

Dual Power Operational Amplifier

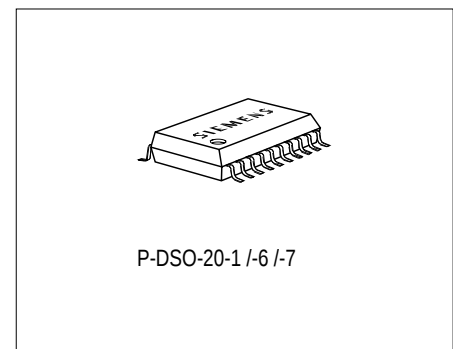
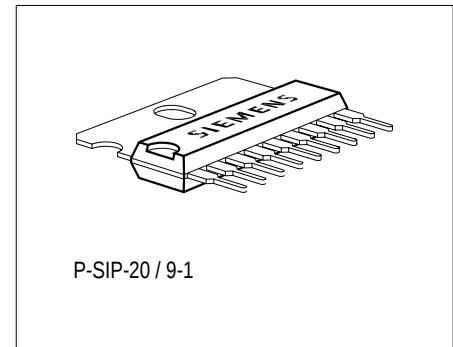
TCA 2465

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/ μ 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

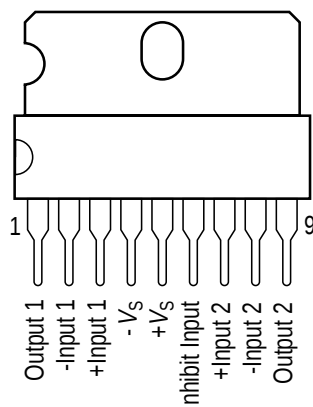


Type	Ordering Code	Package
TCA 2465	Q67000-A8109	P-SIP-9-1
TCA 2465 G	Q67000-A8334	P-DSO-20-6

Description

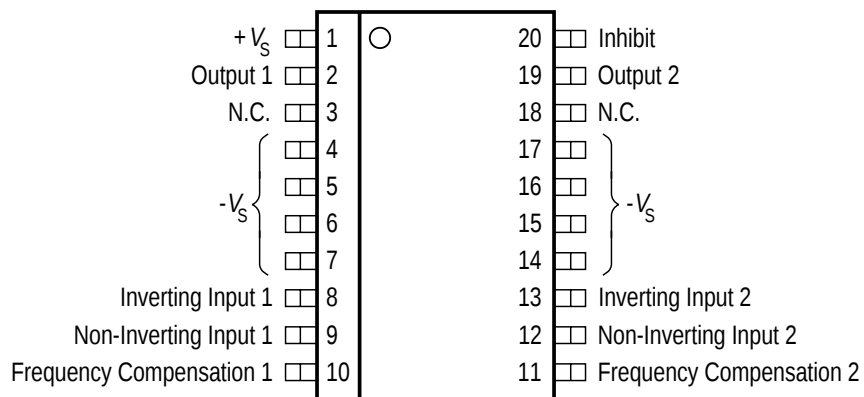
The IC contains two identical op amps, each supplying a high output current of 2.5 A at supply voltages between ± 3 V and ± 20 V. Internal compensation permits negative feedback of the amplifiers up to a min. of 20 dB. Both amplifiers can be disconnected at $V_g \geq 2$ V via an inhibit input. Integrated 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.

TCA 2465



IEP00550

TCA 2465 G



IEP00888

Figure 1 Pin Configuration (top view)

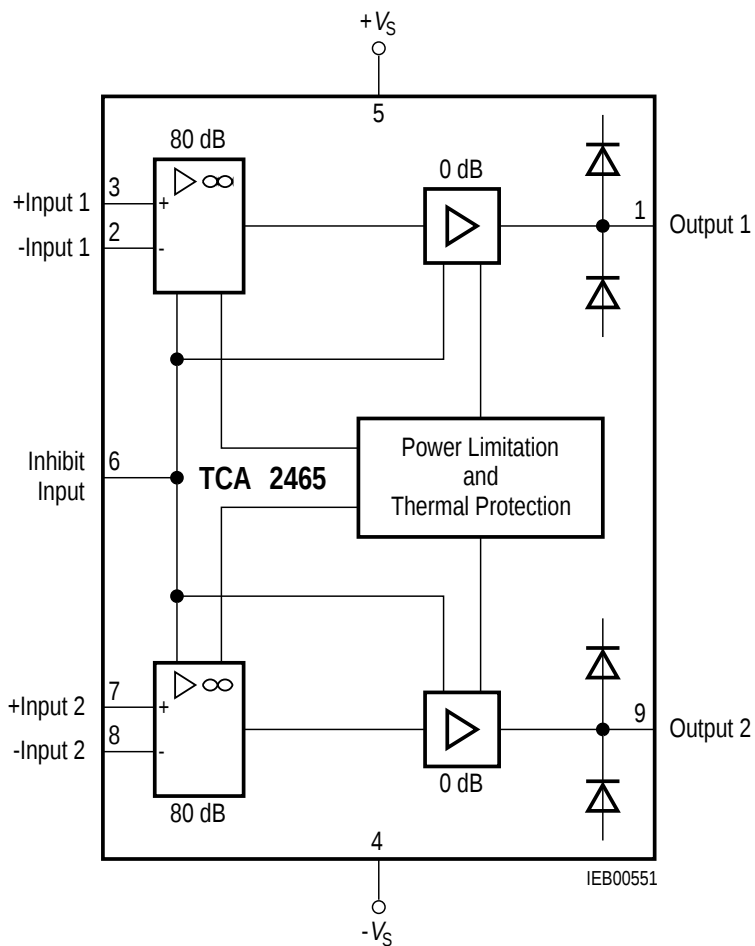


Figure 2 Block Diagram TCA 2465

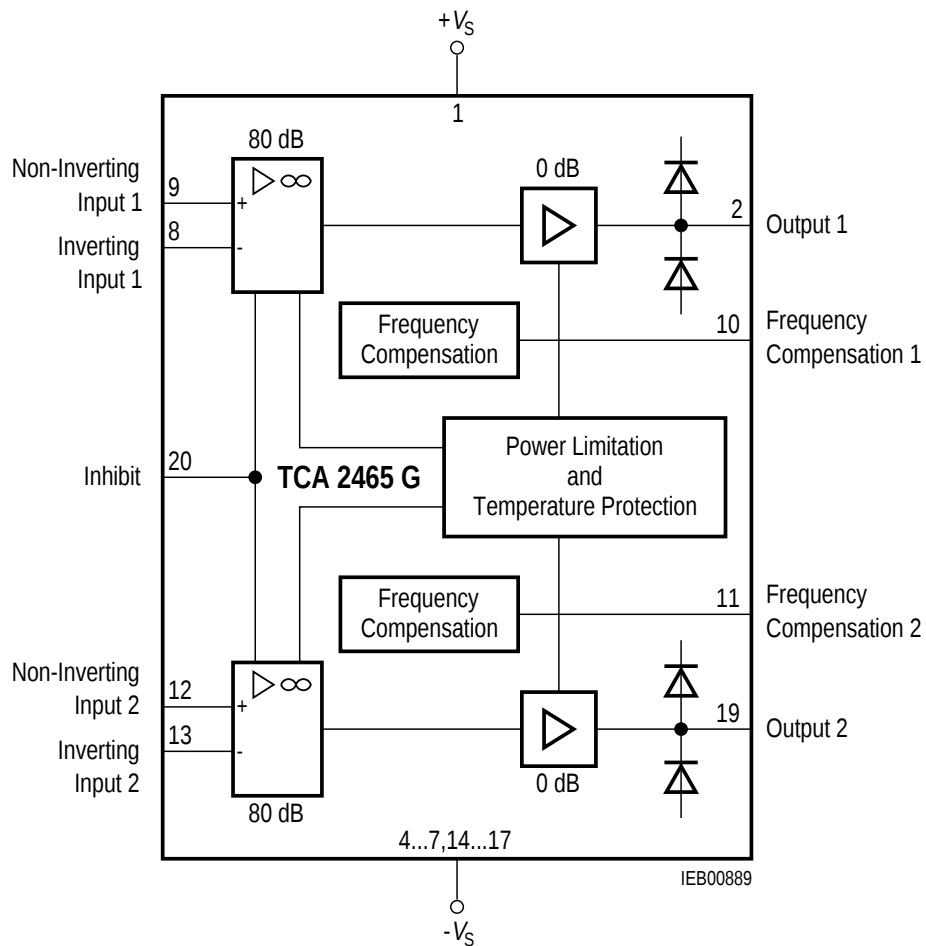


Figure 3 Block Diagram TCA 2465 G

Absolute Maximum Ratings

 $T_C = -40 \text{ to } 85 \text{ }^\circ\text{C}$

Note: Values in brackets refer to TCA 2465 G

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_S	–	± 21	V	ΔV_{2-3} or ΔV_{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 $V_S \geq \pm 15 \text{ V};$ $V_Q < -V_S$
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_I	$-V_S$	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	$^\circ\text{C}$	–
Storage temperature range	T_{stg}	– 50	150	$^\circ\text{C}$	

¹⁾ $t < 1 \text{ ms}, f \leq 400 \text{ Hz}$

Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_S	± 3	± 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⁾ $P_D = 12 \text{ W}$ P-SIP-9-1
 $P_D = 3.5 \text{ W}$ 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	μA	3; 14
Output voltage						
$R_L = 12 \text{ } \Omega$; $f = 1 \text{ kHz}$	$V_{Q \text{ pp}}$	± 8.5	± 9	–	V	4; 15
$R_L = 4 \text{ } \Omega$; $f = 1 \text{ kHz}^{1)}$	$V_{Q \text{ pp}}$	± 8	± 8.5	–	V	4; 15
$R_L = 470 \text{ } \Omega$; $f = 40 \text{ kHz}$	$V_{Q \text{ pp}}$	–	± 8	–	V	4; 15
Input resistance	R_I	1	5	–	M Ω	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_{CMR}	70	80	–	dB	6; 17
Supply voltage rejection	k_{SVR}	– 70	– 80	–	dB	7; 18
Temperature coefficient of V_{IO}	α_{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}	α_{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)	–	V/ μs	8; 19
Slew rate of V_Q for inverting operation	SR	–	2 (0.5)	–	V/ μs	9; 20
Noise voltage (DIN 45405, referred to input)	V_n	–	3	–	μV	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	mA	1; 12
L-input current, $V_6 = 0 \text{ V}^{(2)}$	I_6	—	0.5	3	μA	1; 12
Turn-ON dead time $ I_{1;9} > A^{(3)}$	$t_{D \text{ ON}}$	—	10	20	μs	1; 12
Turn-OFF dead time $ I_{1;9} < 1 A^{(3)}$	$t_{D \text{ OFF}}$	—	10	20	μs	1; 12
Short-circuit current ⁽⁴⁾ (switch S3 closed)	I_{SC}	—	1	—	A	1; 12
Short-circuit current ⁽⁴⁾ (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

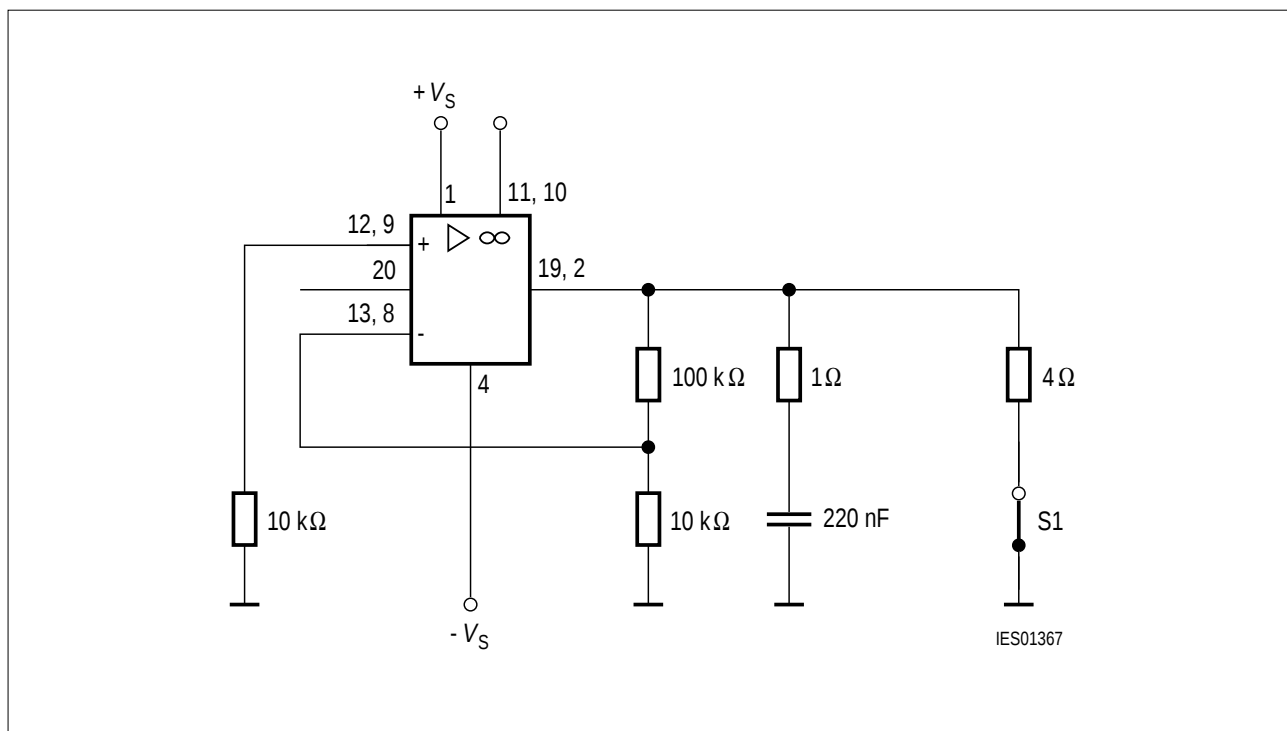


Figure 4 Open-Loop Supply Current Consumption; Noise Voltage (TCA 2465 G)

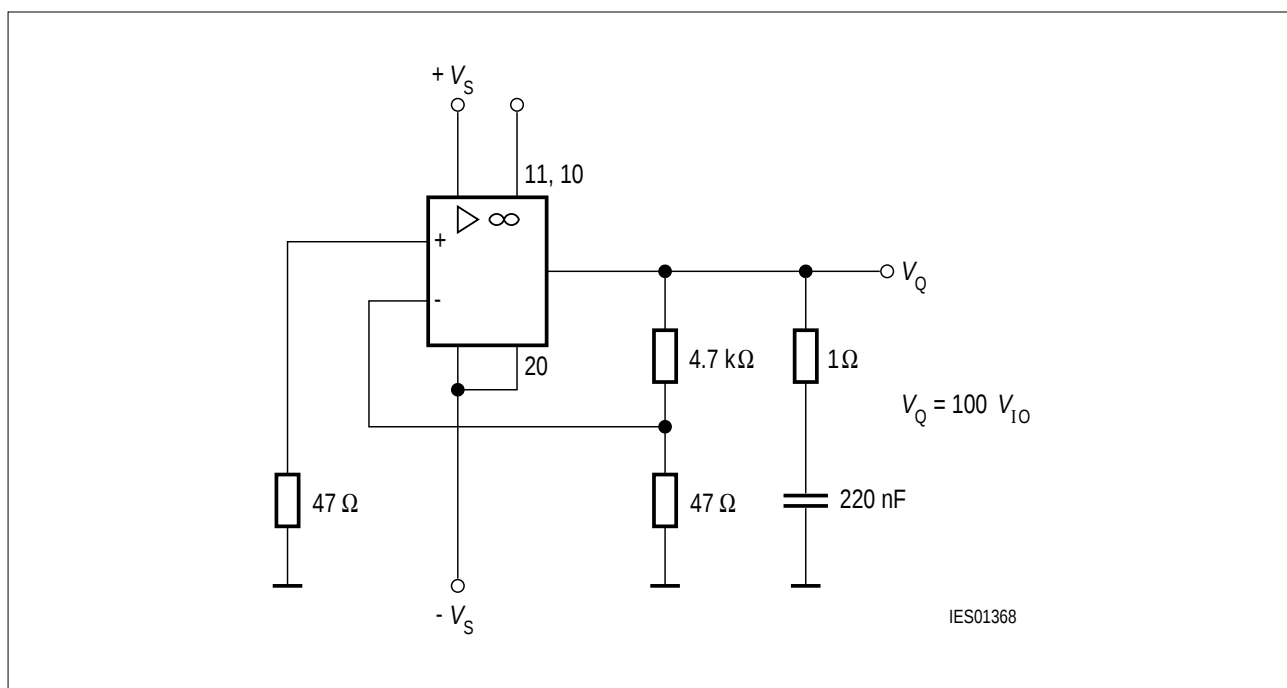


Figure 5 Input Offset Voltage; Temperature Coefficient of V_{IO} (TCA 2465 G)

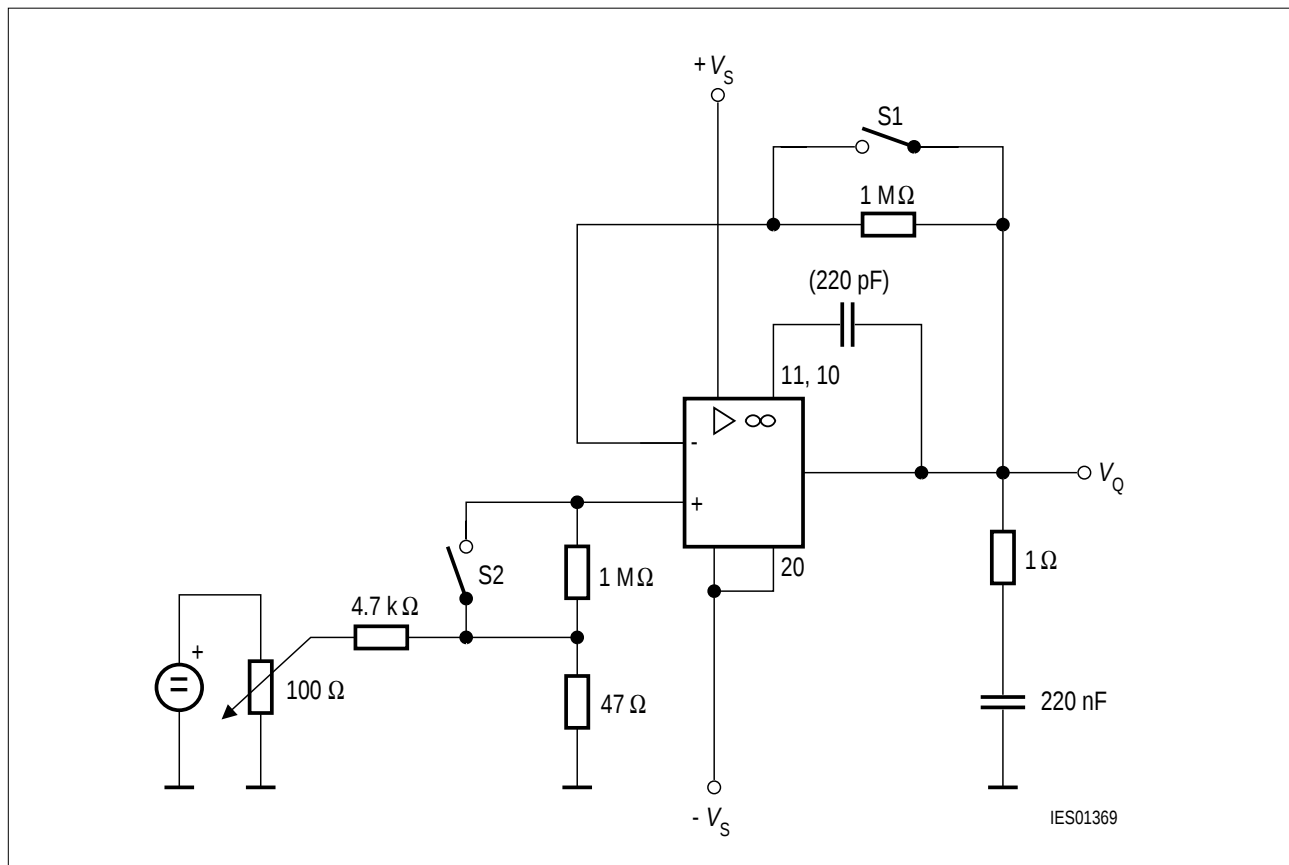


Figure 6 Input Offset Current; Input Current; Temperature Coefficient of I_{IO} (TCA 2465 G)

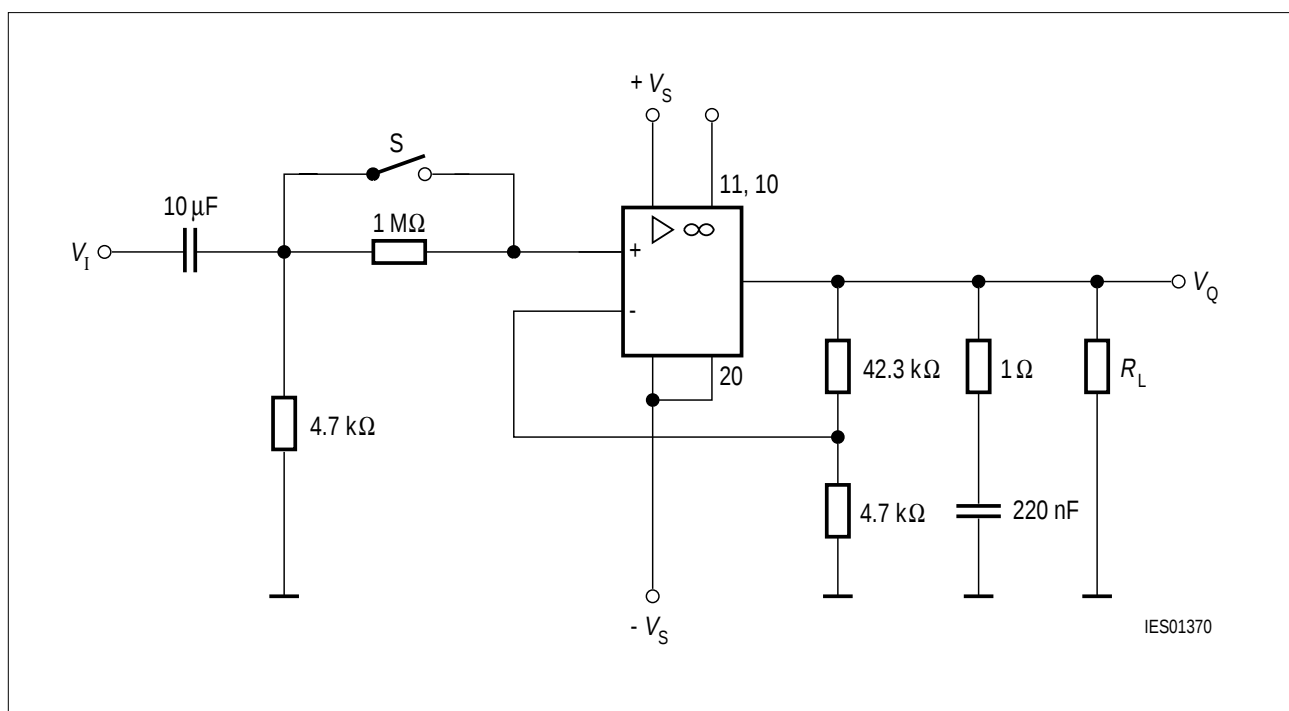


Figure 7 Output Voltage; Input Resistance (TCA 2465 G)

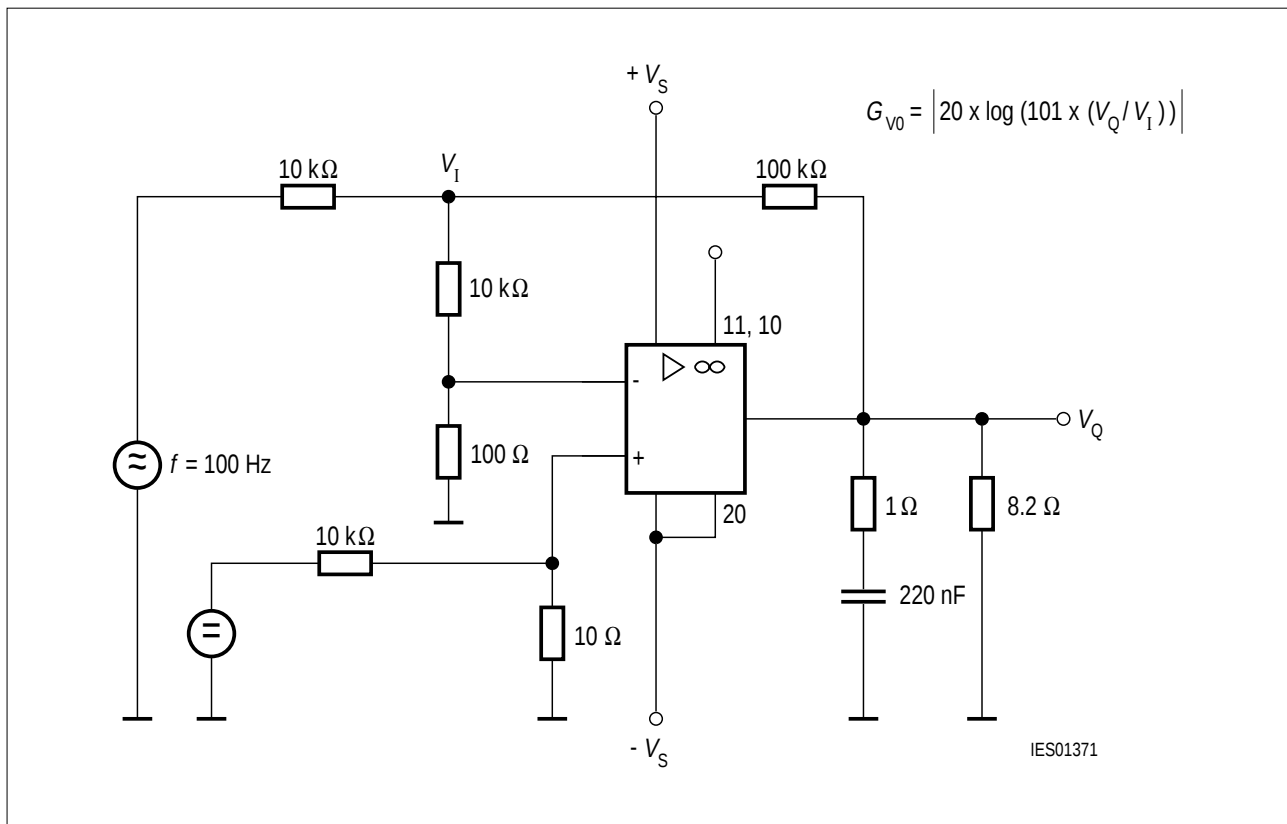
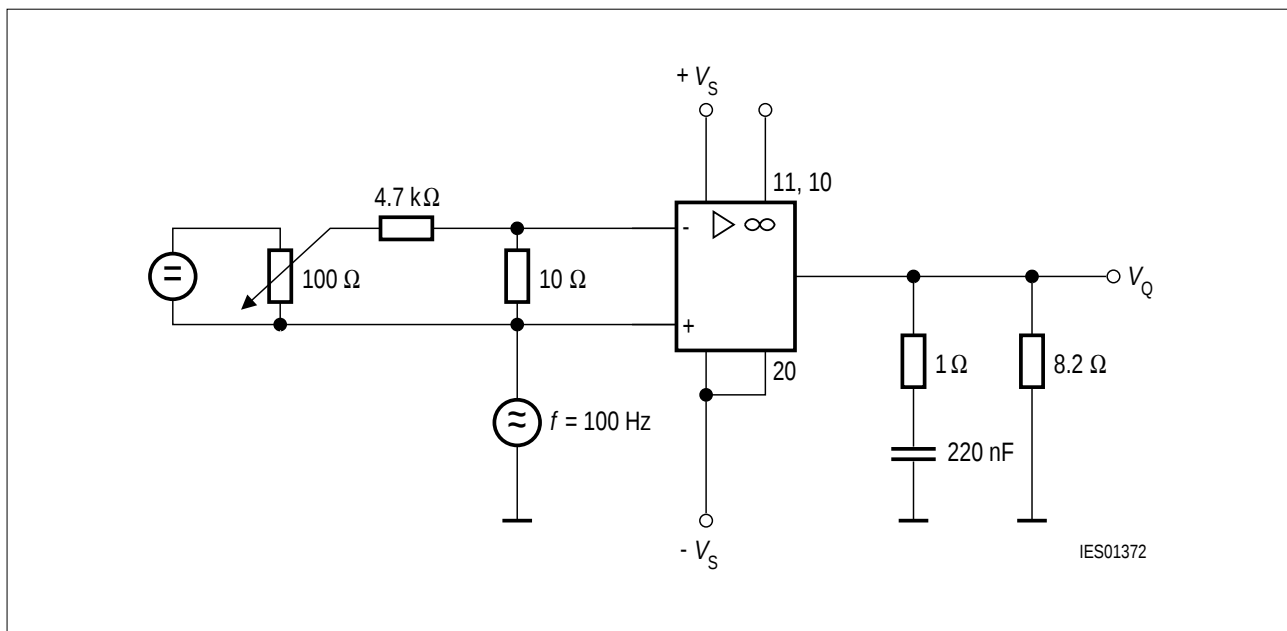


Figure 8 Open-Loop Voltage Gain G_{VO} (TCA 2465 G)



**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)**



The circuit diagram shows an op-amp configured as a square-wave generator. The non-inverting input (+) is connected to a square-wave voltage source (Peak-to-Peak 0.6 V) through a 10 kΩ resistor. The inverting input (-) is connected to the output (V_Q) through a 91 kΩ resistor, forming a voltage divider. The output (V_Q) is also connected to the non-inverting input (+) through a 10 kΩ resistor, creating positive feedback. A 220 nF capacitor is connected between the output (V_Q) and ground. The op-amp is powered by a supply voltage V_S (positive and negative terminals shown). The op-amp model is represented by a triangle with an infinity symbol inside, and the output is labeled V_Q.

Data Sheet

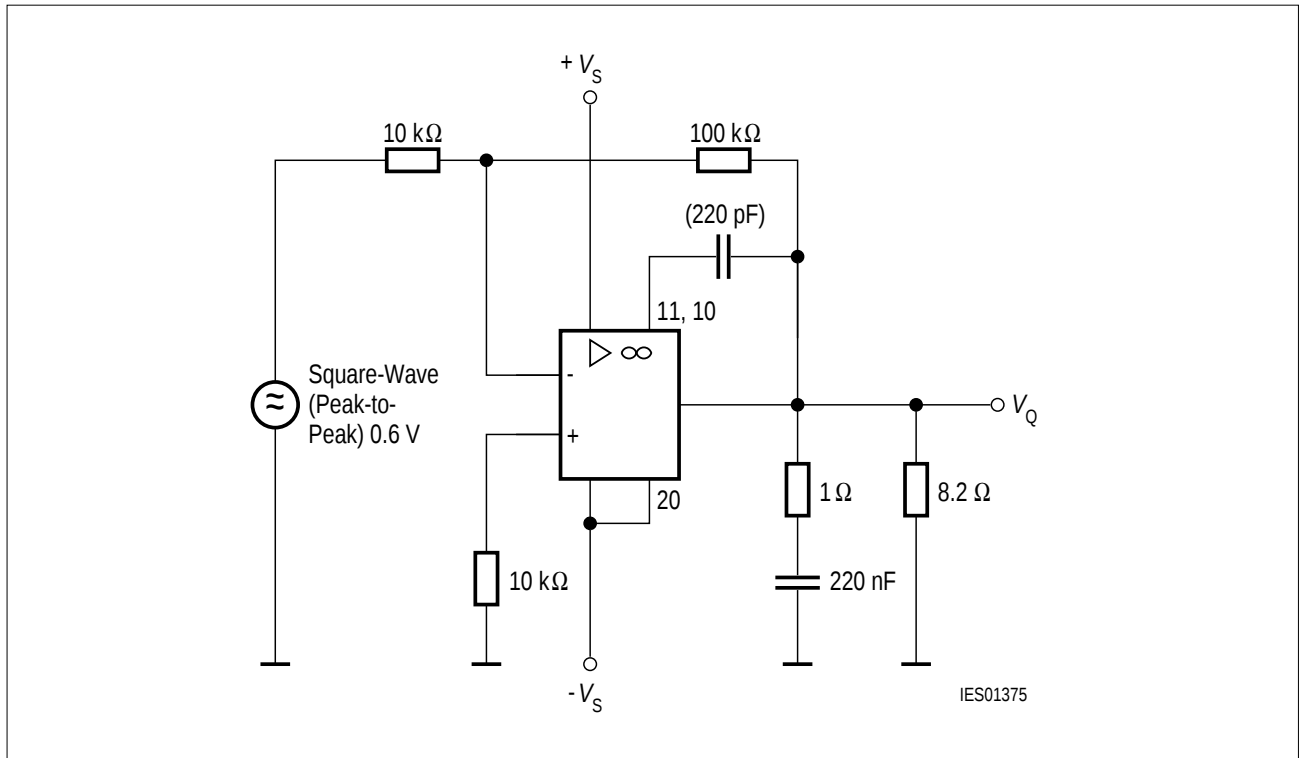
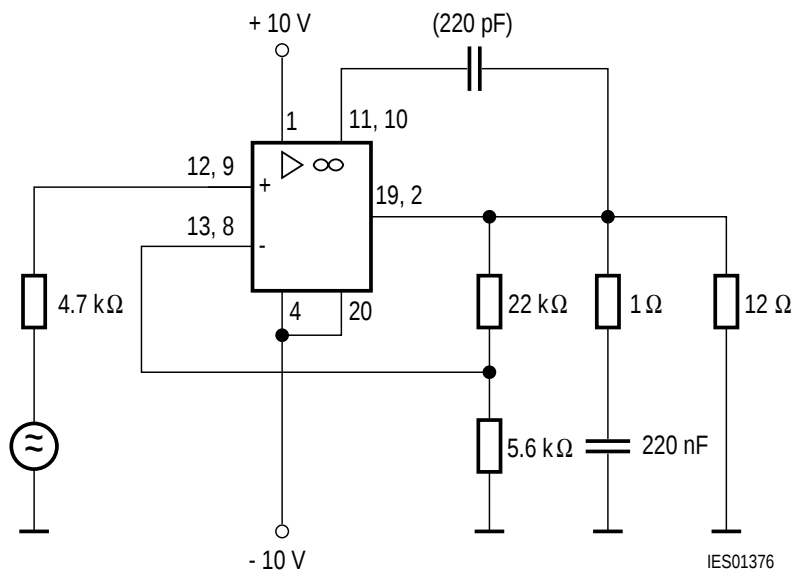


Figure 12 Slew Rate for Inverting Operation (TCA 2465 G)

a) Amplifier; $G_V = 5$



b) Voltage follower TCA 2465 G

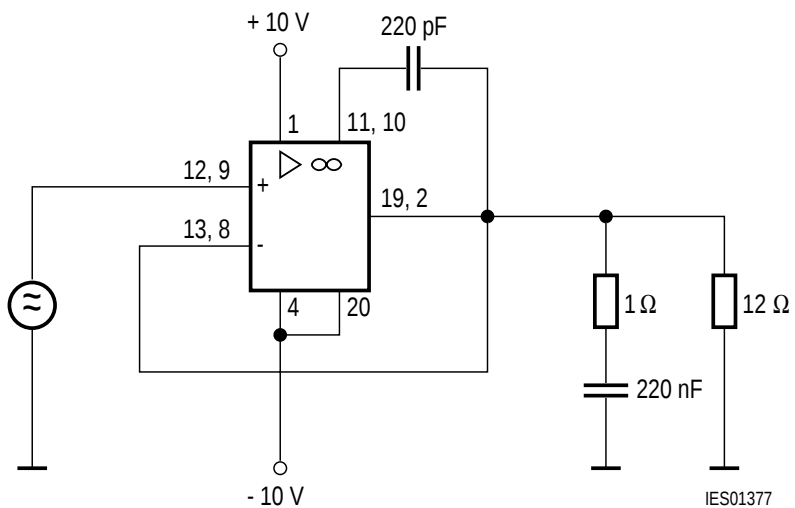
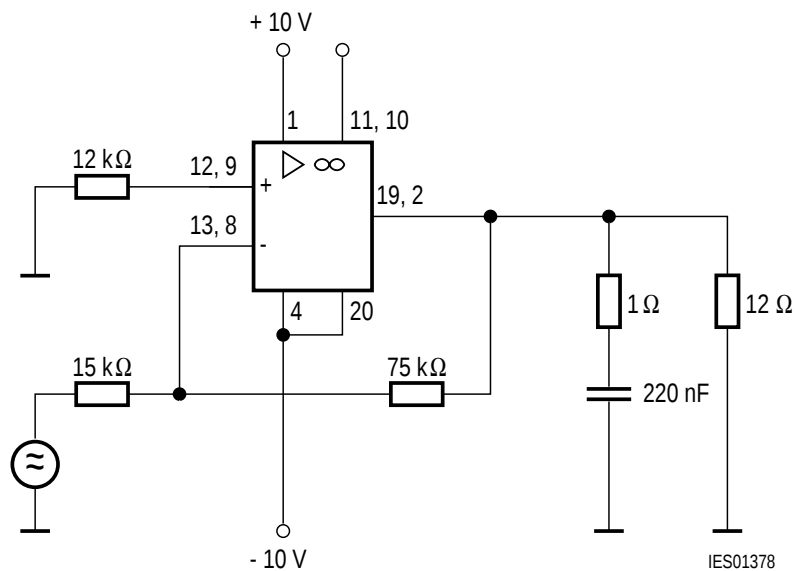


Figure 13 Non-Inverting Operation (TCA 2465 G)

a) Amplifier; $G_V = -5$


b) Inverter TCA 2465 G

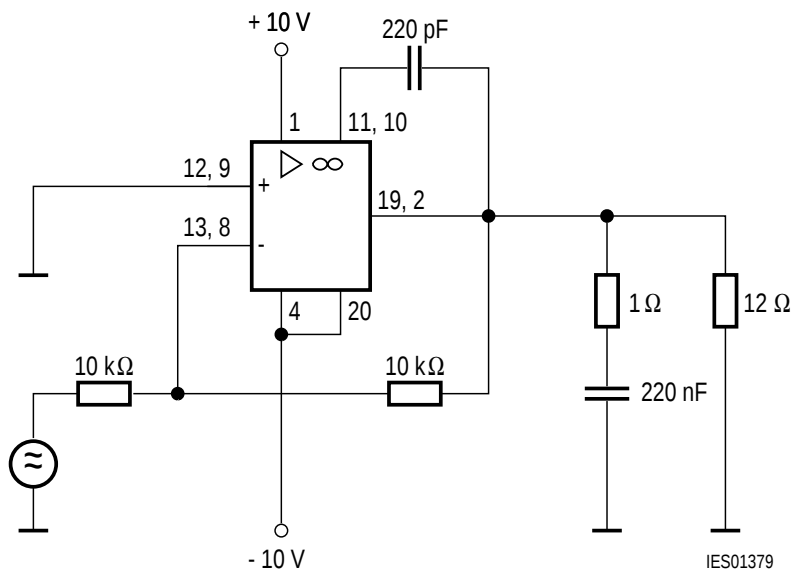


Figure 14 Inverting Operation (TCA 2465 G)

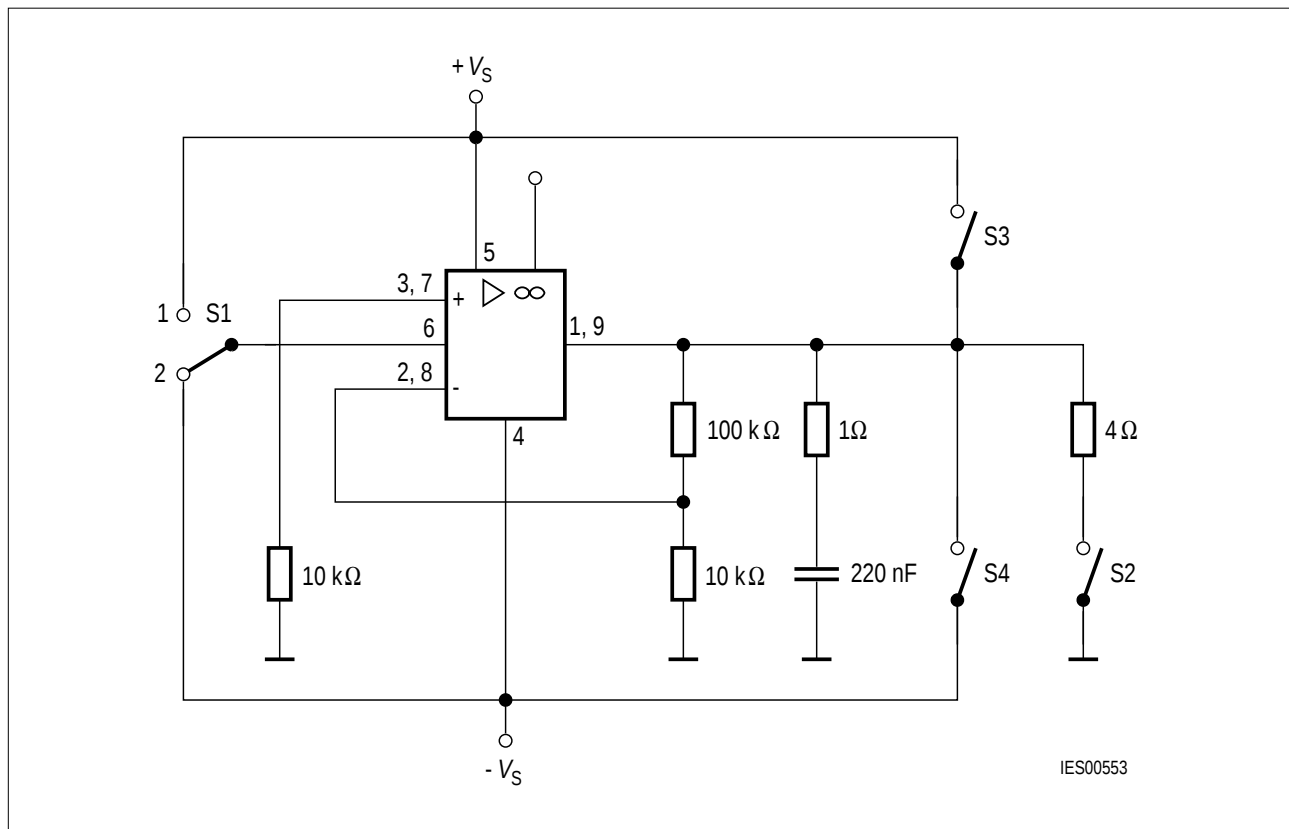


Figure 15 Open-Loop Supply Current Consumption; Noise Voltage (TCA 2465/A)

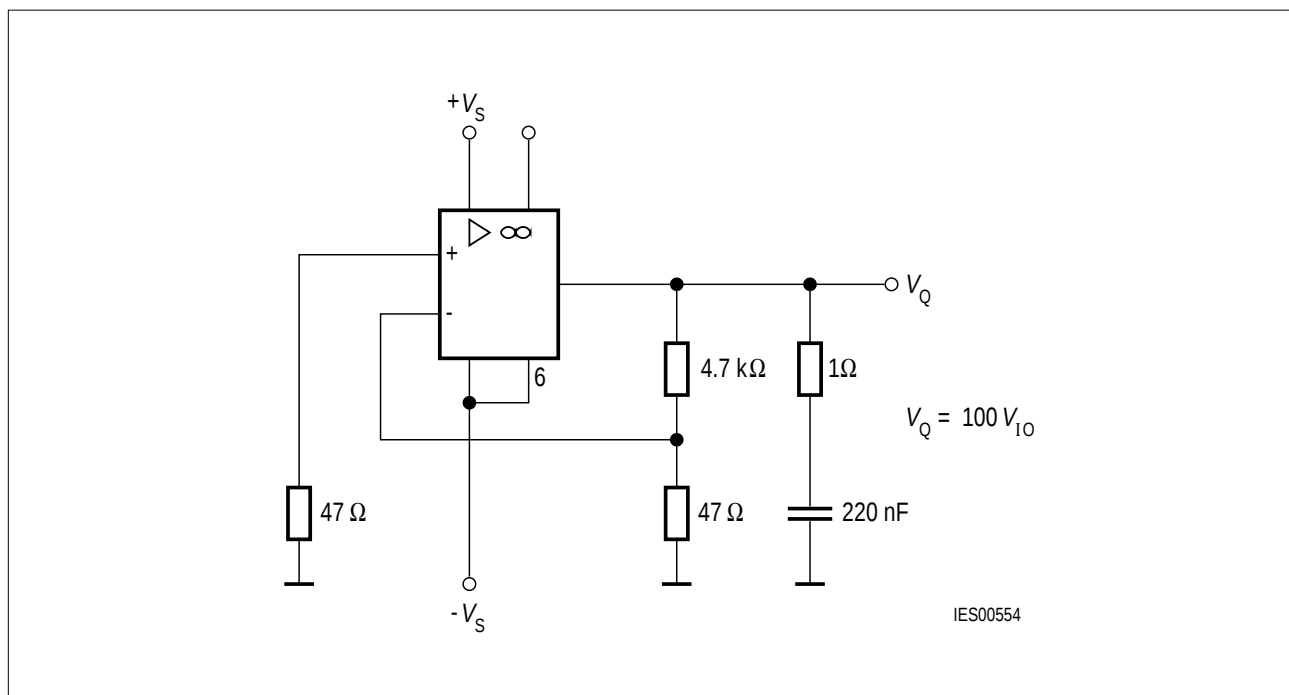


Figure 16 Input Offset Voltage; Temperature Coefficient of V_{IO} (TCA 2465/A)

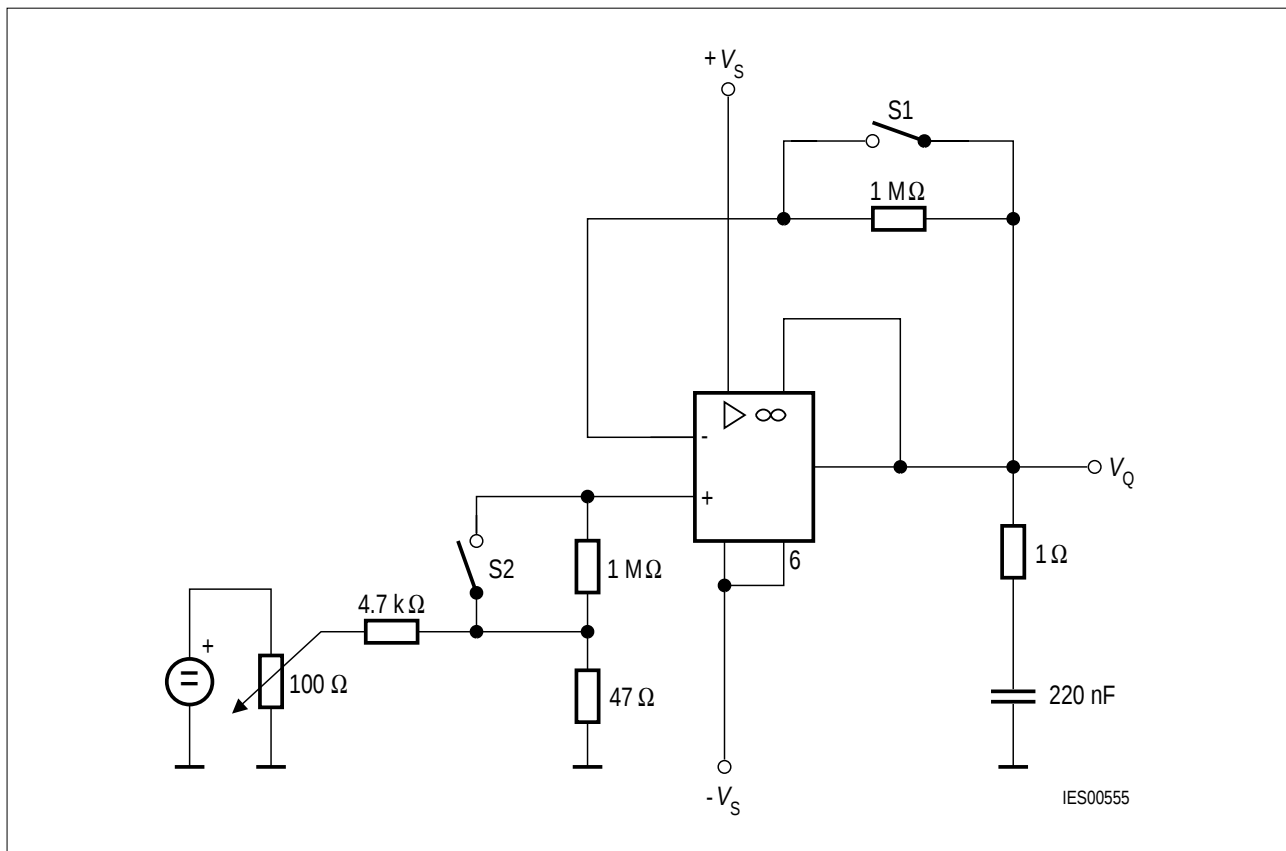


Figure 17 Input Offset Current; Input Current; Temperature Coefficient of I_{IO} (TCA 2465)

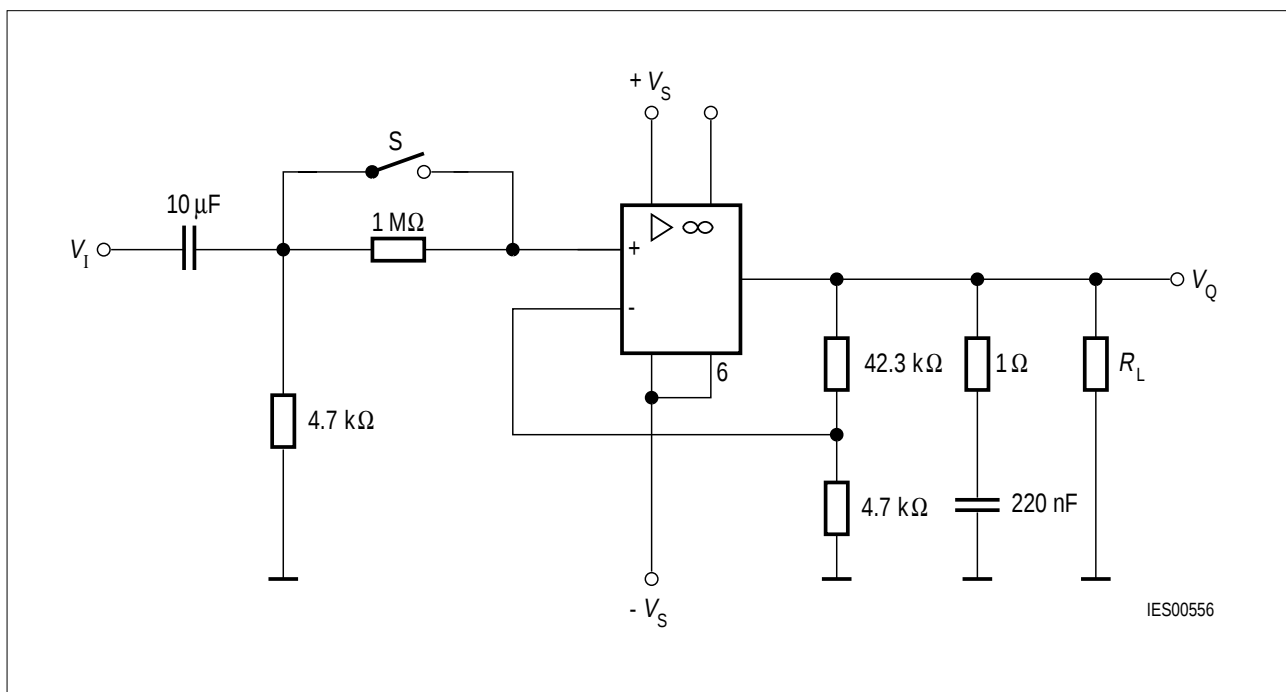


Figure 18 Output Voltage; Input Resistance (TCA 2465)

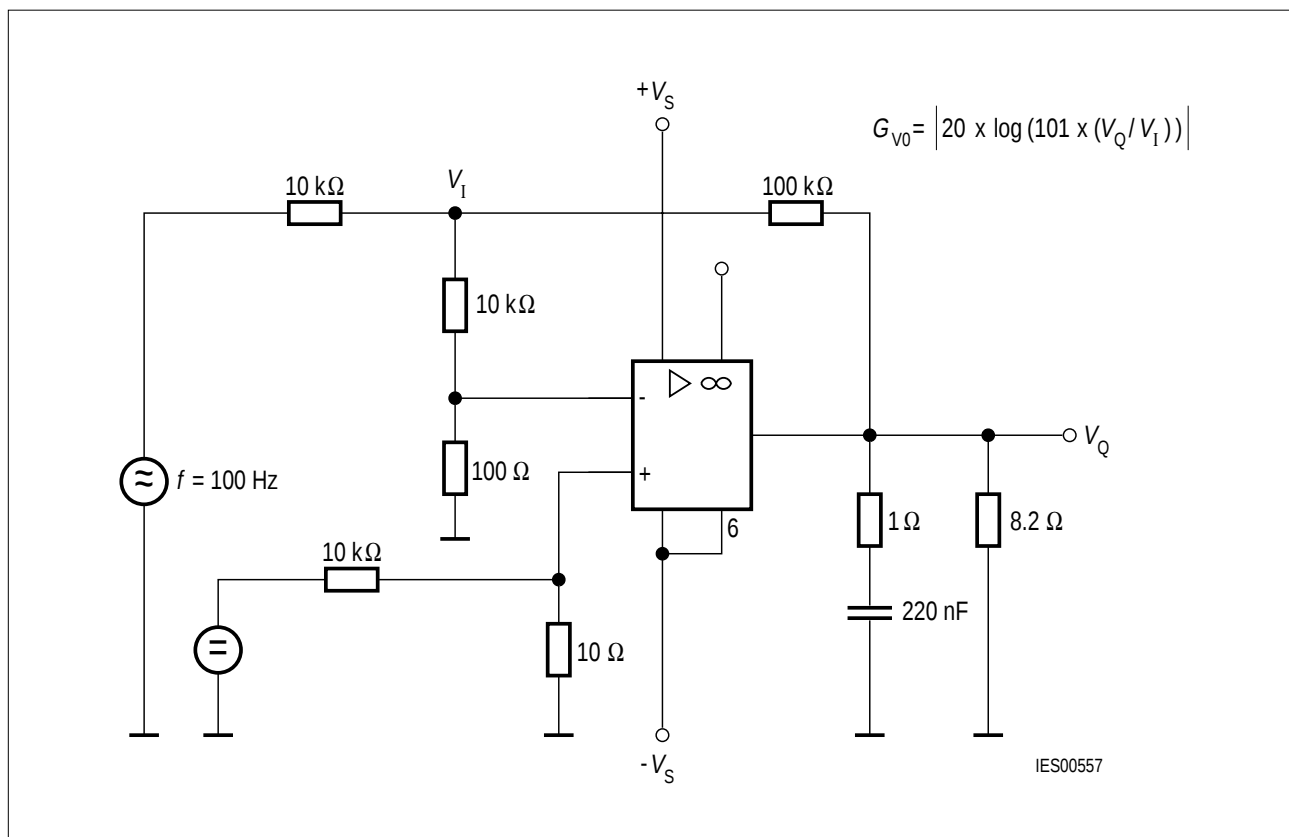
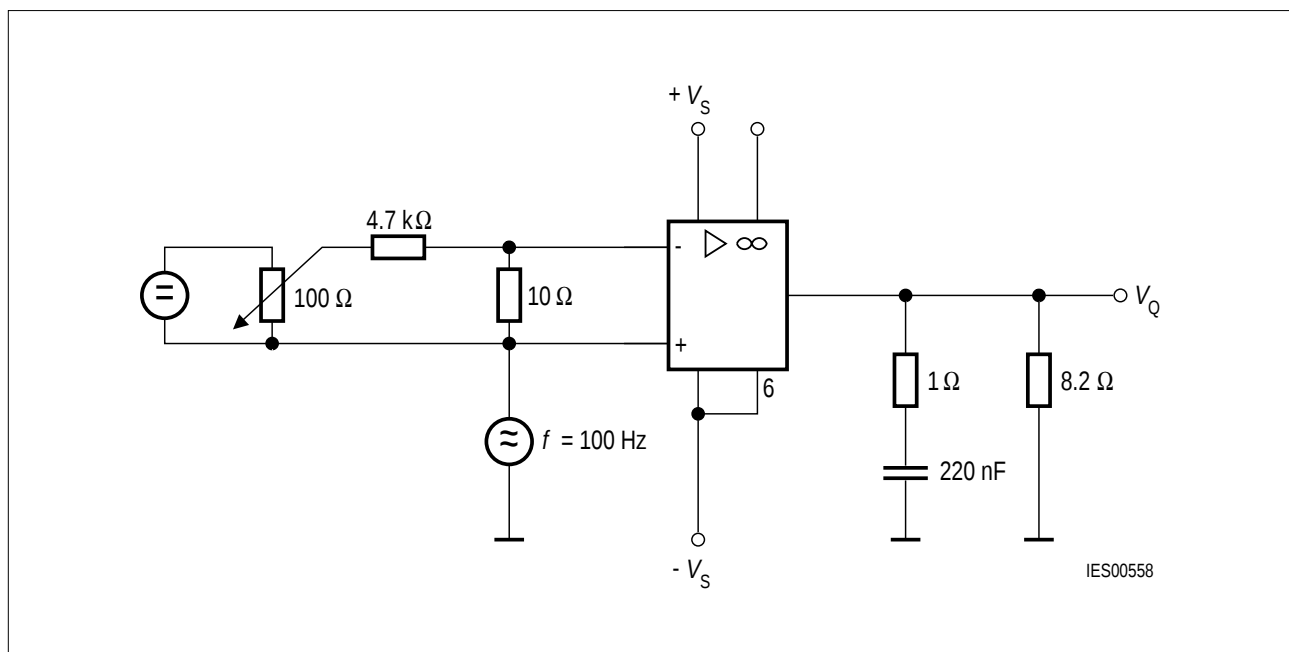


Figure 19 Open-Loop Voltage Gain G_{V0} (TCA 2465)



**Figure 20 Common Mode Voltage Gain G_{VC}
Common-Mode Rejection
 $k_{CMR} \text{ (dB)} = G_{V0} \text{ (dB)} - G_{VC} \text{ (dB)}$ (TCA 2465/A)**

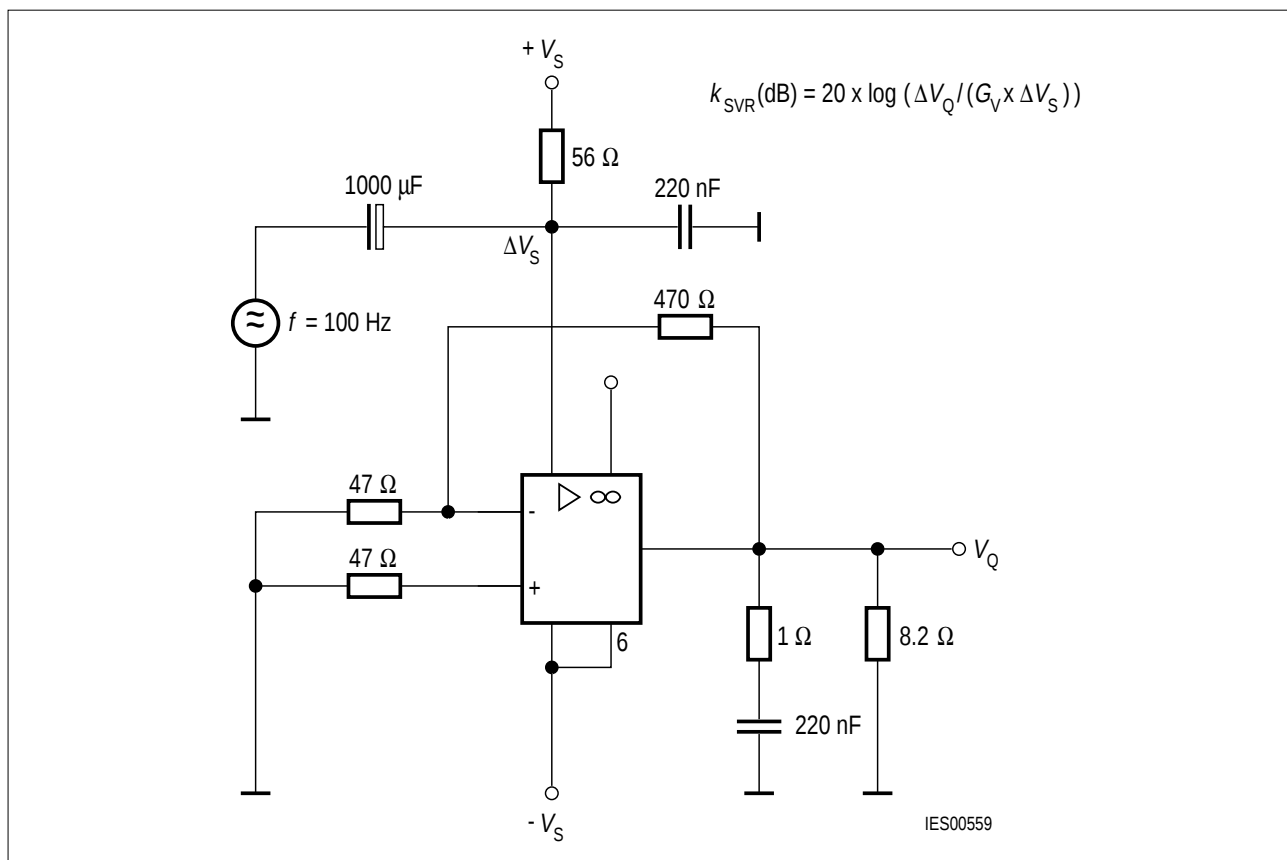


Figure 21 Supply Voltage Rejection k_{SVR} (TCA 2465)

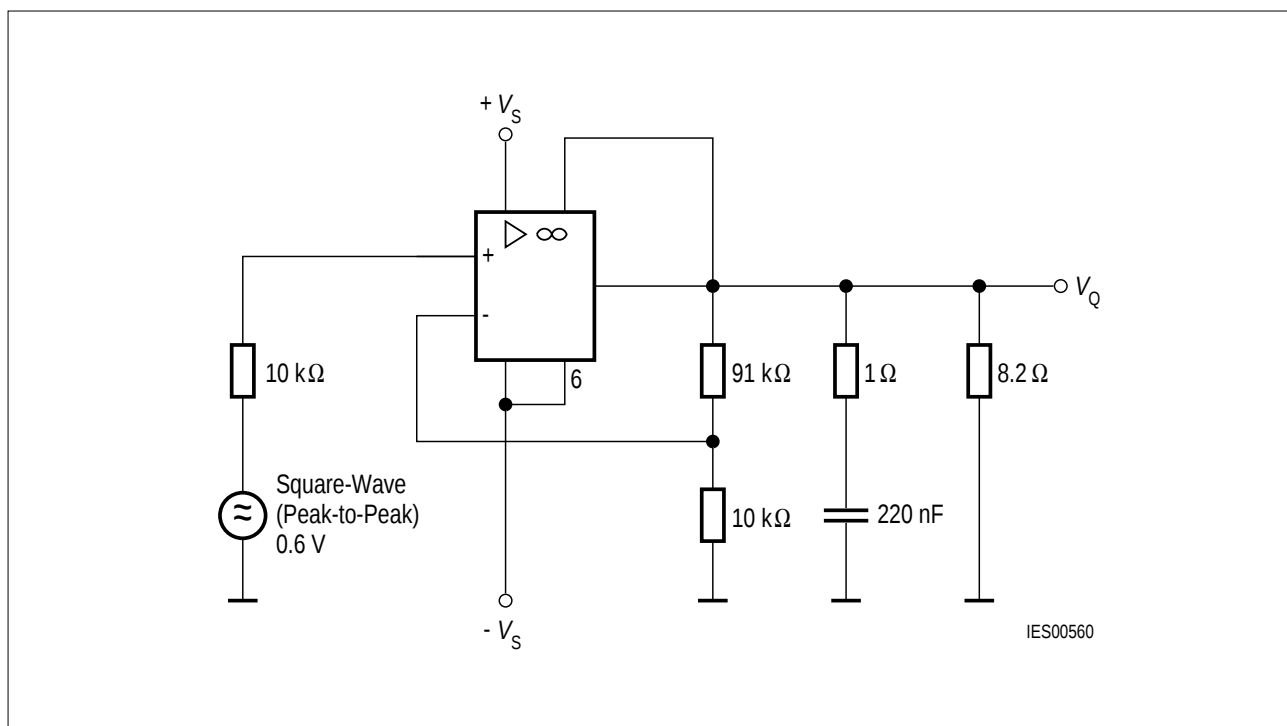


Figure 22 Slew Rate for Non-Inverting Operation (TCA 2465)

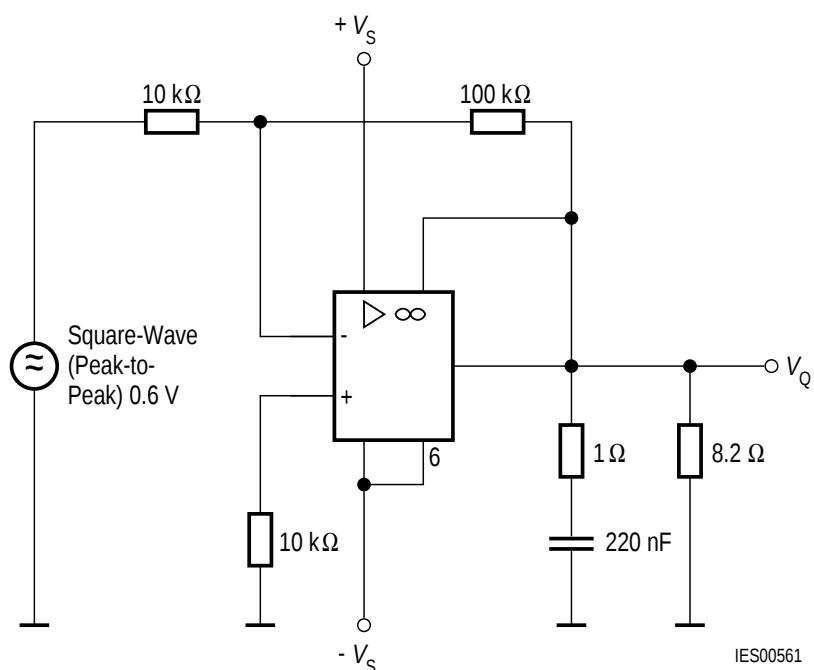


Figure 23 Slew Rate for Inverting Operation (TCA 2465)

Note: Values in brackets refer to TCA 2465 A

Amplifier; $G_V = 5$

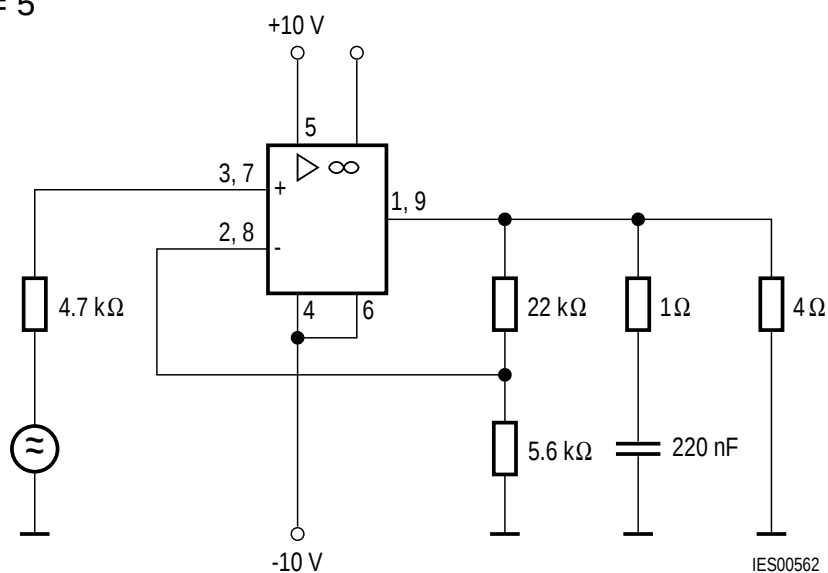


Figure 24 Non-Inverting Operation (TCA 2465)

Amplifier; $G_V = -5$

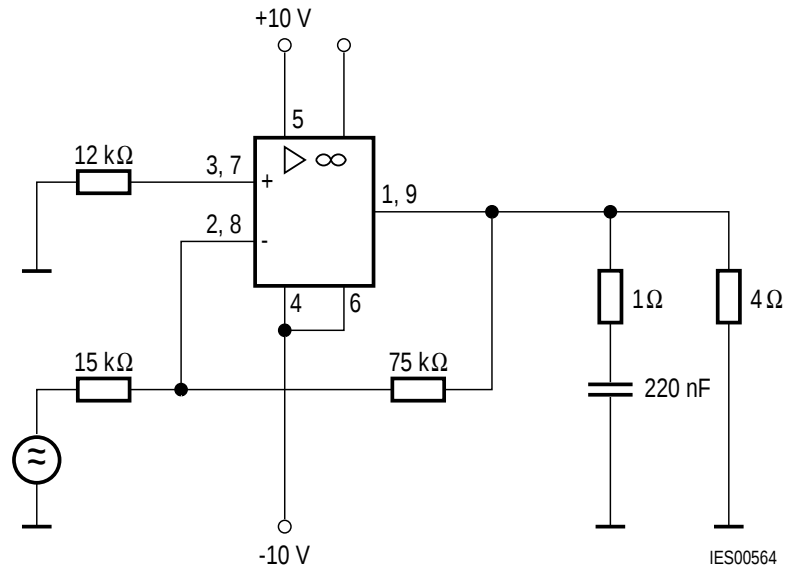


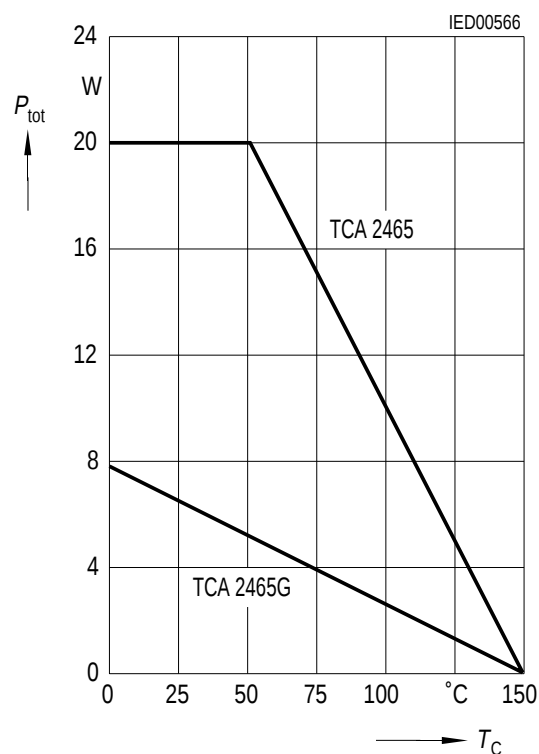
Figure 25 Inverting Operation (TCA 2465)

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

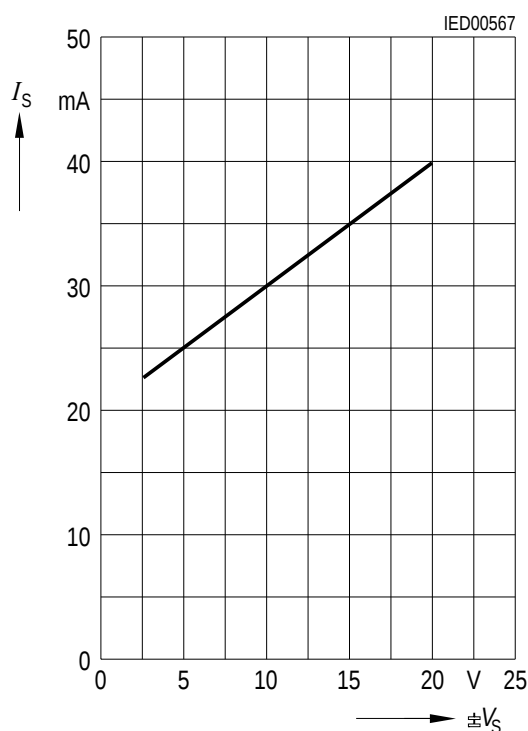
$T_j = 25\text{ }^{\circ}\text{C}$, $V_{CE} = +V_S - V_Q$ or $V_{CE} = -V_S - V_Q$



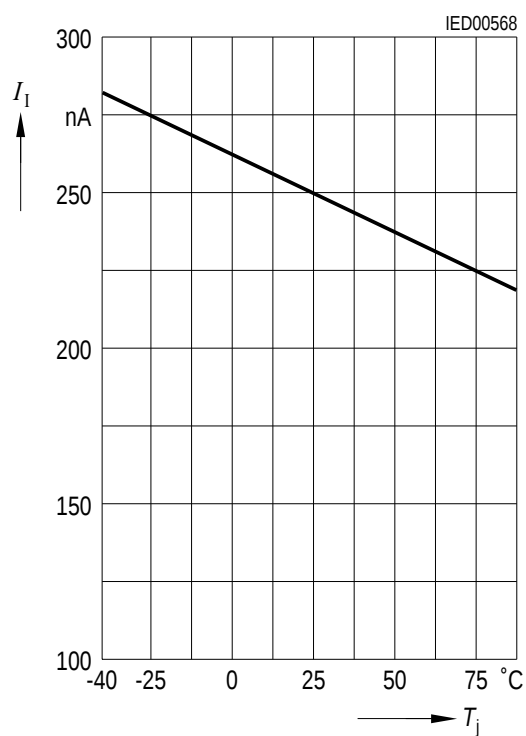
Max. Permissible Power Dissipation versus Case Temperature



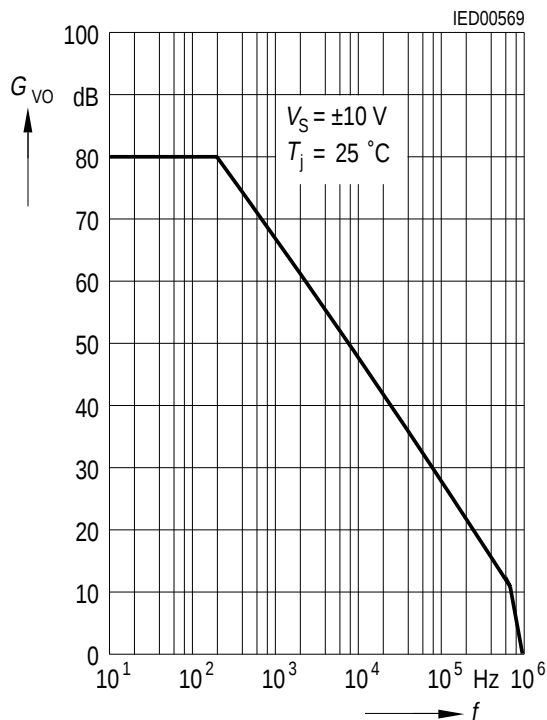
Supply Current versus Supply Voltage $T_j = 25\text{ }^{\circ}\text{C}$



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

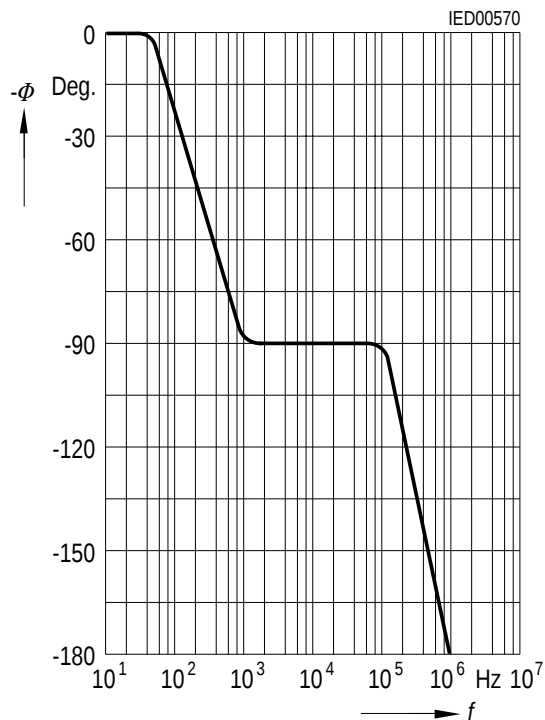


Open-Loop Voltage Gain versus Frequency



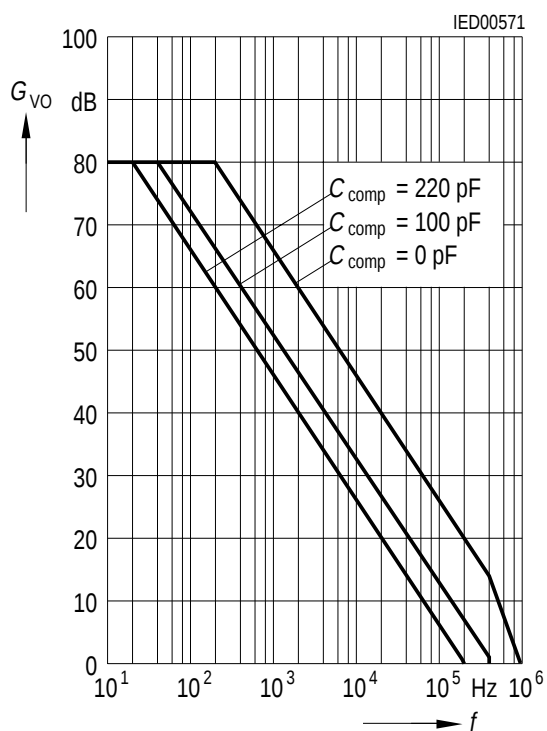
Phase Response versus Frequency

$V_S = \pm 10$ V; $T_j = 25$ °C



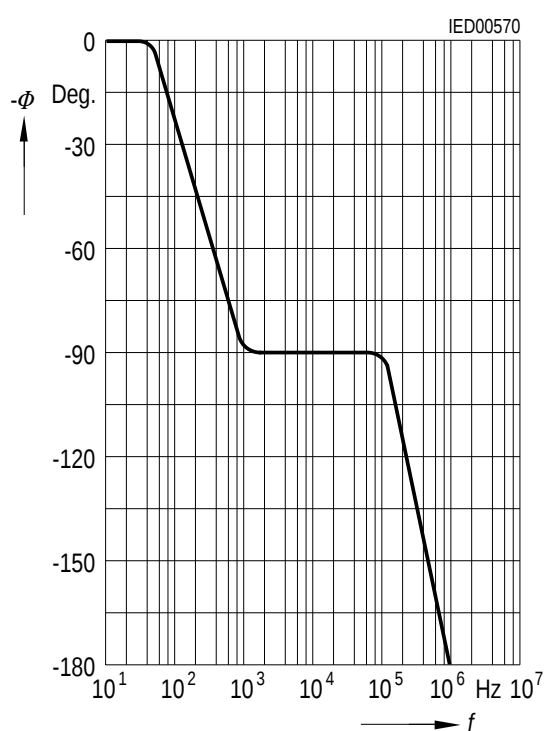
TCA 2465, G Open-Loop Voltage Gain versus Frequency

$V_S = \pm 10$ V, $T_j = 25$ °C

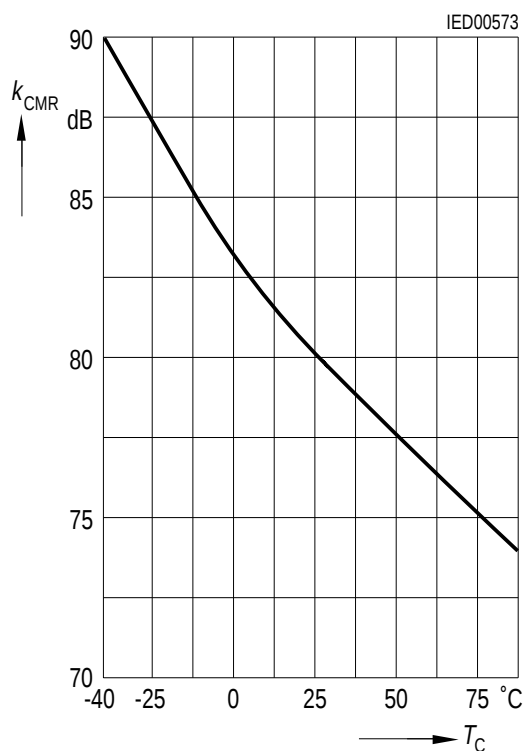


TCA 2465, G Phase Response versus Frequency

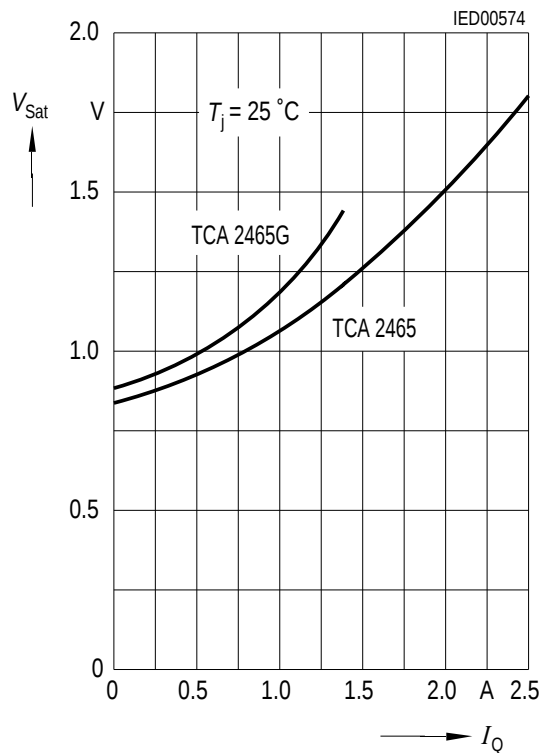
$V_S = \pm 10$ V, $T_j = 25$ °C



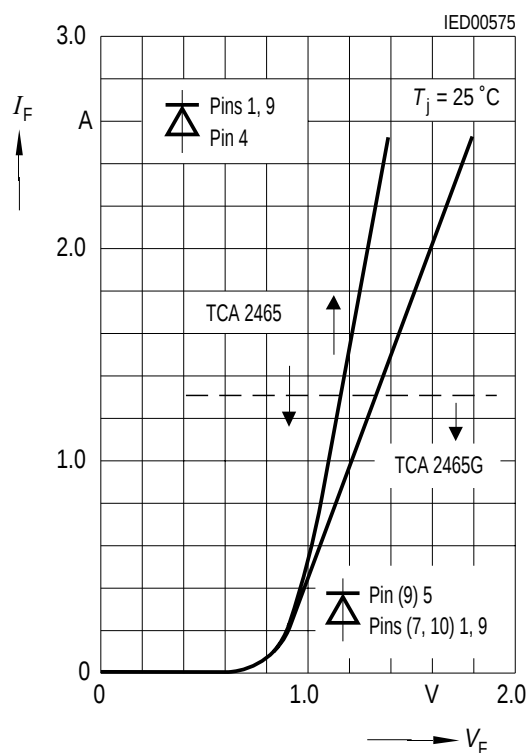
Common-Mode Rejection versus Case Temperature

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


Saturation Voltage versus Peak Output Current

 $T_j = 25 \text{ °C}$


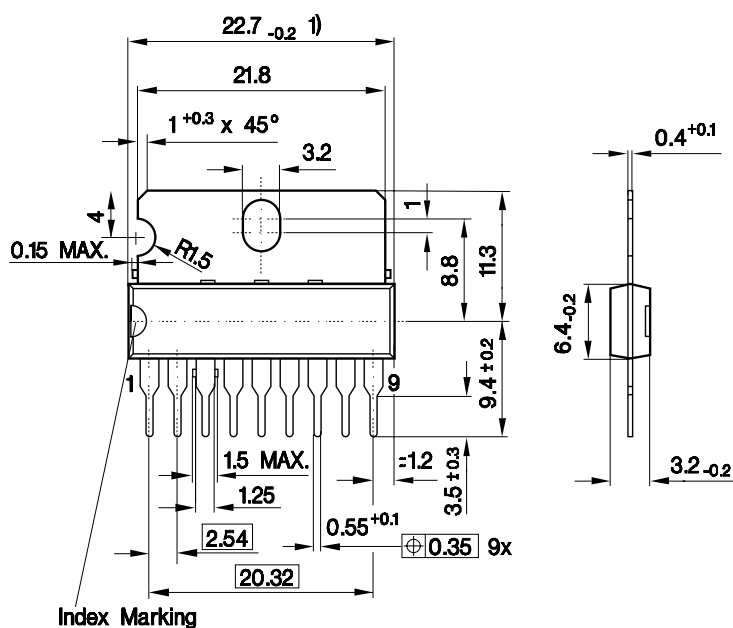
Forward Current versus Forward Voltage



Package Outlines

P-SIP-9-1

(Plastic Single In-line Package)



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

GPI05038

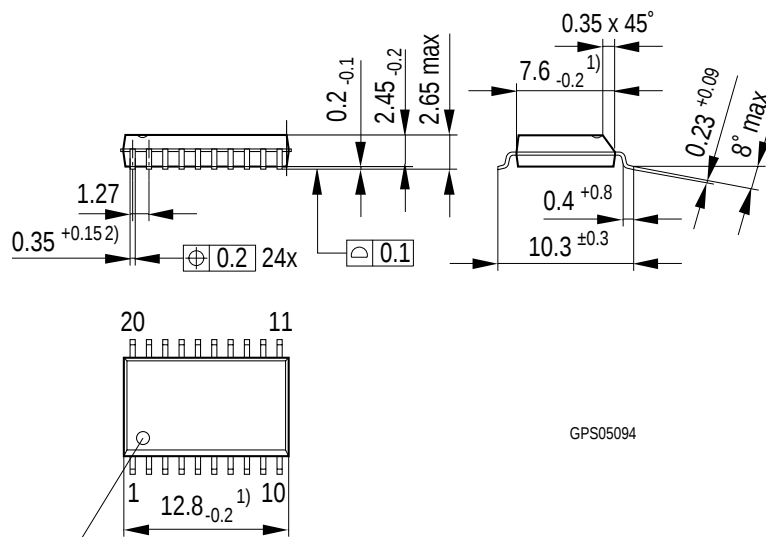
Sorts of Packing

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