

## Dual Power Operational Amplifier

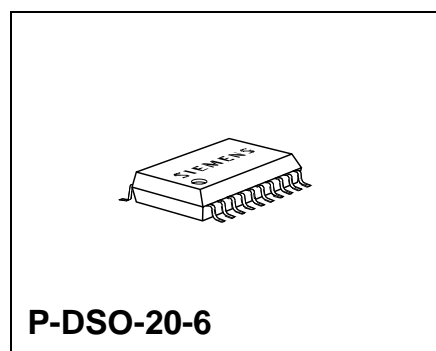
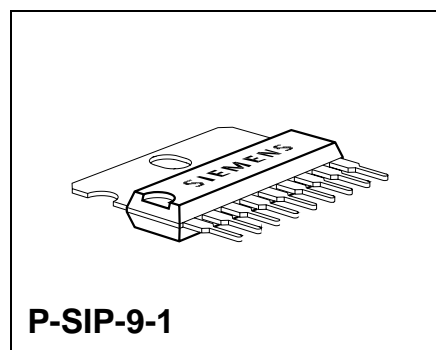
TCA 2465

### Overview

Bipolar IC

### Features

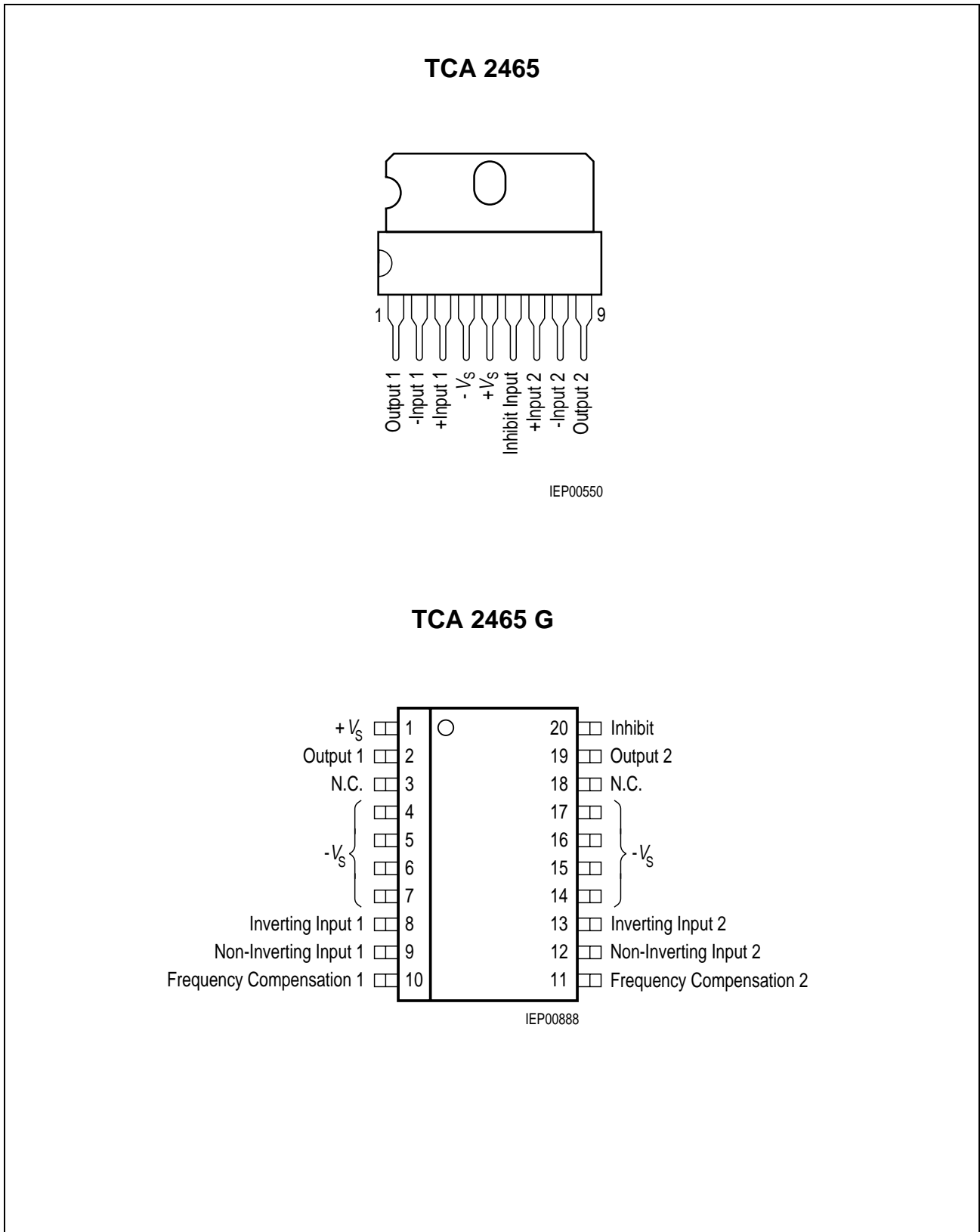
- High output peak current of twice 2.5 A
- Twice 2.0 A output peak current for TCA 2465 G
- Large supply voltage range up to 42 V
- High slew rate of 2 V/ $\mu$ s
- Outputs fully protected (DC short-circuit proof for P-SIP-9-1  $V_S$  up to 18 V; for P-DSO-20-6  $V_S$  up to 14 V)
- Thermal overload protection
- Inhibit input enables "tristate" outputs
- Integrated clamp diodes



Type	Ordering Code	Package
TCA 2465	Q67000-A8109	P-SIP-9-1
TCA 2465 G	Q67000-A8334	P-DSO-20-6

### Description

The IC contains two identical op amps, each supplying a high output current of 2.5 A at supply voltages between  $\pm 3$  V and  $\pm 20$  V. Internal compensation permits negative feedback of the amplifiers up to a min. of 20 dB. Both amplifiers can be disconnected at  $V_g \geq 2$  V via an inhibit input. Integrated protective circuits protect the outputs against short-circuit to  $+V_S$  and  $-V_S$  and prevent thermal overloading of the IC. TCA 2465 G comes in a special surface-mounted power package similar to P-DSO-20 and delivers twice 2.0 A output peak current.



**Figure 1 Pin Configuration (top view)**

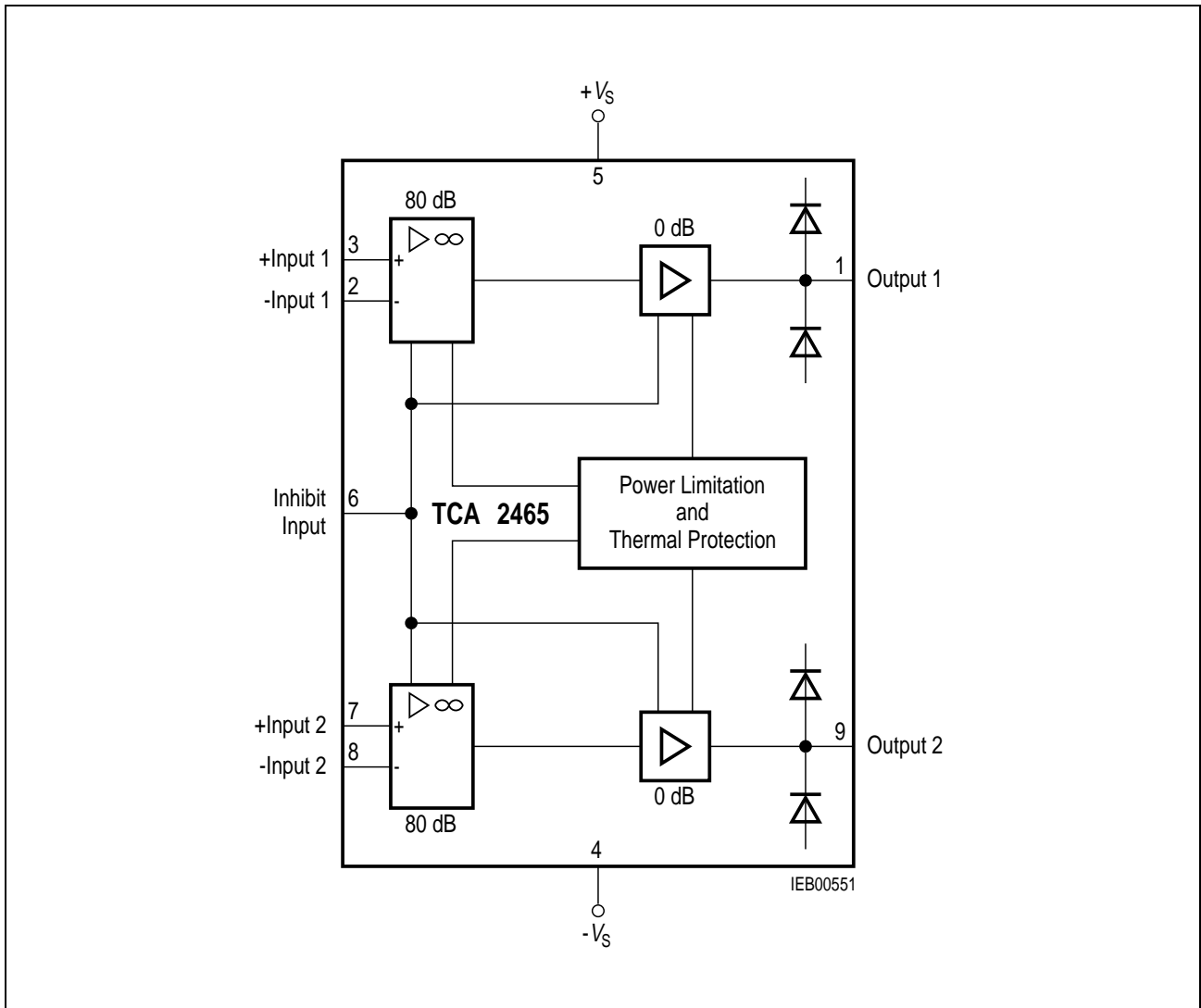


Figure 2 Block Diagram TCA 2465

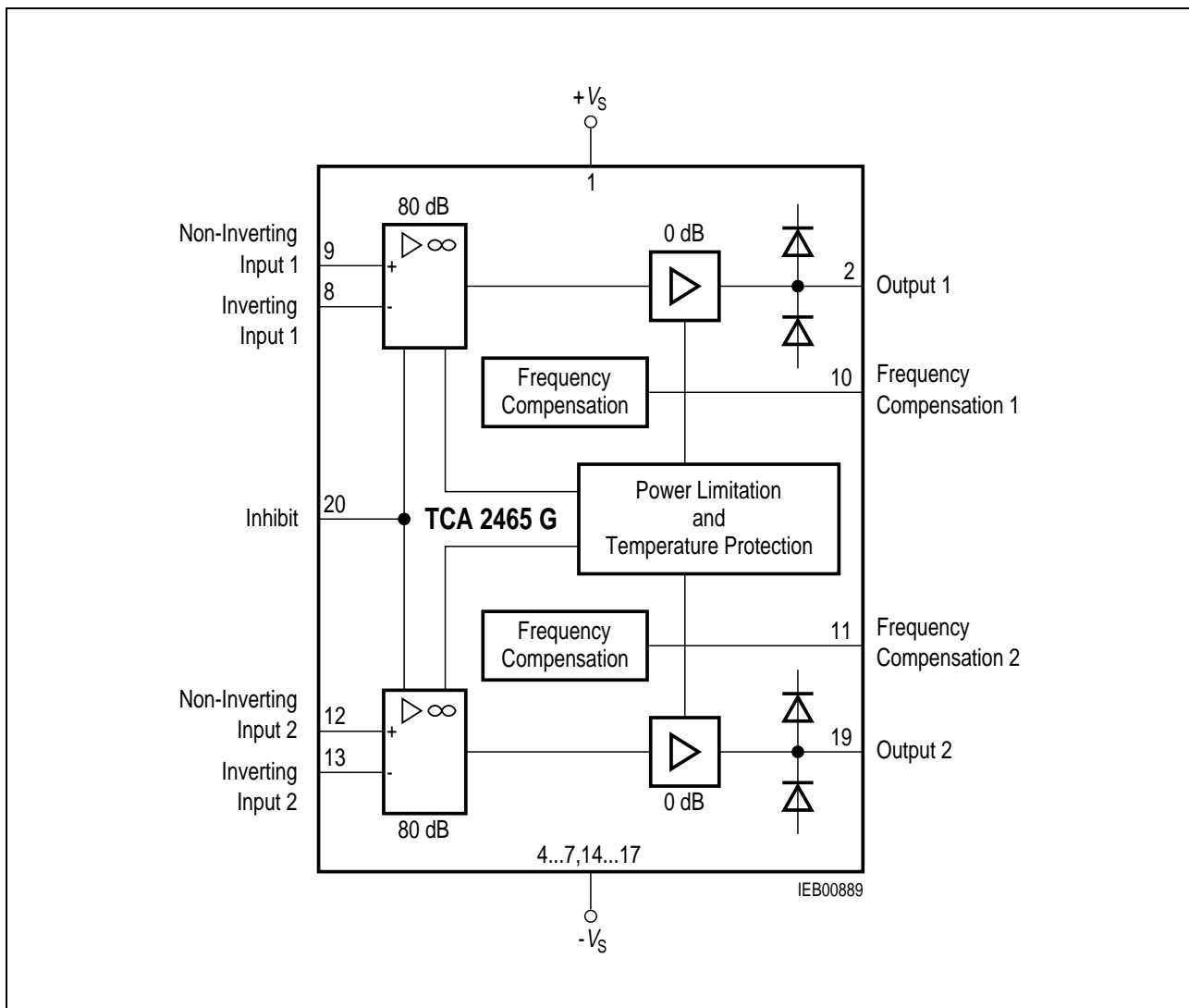


Figure 3 Block Diagram TCA 2465 G

## Absolute Maximum Ratings

$T_C = -40$  to  $85$  °C

Note: Values in brackets refer to TCA 2465 G

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	$V_S$	–	$\pm 21$	V	$\Delta V_{2-3}$ or $\Delta V_{8-7}$
Differential input voltage	$V_{ID}$	–	$(-V_S) + (V_S)$	V	
Output current	$I_Q$	$-2.5 (-2)^{1)}$	$2.5 (2)^{1)}$	A	$I_1$ or $I_9$ $V_S \geq \pm 15$ V; $V_Q < -V_S$
Output current	$I_Q$	– 1.5	–	A	
Supply current	$I_S$	$-5 (-2)^{1)}$	$5.5 (2)^{1)}$	A	$I_S$ $I_4$
Ground current	$I_{GND}$	$-5.5 (-2)^{1)}$	$5 (2)^{1)}$	A	
Input voltage	$V_1$	$-V_S$	$V_S$	V	$V_2, V_3, V_7, V_8$
Inhibit input	$V_6$	$-V_S$	$V_S$	V	
Junction temperature	$T_j$	–	150	°C	–
Storage temperature range	$T_{stg}$	– 50	150	°C	

<sup>1)</sup>  $t < 1$  ms,  $f \leq 400$  Hz

## Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	$V_S$	$\pm 3$	$\pm 20$	V	–
Output current	$I_Q$	(– 1.3)	(1.3)	A	–
Case temperature	$T_C$	– 40	85	°C	1)
Voltage gain	$G_{Vmin}$	20	–	dB	–
Forward current $I_F$ of free wheeling diodes	$I_F$	–	(1.3)	A	–
Thermal resistance junction - ambient	$R_{th jA}$	–	60	K/W	P-SIP-9-1
Thermal resistance junction - case	$R_{th jC}$	–	5	K/W	P-SIP-9-1
Thermal resistance junction - ambient	$R_{th jA}$	–	60	K/W	P-DIP-16-2
Thermal resistance junction - case	$R_{th jC}$	–	12	K/W	P-DIP-16-2
Thermal resistance junction - ambient	$R_{th jA}$	–	(70)	K/W	(soldered) P-DSO-20-6
Thermal resistance junction - case	$R_{th jC}$	–	(22)	K/W	P-DSO-20-6

1)  $P_D = 12$  W P-SIP-9-1  
 $P_D = 3.5$  W P-DSO-20-6

## Characteristics

$V_S = \pm 10\text{ V}$ ;  $T_j = 25\text{ }^\circ\text{C}$ , unless otherwise specified

Note: Values in brackets refer to TCA 2465; G

Parameter	Symbol	Limit Values			Unit	Test Circuit
		min.	typ.	max.		
Open-loop supply current consumption S1 in position 1	$I_S$	–	–	5	mA	1; 12
S1 in position 2	$I_S$	–	30	50	mA	1; 12
Input offset voltage	$V_{IO}$	– 10	–	10	mV	2; 13
Input offset current	$I_{IO}$	– 100	–	100	nA	3; 14
Input current	$I_I$	–	0.25	1	$\mu\text{A}$	3; 14
Output voltage						
$R_L = 12\ \Omega$ ; $f = 1\text{ kHz}$	$V_{Q\text{ pp}}$	$\pm 8.5$	$\pm 9$	–	V	4; 15
$R_L = 4\ \Omega$ ; $f = 1\text{ kHz}^{(1)}$	$V_{Q\text{ pp}}$	$\pm 8$	$\pm 8.5$	–	V	4; 15
$R_L = 470\ \Omega$ ; $f = 40\text{ kHz}$	$V_{Q\text{ pp}}$	–	$\pm 8$	–	V	4; 15
Input resistance	$R_I$	1	5	–	$\text{M}\Omega$	4; 15
$f = 1\text{ kHz}$						
Open-loop voltage gain	$G_{VO}$	70	80	–	dB	5; 16
$f = 100\text{ kHz}$						
Common-mode input voltage range	$V_{IC}$	7/– 10	$\pm 7.5$ /– 10.5	–	V	6; 17
Common-mode rejection	$k_{\text{CMR}}$	70	80	–	dB	6; 17
Supply voltage rejection	$k_{\text{SVR}}$	– 70	– 80	–	dB	7; 18
Temperature coefficient of $V_{IO}$	$\alpha_{VIO}$	–	50	–	$\mu\text{V/K}$	2; 13
$-40\text{ }^\circ\text{C} \leq T_j \leq +85\text{ }^\circ\text{C}$						
Temperature coefficient of $I_{IO}$	$\alpha_{IIO}$	–	0.4	–	nA/K	3; 14
$-40\text{ }^\circ\text{C} \leq T_j \leq +85\text{ }^\circ\text{C}$						
Slew rate of $V_Q$ for non-inverting operation	$SR$	–	2 (0.5)	–	$\text{V}/\mu\text{s}$	8; 19
Slew rate of $V_Q$ for inverting operation	$SR$	–	2 (0.5)	–	$\text{V}/\mu\text{s}$	9; 20
Noise voltage (DIN 45405, referred to input)	$V_n$	–	3	–	$\mu\text{V}$	1; 12
Inhibit input (referred to $-V_S$ )						
$V_6$ for IC turned OFF	$V_{6\text{ OFF}}$	2	–	–	V	1; 12
$V_6$ for IC turned ON	$V_{6\text{ ON}}$	–	–	0.8	V	1; 12

## Characteristics (cont'd)

$V_S = \pm 10 \text{ V}$ ;  $T_j = 25 \text{ }^\circ\text{C}$ , unless otherwise specified

*Note: Values in brackets refer to TCA 2465; G*

Parameter	Symbol	Limit Values			Unit	Test Circuit
		min.	typ.	max.		
H-input current, $V_6 = 5 \text{ V}^{2)}$	$I_{6H}$	–	0.1	0.5	$\mu\text{A}$	1; 12
L-input current, $V_6 = 0 \text{ V}^{2)}$	$I_6$	–	0.5	3	$\mu\text{A}$	1; 12
Turn-ON dead time $ I_{1;9}  > 1 \text{ A}^{3)}$	$t_{D \text{ ON}}$ $t_{D \text{ OFF}}$	–	10	20	$\mu\text{s}$	1; 12
Turn-OFF dead time $ I_{1;9}  < 1 \text{ A}^{3)}$						
} referred to $V_{6 \text{ OFF/ON}}$						
Short-circuit current <sup>4)</sup> (switch S3 closed)	$I_{SC}$	–	1	–	A	1; 12
Short-circuit current <sup>4)</sup> (switch S4 closed)	$I_{SC}$	–	1	–	A	1; 12

1) Only for P-SIP-9-1

2) Referred to  $-V_S$

3) Switch S2 closed

4) Only for P-SIP-9-1, for P-DSO-20-6  $V_S \leq \pm 7 \text{ V}$



Test Circuits

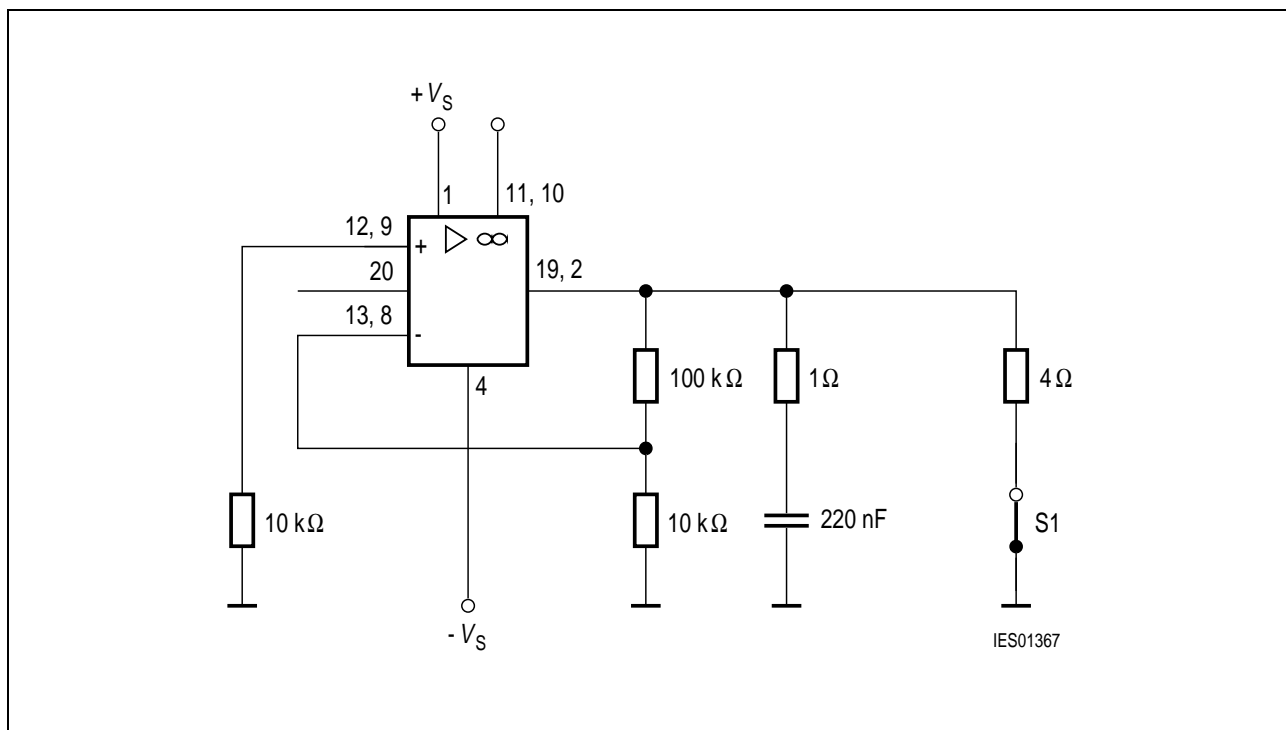


Figure 4 Open-Loop Supply Current Consumption; Noise Voltage (TCA 2465 G)

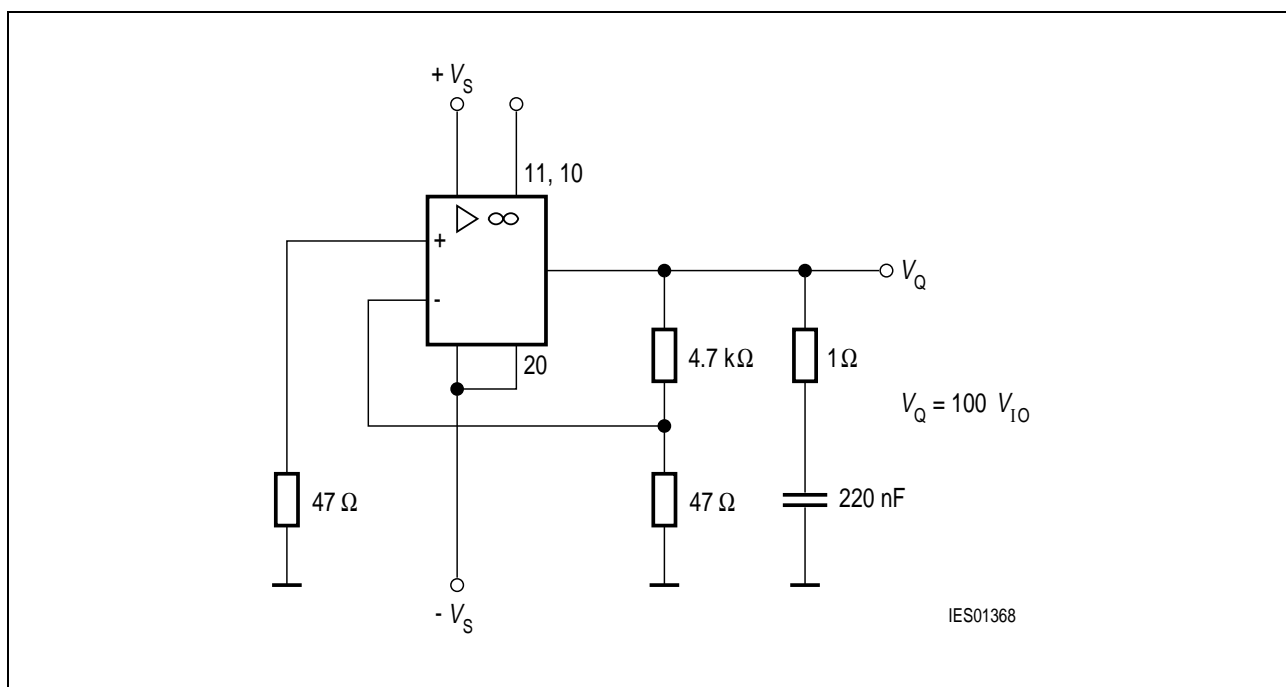


Figure 5 Input Offset Voltage; Temperature Coefficient of V<sub>I0</sub> (TCA 2465 G)

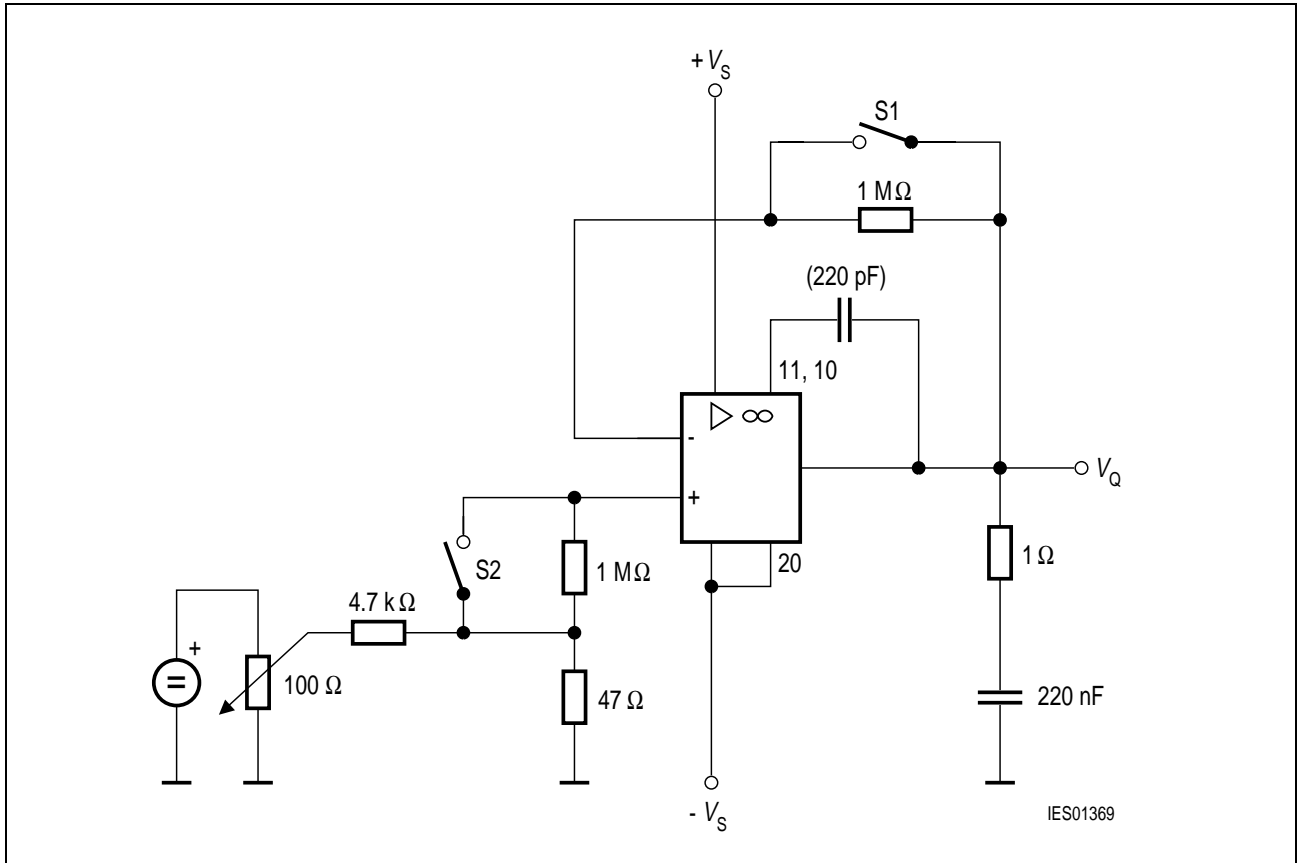


Figure 6 Input Offset Current; Input Current; Temperature Coefficient of  $I_{10}$  (TCA 2465 G)

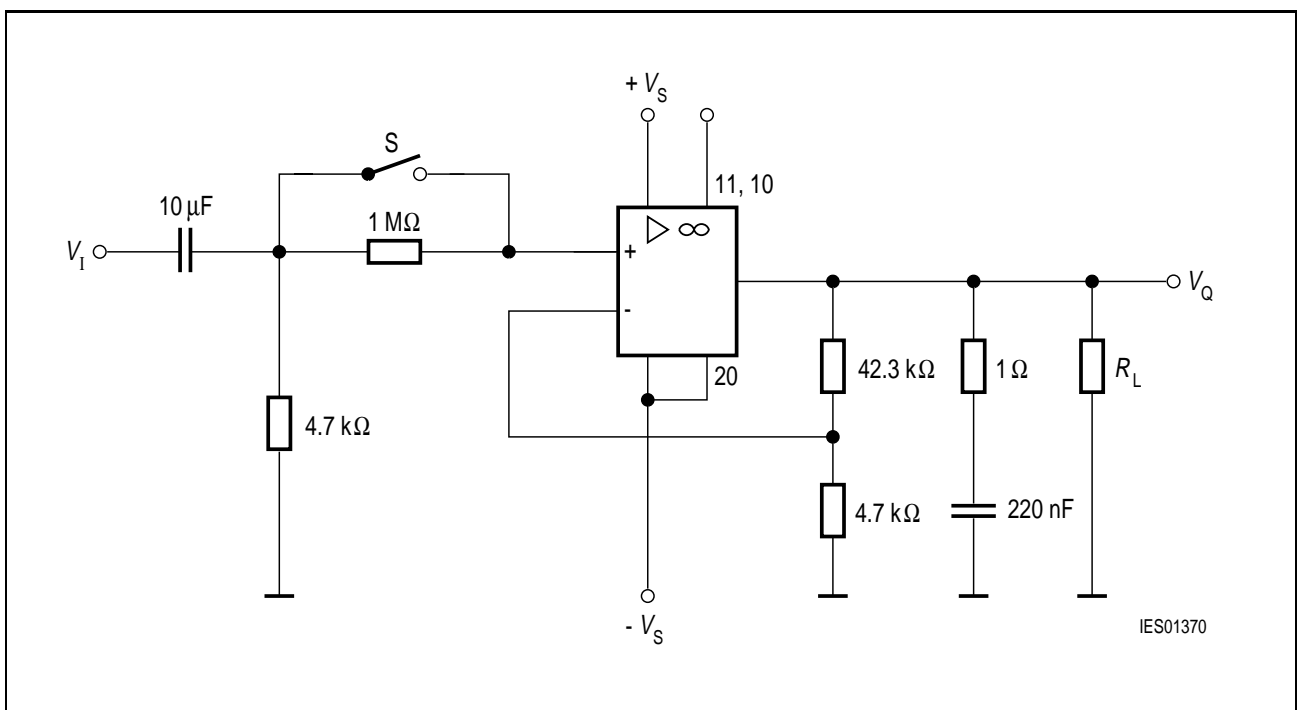


Figure 7 Output Voltage; Input Resistance (TCA 2465 G)

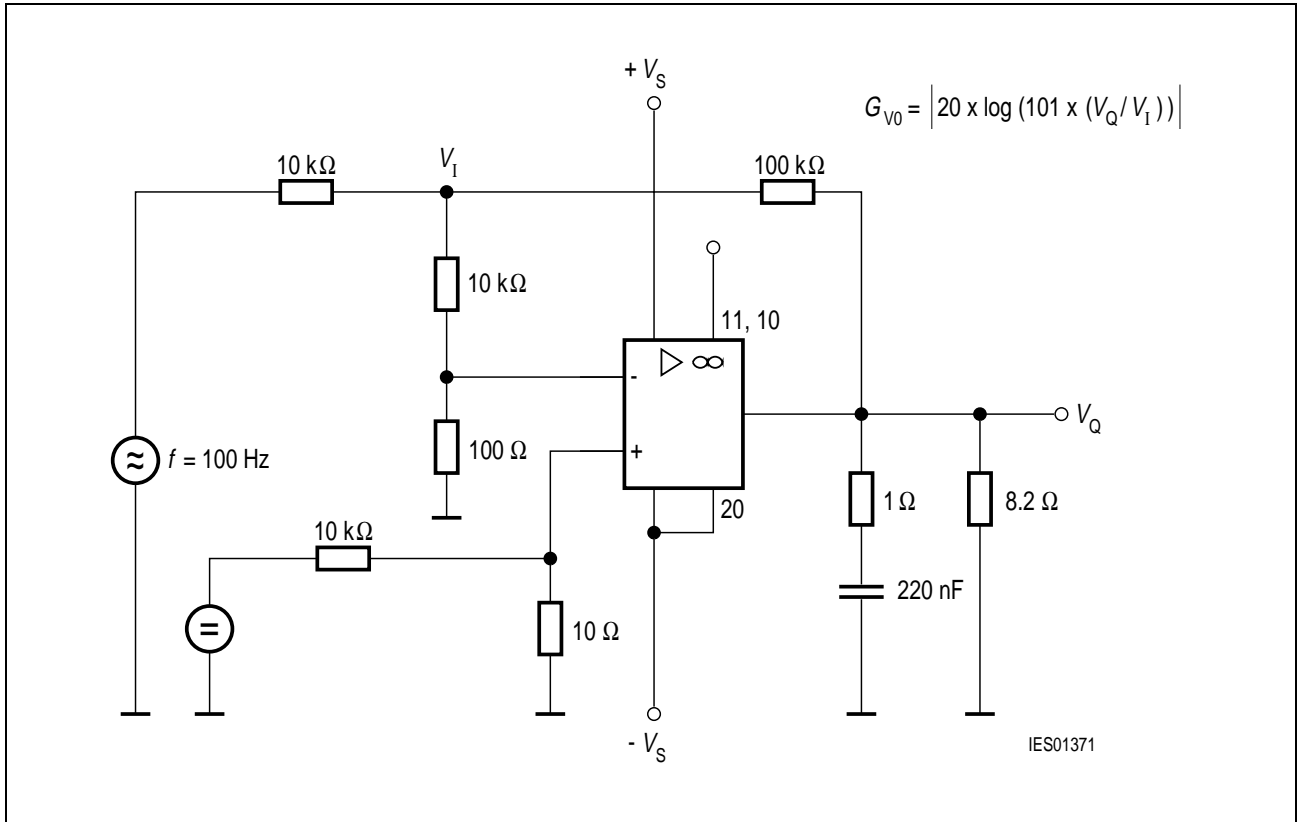


Figure 8 Open-Loop Voltage Gain  $G_{VO}$  (TCA 2465 G)

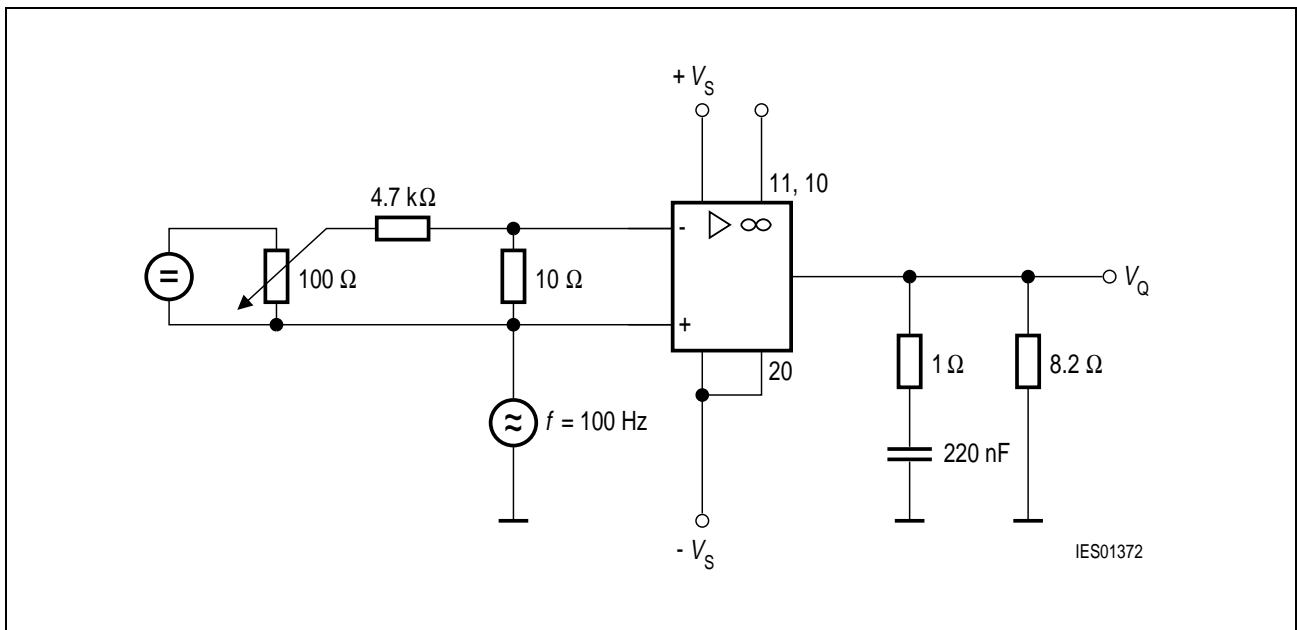


Figure 9 Common Mode Voltage Gain  $G_{VC}$   
 Common-Mode Rejection  
 $k_{CMR} \text{ (dB)} = G_{VO} \text{ (dB)} - G_{VC} \text{ (dB)}$  (TCA 2465 G)

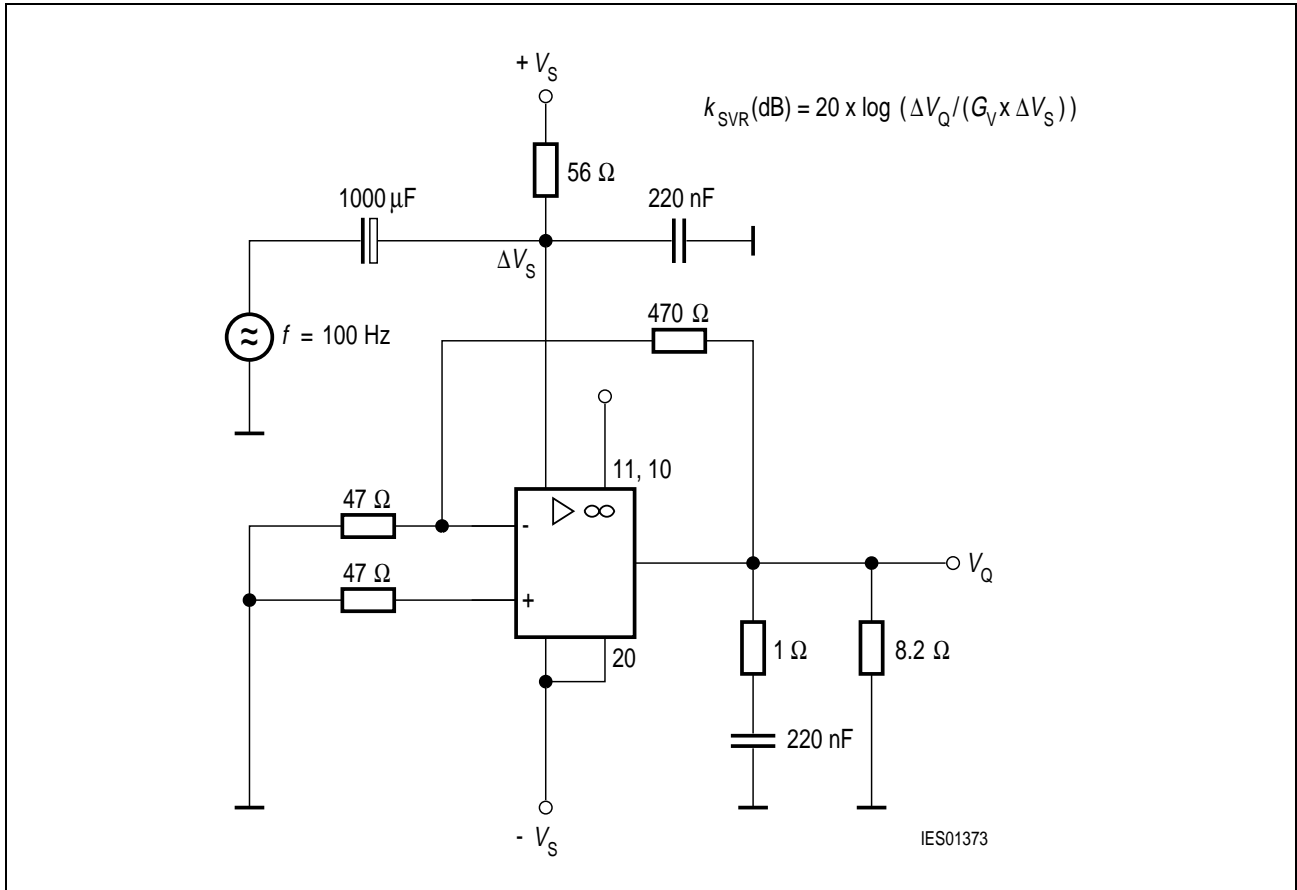


Figure 10 Supply Voltage Rejection  $k_{SVR}$  (TCA 2465 G)

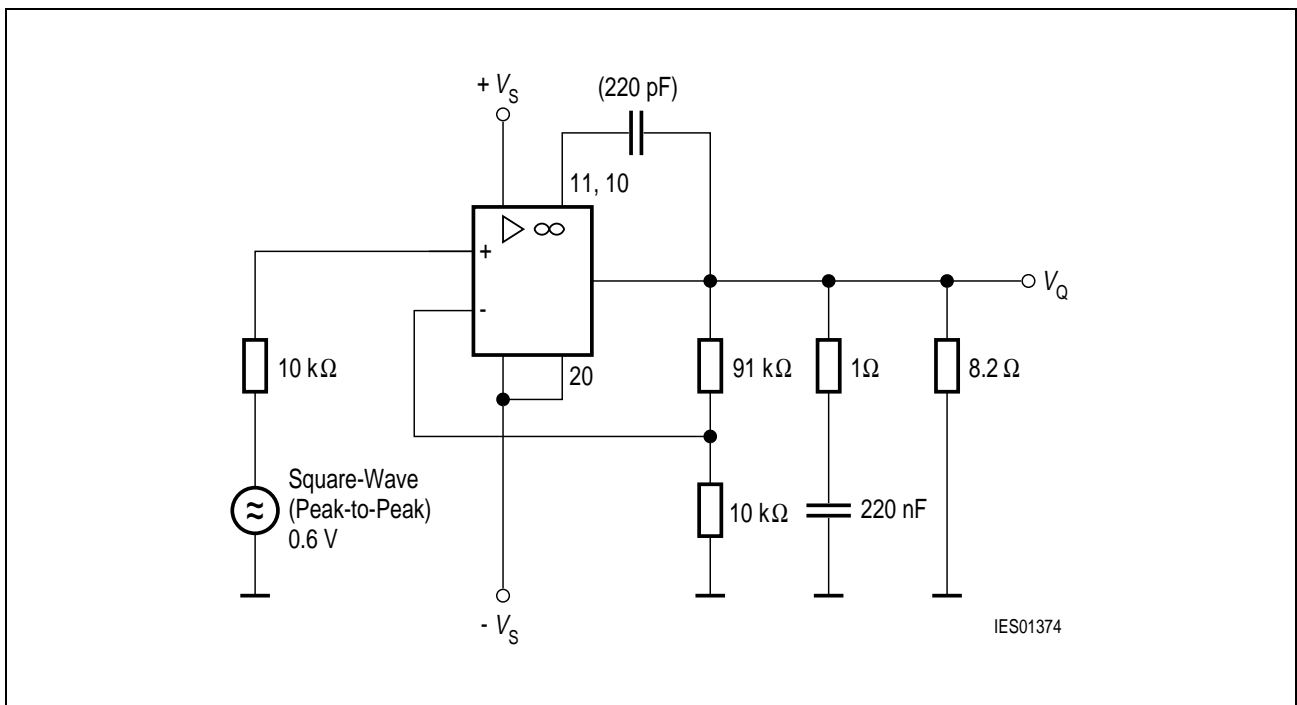


Figure 11 Slew Rate for Non-Inverting Operation (TCA 2465 G)

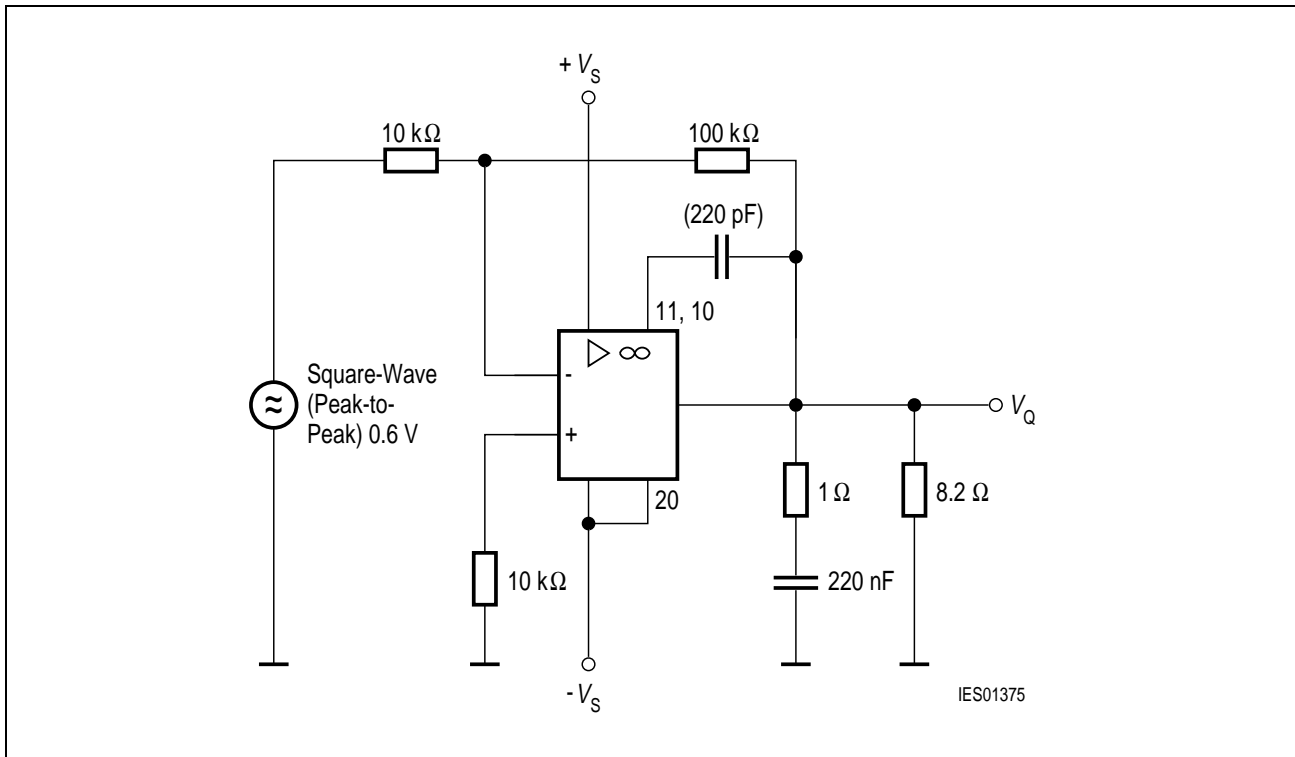
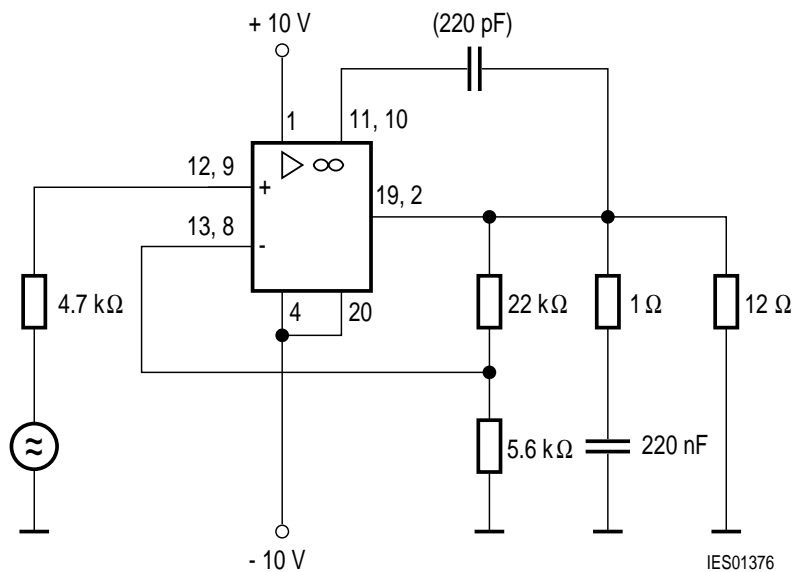


Figure 12 Slew Rate for Inverting Operation (TCA 2465 G)

a) Amplifier;  $G_V = 5$



b) Voltage follower TCA 2465 G

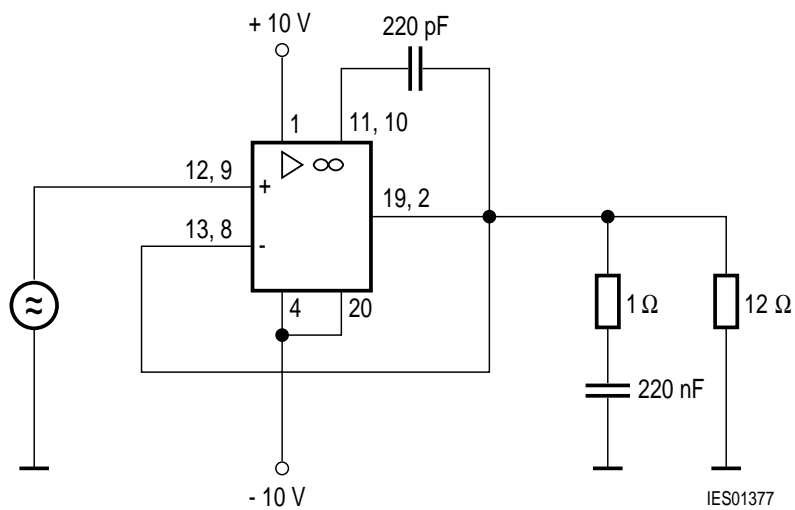
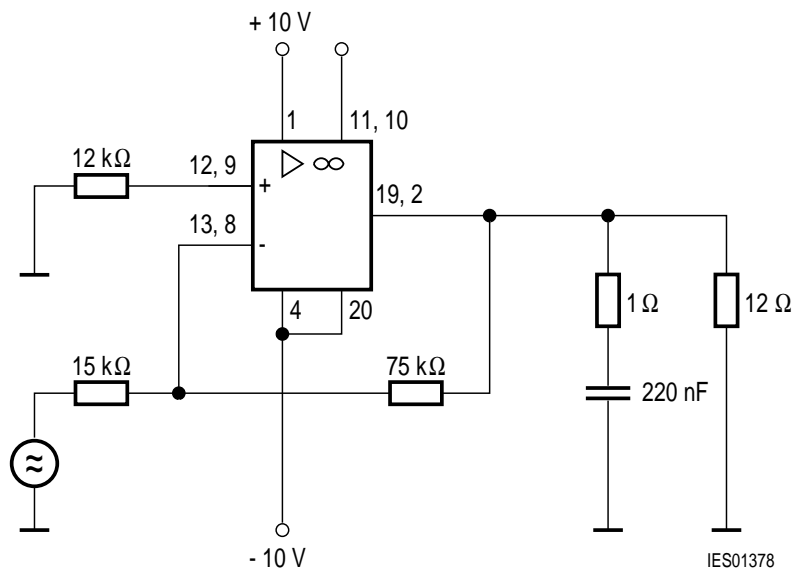


Figure 13 Non-Inverting Operation (TCA 2465 G)

a) Amplifier;  $G_V = -5$



b) Inverter TCA 2465 G

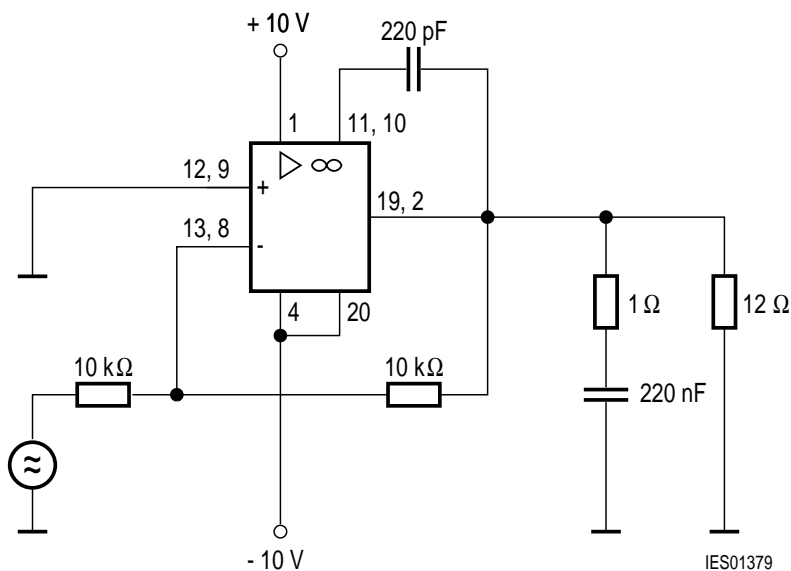


Figure 14 Inverting Operation (TCA 2465 G)

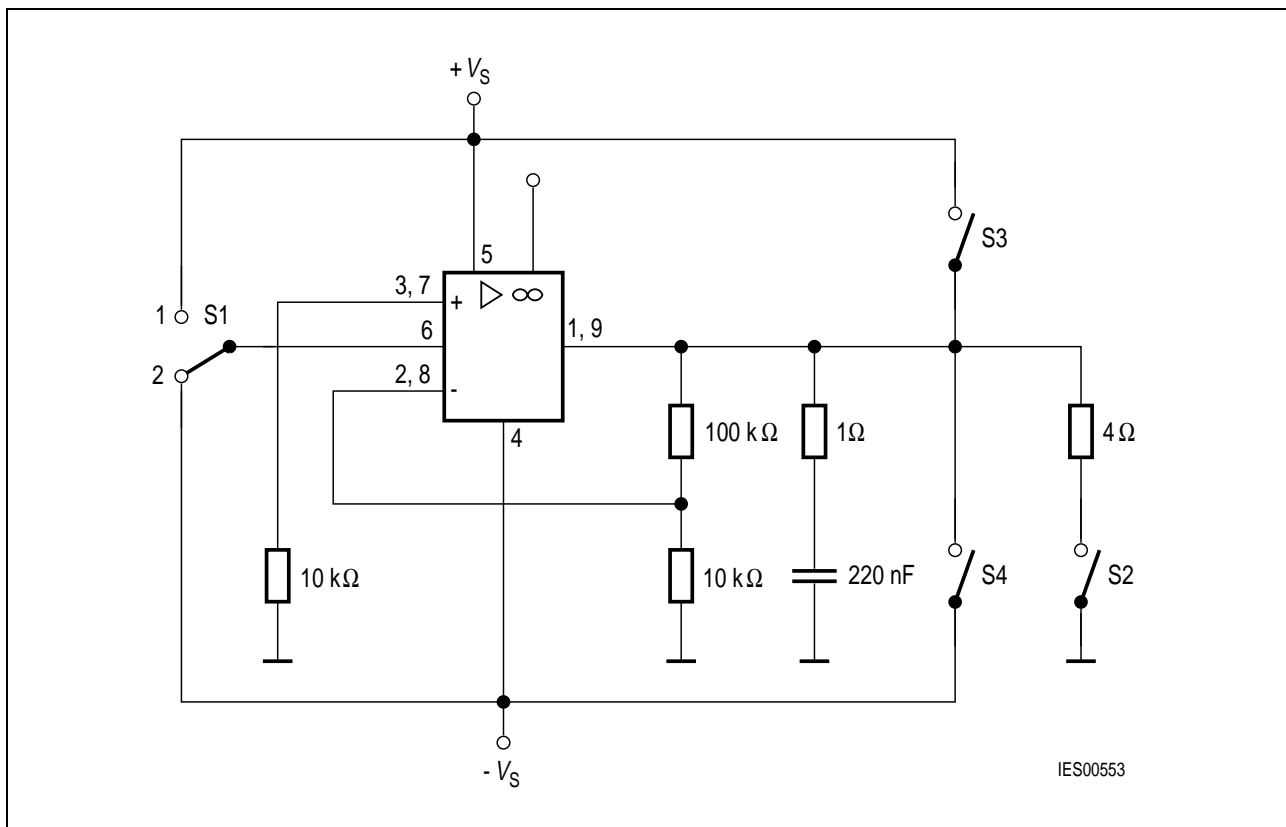


Figure 15 Open-Loop Supply Current Consumption; Noise Voltage (TCA 2465/A)

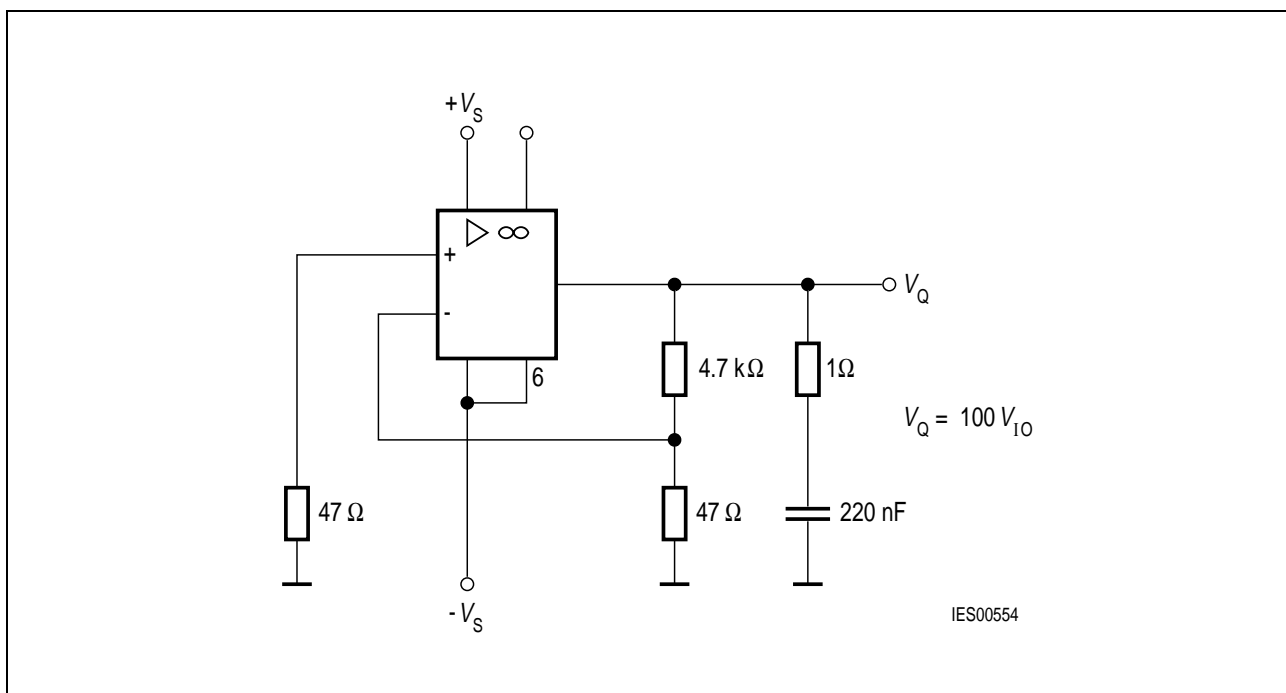


Figure 16 Input Offset Voltage; Temperature Coefficient of  $V_{I0}$  (TCA 2465/A)



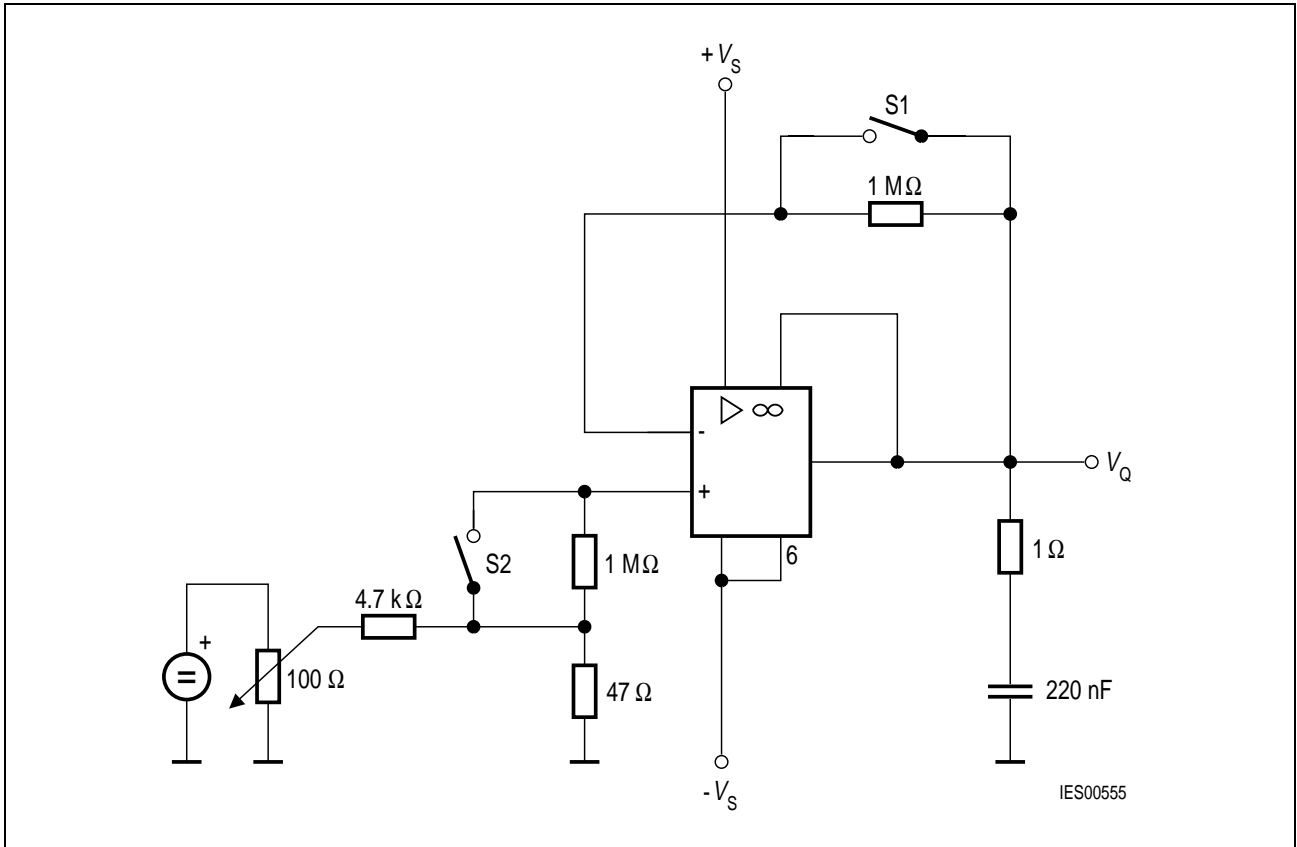


Figure 17 Input Offset Current; Input Current; Temperature Coefficient of  $I_{IO}$  (TCA 2465)

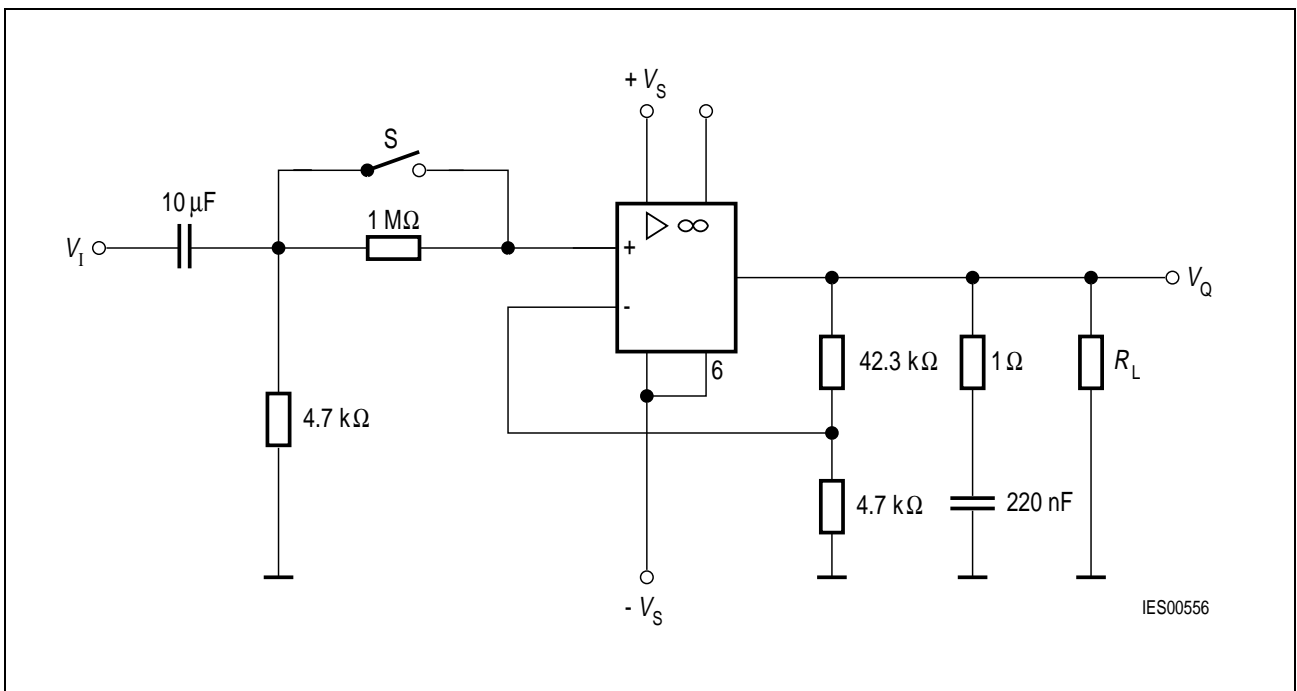


Figure 18 Output Voltage; Input Resistance (TCA 2465)

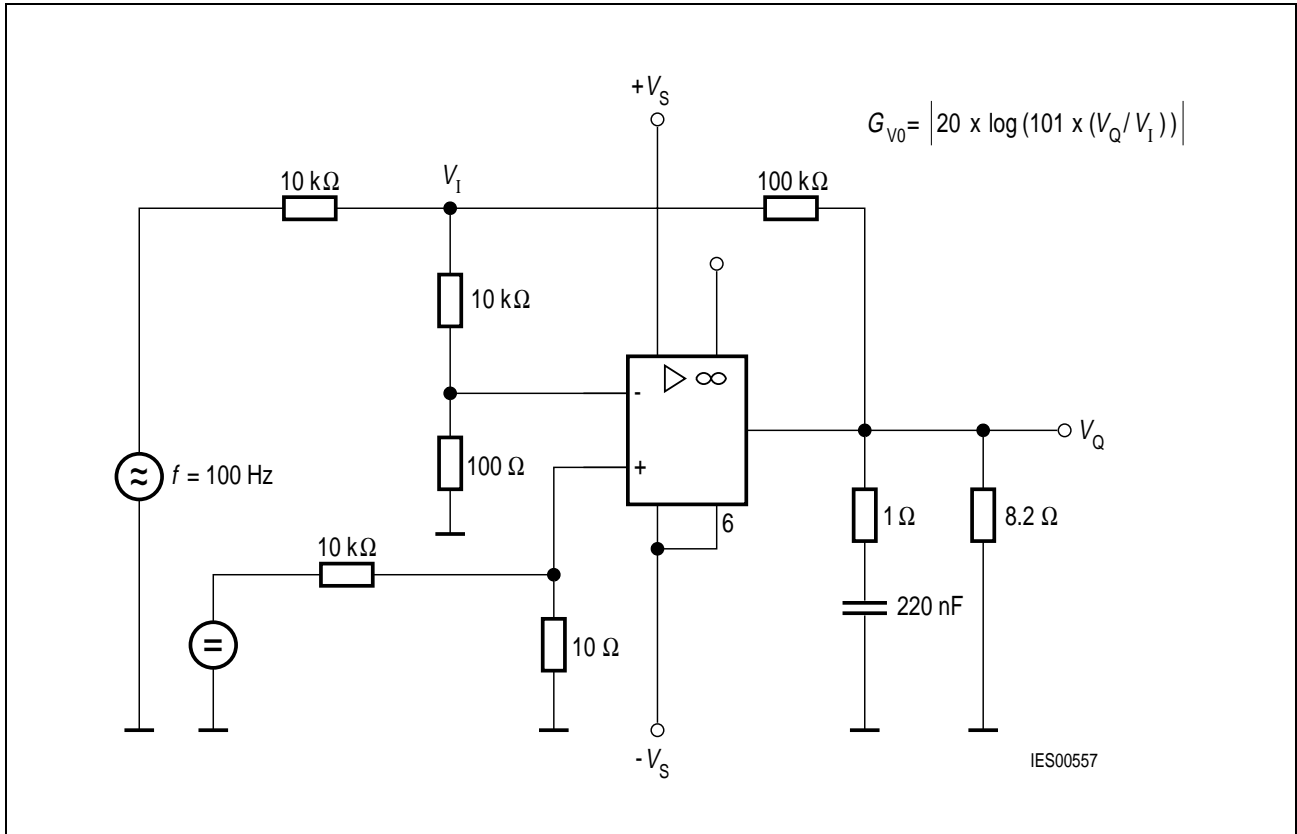


Figure 19 Open-Loop Voltage Gain  $G_{V_0}$  (TCA 2465)

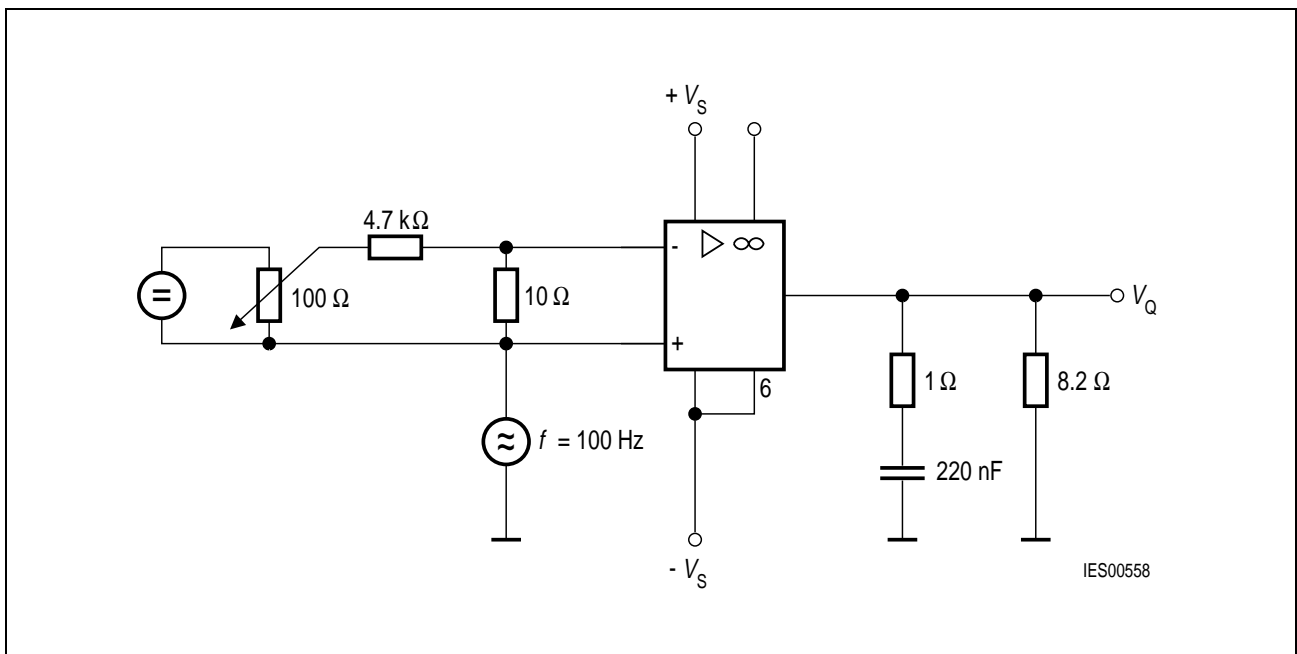


Figure 20 Common Mode Voltage Gain  $G_{V_C}$   
 Common-Mode Rejection  $k_{CMR} \text{ (dB)} = G_{V_0} \text{ (dB)} - G_{V_C} \text{ (dB)}$  (TCA 2465/A)

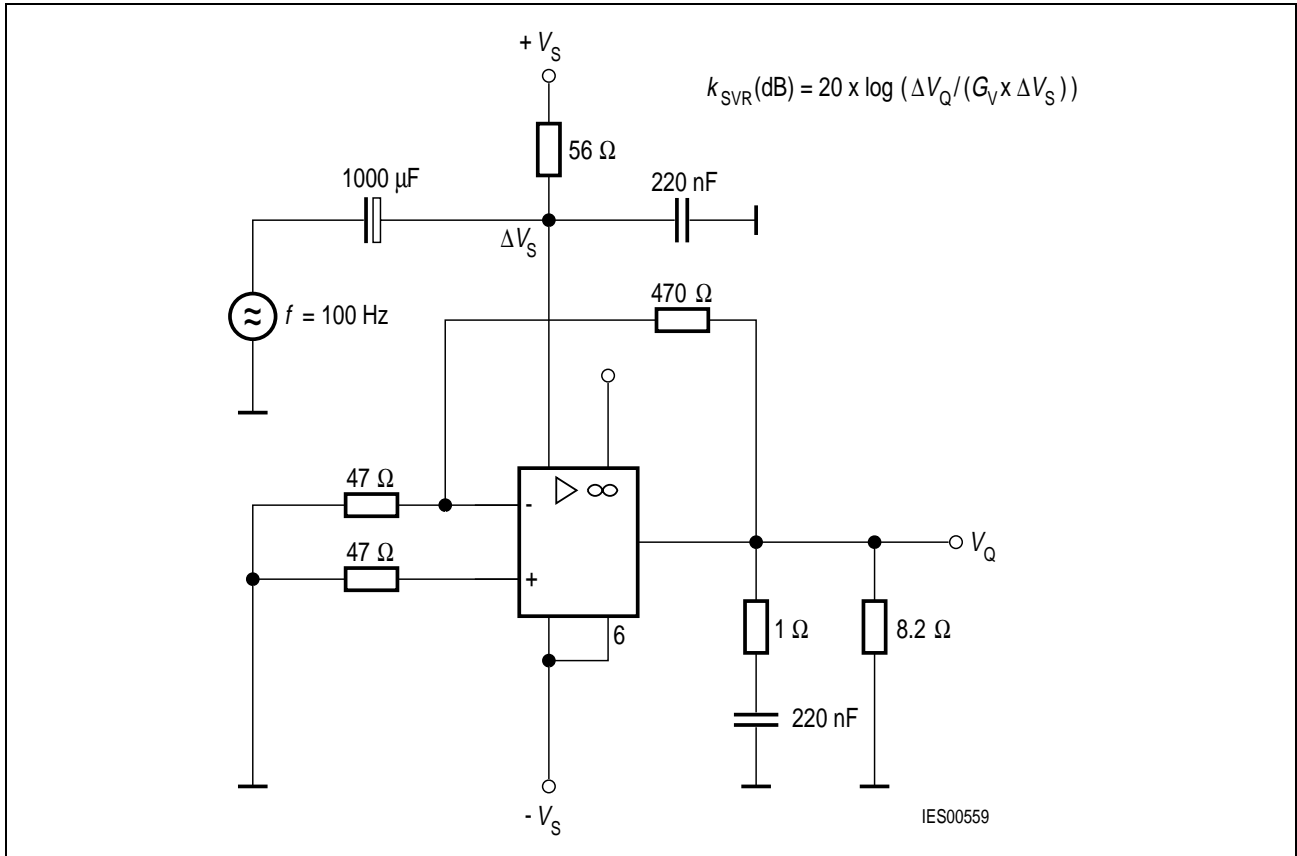


Figure 21 Supply Voltage Rejection  $k_{SVR}$  (TCA 2465)

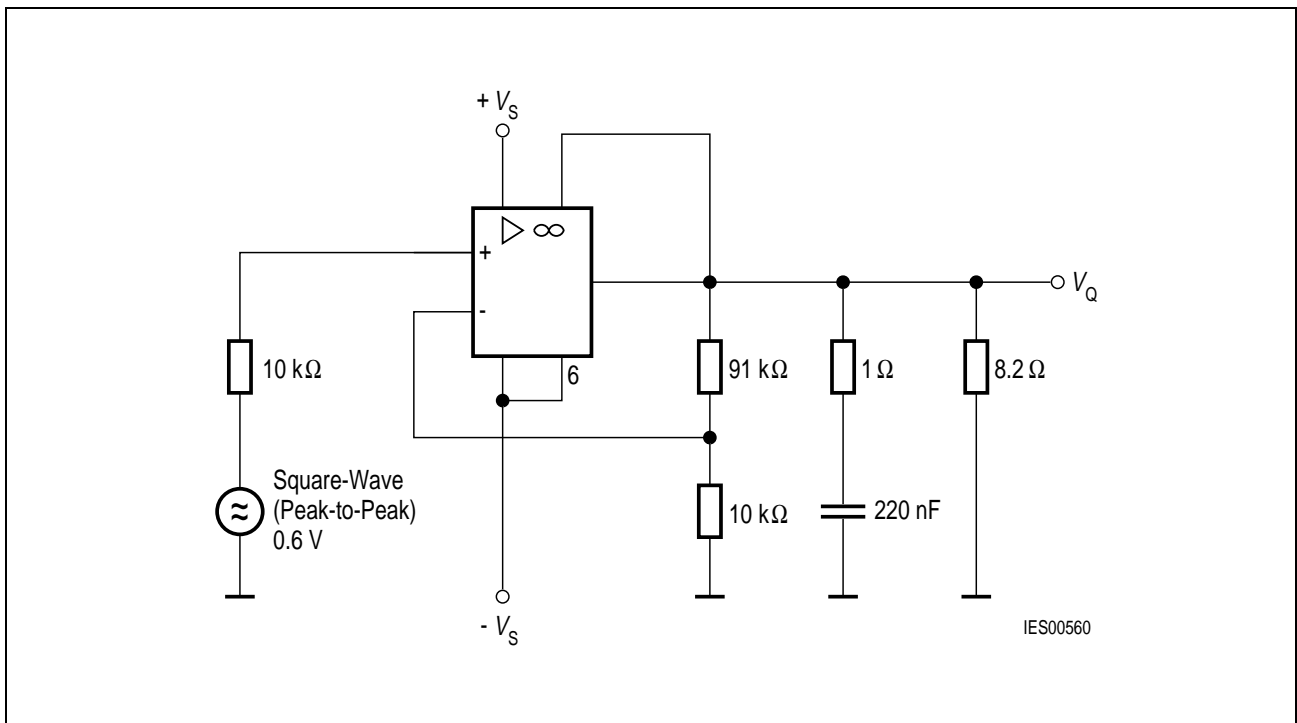


Figure 22 Slew Rate for Non-Inverting Operation (TCA 2465)

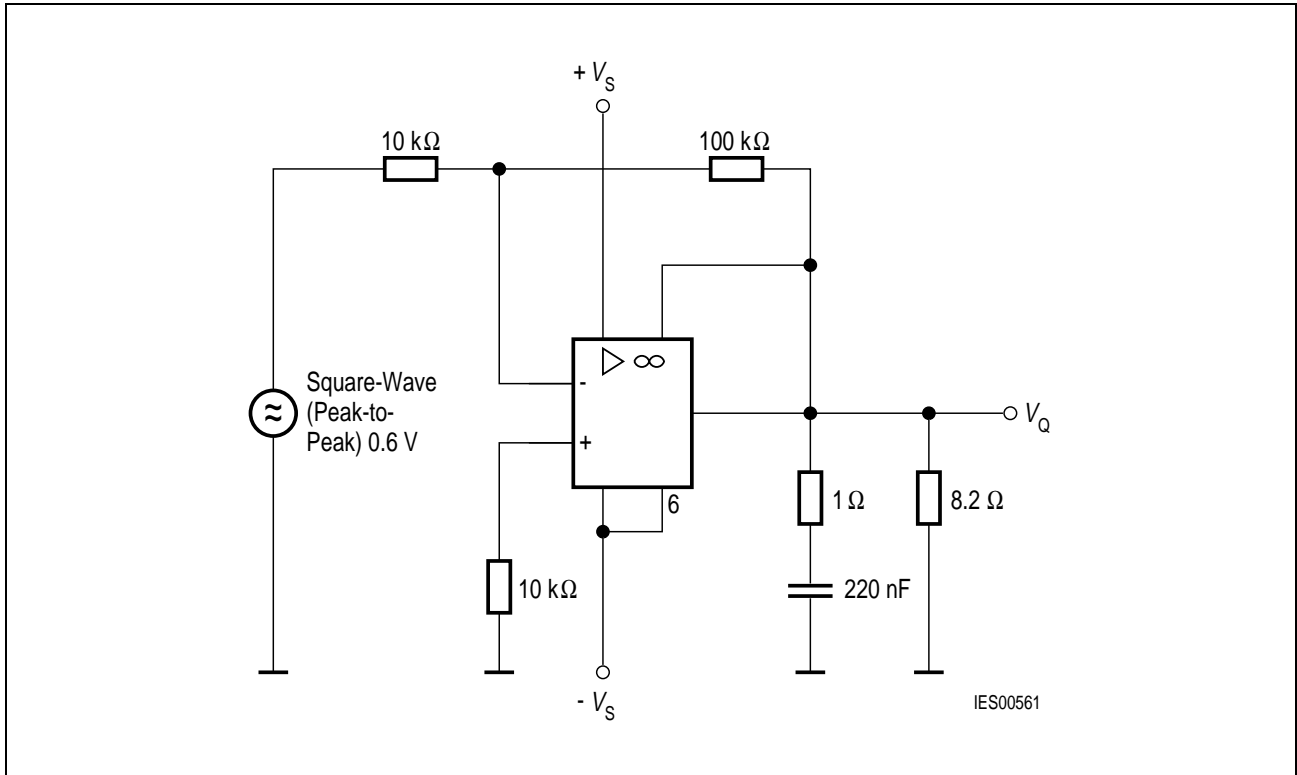


Figure 23 Slew Rate for Inverting Operation (TCA 2465)

Note: Values in brackets refer to TCA 2465 A

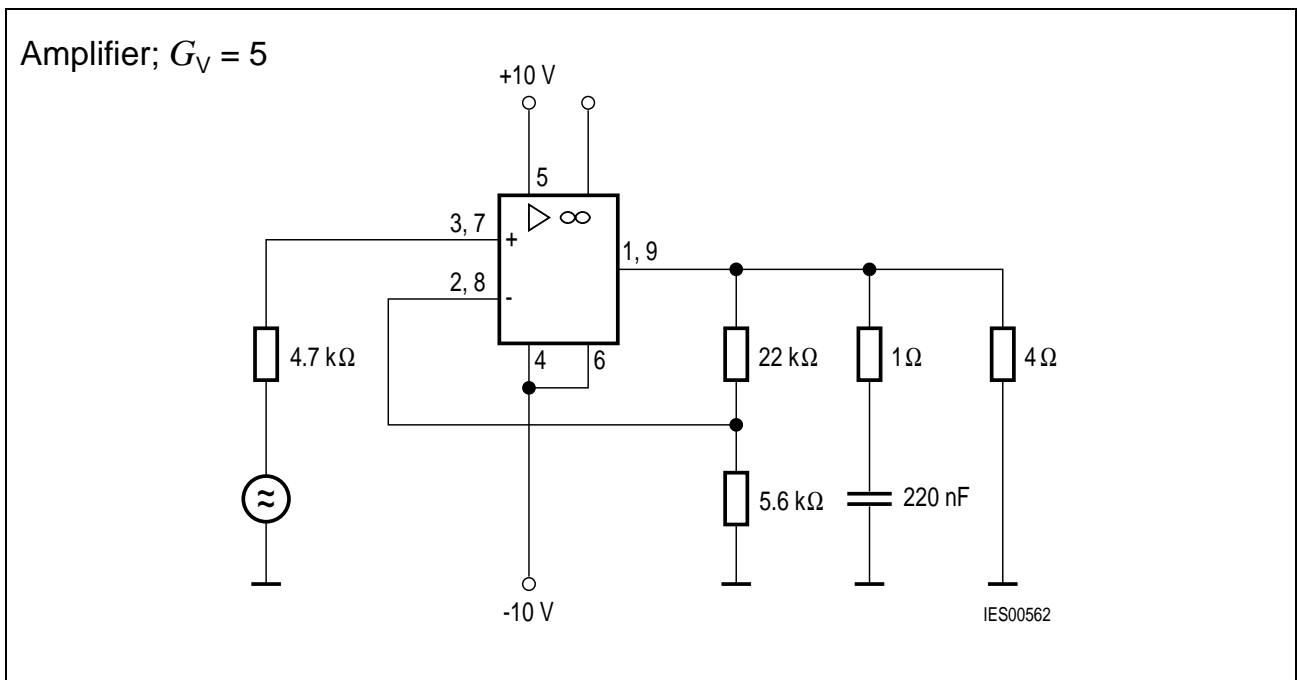


Figure 24 Non-Inverting Operation (TCA 2465)

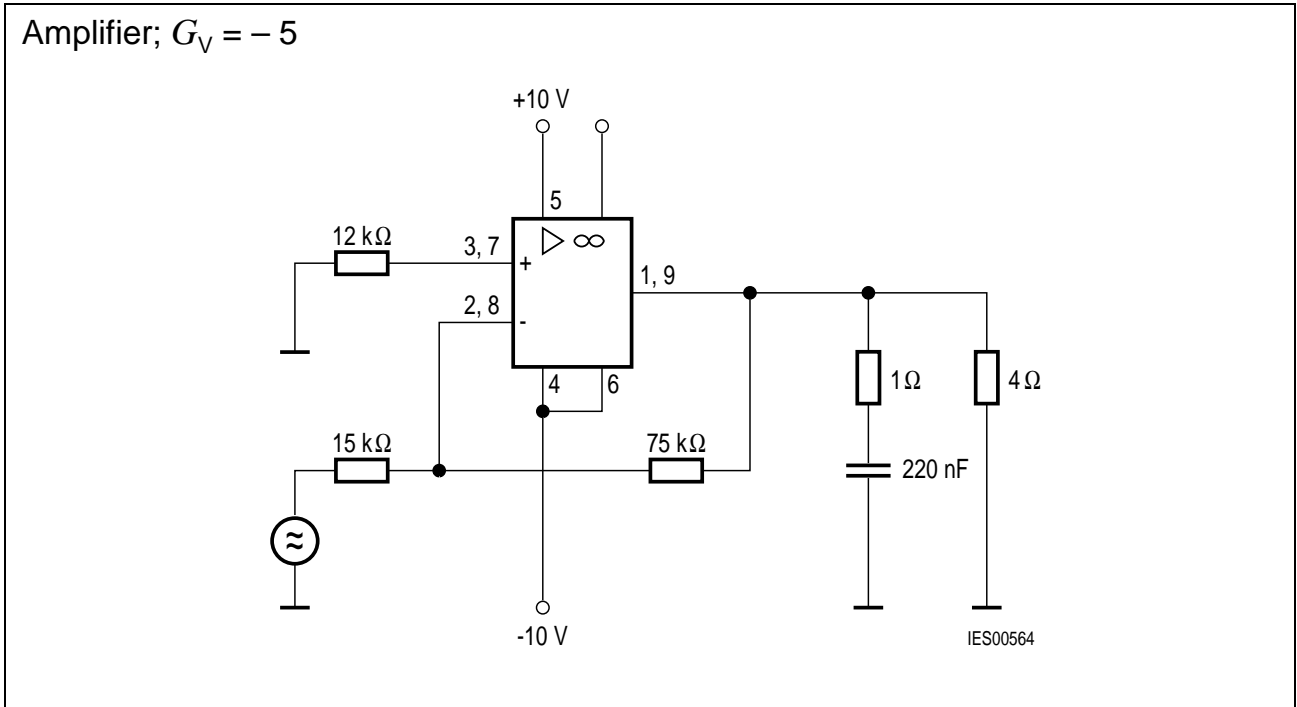
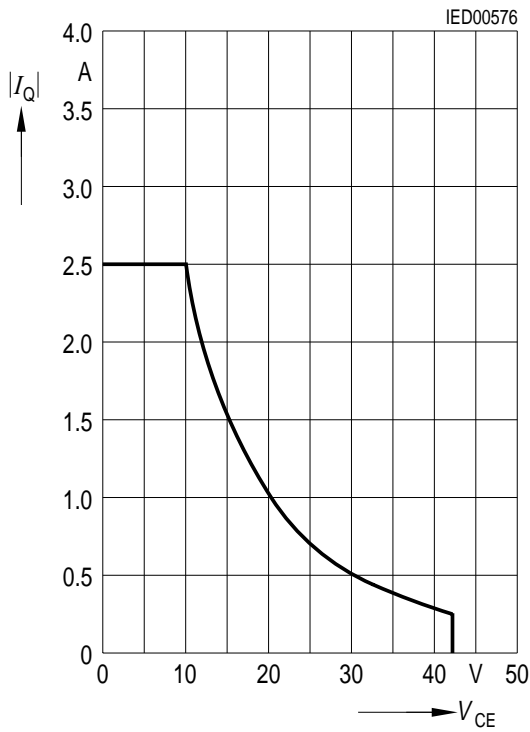


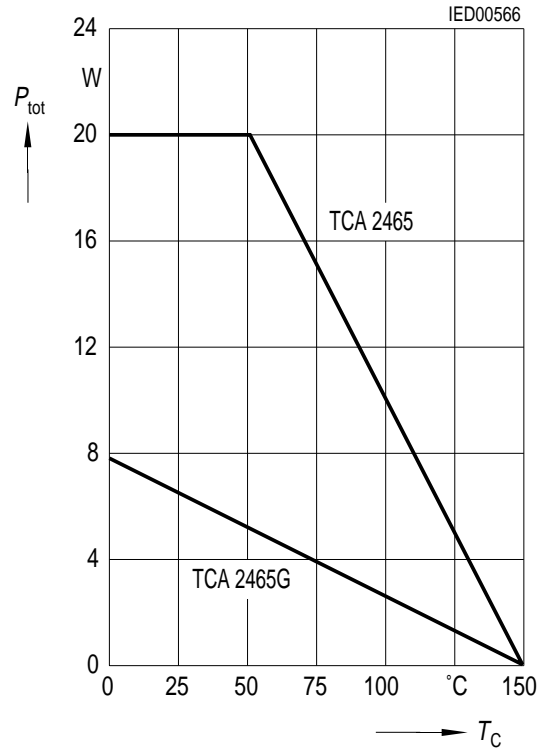
Figure 25 Inverting Operation (TCA 2465)

**Safe Operating Area (SOA) Peak Output Current versus Collector-Emitter Voltage**

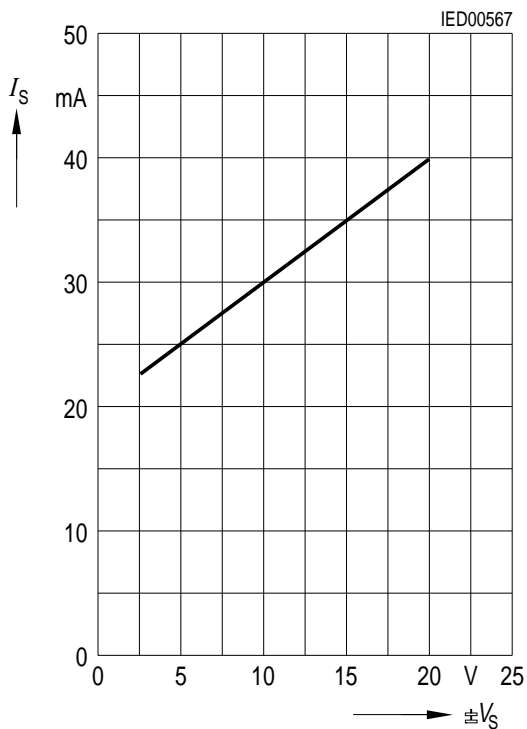
$T_j = 25\text{ }^\circ\text{C}$ ,  $V_{CE} = +V_S - V_Q$  or  $V_{CE} = -V_S - V_Q$



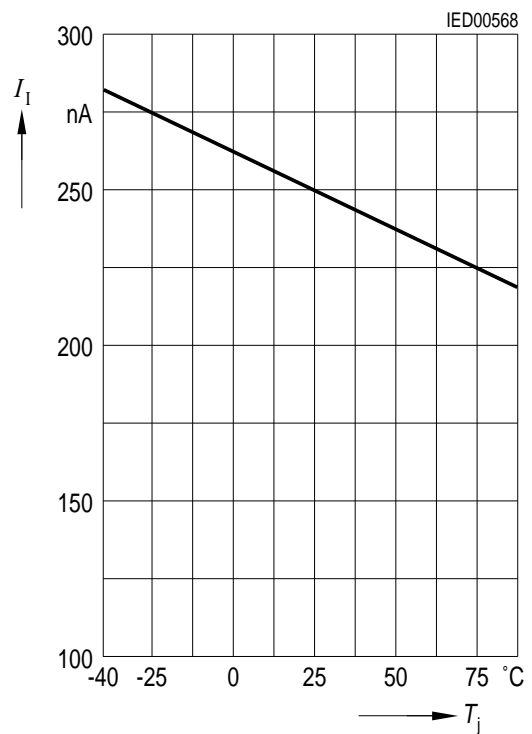
**Max. Permissible Power Dissipation versus Case Temperature**



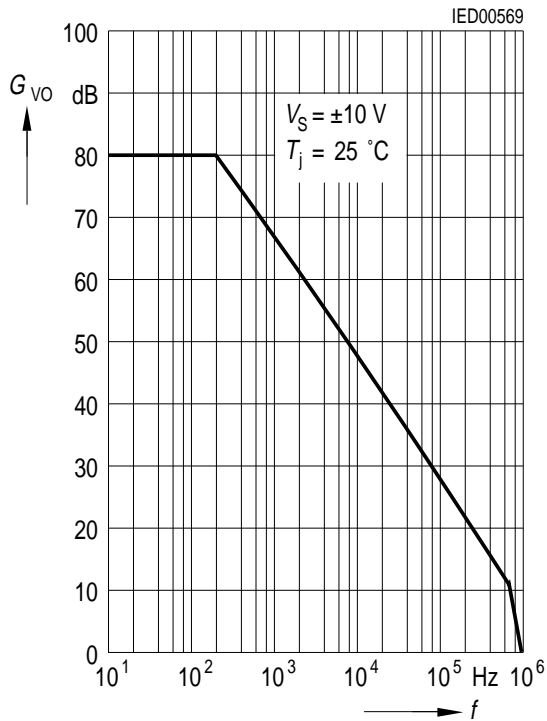
**Supply Current versus Supply Voltage  $T_j = 25\text{ }^\circ\text{C}$**



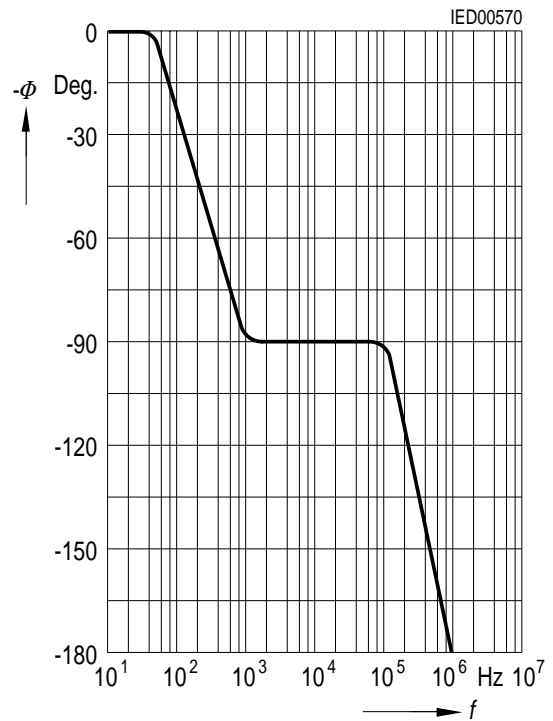
**Input Current versus Junction Temperature  $V_S = \pm 10\text{ V}$**



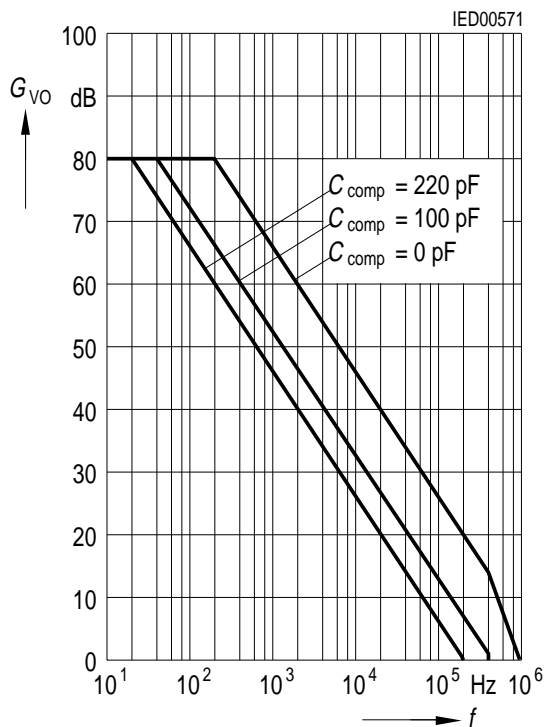
**Open-Loop Voltage Gain versus Frequency**



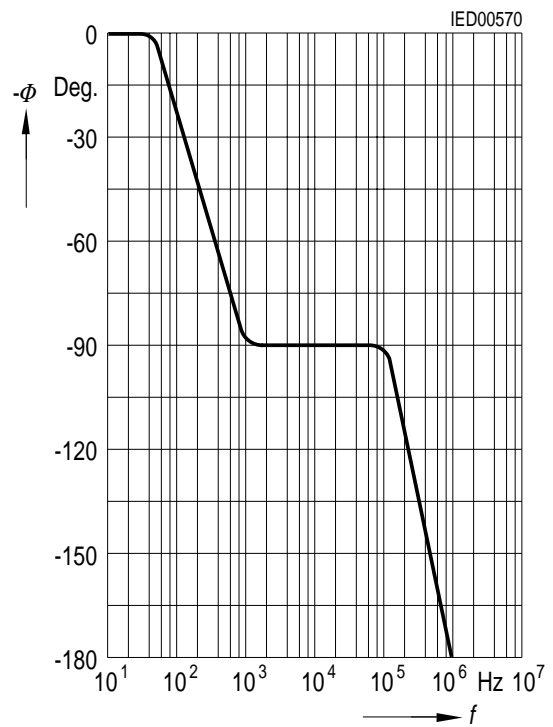
**Phase Response versus Frequency**  
 $V_S = \pm 10 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$



**TCA 2465, G Open-Loop Voltage Gain versus Frequency**  
 $V_S = \pm 10 \text{ V}, T_j = 25 \text{ }^\circ\text{C}$

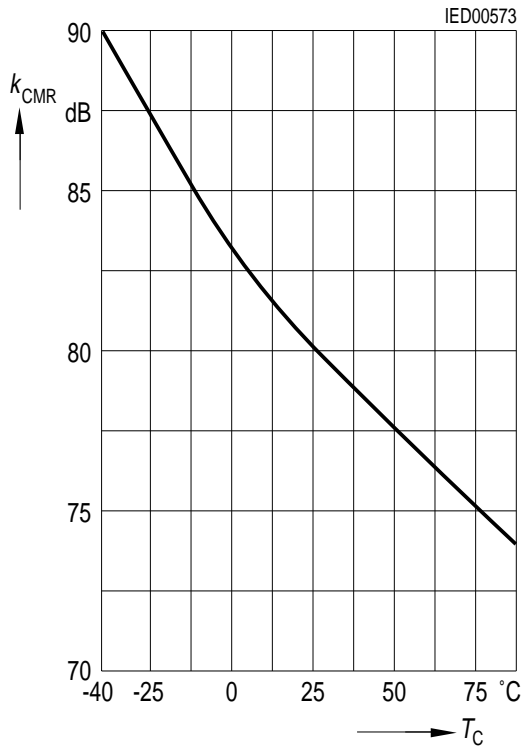


**TCA 2465, G Phase Response versus Frequency**  
 $V_S = \pm 10 \text{ V}, T_j = 25 \text{ }^\circ\text{C}$



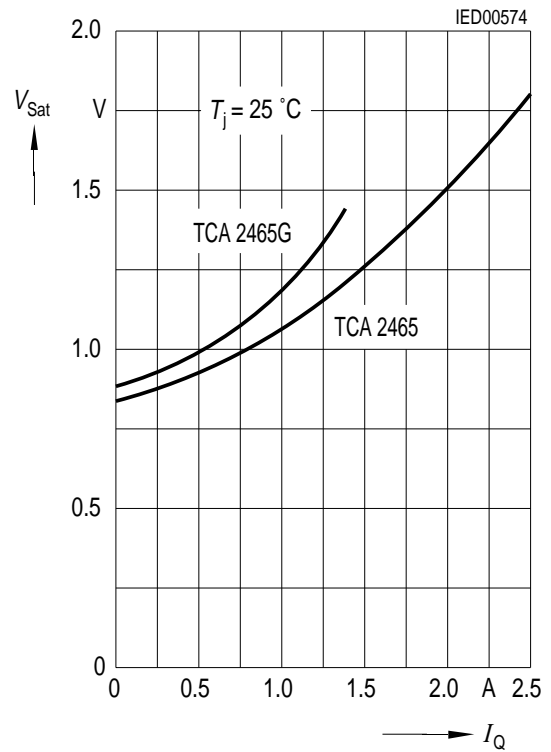
**Common-Mode Rejection versus Case Temperature**

$V_S = \pm 10\text{ V}$

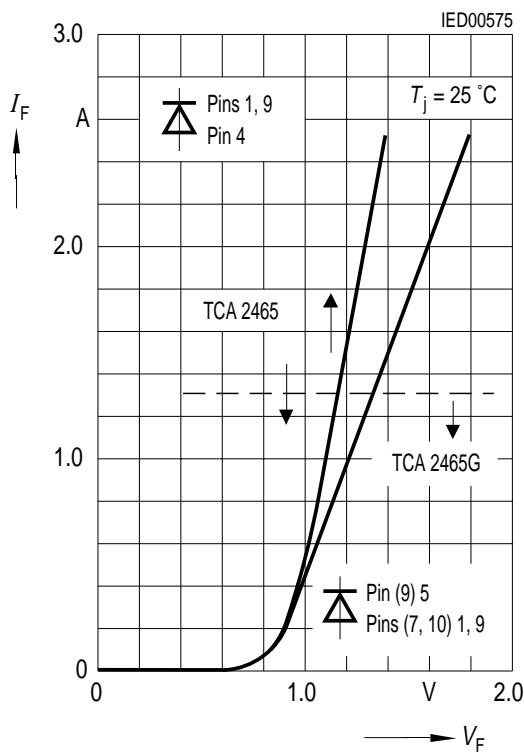


**Saturation Voltage versus Peak Output Current**

$T_j = 25\text{ °C}$



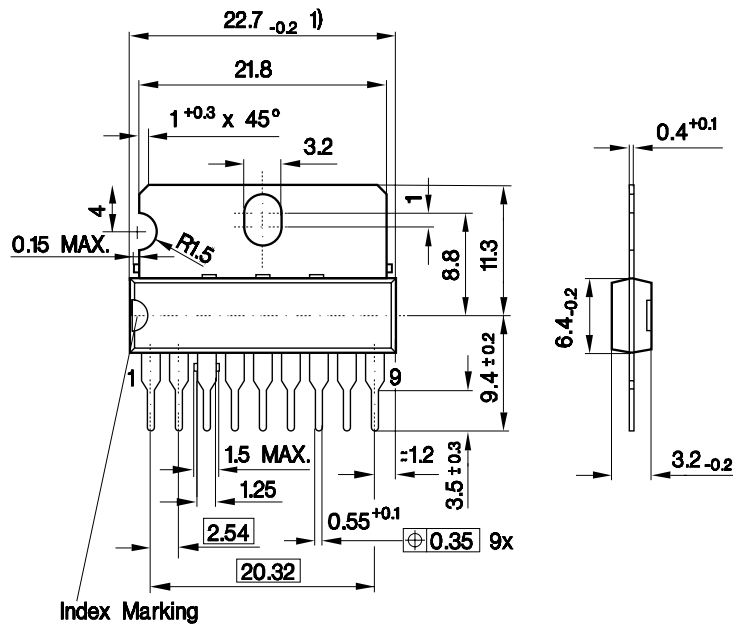
**Forward Current versus Forward Voltage**





Package Outlines

**P-SIP-9-1**  
(Plastic Single In-line Package)



1) Does not include plastic or metal protrusion of 0.25 max.

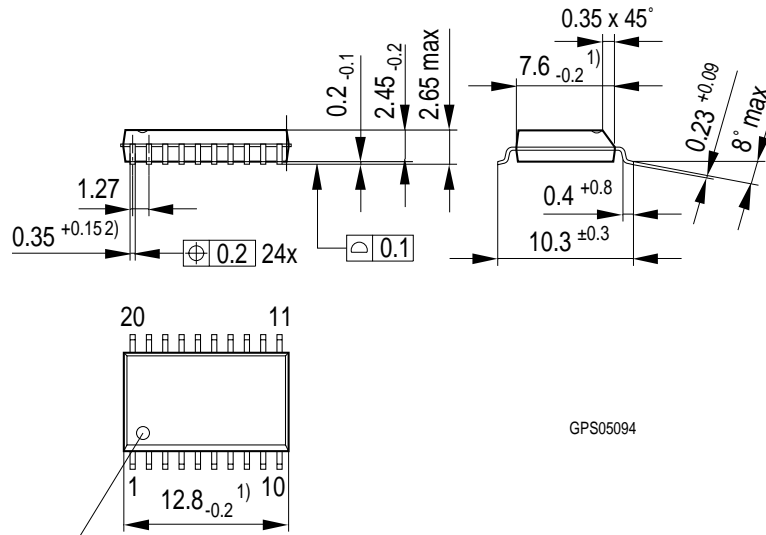
GPI05038

**Sorts of Packing**

Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

Dimensions in mm

**P-DSO-20-6**  
(Plastic Dual Small Outline Package)



GPS05094

Index Marking

- 1) Does not include plastic or metal protrusions of 0.15 max per side
- 2) Does not include dambar protrusion of 0.05 max per side

**Sorts of Packing**

Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

SMD = Surface Mounted Device

Dimensions in mm