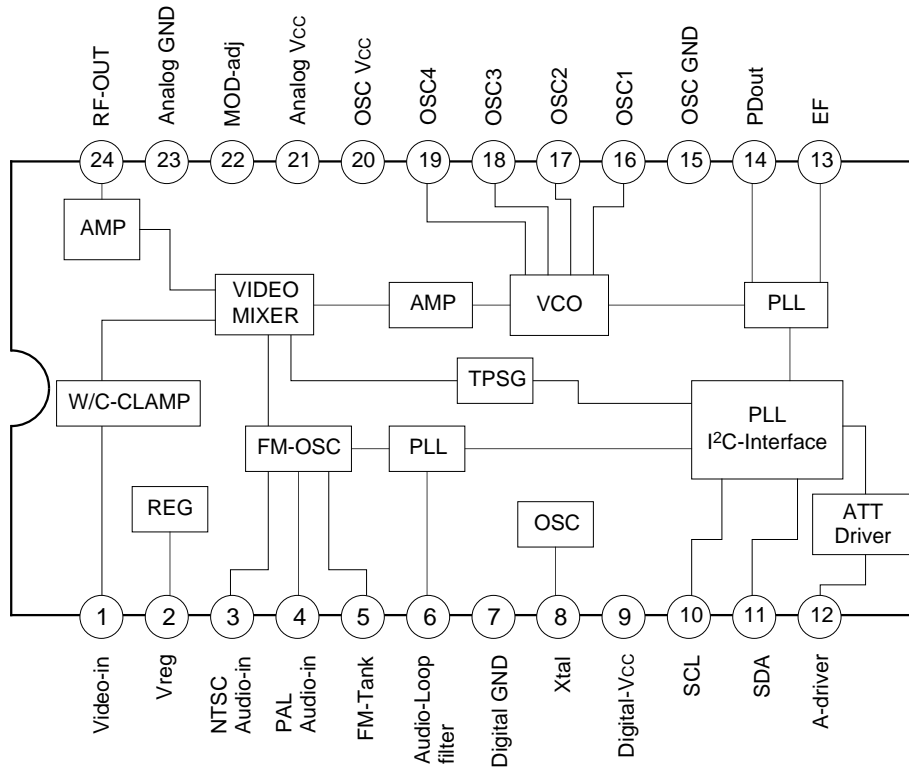
Structure

Bipolar silicon monolithic IC

Recommended Operating Voltages (Ta=25 °C)

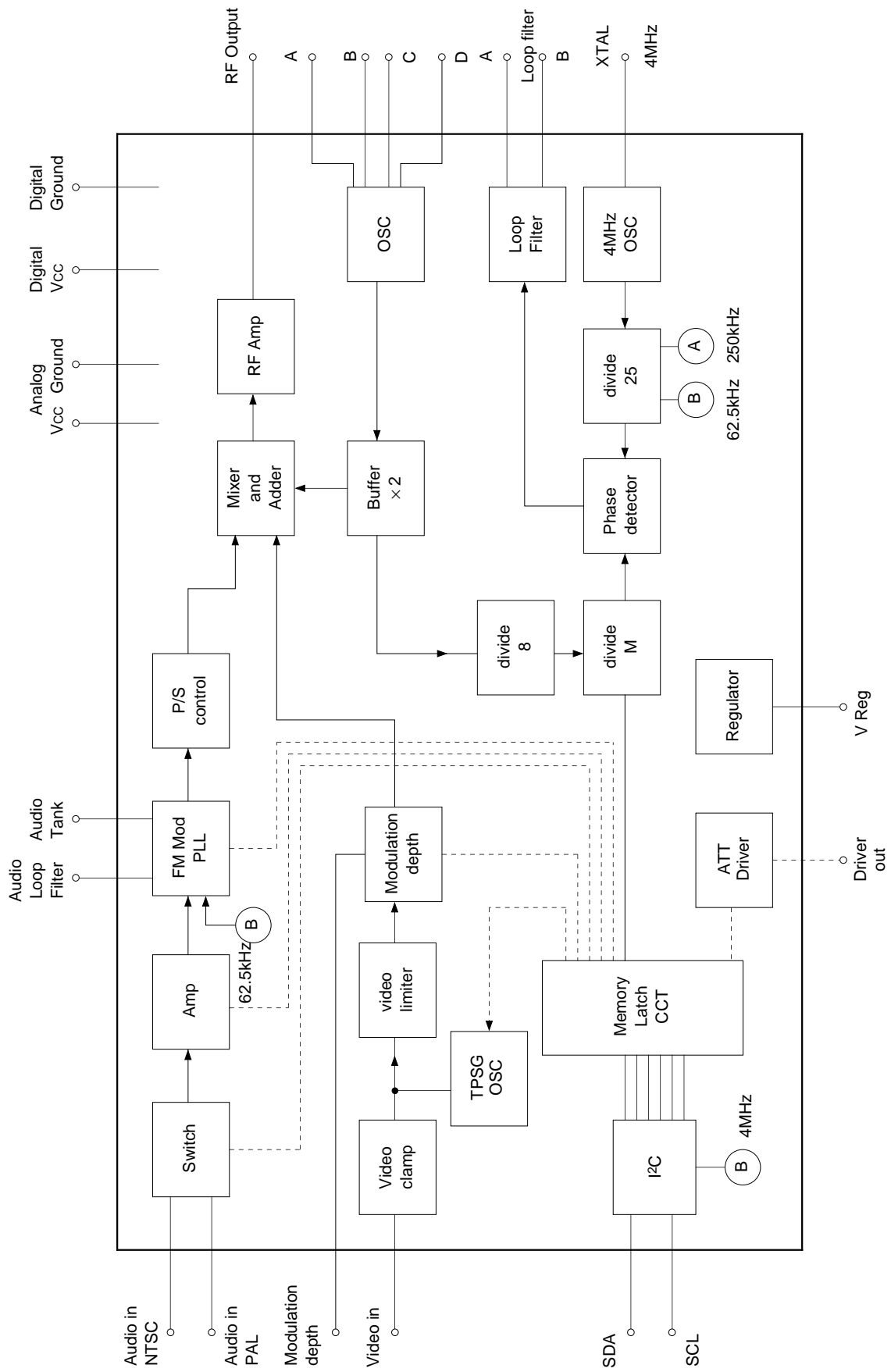
- Supply voltage Vcc 5.0 $\pm$ 0.5 V
- Supply for VCO Varactor -30 to +0.5 °C
- Operating Temperature -10 to +80 °C

Block Diagram



Sony reserves the right to change products and specifications without prior notice. This information does not convey any license by any implication or otherwise under any patents or other right. Application circuits shown, if any, are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits.

Multi-standard RF Modulator



## Functional Description of RF Modulator System

A block diagram of the RF modulator is shown in Fig. 1.

The composite video signal passes through an amplitude limiting circuit and a digitally controlled modulation depth adjustment circuit. By means of three allocated I<sup>2</sup>C control bits it is possible to adjust the modulation depth from a nominal 74 % to 86% in 2.0 % steps. Modulation depth can also be controlled externally by addition of an external resistor on pin3. The video signal is then passed through to the mixer. In the mixer stage, both the video composite signal and FM sound carrier amplitude modulate the RF carrier from the UHF OSC, and the issuing signal is fed to the output via an RF amplifier.

The audio signals enter the chip via pin4. The FM Voltage Controlled Oscillator is band-switched to the approximate centre frequencies of the four sound carrier frequencies 4.5 MHz (NTSC) or 5.5, 6.0, 6.5 MHz (PAL). The required correct audio carrier frequency is fine tuned by the adjustment of f<sub>sound</sub> via I<sup>2</sup>C, where upon the FM phase locked loop will lock the VCO onto the exact centre frequency. Minimum distortion of the FM signal occurs when the centre frequency of the oscillator coincides with a mid-rail control voltage (to 2.0 V). Hence fine adjustment capacitors are also integrated on the chip, which tag into account any capacitance variations from one batch to another. This is achieved by fine adjustment of Delta f<sub>sound</sub> via I<sup>2</sup>C control. The design of the FM modulator eliminates the need for an external varactor.

The amplitude of the FM signal is varied via I<sup>2</sup>C by a digitally controlled logarithmic gain stage, which controls the picture to sound power ratio (P/S). This signal is then fed into the RF amp. Hence at the RF output the P/S ratio can be programmed in 1 dB steps between the range 10 dB and 17 dB (see Electrical Characteristics). Audio sensitivity can be programmed in 8 % steps between the range -32 % and +24 %.

The UHF is phase locked to the reference frequency by means of the UHF phase locked loop. The VCO output passes through a prescaler ( $\approx 8$ ) followed by an I<sup>2</sup>C controlled programmable divider ( $\approx M$ ), and then phase compared with that of a reference signal at 15.625 kHz. The reference signal is derived from a 4 MHz crystal oscillator feeding a -256 divider. The UHF oscillator covers the frequency range 471 MHz to 855 MHz in frequency steps of 125 kHz. This is adequate for the UHF NTSC and PAL TV channels (471.25MHz (CH21) to 855.25 MHz (CH69)). By adjustment of the external components around the oscillator and some adjustment to output matching the RF modulator can also achieve range of frequencies in the VHF range.

The Nicam input (pin 22) accepts the 6.522 MHz Nicam signal subcarrier QPSK at 728 K bits/s data. This is then buffered and feed into a separate mixer (controlled via VCO). This then feeds to the RF amp with the composite video and audio. The I<sup>2</sup>C control will switch the Nicam signal output off or on.

**I<sup>2</sup>C Interface Data format**

Modulator Address	1	1	0	0	1	0	0	R/W	ask
Data 1	RF	ADJ1	ADJ0	S1	S0	TPSG	OVM	ATT	ask
Data 2	M12	M11	M10	M9	M8	M7	M6	M5	ask
Data 3	M4	M3	M2	M1	M0	MD2	MD1	MD0	ask
Data 4	—	OSC	FM2	FM1	FM0	PS2	PS1	PS0	ask

**Sound Carrier Course Adjust**

S1	S0	Sound Carrier Frequency	TV System (Pre-emphasis)
0	0	4.5 MHz	NTSC
0	1	5.5 MHz	PAL
1	0	6.0 MHz	PAL
1	1	6.5 MHz	PAL

**Sound Carrier Fine Adjust**

ADJ1	ADJ0	df Adjust	on chip capacitance
0	0	-f	6.4 pF
0	1	Normal	3.2 pF
1	0	+f	1.6 pF
1	1	+f	0

RF	RF Power on (RF Amp & RF Mixer Driver)	1 bit
TPSG	TEST Pattern Signal Generator	1 bit
ATT	Local/distance external attenuator driver	1 bit
OSC	Oscillator ON/OFF switch	1 bit
OVM	Over Modulation Test	1 bit
M12–M0	Main divider control data	13 bits
S1–S0	Sound carrier frequency selection	2 bits
ADJ1–ADJ0	Sound carrier frequency adjust (0 to 6.4 RF)	2 bits
MD2–MD0	Modulation Depth	3 bits
PS2–PS0	Picture/Sound control	3 bits
FM	FM deviation adjust	3 bits
M12	MO	Main UHF PLL Divider
MSB	LSB	8191 to 2

Video Carrier frequency calculated from = 125 (M+2) kHz

## Software Application Notes

The minimum requirement to drive the CXA3050 and I<sup>2</sup>C bus drive is a 386/486 with 4 M bytes hard disk space, 16 MHz clock speed and running DOS5.00 or above. Insert the disc into the drive and type TESTS and at the prompt type iic. At this there should appear a single list of user friendly functional tests that can be changed by keyboard manipulation. As an aid the test list is written below. Note Page up increments the status, page down decrements the status.

Function	Normal Status	Comments
RF Output Power	1/0	Turns RF Amp on/off
Delta Sound	1	Fine tune audio carrier
Fsound	0	Course adjust for 4.5 MHz (0) 5.5 MHz (1) 6.0 MHz (2) 6.5 MHz (3)
Frequency mode	2 to 8191	Check listing on page 10 for frequency to hex conversation
Mod depth	4	Ranges mod depth from 72 % to (4)
FM deviation	4	Sensitivity adjustable
P/S Ratio	4	Programmable in 8 steps of 1 dB
Over Mod	1/0	Increase Video modulation ratio
TPSG	1/0	Sets internal test pattern generator ON/OFF
OSC on.	1/0	Turns oscillator ON/OFF
Attenuator Driver	1/0	Output logic ON/OFF

Pin Description

Pin No.	Reference	Pin Voltage Typical DC	Equivalent circuit	Description
1	Video-in	2.5 V		Video input
2	Vreg	3.1 V		Chip voltage supply regulator
3	NTSC Audio-in	2.5 V		NTSC Audio input
4	PAL Audio-in	10 mA		PAL Audio input
5	FM-Tank	4.0 V		Sound Carrier oscillator tank

Pin No.	Reference	Pin Voltage Typical DC	Equivalent circuit	Description
6	Audio-Loop filter	2.02 V		Sound Carrier FM tank loop filter. See page 2 for set up note
8	Xtal	1.5 V		4 MHz input crystal frequency
10	SCL	5/0 V		I <sup>2</sup> C Clocking signal input
11	SDA	5/0 V		I <sup>2</sup> C Data signal input
13	EF	0.7 V		Charge pump output

Pin No.	Reference	Pin Voltage Typical DC	Equivalent circuit	Description
14	PDout	2.1 V		Phase detector output
15	OSC GND	0 V		VCO Ground
16	OSC 1	2.5 V		UHF OSC
17	OSC 2	1.7 V		
18	OSC 3	1.7 V		
19	OSC 4	2.5 V		
20	OSC Vcc	5.V		Oscillator supply Voltage 5 V
22	Mod-Adj	2.5 V		External Adjust Mod depth.
24	RF-OUT	3.4 V		RF output. Must be terminated with 75 Ω.

**Application Circuit Notes**

- RF output pin 24 should be connected to a 75 Ω load in order to measure accurate input level. Also note pin 24 has 2.7 kΩ to GND.  
The output is measured using a spectrum analyzer.
- After turning the device on, tune the variable inductor FM Tank so at the 6.5 MHz setting (set by I<sup>2</sup>C control) the voltage on pin 6 should read 2.02 V  
Set Fsound = 3  
Delta Fsound = 1



**Specifications**

Parameter	New Specification
Operating temperature range	-10 to 80 °C
Modulation index	77.5 to 90 %
Diff. Gain 80 to 87.5 % modulation	±6.5 %
Diff. Gain 80 to 87.5 % modulation	±6.5 degree
Deviation range (audio)	±10 kHz to ±100 kHz
Picture/sound ratio adj	1 dB × 7 steps
Video modulation adj	2.5 % × 7 steps
Audio FM sensitivity	7 % × 7 steps
Picture/Sound ratio	1 dB × 7 steps
Inter carrier accuracy	±1 kHz

Parameter	Condition	Min.	Typ.	Max.	Unit
Current consumption Full operation V <sub>CC</sub> = 5 V	Analog	29	36.6	44	mA
	digital	31	38.6	47	mA
	OSC	6.0	7.5	9.0	mA
DC Supply operating range		4.5	5.0	7	Vdc
Operating temperature range		-10		80	°C

## RF Characteristics

Parameter	Condition	Min.	Typ.	Max.	Unit
Output impedance			75		$\Omega$
Output return loss		-7			dB
RF Output level	700 MHz 75 $\Omega$ termination		80.5	$\pm 2.5$	dB $\mu$ V
RF Frequency response	Using attached application			$\pm 1$	dB
Picture/Sound ratio		9.5	13.5	17.5	dBc
VHF1 Frequency range		50		120	MHz
VHF 2 Frequency range		170		230	MHz
UHF Frequency range 1		470		860	MHz
UHF Frequency range 2	Using attached application	670		800	MHz
RF Accuracy				$\pm 50$	kHz
Inter-carrier frequency range	4.5, 5.5, 6.0, 6.5	4.5		6.5	MHz
Inter-carrier accuracy	4.5, 5.5, 6.0, 6.5	0		$\pm 1$	kHz
RF Carrier phase noise	10 kHz offset frequency		-84.7	-80	dBc/Hz
Sound carrier phase noise	10 kHz offset frequency		-84.7	-80	dBc/Hz
Hum modulation				-60	dB
Chroma beat			-74	-65	dBc
C/N Ratio	1/2 Video band offset		-63	-60	dB
RF Harmonics				-15	dBc
Sub-carrier harmonics			-65	-58	dBc
Reference spurious frequency.	15.625 kHz		-60	-55	dBc
Spurious output level				-65	dBc
ATT driver ON		3.7	3.9	4.2	V
ATT driver OFF		0	0.05	0.1	V

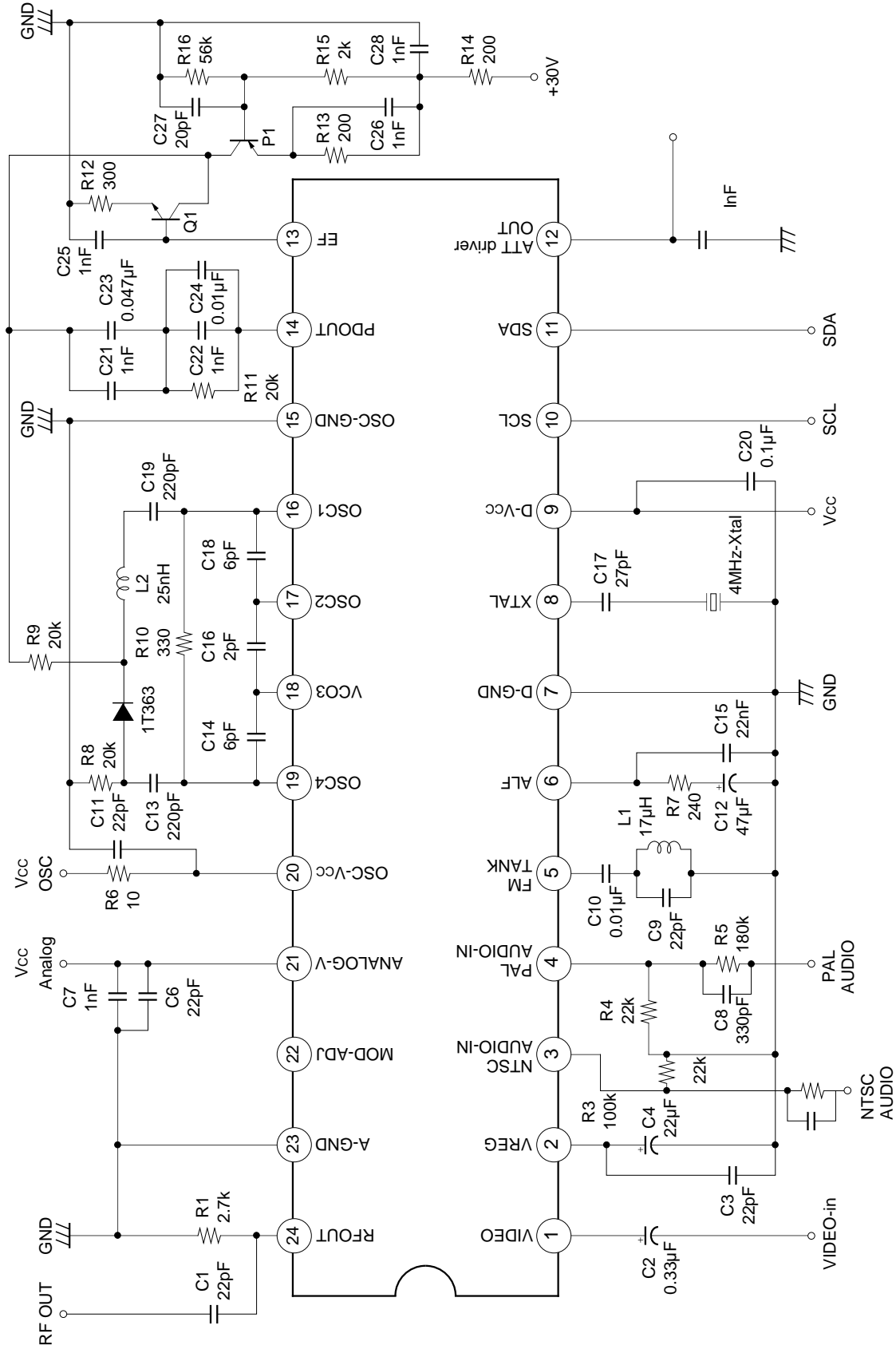
## Video Characteristics

Parameter	Condition	Min.	Typ.	Max.	Unit
Input resistance		30	100		k $\Omega$
Input voltage	80 % Modulation		0.46		Vp-p
% Modulation Clipping			93	97	%
I <sup>2</sup> C control index	7 steps		2	$\pm 0.4$	%
Modulation flatness	Band Limited (46 CH to 60 CH)			$\pm 1$	%
Modulation	0.46 p-p input (mod Adja)	73	80	87	%
Modulation stability by temperature	mp (Ta = -10 to 80 °C) -mp (Ta = 25 °C)			$\pm 3$	%
Field time distortion		0	0.5	2	IRE
Line time distortion		0	0.5	2	IRE
S/N	Weighted		-66	-60	dB
K Factor	With 2T pulse			2	%
Video frequency response	Per standard	0		$\pm 0.5$	dB
TPSG modulation	TPSG ON	65	73	81	%
Sync crush level		0	1	5	%

## Audio Characteristics

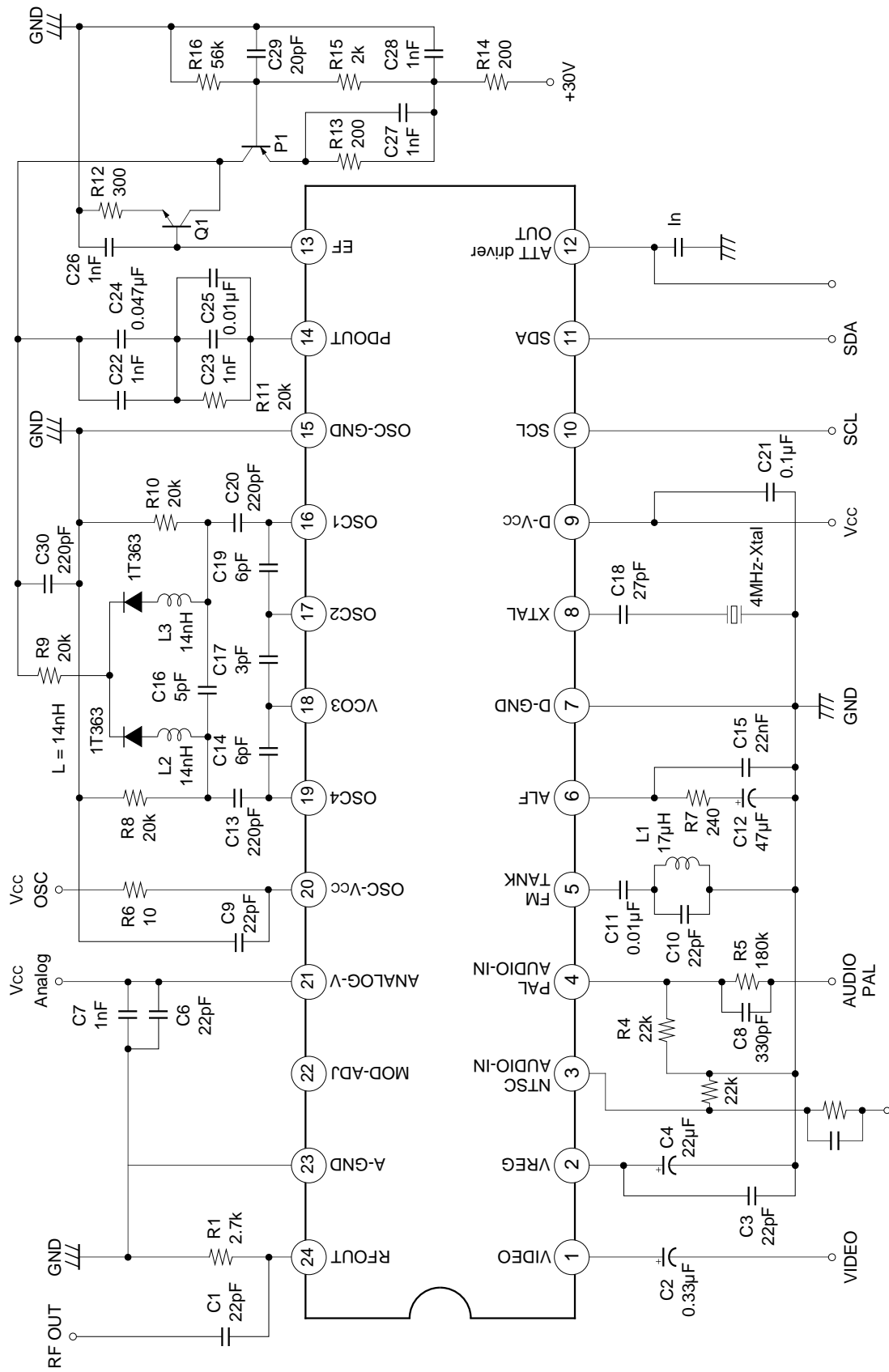
Parameter	Condition	Min.	Typ.	Max.	Unit
Input Voltage	@50 kHz, Deviation	0.1			Vp-p
Input resistance		20			k $\Omega$
Deviation range		$\pm 10$		$\pm 100$	kHz
Audio distribution	4.5 MHz		0	$\pm 15$	%
Deviation sensitivity adj=(3)	System M 4.5 MHz $\pm 25$ kHz=100 %=0 dB	0.354	0.407	0.468	kHz/mV
	System B/G 5.5 MHz $\pm 50$ kHz=100 %=0 dB	0.263	0.303	0.348	kHz/mV
	System I 6 MHz $\pm 50$ kHz=100 %=0 dB	0.334	0.384	0.441	kHz/mV
	System D/K 6.5 MHz $\pm 50$ kHz=100 %=0 dB	0.399	0.459	0.528	kHz/mV
Audio SNR	Quasi-Parallel, Detection			-60	dB
Harmonic distortion	50 to 100 %, Deviation			1	%
Frequency response	50 to 15 kHz	-1		+1	dB
FM Hum and noise	25 to 75 kHz, Deviation			$\pm 5$	kHz

Application Circuit 1



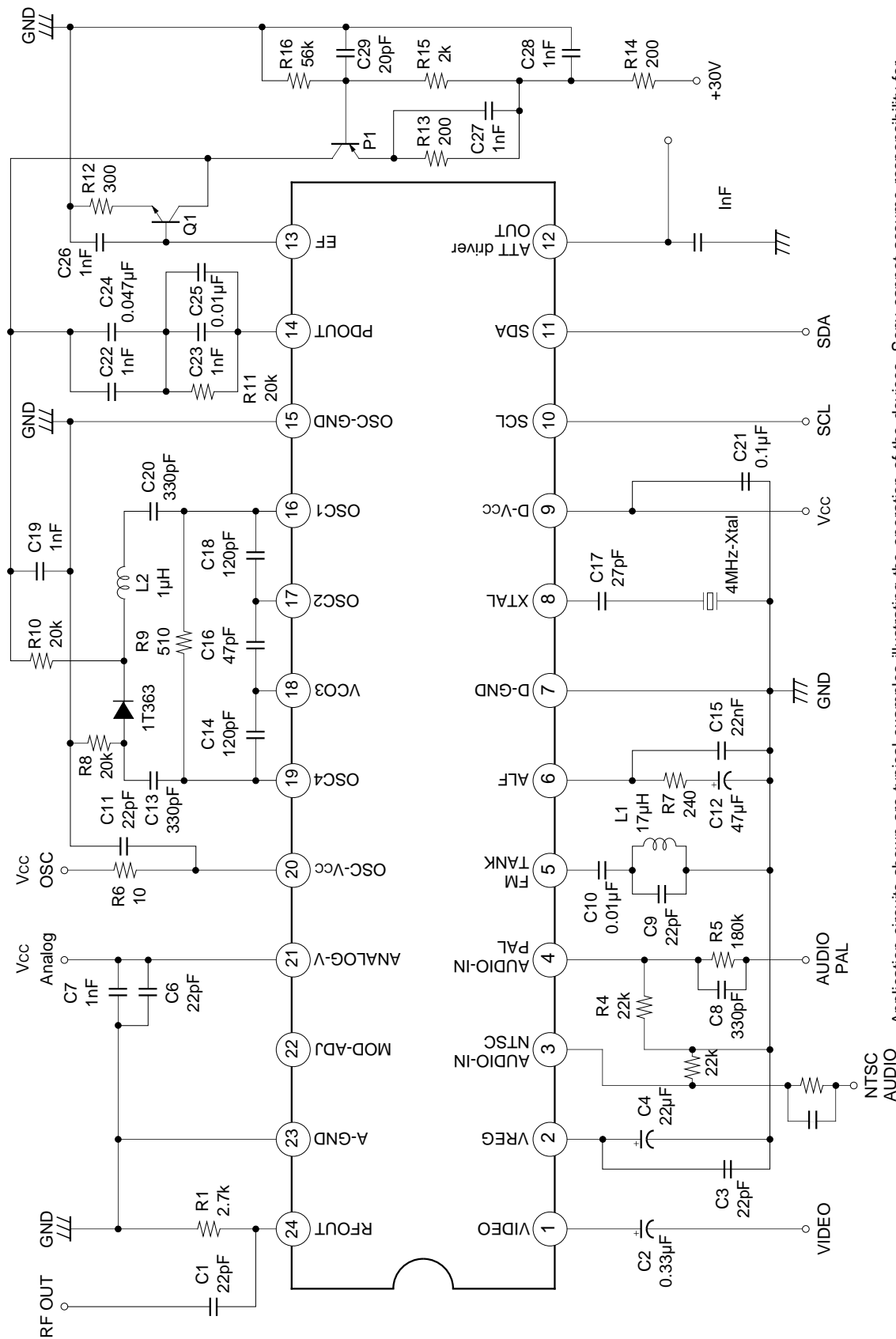
Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party and other right due to same.

**Application Circuit 2**  
**Dual-OSC**



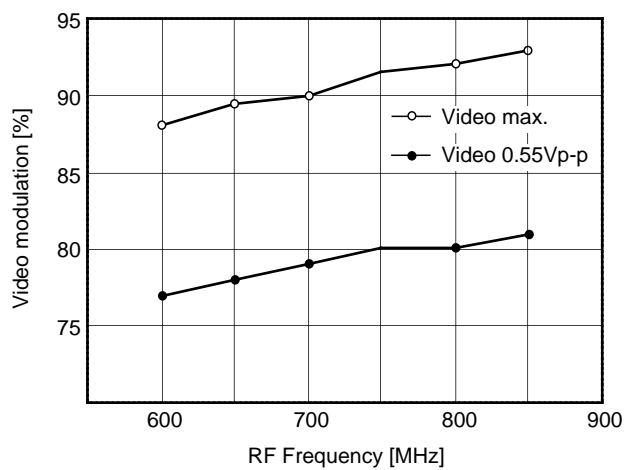
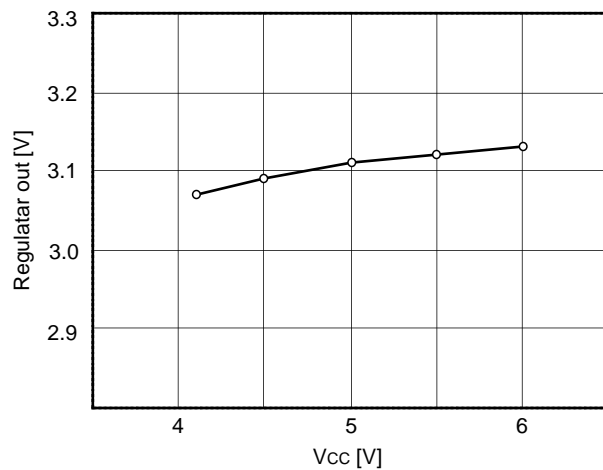
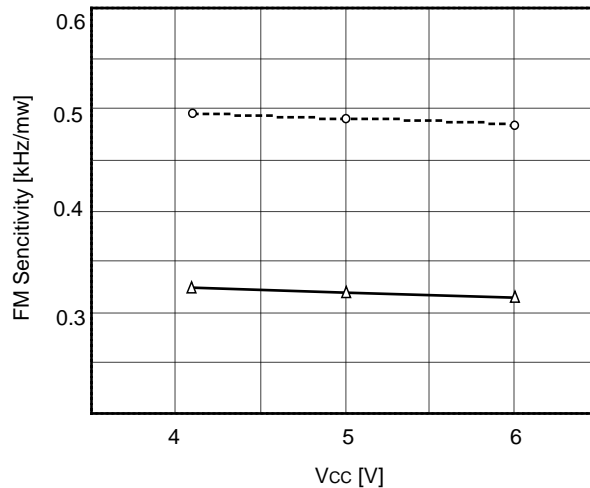
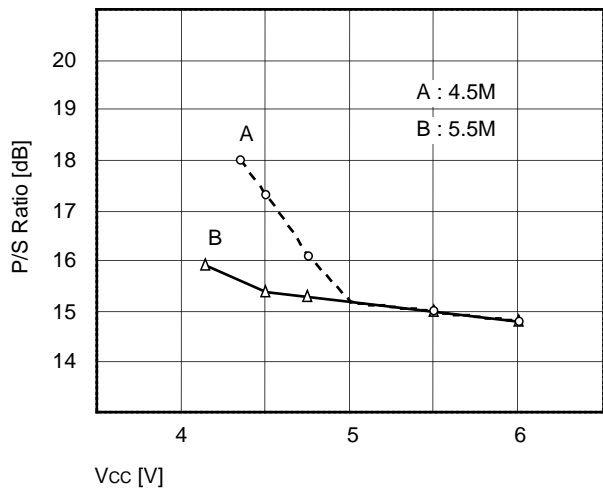
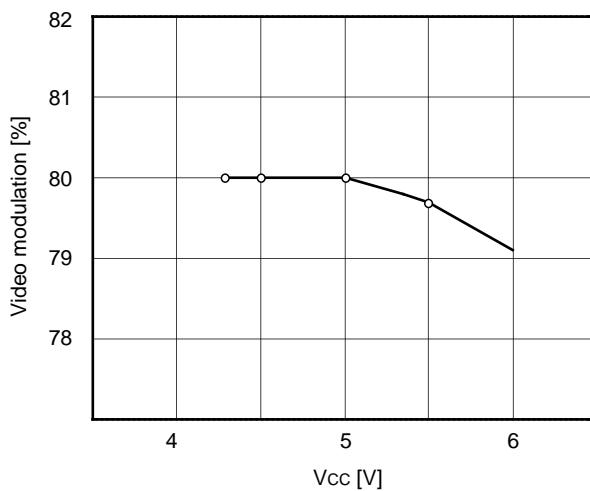
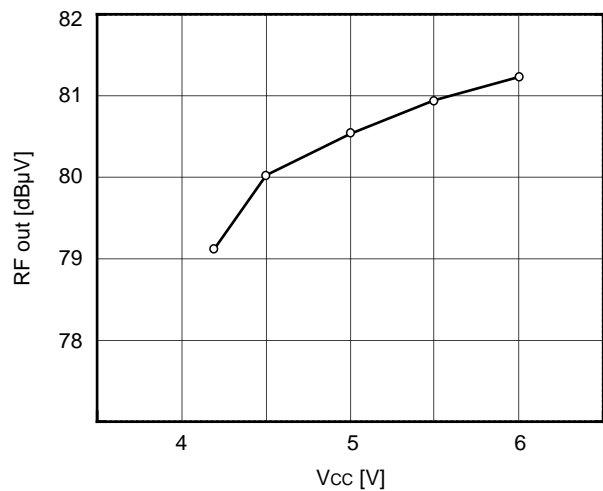
Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party and other right due to same.

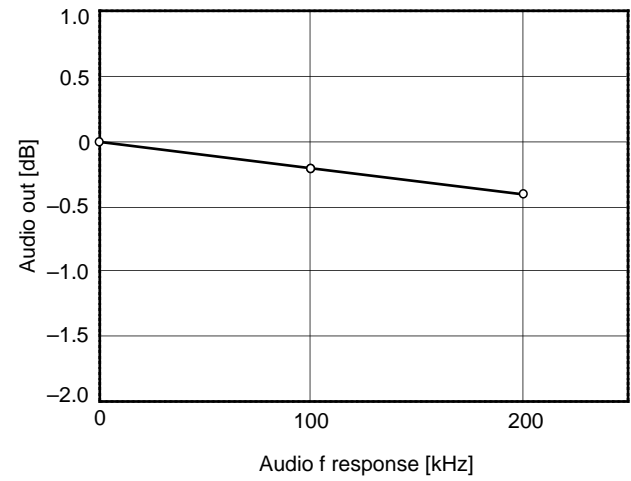
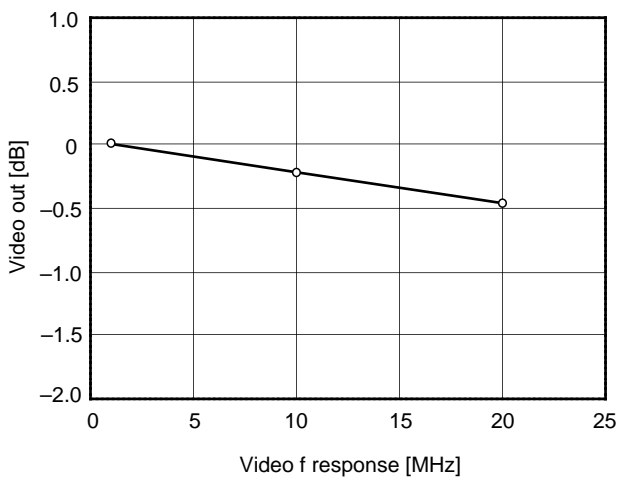
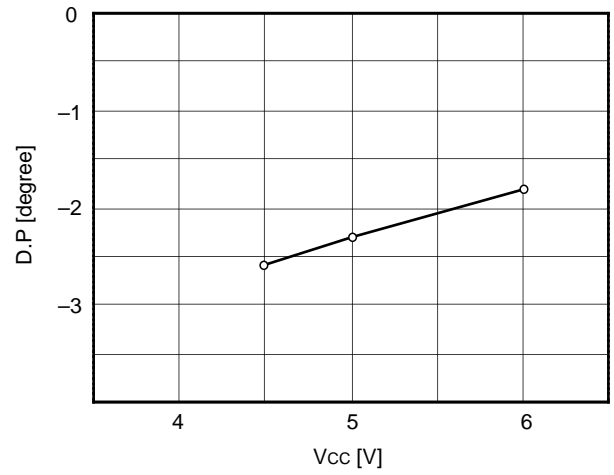
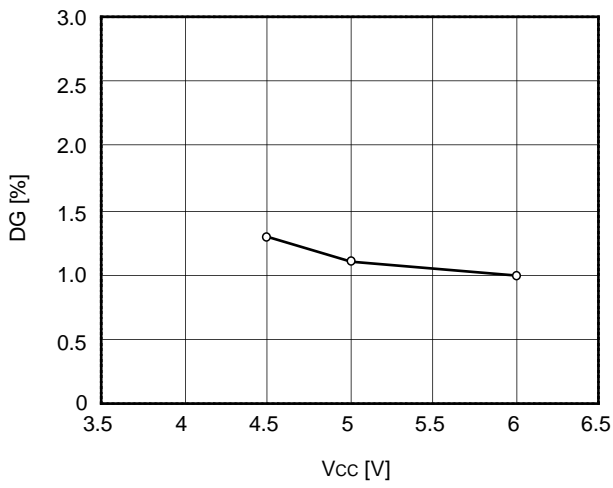
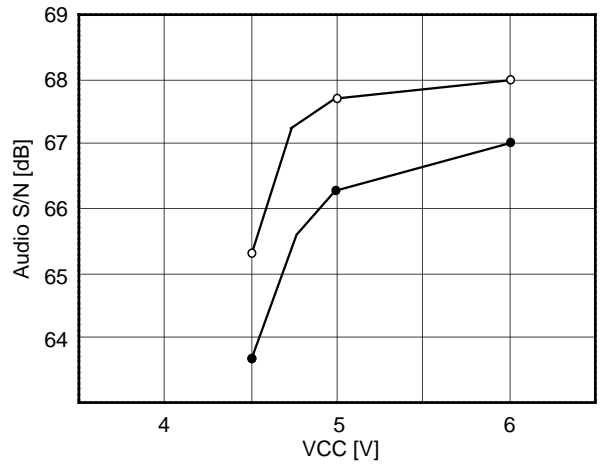
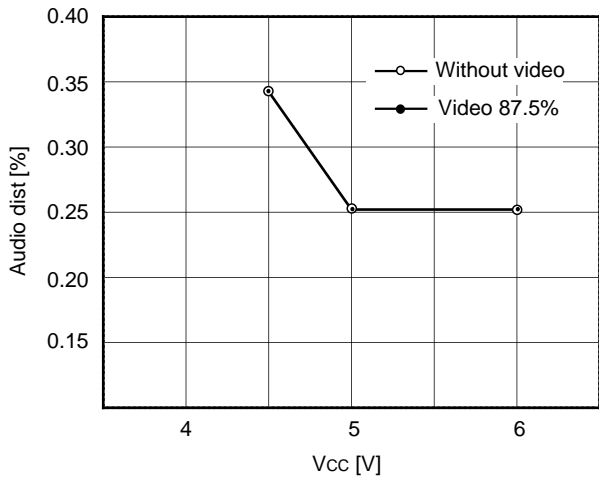
**Application Circuit 3**  
**VHF-Band**



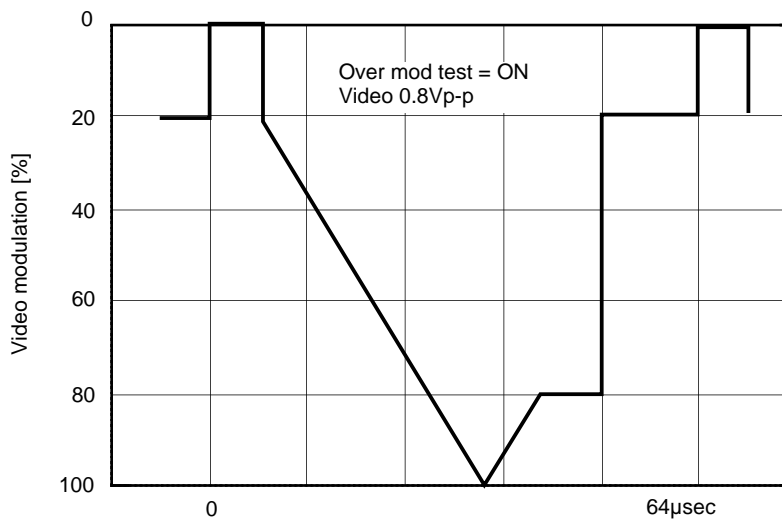
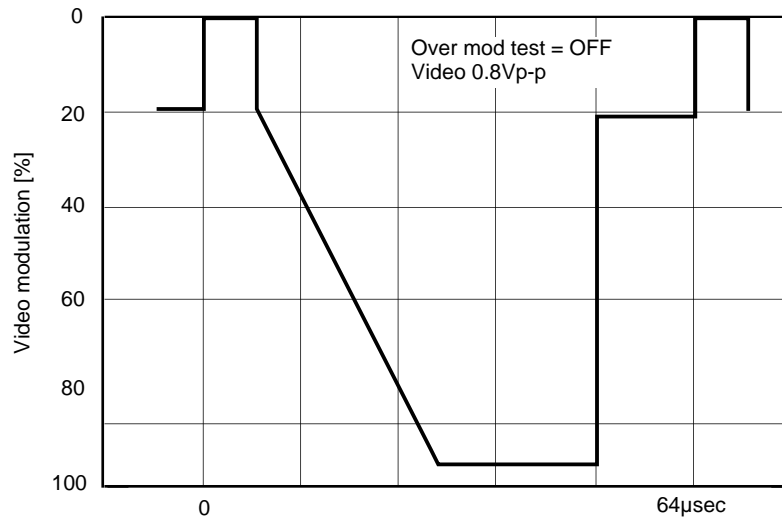
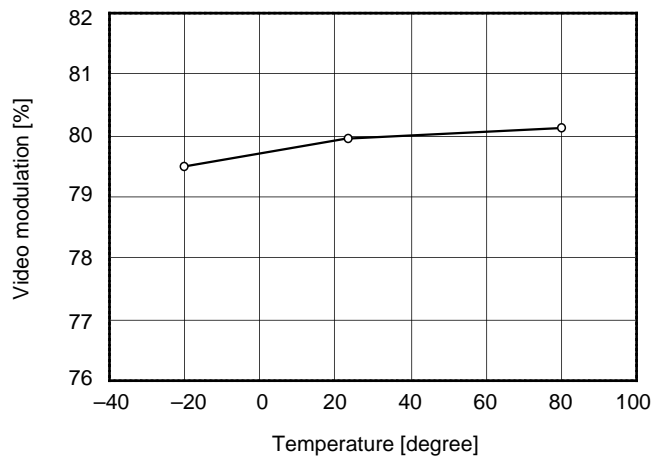
Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party and other right due to same.

Example of Representative Characteristics



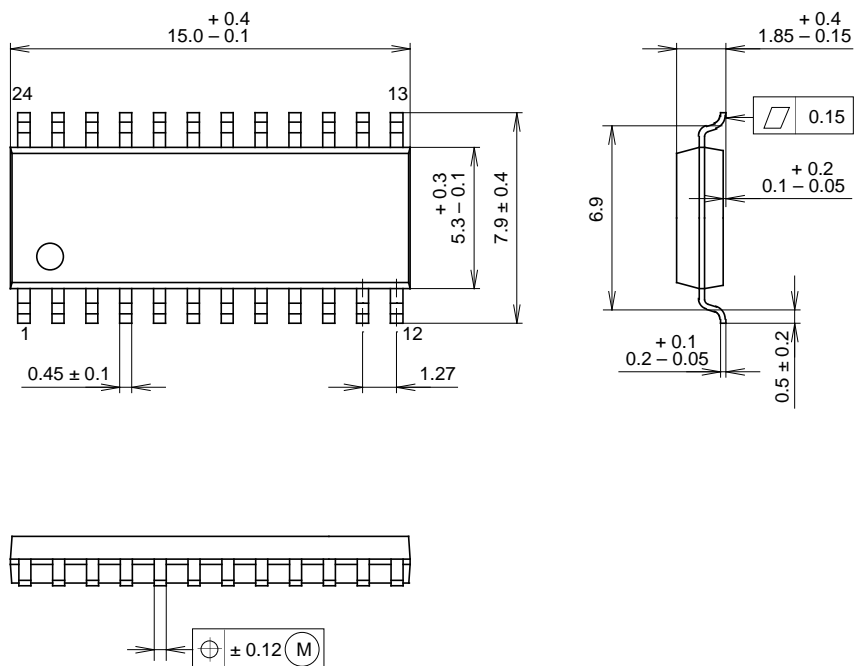






Package Outline Unit : mm

24PIN SOP (PLASTIC)



PACKAGE STRUCTURE

SONY CODE	SOP-24P-L01
EIAJ CODE	*SOP024-P-0300-A
JEDEC CODE	—

MOLDING COMPOUND	EPOXY/PHENOL RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	COPPER ALLOY / 42ALLOY
PACKAGE WEIGHT	0.3g