To our customers,

Old Company Name in Catalogs and Other Documents

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April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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M52390FP

NTSC/PAL Encoder

Description

The M52390FP is a semiconductor integrated circuit that has a function for converting R, G and B signals into NTSC/PAL composite video signals, as well as a superimpose function, on a single chip.

Features

- RGB encoder-related
  - Built-in LPF for color discrimination. An external resistor enables cutoff frequency control.
  - An internal VCA circuit enables gain control of the chroma unit.
  - A high-precision modulation circuit and clamping circuit realize low carrier leaks.
  - Burst and synch signals are generated in the IC.
- Superimpose-related
  - Y_S IN (control input) enables switching between two input signals, VIDEO IN and RGB IN.
  - An internal high-speed analog switch makes it possible to insert fine text.
  - An internal APC circuit automatically adjusts the color phases of new screen (VIDEO IN) and RGB encoder signals.
- Overall
  - The VIDEO OUT signal is output at 2 V_{P-P}, making it possible to configure a 75 Ω drive circuit with a single transistor.
  - Both NTSC and PAL are supported.

Application

- TVs, VCRs, monitors and other audio/video devices

Recommended Operating Conditions

- Power supply voltage range: 4.7 to 5.3 V
- Recommended power supply voltage: 5.0 V

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Block Diagram

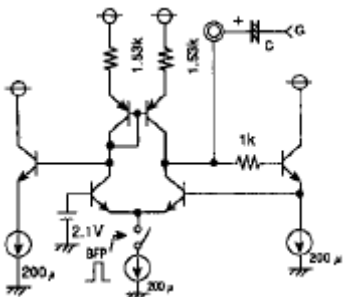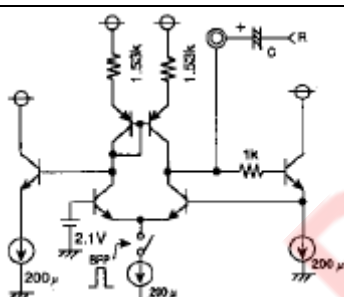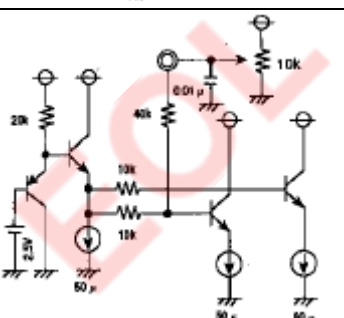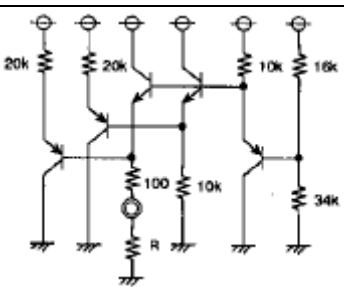## Pin Configuration

Package: 20P2N-A
(lead pitch: 1.27 mm)

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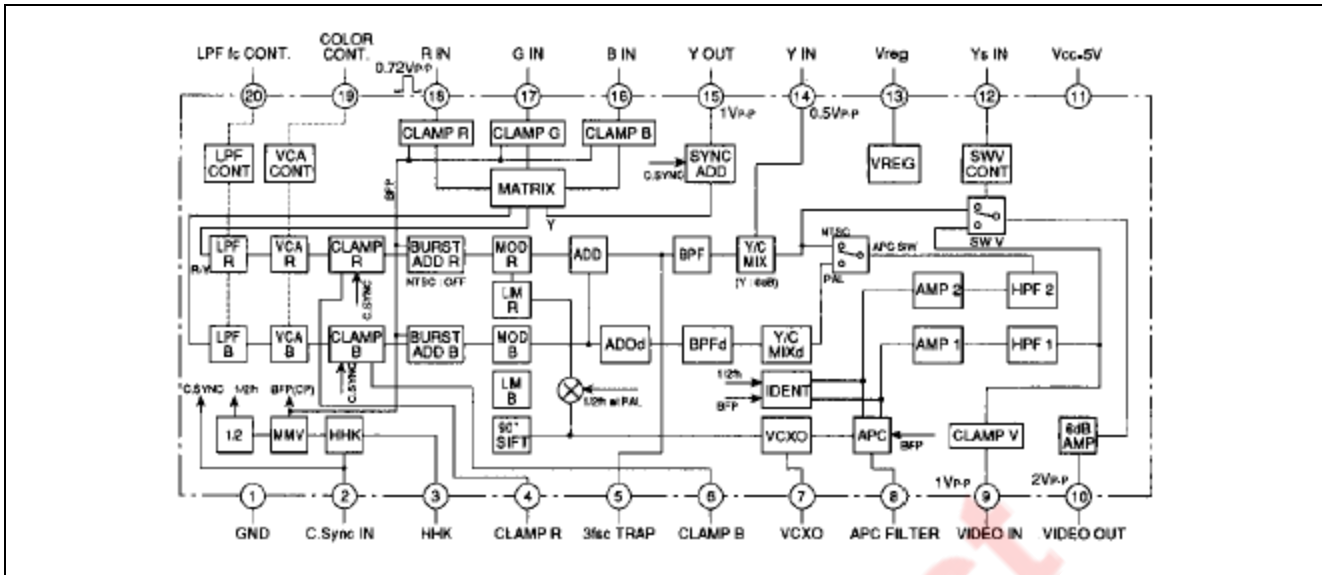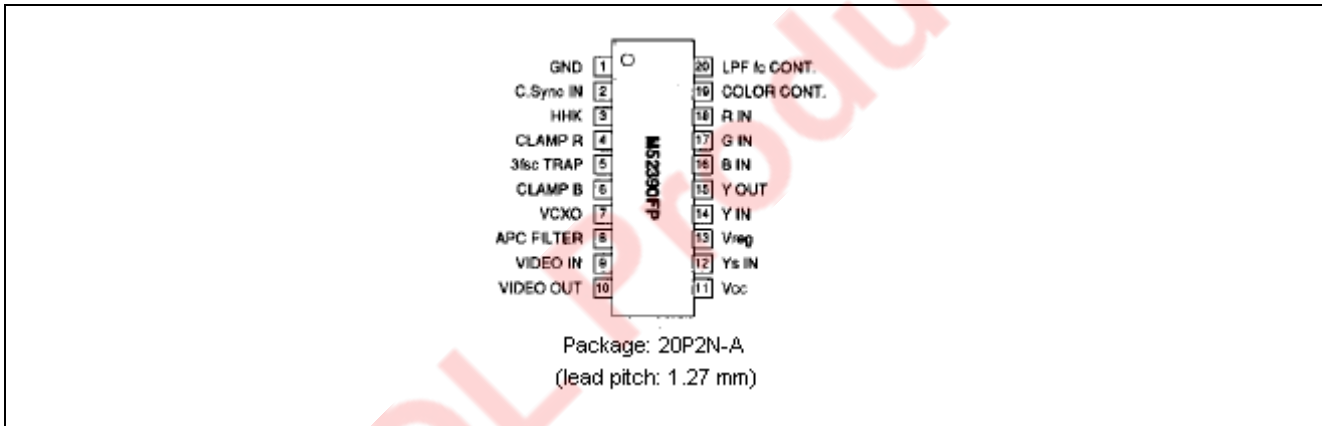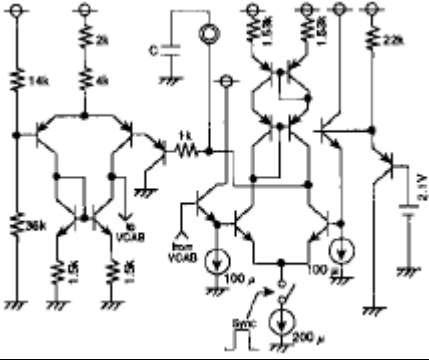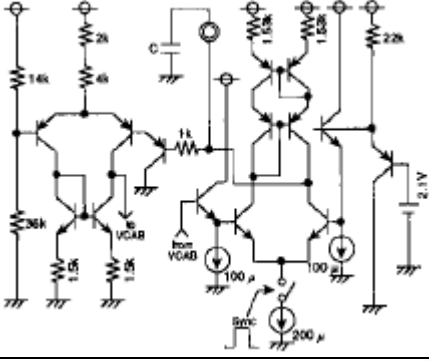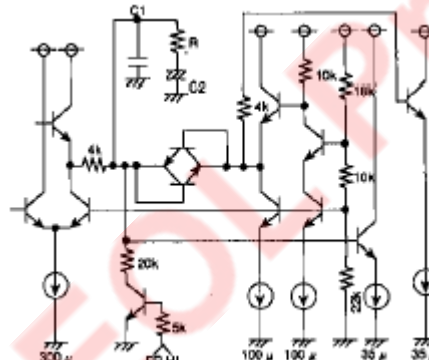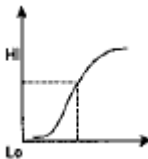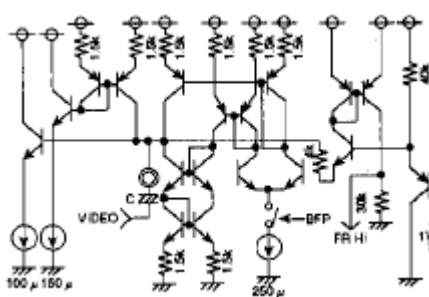
Description of Pin

Pin no.	Pin name	Pin peripheral circuit	Pin voltage	Notes
1	GND			
2	C.SYVC IN		AC: Sync input	V_{TH} = 2.5 V ± 0.3 V
3	HHK		AC	The HHK pulse width can be varied using the external resistor. Recommended value: HHK: 3/4H R = 91 k C = 270 p
4	OFFSET R		DC = 3.1 V	External recommended value. C = 0.1 μ

5	TRAP		AC: Chroma
			
			Burst: 300 mV$_{P-P}$
			
			[15] Test mode output at 5 V
			  [12] Hi: R-Y output
			  [12] Lo: B-Y output
				External recommended value.
				　　　　　L　　C
				NTSC : 15 μ　12P
				PAL　 : 10 μ　12P
				
				[5] 5 V: Test mode setting
				[15] Pulse output
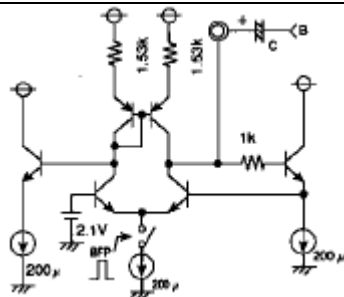
Description of Pin (cont)

Pin no.	Pin name	Pin peripheral circuit	Pin voltage	Notes
6	OFFSET B		DC: 3.1 V	External recommended value C = 0.1 μ
7	VCXO IN		DC: 3.2 V	The free run frequency is set using the trimmer capacitor. [7] 0 V: Carrier OFF
8	APC FILTER		DC: 3.3 V In Free Run mode: DC: 2.7 V	β characteristic Frequency APC voltage External recommended values R = 1.5 k C1 = 0.01 μ C2 = 1 μ
9	VIDEO IN		AC: VIDEO 1 V$_{P-P}$ Pedestal: 2.9 V 	Clamping input (burst timing) External recommended value C = 4.7 μ [9] 0 V: Free Run mode setting

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Description of Pin (cont)

Pin no.	Pin name	Pin peripheral circuit	Pin voltage	Notes
10	VIDEO OUT		AC: VIDEO 2 V_{P-P} Pedestal: 1.8 V	
11	V_{CC}		DC: 5 V	Icc: 50 mA
12	Ys		Switching signal input when using Superimpose Hi: Insertion screen (RGB IN output)	V_{TH} = 1.5 V ± 0.3 V Hi: RGB IN output Lo: VIDEO IN output [15 Output setting when using 5 V [5] Output | [12] | [5]output | | Hi | R-Y | | Lo | B-Y |
13	VRE G		DC: 2.1 V	External recommended value C = 4.7 μ PAL mode at 2 mA
14	Y IN		AC: Y 0.5 V_{P-P} Pedestal: 2.1 V	
15	Y OUT		AC: Y 1 V_{P-P} Pedestal: 2.1 V	
			(5) Test mode output at 5 V Pulse output	[12] 5 V: Test mode setting | [12] | [5]output | | Hi | R-Y | | Lo | B-Y |

Description of Pin (cont)

Pin no.	Pin name	Pin peripheral circuit	Pin voltage	Notes
16	B IN		AC: B 0.71 V_{P-P} Sync: 2.9 V	Clamping input (burst timing) External recommended value C = 4.7 μ
17	G IN		AC: G 0.71 V_{P-P} Sync: 2.9 V	Clamping input (burst timing) External recommended value C = 4.7 μ
18	R IN		AC: R 0.71 V_{P-P} Sync: 2.9 V	Clamping input (burst timing) External recommended value C = 4.7 μ
19	COLOR CONT.		DC: 2.5 V	Color control for RGB encoder output 5 V: Chroma unit +2 dB 2.5 V: Typ. 0 V: Chroma unit –3 dB
20	fc. CONT.		DC: 3.3 V	fc of LPF can be adjusted using external resistor. External recommended value R = 30 k

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Absolute Maximum Rating

(Unless otherwise noted, Ta = 25°C)

Symbol	Item	Ratings	Units
Vcc	Power supply voltage	7	V
Pd	Internal current consumption	620 (900)	mW
Topr	Ambient operating temperature	−20 to 75	°C
Tstg	Storage temperature	−40 to 125	°C
kθ	Thermal derating (Ta = 25°C)	6.2 (9.0)	mW/°C

Note: Values in parentheses are the values when mounted on a typical PCB.

Thermal Derating (Maximum Rating)

Typical PCB
Material --- Glass epoxy (Cu foil pattern on one side)
Size: 70 mm² , thickness = 1.6 mm
Cu foil thickness - 18 μm
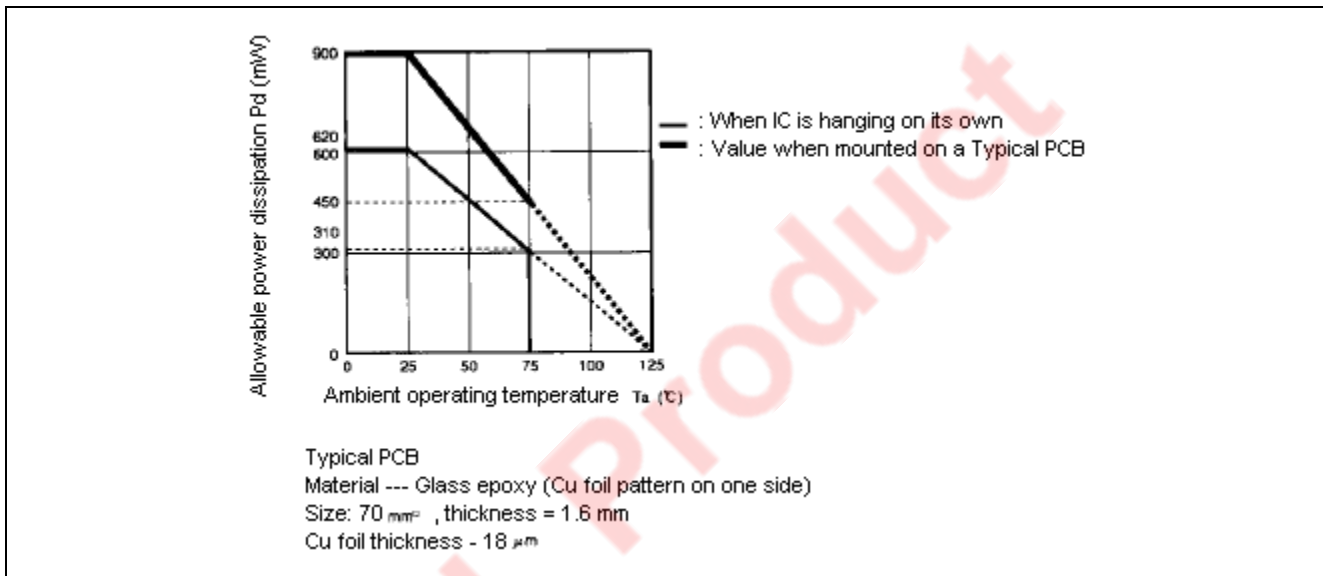
Electrical Characteristics

(unless otherwise noted, Ta=25°C, Vcc = 5 V, SG2 = sync)

No.	Symbol	Item	Measurement conditions	Measurement point	Limits Min.	Typ.	Max.	Unit
1	$I_{CC}1$	Circuit current 1	NTSC MODE, [12] 5 V	[11]	35	50	65	mA
2	$I_{CC}2$	Circuit current 2	NTSC MODE, [12] 5 V	[11]	37	52	67	mA
RGB IN → Y OUT								
3	ER	Matrix ratio R	SG18: 1 Vp-p	[15]	0.27	0.30	0.33	Vp-p
4	EG	Matrix ratio G	SG17: 1 Vp-p	[15]	0.53	0.59	0.65	Vp-p
5	EB	Matrix ratio B	SG16: 1 Vp-p	[15]	0.09	0.11	0.13	Vp-p
6	EY	At RGB 100% Y level	SG16, SG17, SG18: 0.71 Vp-p	[15]	0.63	0.71	0.79	Vp-p
7	FR	R IN → Y OUT frequency characteristic	SG18: 500 kHz/5 MHz, 0.5 Vp-p CW, SW16, 17, 18:ON [2] 0 V (SG2: OFF)	[15]	−1.5	0	1.5	dB
8	FG	G IN → Y OUT frequency characteristic	SG17: 500 kHz/5 MHz, 0.5 Vp-p CW, SW16, 17, 18:ON [2] 0 V (SG2: OFF)	[15]	−1.5	0	1.5	dB
9	FB	B IN → Y OUT frequency characteristic	SG16: 500 kHz/5 MHz, 0.5 Vp-p CW, SW16, 17, 18:ON [2] 0 V (SG2: OFF)	[15]	−1.5	0	1.5	dB
10	VS1	Sync level 1	NTSC MODE	[15]	257	286	315	Vp-p
11	VS2	Sync level 2	PAL MODE (SW13: ON)	[15]	270	300	330	Vp-p
Y IN → VIDEO OUT								
12	G_Y	Y IN → VIDEO OUT gain	SG14: 500 kHz, 0.5 Vp-p CW, [12] 5 V	[10]	10.5	12	13.5	dB
13	F_Y	Y IN → VIDEO OUT frequency characteristic	SG14: 500 kHz, 0.5 Vp-p CW, [12] 5 V	[10]	−1.5	0	1.5	dB
RGB IN → TRAP								
14	$D_{L(R-Y)}$	Delay (R-Y)	SG18: 1 Vp-p [15] 5 V, [12] 5 V, [7] 0 V	[5]	210	310	410	ns
15	$D_{L(B-Y)}$	Delay (B-Y)	SG16: 1 Vp-p [15] 5 V, [12] 0 V, [7] 0 V	[5]	210	310	410	ns
16	$G_{H(R-Y)}$	Gain (R-Y) VCA: Hi	SG18: 500 kHz, 0.5 Vp-p CW, SW4, 6, 17, 18: ON [15] 5 V, [12] 5 V, [7] 0 V, [19] 5 V/2.5 V, [2] 0V (SG2: OFF)	[5]	1	2	3.5	dB
17	$G_{H(B-Y)}$	Gain (B-Y) VCA: Hi	SG16: 500 kHz, 0.5 Vp-p CW, SW4, 6, 17, 18: ON [15] 5 V, [12] 0 V, [7] 0 V, [19] 5 V/2.5 V, [2] 0V (SG2: OFF)	[5]	1	2	3.5	dB
18	$G_{L(R-Y)}$	Gain (R-Y) VCA: Lo	SG18: 500 kHz, 0.5 Vp-p CW, SW4, 6, 17, 18: ON [15] 5 V, [12] 5 V, [7] 0 V, [19] 0 V/2.5 V, [2] 0V (SG2: OFF)	[5]	−4.5	−3	−2	dB
19	$G_{L(B-Y)}$	Gain (B-Y) VCA: Lo	SG18: 500 kHz, 0.5 Vp-p CW, SW4, 6, 17, 18: ON [15] 5 V, [12] 5 V, [7] 0 V, [19] 0 V/2.5 V, [2] 0V (SG2: OFF)	[5]	−4.5	−3	−2	dB

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Electrical Characteristics (cont)

No.	Symbol	Item	Measurement conditions	Measurement point	Limits			Unit
					Min.	Typ.	Max.	
RGB IN → VIDEO OUT								
20	V_B1	NTSC burst level	NTSC MODE [12] 5 V	[10B]	243	286	329	mVp-p
21	V_B2	PAL burst level	PAL MODE (SW13: ON) [12] 5 V	[10B]	255	300	345	mVp-p
22	V_B3	PAL burst level differential	PAL MODE (SW13: ON) [12] 5 V	[10B]	−30	0	30	mVp-p
23	P_PB	PAL burst phase differential	PAL MODE (SW13: ON) [12] 5 V	[10B]	82	90	98	deg
24	V_R/B	R/burst level ratio	SG18: 0.71 Vp-p [12] 5 V	[10B]	2.68	3.15	3.62	
25	V_G/B	G/burst level ratio	SG17: 0.71 Vp-p [12] 5 V	[10B]	2.51	2.95	3.39	
26	V_B/B	B/burst level ratio	SG16: 0.71 Vp-p [12] 5 V	[10B]	1.91	2.25	2.59	
27	V_C/B	NTSC MODE carrier leak	NTSC MODE [12] 5 V	[10B]	—	−40	−28	dB
28	P_R/B	R/burst phase differential	SG18: 0.71 Vp-p [12] 5 V	[10B]	96	104	112	deg
29	P_G/B	G/burst phase differential	SG17: 0.71 Vp-p [12] 5 V	[10B]	233	241	249	deg
30	P_B/B	B/burst phase differential	SG16: 0.71 Vp-p [12] 5 V	[10B]	339	347	355	deg
VIDEO IN → VIDEO OUT								
31	GVIO	VIDEO IN → VIDEO OUT gain	SG9: 500 kHz, 0.5 Vp-p CW, SW9: ON [12] 0 V, [2] 0 V (SG2: OFF)	[10]	5	6	7	dB
32	FVIO	VIDEO IN → VIDEO OUT frequency characteristic	SG9: 5 MHz, 0.5 Vp-p CW, SW9: ON [12] 0 V, [2] 0 V (SG2: OFF)	[10]	−1.5	0	1.5	dB
SUPER IMPOSE								
33	PDI	RGB/VIDEO IN burst phase differential	SG9: 3.85 MHz, 286 mVp-p CW, SG12: 1 Vp-p	[10B]	−5	0	5	deg
34	VOS	DC offset	SG9: burst, 286 mVp-p CW, SG12: 1 Vp-p	[10]	−20	0	20	mV
MMV								
35	HHK	HHK width	PAL MODE (SW13: ON) [5] 5V	[2] [15]	40	47	54	µs
36	BFPP	BFP position (burst position)	[5] 5V	[2] [15]	4.5	5.6	6.7	µs
37	BFPW	BFP width (burst width)	[5] 5V	[15]	2.0	2.5	3.0	µs

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Electrical Characteristics Measurement Method
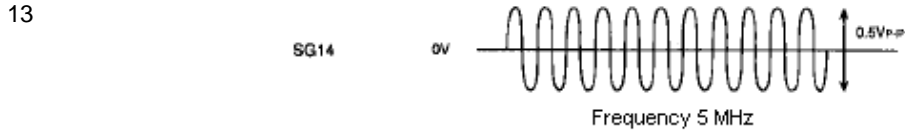
Tables for the various modes (common to all tests)

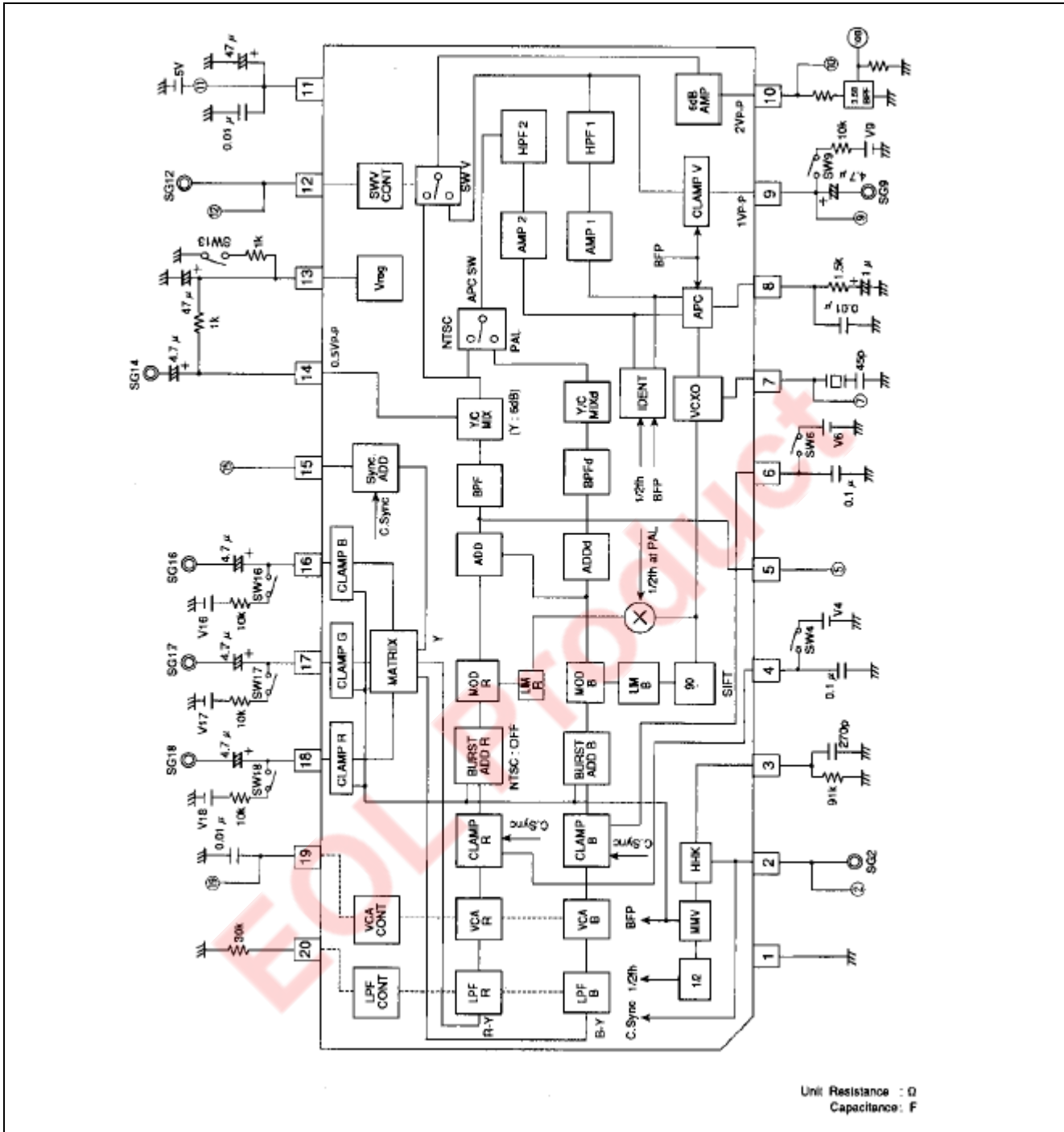| Mode	Setting condition	Function
FREE RUN MODE	⑨ 0~0.3V	VCXO FREE RUN
PAL MODE	⑬ 2~2.2mA	Carrier phase for MOD R reversed at each 1H
SUPER IMPOSE MODE	⑫ HI : 2~5V Lo : 0~1V	[10] VIDEO OUT RGB ENCODE signal out VIDEO IN signal out
TEST MODE MR TEST MODE MB TEST MODE DR TEST MODE DB	⑮ ⑫ ⑦ 4.7~5V 2~5V OPEN 4.7~5V 0~1V OPEN 4.7~5V 2~5V 0~0.3V 4.7~5V 0~1V 0~0.3V	[5] Color difference output MOD R-Y out MOD B-Y out DIFF R-Y out DIFF B-Y out
TEST MODE P	⑤ 4.7~5V	[10] PULSE output PAL MODE: BFP, HHK mix NTSC MODE: BFP
V4, V6, V9, V16, V17, V18	Various pin voltages when SYNC is input to [2] (C. SYNC IN) (for clamping)	

Measurement method and method for computing limit values

Meas. no.	Measurement method and method for computing limit values
1	Current flowing into [11] is measured.
2	
3 4 5	
6	
7 (8, 9)	
10 11	
12	

For measurement 7(8,9):

$$F = 20 \log \frac{V \text{ out (5MHz)}}{V \text{ out (500kHz)}} \quad \text{(dB)}$$

For measurement 12:

The 500 kHz component V12 with respect to [10] is measured, and is computed using the following equation.

$$GY = 20 \log \frac{V_{12}}{0.5V_{P-P}} \quad \text{(dB)}$$

Measurement method and method for computing limit values (cont)

Meas. no.	Measurement method and method for computing limit values
13	SG14 0V 0.5Vp-p Frequency 5 MHz The 500 MHz component V13 with respect to (10) is measured, and is computed using the following equation. $IcY = 20 \log \dfrac{V_{13}}{V_{12}}$ (dB)
14 (15)	SG2 5V / 0V 5 μs 64 μs SG18 (SG16) 1V / 0V 2 μs 52 μs 10 μs ⑤Output DL
13	SG14 0V 0.5Vp-p Frequency 5 MHz The 500 MHz component V13 with respect to (10) is measured, and is computed using the following equation. $IcY = 20 \log \dfrac{V_{13}}{V_{12}}$ (dB)
14 (15)	SG2 5V / 0V 5 μs 64 μs SG18 (SG16) 1V / 0V 2 μs 52 μs 10 μs ⑤Output DL
16 (17) 18 (19)	SG18 (SG16) 0V f=500kHz 0.5Vp-p CW ⑤ Output V out $GH = 20 \log \dfrac{V \text{ out } (\text{⑧ } 5V)}{V \text{ out } (\text{⑨ } 2.5V)}$ (dB) $GL = 20 \log \dfrac{V \text{ out } (\text{⑨ } 0V)}{V \text{ out } (\text{⑨ } 2.5V)}$ (dB)

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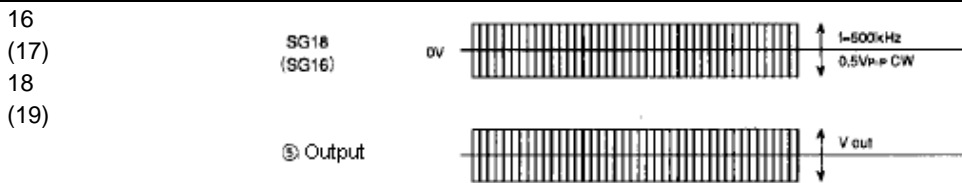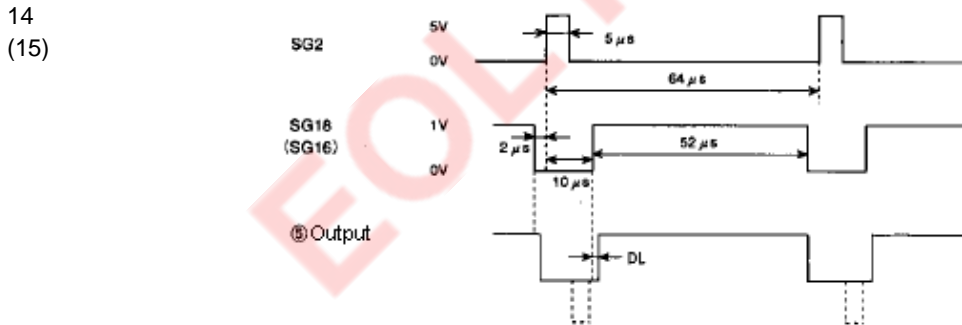
Measurement method and method for computing limit values (cont)

Meas. no.	Measurement method and method for computing limit values
20 21 22	SG2: 5V, 0V, 5 μs, 64 μs Output: V_{nH}, $V_{(n+1)H}$ $V_{B1} = V_{nH}$ $V_{B2} = V_{nH}$ $V_{B3} = V_{nH} - V_{(n+1)H}$
23	SG2: 5V, 0V, 5 μs, 64 μs Output: P_{nH}, $P_{(n+1)H}$ $P_{PS} = |P_{nH}$ burst phase $- P_{(n+1)H}$ burst phase$|$
24 (25, 26)	SG2: 5V, 0V, 5 μs, 64 μs SG18 (SG17, SG16): 1V, 0V, 2 μs, 10 μs, 52 μs, 0.71Vp-p Output: V_B, V_C R (G, B) / Burst level ratio $= \dfrac{V_C}{V_B}$
27	SG2: 5V, 0V, 5 μs, 64 μs Output: V_B, V_C $VC/B = 20 \log \dfrac{V_C}{V_B}$ (dB)
28 (29, 30)	SG2: 5V, 0V, 5 μs, 64 μs SG18 (SG17, SG16): 1V, 0V, 2 μs, 10 μs, 52 μs, 0.71Vp-p Output: P_B, P_C

Measurement method and method for computing limit values (cont)

Meas. no.	Measurement method and method for computing limit values
31 32	SG9 — 0V — 500kHz / 5MHz — 0.5Vp-p CW Output — V out $G_{VIO} = 20 \log \dfrac{V \text{ out (500kHz)}}{0.5Vp-p}$ (dB) $F_{VIO} = 20 \log \dfrac{V \text{ out (5MHz)}}{V \text{ out (500kHz)}}$ (dB)
33	SG2 — 5V / 0V — 5μs — 64μs SG9 — 0V — 286mVp-p CW 3.58MHz SG12 — 2V / 1V — 2μs — 30μs — 32μs — Output on RGB side / Output on VIDEO IN side Output — P_{RGB} — P_{VIN} $P_{SI} = P_{RGB} - P_{VIN}$ (deg)
34	SG2 — 5V / 0V — 5μs — 64μs SG12 — 2V / 1V — 2μs — 30μs — 32μs SG9 — 0V — 286mVp-p 3.58MHz Output — 0V — V_{VIN} — V_{RGB} $V_{OS} = V_{RGB} - V_{VIN}$ (mV)

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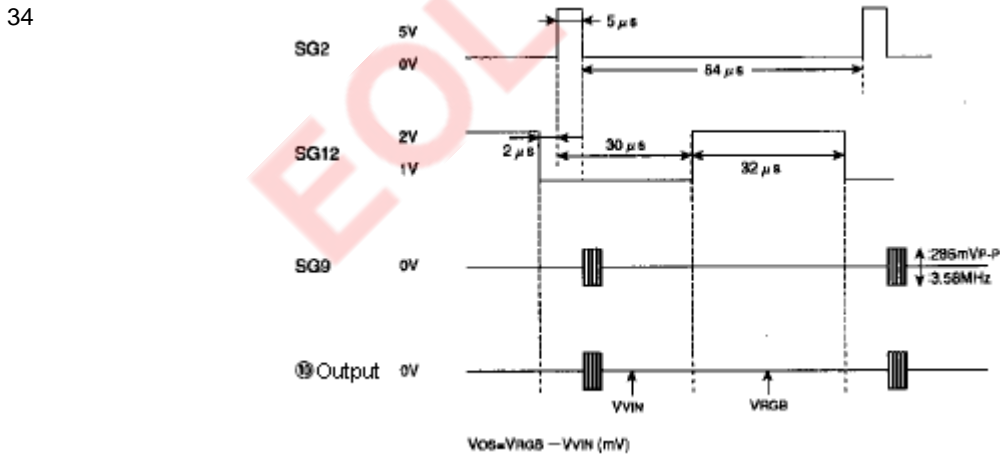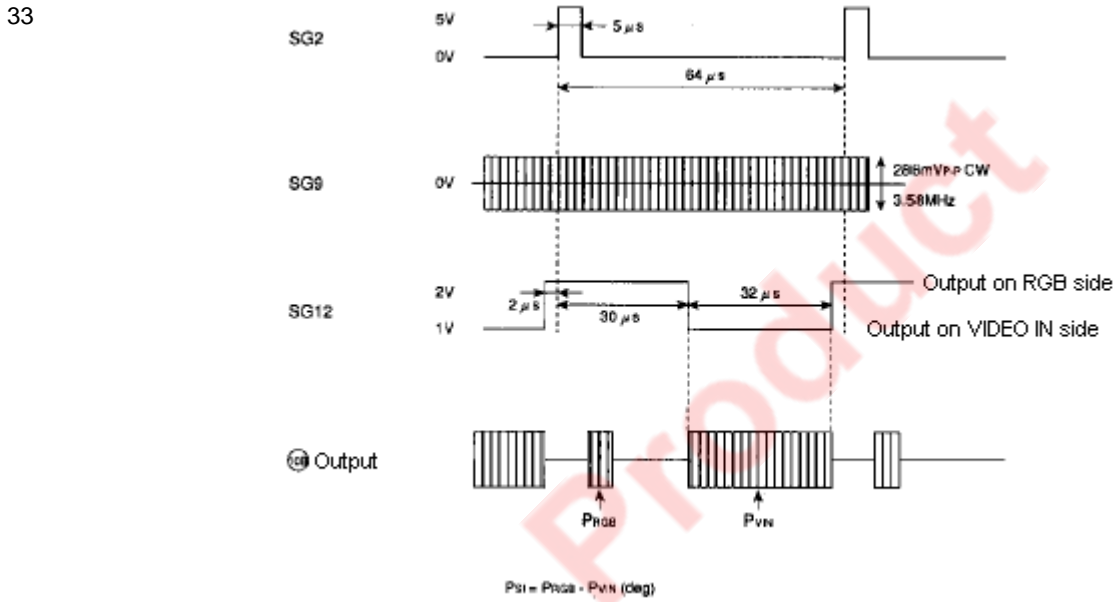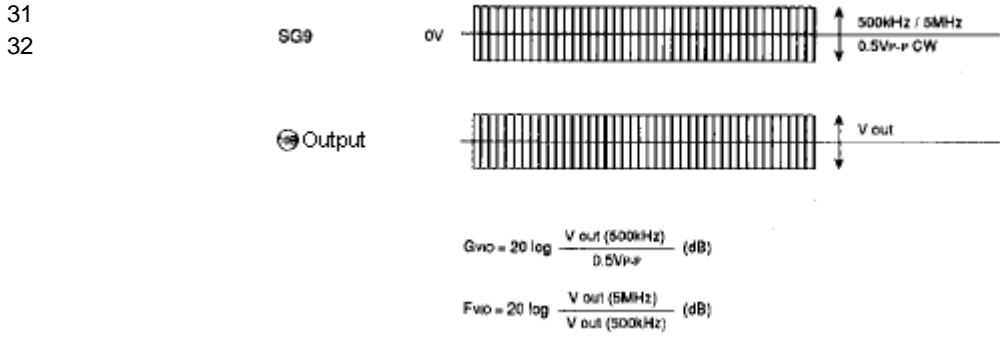
Measurement method and method for computing limit values (cont)

Meas. no.	Measurement method and method for computing limit values
35	
36	

Test Circuit

Unit Resistance : Ω
Capacitance: F

Usage Precautions

(1) Typical values for input signals

Pin no.	Pin name	Specifications

(2) Setting the Free Run frequency

This IC generates the fsc by means of the VCXO circuit.

Consequently, the VCXO oscillation frequency must always be set to fsc before the IC is used, by following the procedure outlined below.

1. Connect [9] (VIDEO IN) to GND, and set the Free Run mode.
2. Set the [2] (OFFSET R) voltage when SYNC was input to [4] (C. SYNC IN) to V_4, and apply a voltage of $V_4 = 0.5$ V to [4] (OFFSET R).
3. Fix C.[2] (SYNC IN) in the High state. (5 V applied)
4. Adjust the output frequency of [5] (TRAP) to the trimmer capacitor of [7] (VCXO IN), and set it to fsc.

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(3) Setting the color difference LPF

The frequency characteristic of the color difference LPF built into this IC can be set as shown in Fig. 1, using the [20] (fc CONT.) external resistor.

When doing this, the group delay characteristic also changes, as shown in Fig. 2.
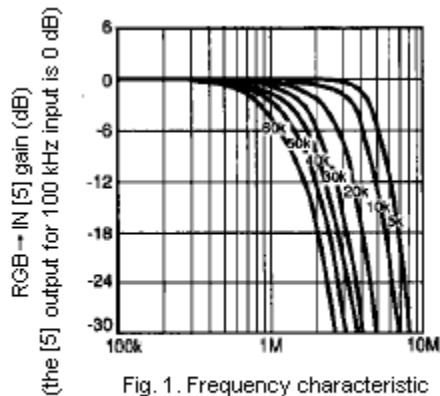
Fig. 1. Frequency characteristic of the color difference LPF (for measurement conditions, see TEST nos. 14 and 15)
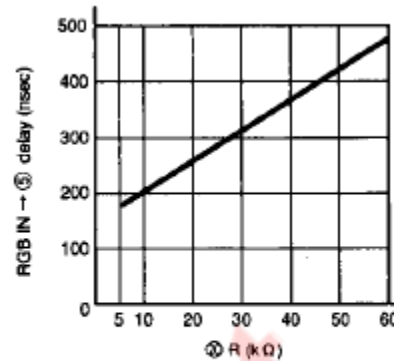
Fig. 2 Group delay characteristic for the color difference LPF (for measurement conditions, see TEST nos. 14 and 15)

(4) Setting Y DL

The group delay characteristic of the color signal of the RGB encoder output changes in response to the [20] (fc CONT) external resistor, so Y DL should be set in such a way that the group delay characteristic is the amount of group delay obtained from the group delay characteristic of Fig. 2, with 40 ns added.

Also, if the [6] (TRAP) circuit is being added, a further delay of +5 to +10 ns should be taken into consideration.

(5) COLOR CONT characteristic

The gain of the chroma unit can be set as shown in Fig. 3, using the [19] (COLOR CONT) applied voltage. (The burst amplitude is constant.)
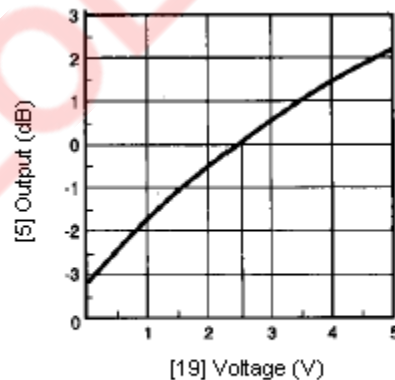
Fig. 3. COLOR CONT. characteristic (for measurement conditions, see TEST nos. 16, 17, 18, and 19)

(6) The relationship between BFP and HHK

The pulse width of BFP and HHK can be set as shown in Fig. 4, using the [3] (HHK) external CR.
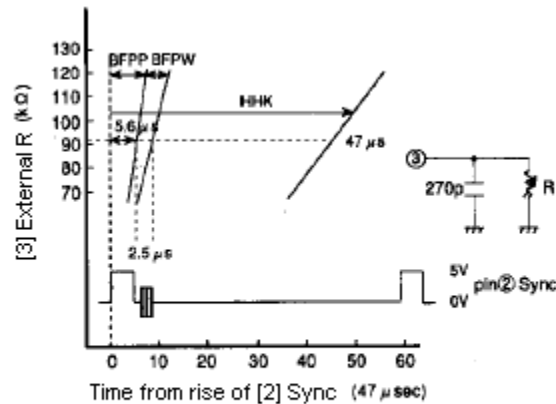
Fig. 4. [3] RC product versus pulse generated internally
(for measurement conditions, see TEST nos. 35, 36, and 37)

(7) Input pin drive

Input pins [9], [16], [17], and [18] use clamp input, so they should always be driven with a low impedance.

(8) Input/output relationship between SYNC and burst during the V cycle

Input/output relationship between SYNC and burst
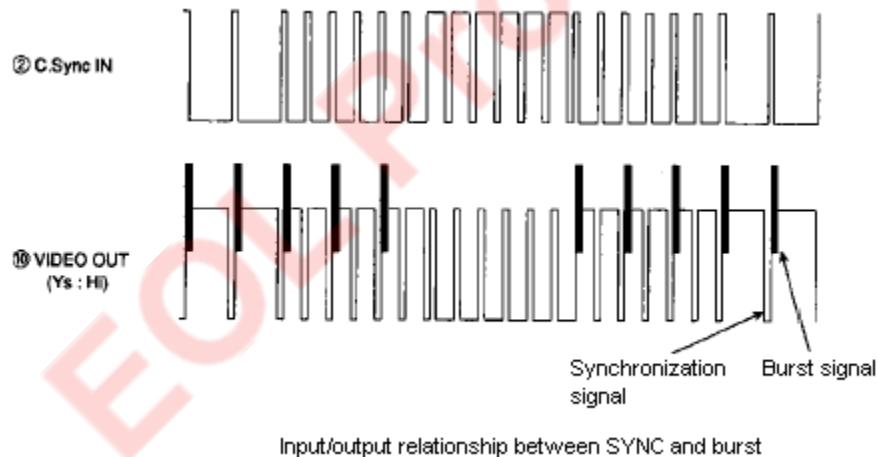
(9) V DL and Y_S DL settings when the SUPERIMPOSE mode is being used

1) V DL is used to adjust the timing of the RGB encoder signal and the VIDEO IN signal.
2) Y_S DL is used to adjust the timing of the RGB encoder signal and the Y_s IN signal.
3) When the timing is the same for C. SYNC IN, RGB IN, VIDEO IN and Y_s IN, V DL and Y_S DL should be set using the amount of delay shown below as a guide.

V DL = Y DL (item 4) + 10 (ns)

Y_S DL = Y DL − 10 (ns)

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Application Example (1)

Example showing RGB video signals being encoded in NTSC/PAL signal
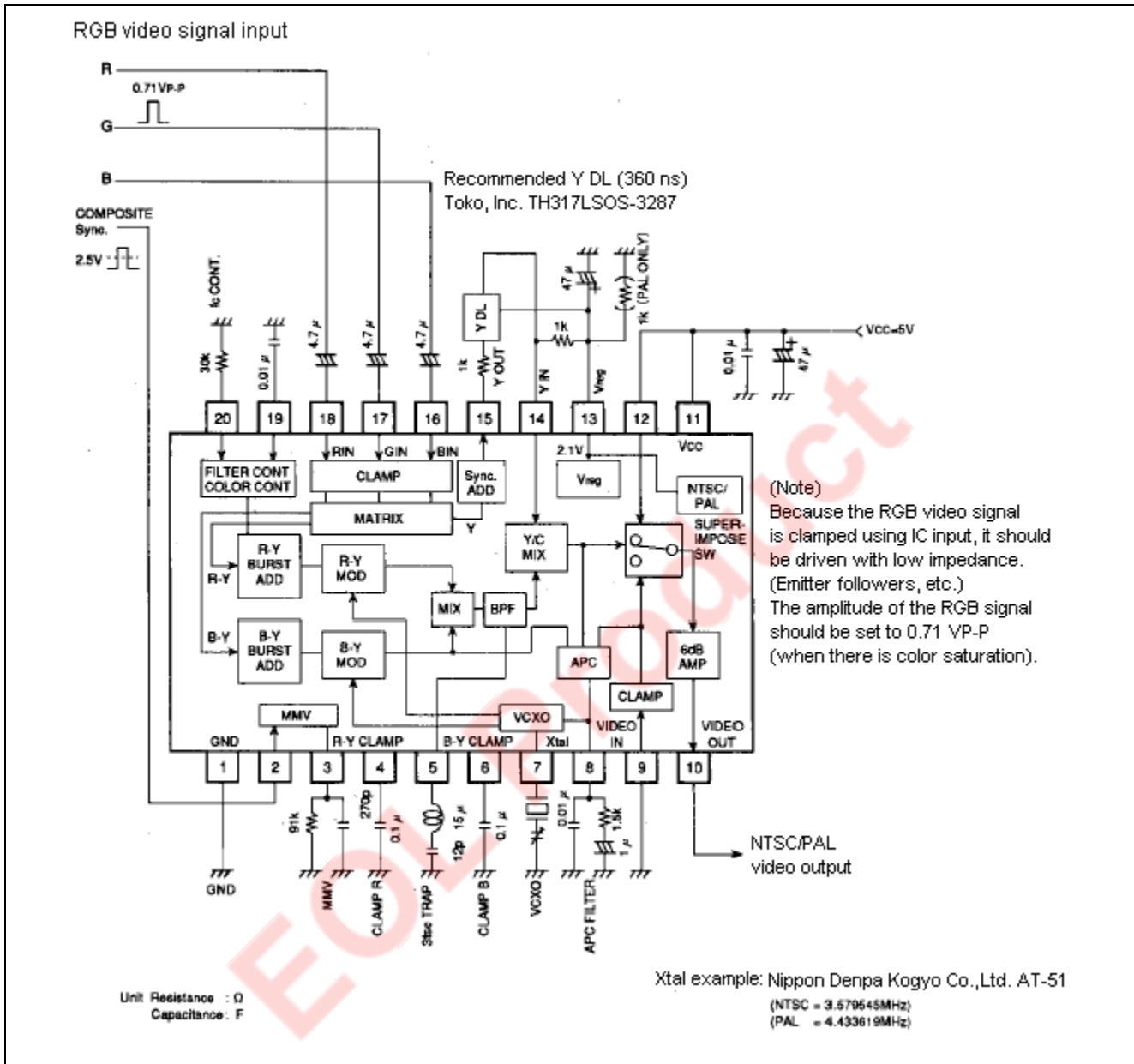
Application Example (2)

Example showing RGB text signals superimposed on NTSC/PAL signals

(*The values in brackets show what takes place when the RGB signals of a personal computer or other device are superimposed on NTSC/PAL signals as a sub-screen.)

If signals delayed by approximately 350 nm after the text (*sub-screen) RGB signals are created directly, as Ys signals, Ys DL is not necessary. If RGB and Ys are at same timing, the delay time of Ys DL should be set to 350 ns (typical).

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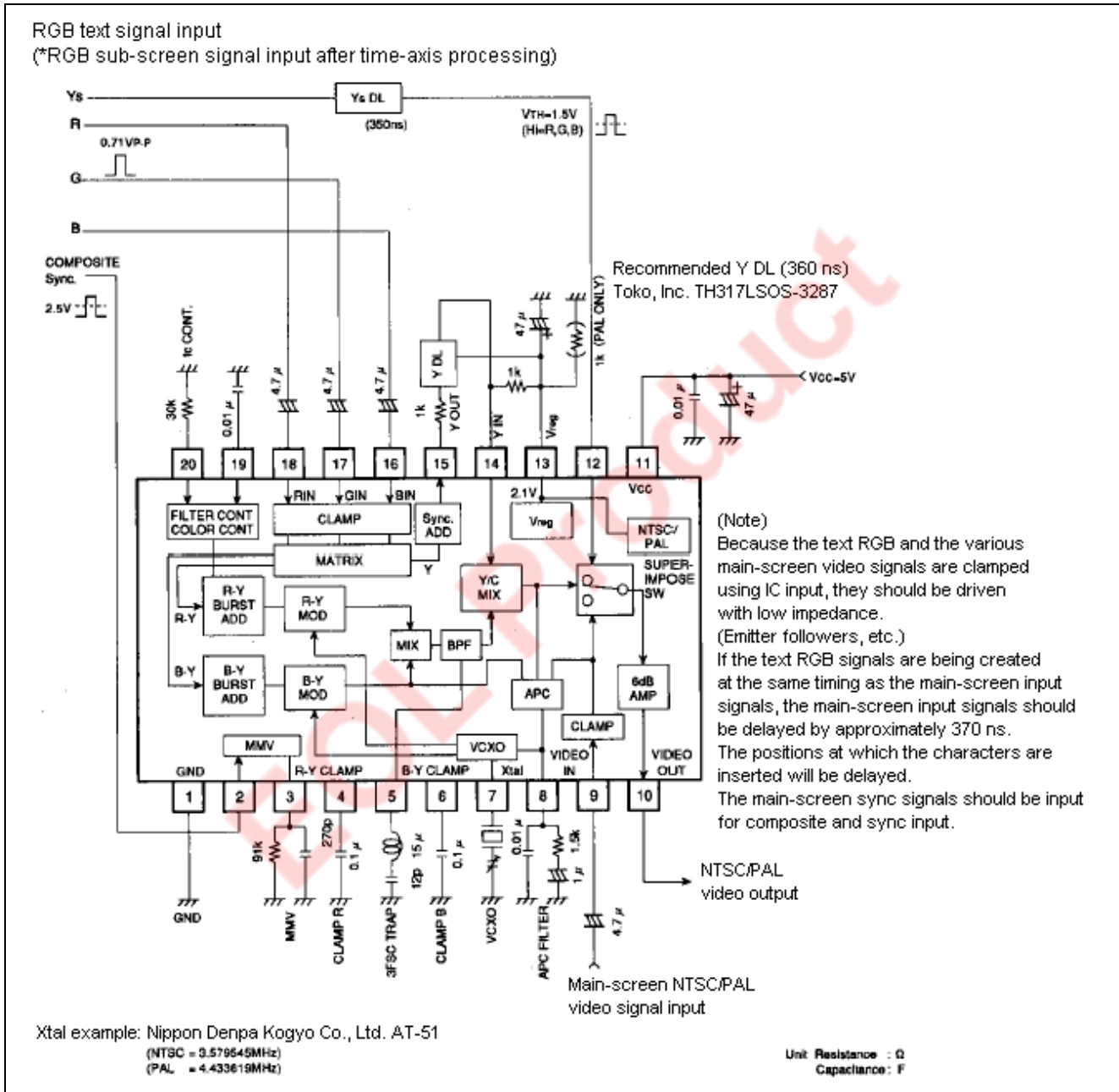
Package Dimensions

Plastic 20pin 300mil SOP

20P2N-A (MMP)

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SOP20-P-300-1.27	—	0.26	Cu Alloy
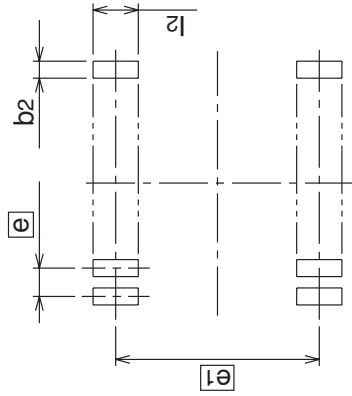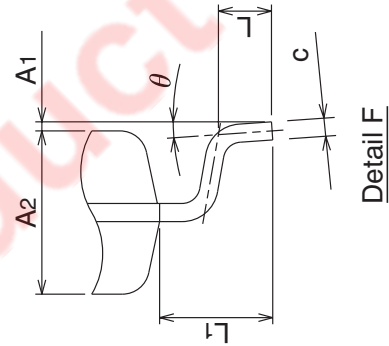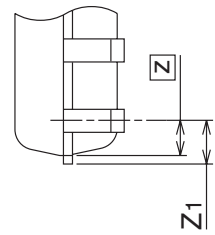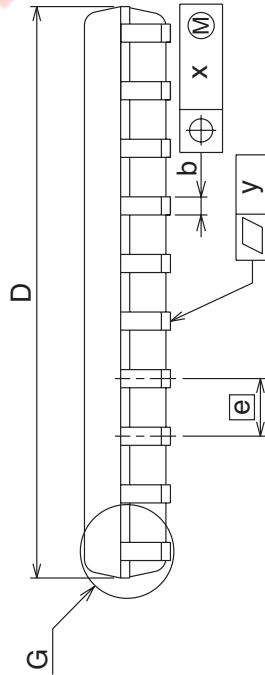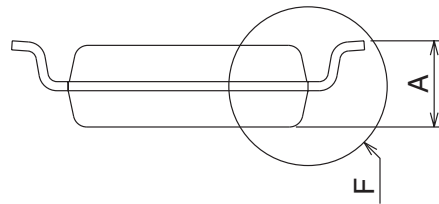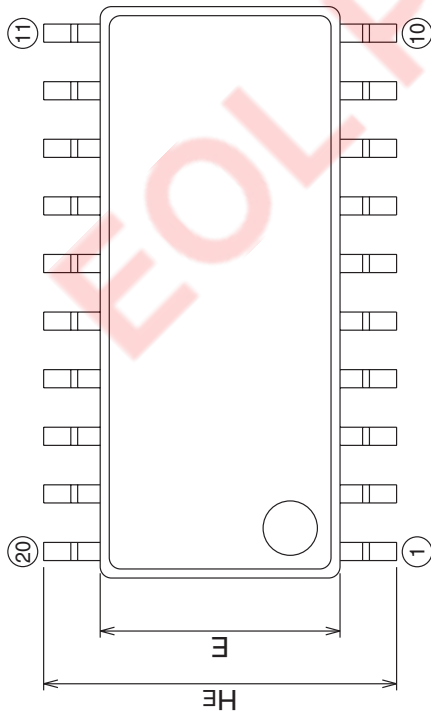
Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	2.1
A1	0	0.1	0.2
A2	—	1.8	—
b	0.35	0.4	0.5
c	0.18	0.2	0.25
D	12.5	12.6	12.7
E	5.2	5.3	5.4
e	—	1.27	—
HE	7.5	7.8	8.1
L	0.4	0.6	0.8
L1	—	1.25	—
z	—	0.585	—
Z1	—	—	0.735
x	—	—	0.25
y	—	—	0.1
θ	0°	—	8°
b2	—	0.76	—
e1	—	7.62	—
l2	1.27	—	—

Detail F

Detail G

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RenesasTechnology Corp. Sales Strategic Planning Div.   Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

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RENESAS SALES OFFICES

http://www.renesas.com

Renesas Technology America, Inc.
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500 Fax: <1> (408) 382-7501

Renesas Technology Europe Limited.
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, United Kingdom
Tel: <44> (1628) 585 100, Fax: <44> (1628) 585 900

Renesas Technology Europe GmbH
Dornacher Str. 3, D-85622 Feldkirchen, Germany
Tel: <49> (89) 380 70 0, Fax: <49> (89) 929 30 11

Renesas Technology Hong Kong Ltd.
7/F., North Tower, World Finance Centre, Harbour City, Canton Road, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2375-6836

Renesas Technology Taiwan Co., Ltd.
FL 10, #99, Fu-Hsing N. Rd., Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology (Shanghai) Co., Ltd.
26/F., Ruijin Building, No.205 Maoming Road (S), Shanghai 200020, China
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

Renesas Technology Singapore Pte. Ltd.
1, Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001