APPLICATION MANUAL

High-Speed Dual Video Amplifier IC
TK15450M/L

CONTENTS

MEETING YOUR NEEDS
TOKO, Inc.

High-Speed Dual Video Amplifier IC
TK15450M/L

1. DESCRIPTION

The TK15450M/L is a video amplifier IC capable of driving 75 Ω. There are two general-purpose amplifiers in one package.
The TK15450M/L, enclosed in the SOP-8 and SOT23L-8 packages, are the high-speed versions of the TK15420M.
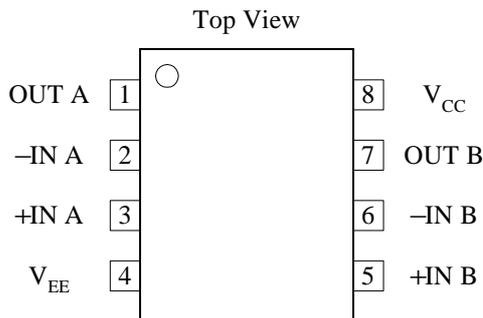
2. FEATURES

- High Frequency Operation (Flat to 30MHz)
- General-purpose Amplifier Type
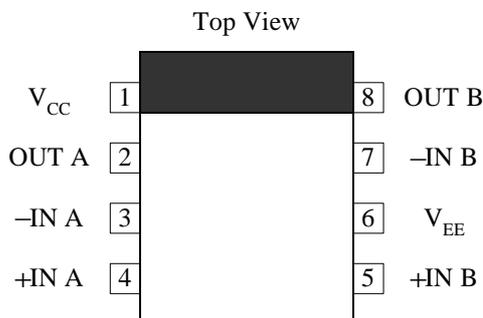- Can Drive Two Video Loads (75Ω)

3. APPLICATIONS

- Video and RF Signal Amplification
- 75Ω Driver

4. PIN CONFIGURATION

- SOP-8 (TK15450M)

Top View

OUT A	1	8	V_{CC}
–IN A	2	7	OUT B
+IN A	3	6	–IN B
V_{EE}	4	5	+IN B

- SOT23L-8 (TK15450L)

Top View

V_{CC}	1	8	OUT B
OUT A	2	7	–IN B
–IN A	3	6	V_{EE}
+IN A	4	5	+IN B

5. PACKAGE OUTLINE

- SOP-8 (TK15450M)

* Package size value is typical

- SOT23L-8 (TK15450L)
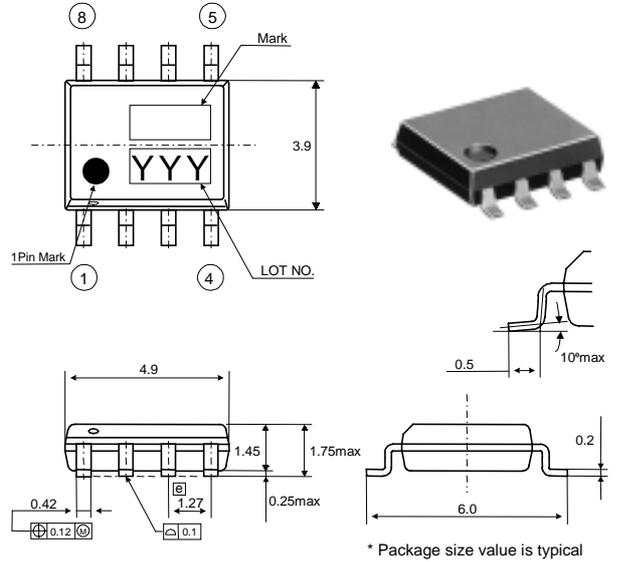
* Package size value is typical

6. BLOCK DIAGRAM

■ SOP-8 (TK15450M)
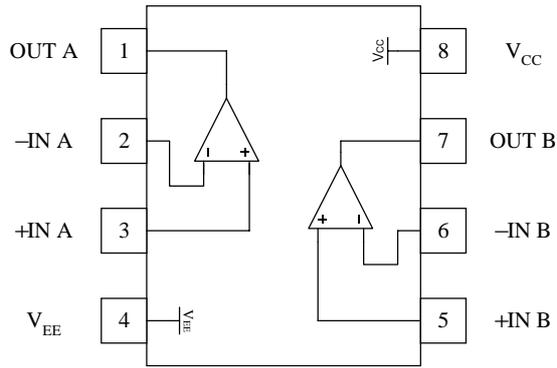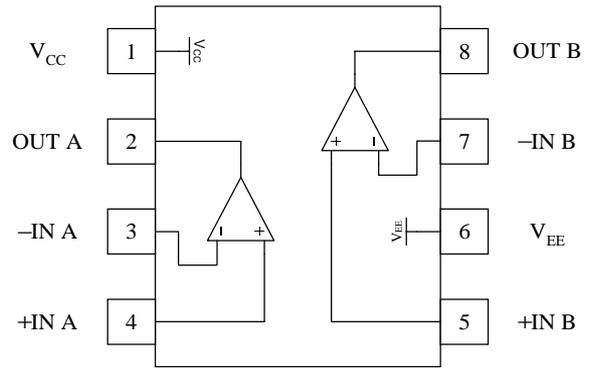
■ SOT23L-8 (TK15450L)

7. ABSOLUTE MAXIMUM RATINGS

$T_a = 25°C$

Parameter	Symbol	Rating	Units	Conditions
Supply Voltage	V_{CC}	12.0	V	
Power Dissipation (SOP-8)	P_D	1500	mW	Board Mounted *1
Power Dissipation (SOT23L-8)	P_D	1200	mW	Board Mounted *2
Storage Temperature Range	T_{stg}	-55 ~ +150	°C	
Operating Temperature Range	T_{OP}	-25 ~ +75	°C	
Maximum operating Frequency	f_{MAX}	~ 200	MHz	
Operating Voltage Range	V_{OP}	4.0 ~ 11.0	V	

*1 P_D must be decreased at the rate of 12.0mW/°C for operation above 25°C.

*2 P_D must be decreased at the rate of 9.6mW/°C for operation above 25°C.

8. ELECTRICAL CHARACTERISTICS

8-1. ±5V Dual Supply Electrical Characteristics

$V_{CC}/V_{EE}=\pm5.0V$, $T_a=25°C$, $R_L=150\Omega$

| Parameter	Symbol	Value			Units	Conditions
		MIN	TYP	MAX		
Supply Current	I_{CC}	–	35.3	55.0	mA	No Signal
Output Source Current	I_{SO}	–	60	–	mA	
Output Sink Current	I_{SI}	–	60	–	mA	
Input Bias Current	I_{IB}	–	19.8	60	μA	
Input Offset Voltage	V_{IO}	–	22	–	mV	
Open Circuit Voltage Gain	G_{VO}	–	40	–	dB	
Gain-Bandwidth Product	GB	–	200	–	MHz	
Slew Rate	SR	–	320	–	V/μs	
Voltage Gain	G_V	5.3	5.8	6.3	dB	fin=1MHz
Frequency Response	fr	–	0.0	–	dB	fin=1MHz/30MHz
Differential Gain	DG	-3	0.2	3	%	Vin=1.0Vp-p 10 stair case
Differential Phase	DP	-3	0.1	3	deg	Vin=1.0Vp-p 10 stair case
Cross Talk1	CT1	–	-63	-50	dB	fin=4.43MHz, Vin=1.0Vp-p
Cross Talk2	CT2	–	-45	–	dB	fin=30.0MHz, Vin=1.0Vp-p
Supply Voltage Rejection Ratio1	SVRR1	–	-52	–	dB	$\Delta V_{CC}=0.4Vp-p$, f=100kHz
Supply Voltage Rejection Ratio2	SVRR2	–	-41	–	dB	$\Delta V_{EE}=0.4Vp-p$, f=100kHz
Input Capacitance	Cin	–	1.1	–	pF	SOP-8 Package
Input Capacitance	Cin	–	0.8	–	pF	SOT23L-8 Package

8-2. 5V Single Supply Electrical Characteristics (Reference Data)
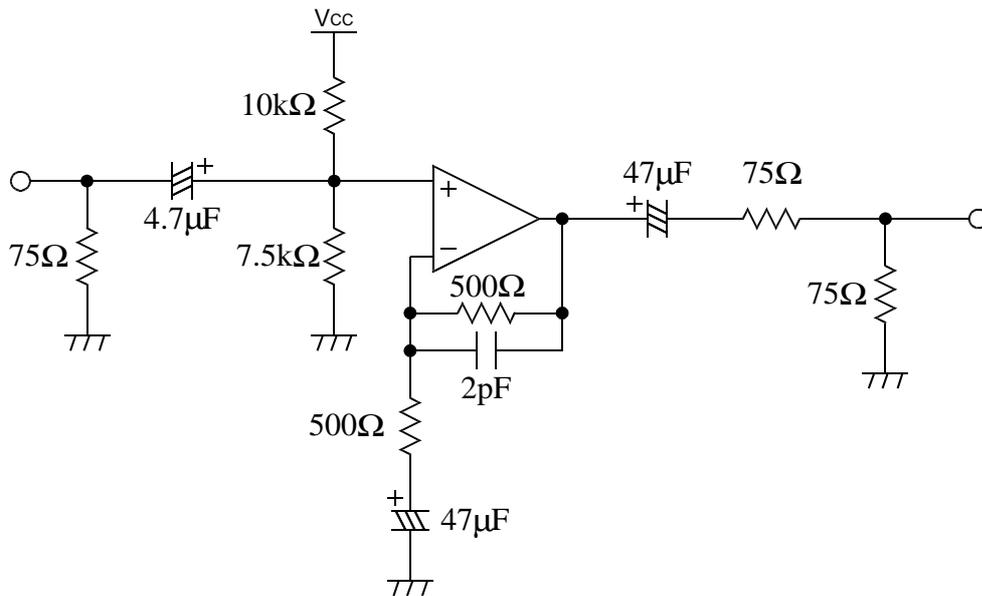
$V_{CC}=5.0V$, $T_a=25°C$, $R_L=150\Omega$

Parameter	Symbol	Value			Units	Conditions
		MIN	TYP	MAX		
Supply Current	I_{CC}	–	30.4	–	mA	No Signal
Output Source Current	I_{SO}	–	50	–	mA	
Output Sink Current	I_{SI}	–	50	–	mA	
Input Bias Current	I_{IB}	–	15	–	μA	
Input Offset Voltage	V_{IO}	–	10	–	mV	
Open Circuit Voltage Gain	G_{VO}	–	40	–	dB	
Gain-Bandwidth Product	GB	–	200	–	MHz	
Slew Rate	SR	–	180	–	V/μs	
Voltage Gain	G_V	–	5.8	–	dB	fin=1MHz
Frequency Response	fr	–	0.0	–	dB	fin=1MHz/30MHz
Differential Gain	DG	–	0.4	–	%	Vin=1.0Vp-p 10 stair case
Differential Phase	DP	–	0.1	–	deg	Vin=1.0Vp-p 10 stair case
Cross Talk1	CT1	–	-61	–	dB	fin=4.43MHz, Vin=1.0Vp-p
Cross Talk2	CT2	–	-44	–	dB	fin=30.0MHz, Vin=1.0Vp-p
Supply Voltage Rejection Ratio	SVRR	–	-44	–	dB	$\Delta V_{CC}=0.4Vp-p$, f=100kHz

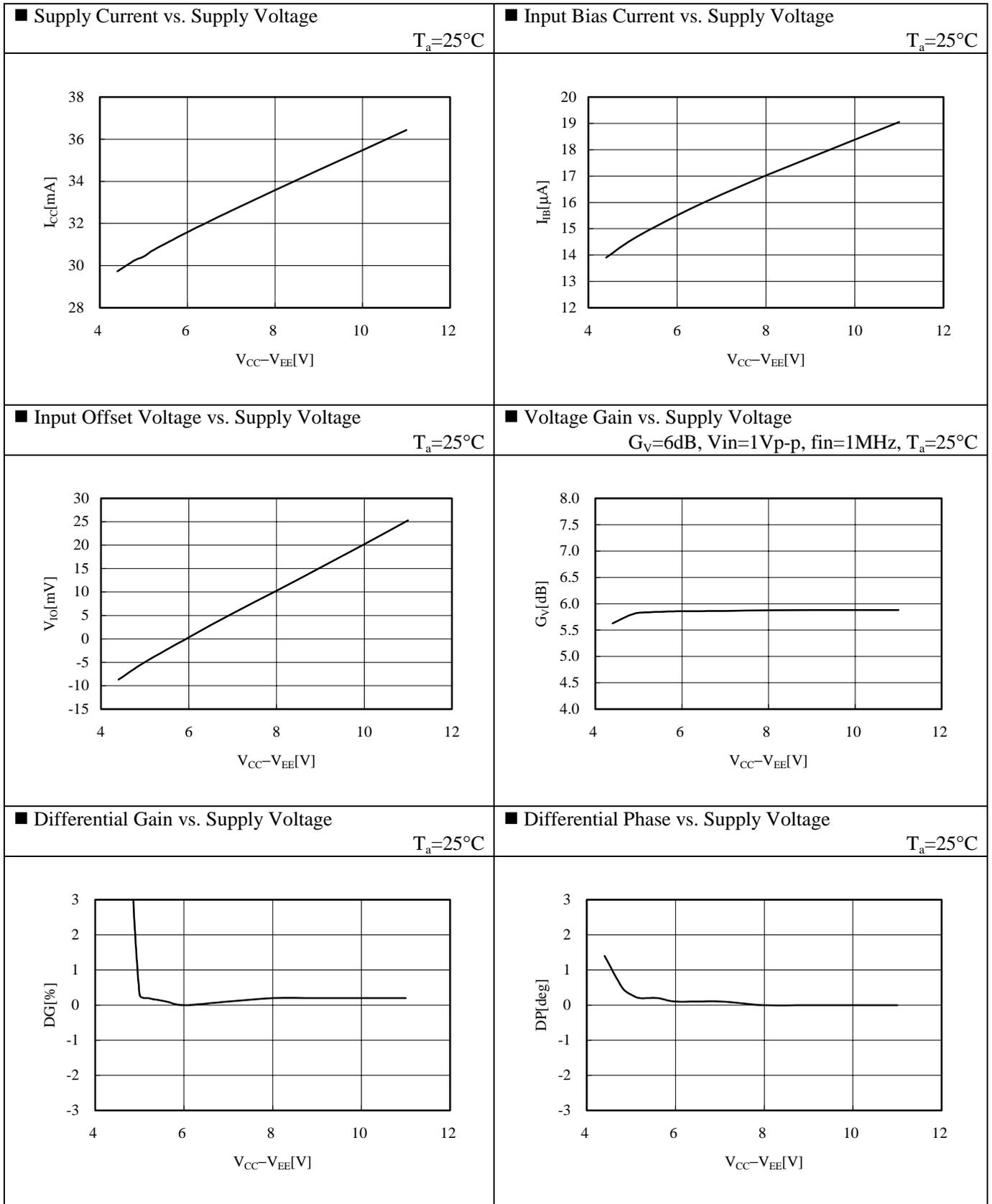## 9. TEST CIRCUIT

9-1. ±5V Dual Supply Test Circuit
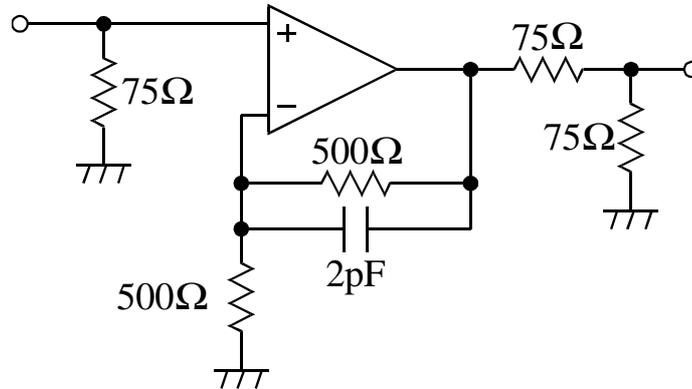
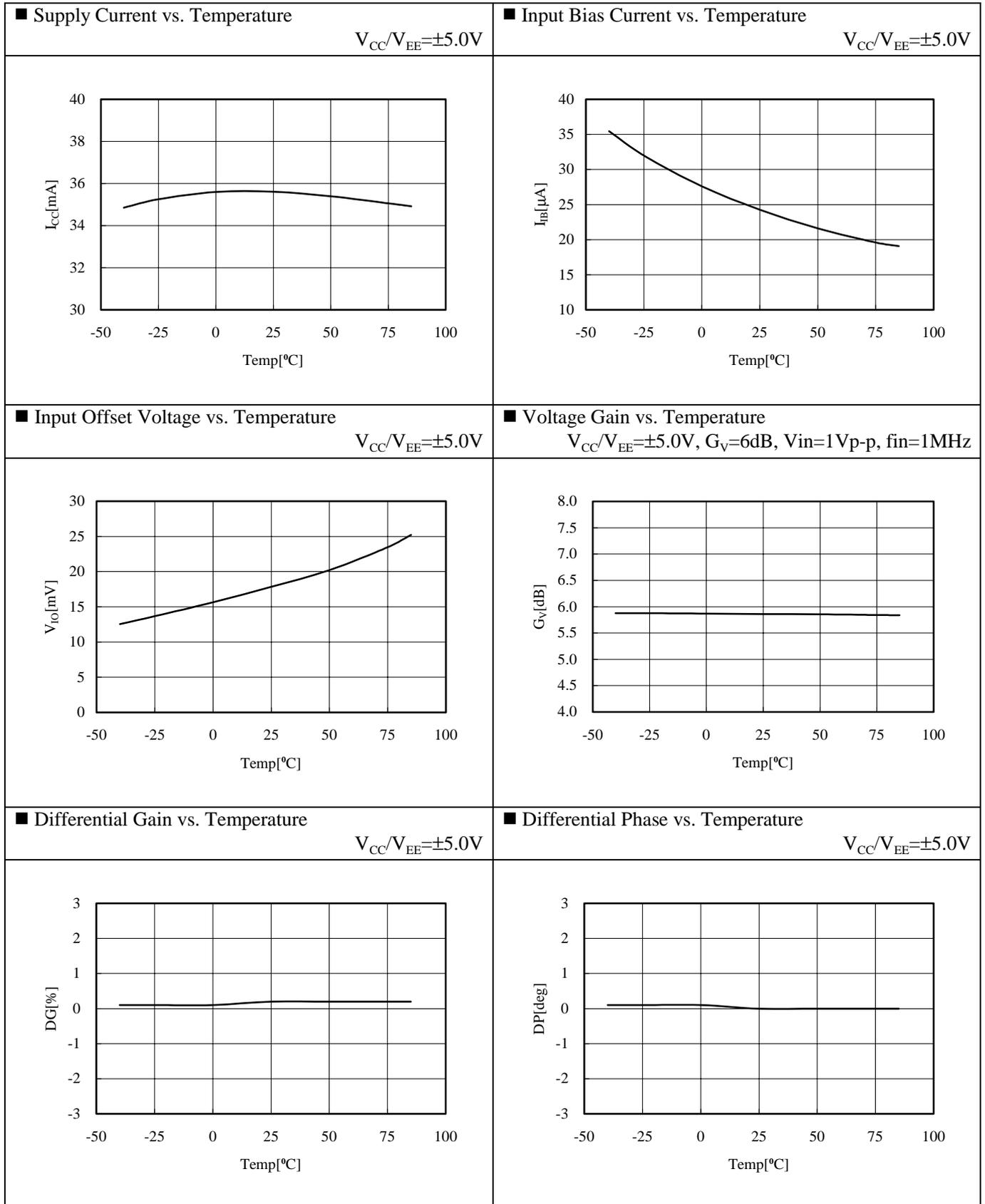### 9-2. 5V Single Supply Test Circuit

10. TYPICAL CHARACTERISTICS

10-1. Supply Voltage Characteristics

■ Supply Current vs. Supply Voltage

T_a=25°C

■ Input Bias Current vs. Supply Voltage

T_a=25°C

■ Input Offset Voltage vs. Supply Voltage

T_a=25°C

■ Voltage Gain vs. Supply Voltage

G_V=6dB, Vin=1Vp-p, fin=1MHz, T_a=25°C

■ Differential Gain vs. Supply Voltage

T_a=25°C

■ Differential Phase vs. Supply Voltage

T_a=25°C

ITOKO

10-2. Temperature Characteristics

■ Supply Current vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$

■ Input Bias Current vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$

■ Input Offset Voltage vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$

■ Voltage Gain vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$, $G_V=6dB$, Vin=1Vp-p, fin=1MHz

■ Differential Gain vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$

■ Differential Phase vs. Temperature

$V_{CC}/V_{EE}=\pm 5.0V$

10-3. Various Main Characteristics

■ Open Loop Gain vs. Frequency
$V_{CC}/V_{EE}=\pm 5.0V$, $T_a=25°C$

■ Closed Loop Gain and Group Delay vs. Frequency
$V_{CC}/V_{EE}=\pm 5.0V$, Gv=6dB, Vin=1Vp-p, $T_a=25°C$

■ Closed Loop Gain and Group Delay vs. Frequency
$V_{CC}/V_{EE}=\pm 5.0V$, Gv=6dB, $T_a=25°C$, Small Signal Input

■ Cross Talk vs. Frequency
$V_{CC}/V_{EE}=\pm 5.0V$, Vin=1Vp-p, $T_a=25°C$

chB to A

chA to B

■ Input Voltage Noise vs. Frequency
$V_{CC}/V_{EE}=\pm 5.0V$, $T_a=25°C$

■ Common Mode Rejection Ratio vs. Input Voltage
$V_{CC}=5.0V$, $V_{EE}=0V$, $T_a=25°C$

10-4. Pulse Input Characteristics

■ 10MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=2pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

■ 10MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=5pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

■ 20MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=2pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

■ 20MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=5pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

■ 30MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=2pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

■ 30MHz Pulse Input Response
$V_{CC}/V_{EE}=\pm5.0V$, Vout=2.0Vp-p, Cf=5pF, $T_a=25°C$

Ch1 500mV Ω   M 10.0ns

10-5. Video Signal Characteristics

■ Bar & Line Time Characteristics
$$V_{CC}/V_{EE}=\pm5.0V, T_a=25°C, R_L=150\Omega$$
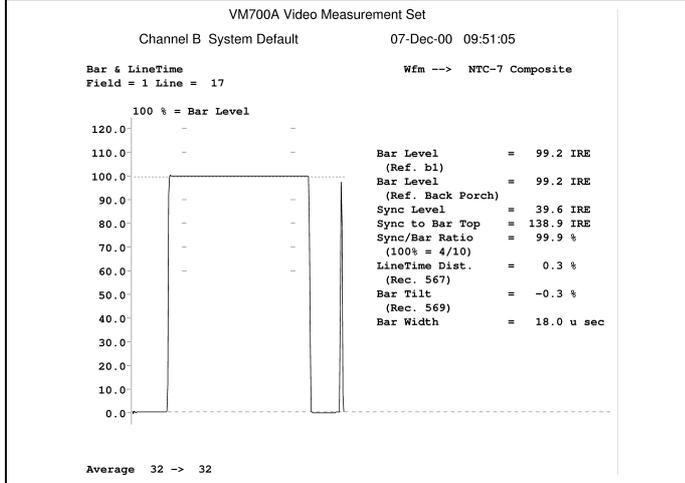
■ DG/DP characteristics
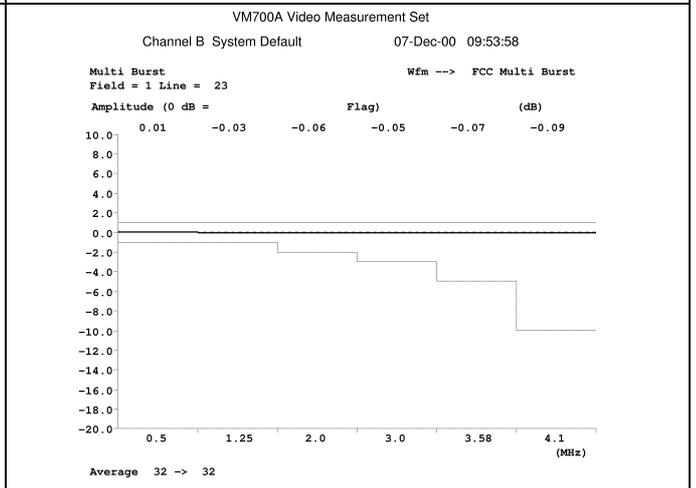$$V_{CC}/V_{EE}=\pm5.0V, T_a=25°C, R_L=150\Omega$$
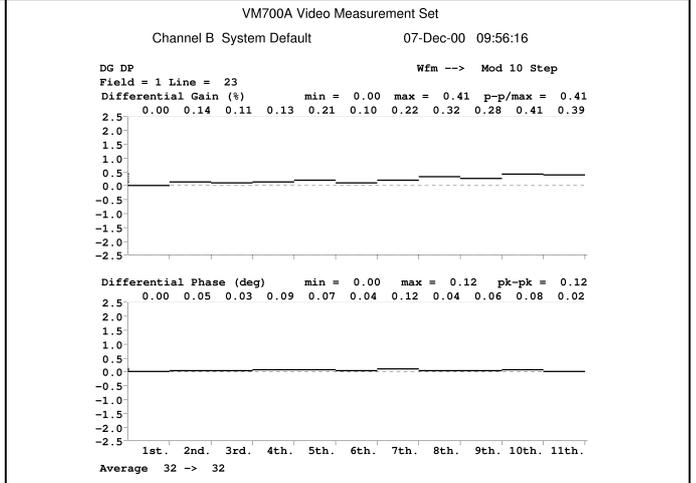
■ Color Bar Characteristic
$$V_{CC}/V_{EE}=\pm5.0V, T_a=25°C, R_L=150\Omega$$
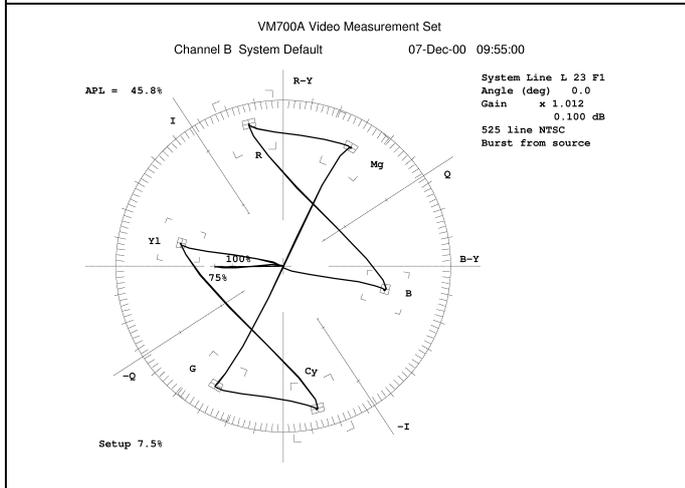
■ Multi Burst Characteristic
$$V_{CC}/V_{EE}=\pm5.0V, T_a=25°C, R_L=150\Omega$$

11. PIN DESCRIPTION

SOP-8 Package

Pin No.	Name	Internal Equivalent Circuit	Description
1	OUT A		Output terminal of channel A.
2 3	–IN A +IN A		Inverting and Non-inverting input terminals of channel A. This circuit is a differential amplifier structure using NPN transistors.
4	V_{EE}		Negative Power Supply Terminal.
5 6	+IN B –IN B		Inverting and Non-inverting input terminals of channel B. This circuit is a differential amplifier structure using NPN transistors.
7	OUT B		Output terminal of channel A.
8	V_{CC}		Positive Power Supply Terminal.

12. APPLICATIONS INFORMATION

12-1. About Amplitude Restrictions

In certain applications, the output voltage is limited by the input voltage.

This is explained in the outline below using the internal equivalent circuit shown in Figure 1.
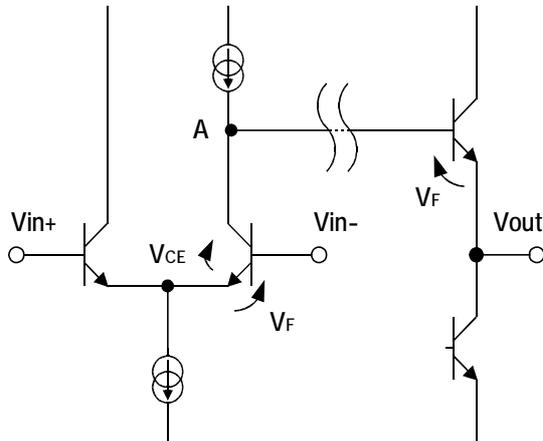

Figure 1: The internal equivalent circuit

From Figure 1, if the voltage V_A at A point is shown from the input side and the output side respectively, the expression is as follows:

$$V_A \geq V_{in} - V_F + V_{CE} \qquad (1)$$

$$V_A = V_{out} + V_F \qquad (2)$$

Thus

$$V_{out} - V_{in} + 2V_F \geq V_{CE} \qquad (3)$$

Substitution of $V_F = 0.7V$ into (3) gives

$$V_{out} - V_{in} + 1.4V \geq V_{CE} \qquad (4)$$

Depending on the relationship between Vout and Vin, it may become impossible to secure the Saturation voltage V_{CE} (about 0.3 V) of the inverting input transistor; as a result, the linearity of the input and output voltage will collapse.

An example of this application is shown in Figure 2 with the measures explained below.

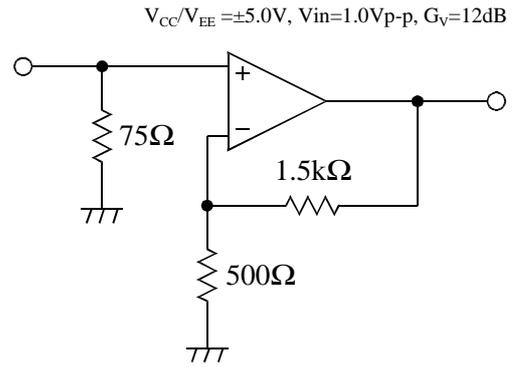$V_{CC}/V_{EE} = \pm 5.0V$, Vin=1.0Vp-p, G_V=12dB

Figure 2: Application example

In Figure 2, if -0.5V (the minimum value of input amplitude) is given to the input, the output voltage will be set to -2.0V. Substitution of Vin and Vout into (4) gives

$$V_{out} - V_{in} + 1.4V = -0.1V \leq V_{CE}(0.3V) \qquad (5)$$

This shows that the transistor of the inverting input is operating in the saturation region; for this reason, it becomes impossible to keep linearity of the input-to-output voltage. As shown in Figure 3, there is a method of providing V_{REF} as a preventive measure. It is possible to raise the output voltage by setting up V_{REF} appropriately, and avoid amplitude restrictions.
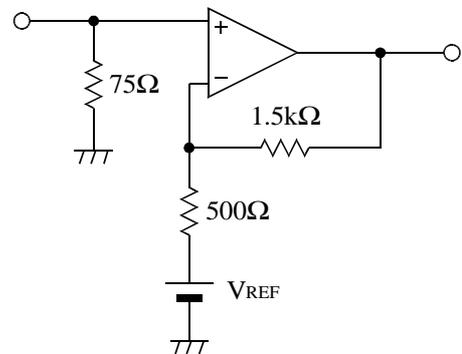

Figure 3: Example of preventive measures

If the input voltage and V_{REF} are assumed to be -0.5V, the output voltage also becomes -0.5V.

This result is substituted into expression (4)

$$V_{out} - V_{in} + 1.4V = 1.4V \geq V_{CE}(0.3V) \qquad (6)$$

As a result, the saturation voltage of the inverting input transistor is secured, and the amplitude limitation can be avoided. However, it is necessary to pay attention to the dynamic range, especially when using this IC with a low power supply. This method may be used to control the output bias voltage.

12-2. Two-Line Video Driver

As shown in Figure 4, this IC is a useful circuit for driving two-video lines.
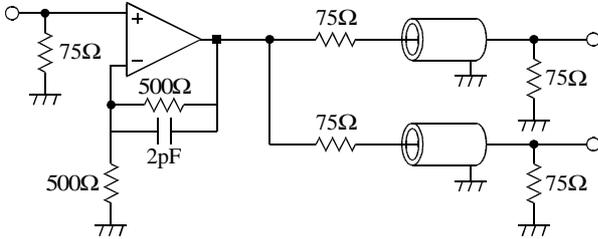Figure 5 and Figure 6 show the frequency characteristic and the DG/DP characteristics.
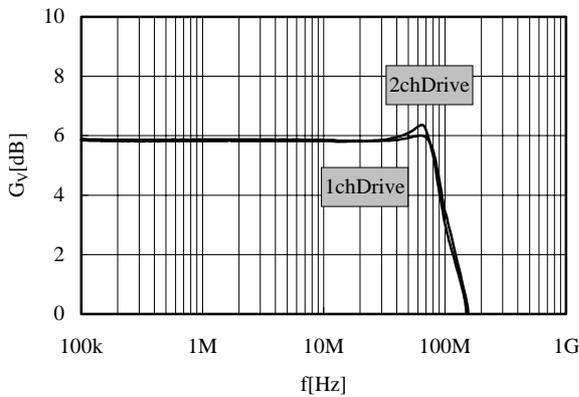
Figure 4: Two-line video driver

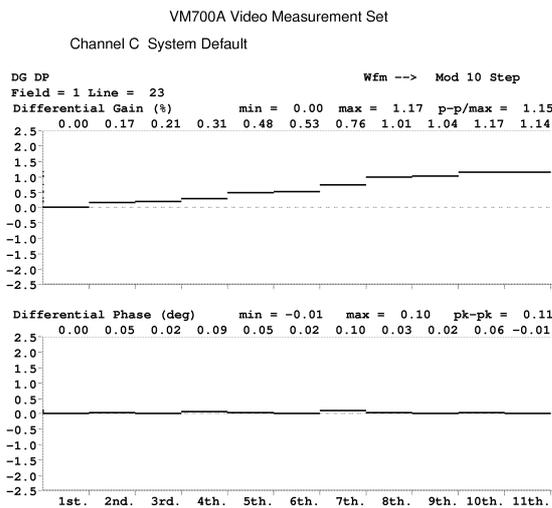Figure 5: Frequency characteristics

VM700A Video Measurement Set

Channel C System Default

```
DG DP                              Wfm -->   Mod 10 Step
Field = 1 Line =  23
Differential Gain (%)        min =  0.00  max =  1.17  p-p/max =  1.15
     0.00  0.17  0.21  0.31  0.48  0.53  0.76  1.01  1.04  1.17  1.14
```

```
Differential Phase (deg)     min = -0.01   max =  0.10   pk-pk =  0.11
     0.00  0.05  0.02  0.09  0.05  0.02  0.10  0.03  0.02  0.06 -0.01
```

Figure 6: DG/DP characteristics

12-3. About Frequency Characteristic

If the gain is raised, the frequency characteristic falls on the balance with the open loop characteristic; this may end realizing the 30MHz flat characteristic. In this case, the frequency characteristic can be improved by a combination application shown in Figure 7.
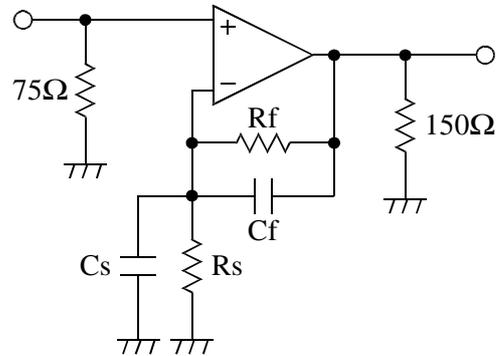
Figure 7: Example of designing a 30MHz flat circuit

The frequency characteristics shown in Figure 8 can be obtained by setting each constant according to the gain as follows.

G_V=6dB   Rf=500Ω, Rs=470Ω, Cf=2pF
G_V=9dB   Rf=470Ω, Rs=240Ω
G_V=12dB   Rf=470Ω, Rs=150Ω, Cs=6pF
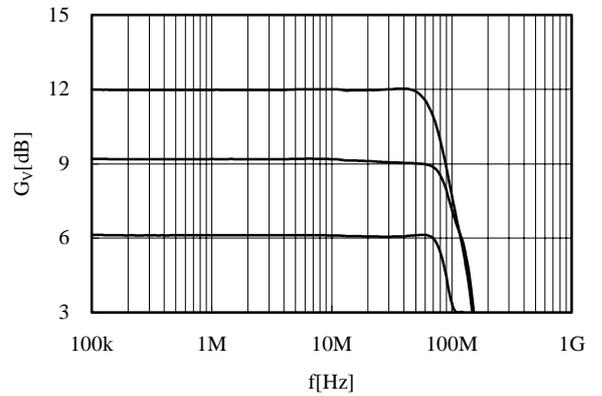
Figure 8: 30MHz flatness characteristics

12-4. Driving Capacitive Loads

If a capacitive load (C_L) is assumed in the measurement circuit of Figure 9, and the gain is measured, the resulting frequency characteristic is shown in Figure 10.
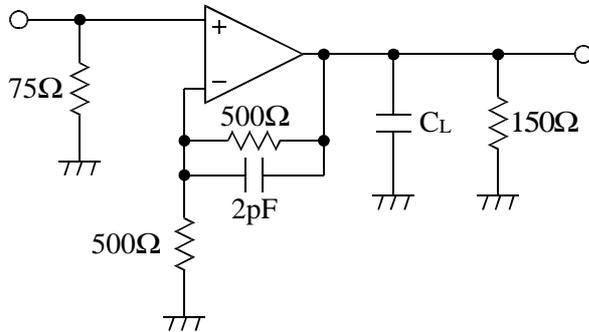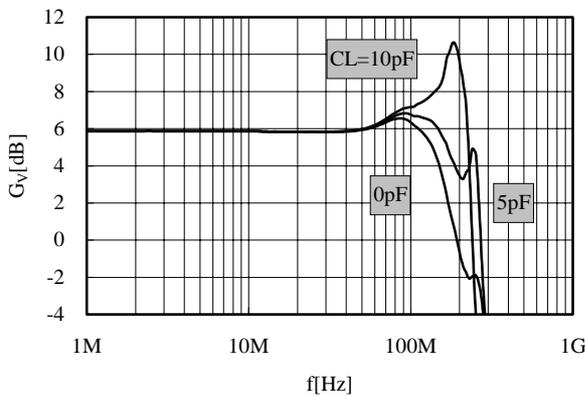

Figure 9: Measurement circuit

Figure 10: Frequency characteristics of capacitive load

Therefore, please note that oscillation may occur when a capacitive load is directly connected to the output terminal.

12-5. Use as a Buffer Amplifier

The gain of this operational amplifier IC can be changed with the external parts.
However, if this IC is used as a buffer amplifier (Figure 11), peaking is generated as shown in Figure 12.
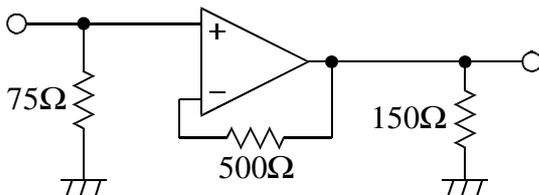

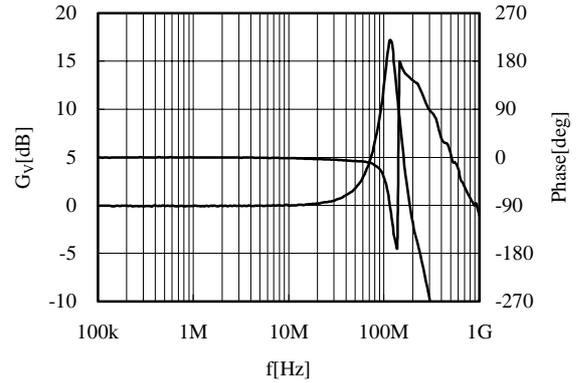Figure 11: Example of using buffer amplifier

Figure 12: Frequency characteristic of buffer amplifier

There is a possibility of oscillation, so please do not use the amplifier as a buffer.

12-6. Differential Input Signal Swing

Application of this IC as a differential Amplifier is also possible. One example is shown in Figure 13, with the waveforms of each terminal shown in Figure 14.

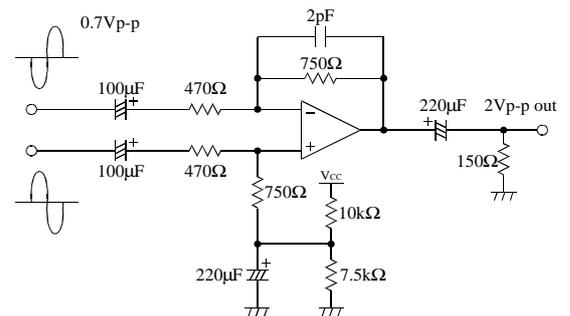The use of 5.0V single power supply is assumed.

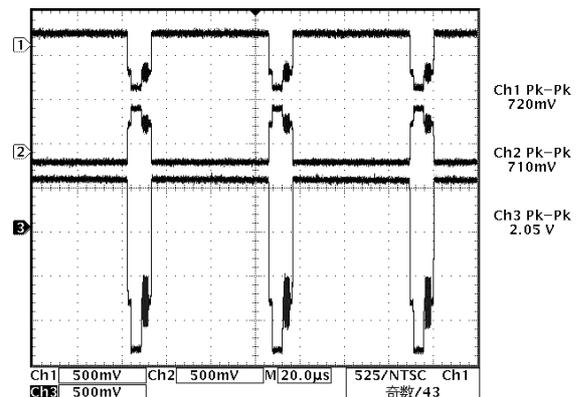Figure 13: Differential input signal application

Figure 14: Waveforms of each terminal

Waveforms are non-inverting input, inverting input and output from the top.

13. NOTES

■ Please be sure that you carefully discuss your planned purchase with our office if you intend to use the products in this application manual under conditions where particularly extreme standards of reliability are required, or if you intend to use products for applications other than those listed in this application manual.

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■ None of ozone depleting substances (ODS) under the Montreal Protocol is used in manufacturing process of us.

14. OFFICES

If you need more information on this product and other TOKO products, please contact us.

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