PR2301 Single-Chip 48 V True Phantom® Power Supply

PR2301 provides 48 V phantom power for devices in compliance with IEC 61938.

It reduces harmonic distortion of a condenser microphone output to the minimum achievable with a given microphone, microphone preamplifier and load current.

Distortion is reduced by increasing the load resistance for a microphone output stage. For a typical microphone with 4 mA supply current with a PR2301, harmonic distortion decreases by 3.6 dB with a 1 kΩ load and by 14 dB with a 5 kΩ load compared to a standard phantom supply.

Microphone output current is reduced so higher audio levels can be processed without clipping.

Features

- supplies 48 V of phantom power with an 0.8 mA to 10 mA supply current
- reduces total harmonic distortion by between 3.6 dB and 14 dB
- allows larger signal amplitudes without clipping
- complies with standard IEC 61938, P48

Applications

- mixing consoles
- microphone preamplifiers
- standalone digital recorders
- replaces a phantom power supply

Application Circuit

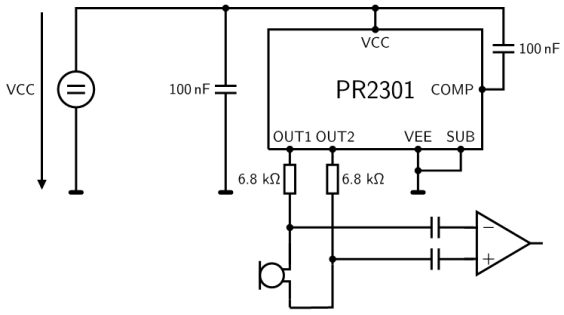

Figure 1: Application circuit.

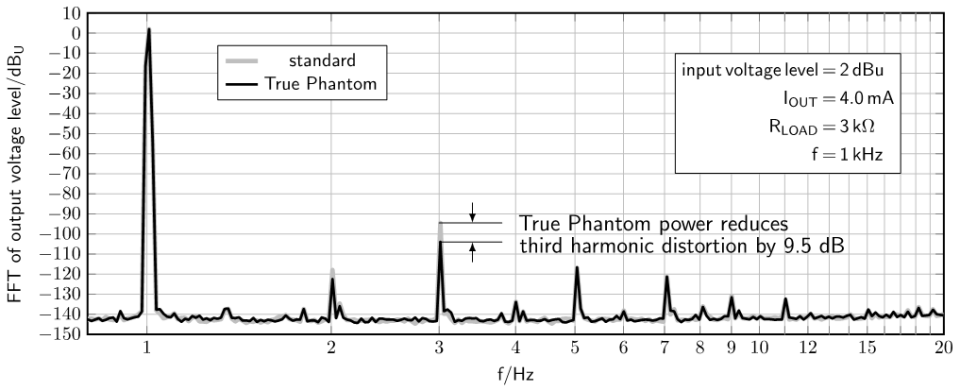

Figure 2: FFT of output signal. Distortion of a condenser microphone output stage consisting of two PNP emitter followers. True Phantom versus standard phantom power for a 1 kHz sine wave. Harmonic distortion is greatly reduced.

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Electrical Characteristics

Absolute Maximum Ratings

Parameter	min	typ	max	Unit
V_{CC}			80	V
I_{OUT}[1]	18			mA
Tj (junction temperature)			125	°C

The 6.8 kΩ resistors that are part of IEC 61938 protect the chip outputs against short circuits.

Parameters

@ VCC = 65 V, T = 21 °C, I_{OUT} = 4 mA

Parameter	min	typ	max	Unit
operating temperature	0		65	°C
T_j (junction temperature)			100	°C
V_{CC}	60	65	70	V
$I(V_{CC})$		5		mA
I_{OUT}	0.8		10	mA
V(OUT1), V(OUT2)	46	48	50	V
I(OUT1) vs. I(OUT2) mismatch			0.4	%
R_{OUT} C_{OUT}	1	 3		MΩ pF

1 for 5 seconds. I_{OUT} is the sum of the currents through outputs OUT1 and OUT2.

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Performance

Performance for a condenser microphone with I_{OUT} = 4.0 mA

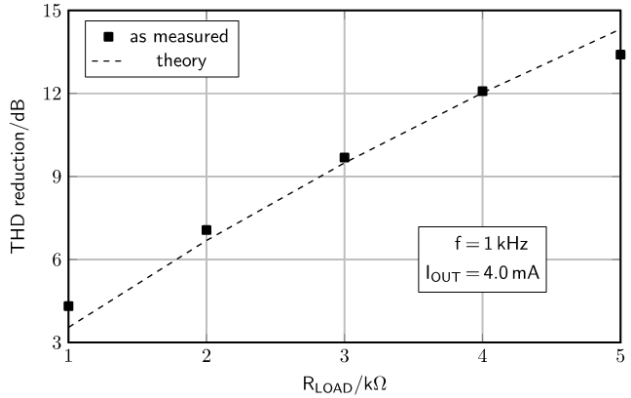
All measurements were made with the PR2301.

Dashed lines in diagrams represent theoretical values without clipping. Equations for theoretical values are given in the appendix of this datasheet.

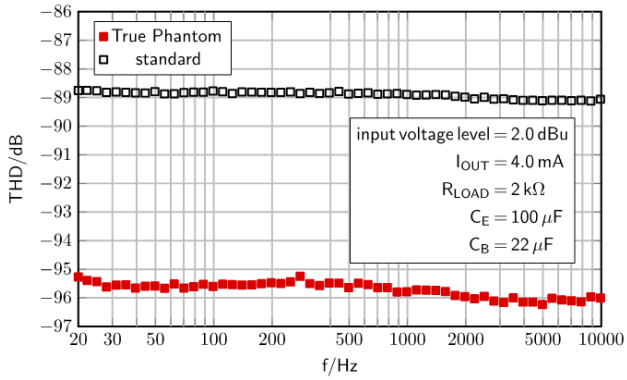
R_{LOAD} represents the input resistance of a microphone preamplifier connected to each side of the microphone output stage.

I_{OUT} is the sum of the two output currents through terminals OUT1 and OUT2.

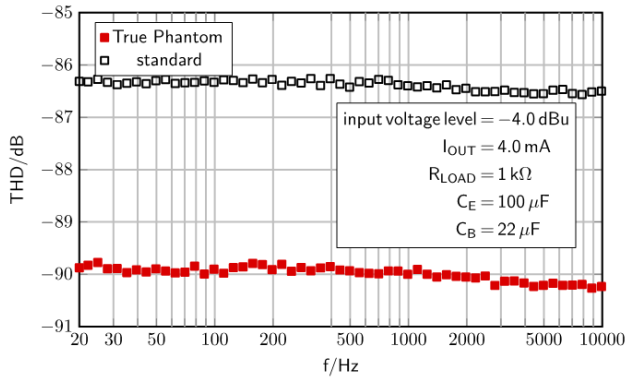
Harmonic Distortion



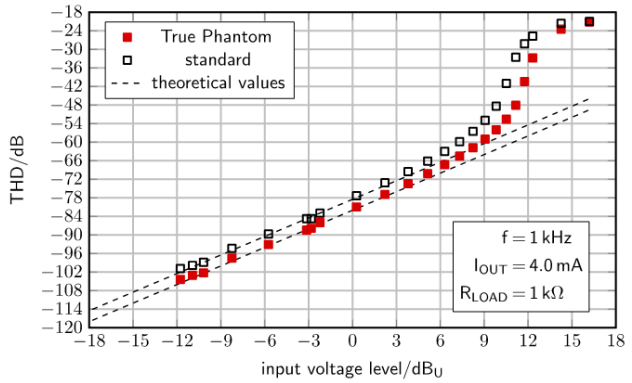
True Phantom power reduction of distortion over standard phantom power supply



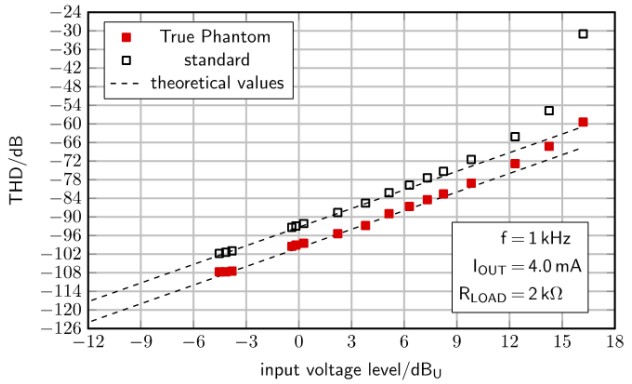
Total harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 2 kΩ, input voltage = 976 mV (2 dBu)



Total harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 1 kΩ, input voltage = 489 mV (-4 dBu)

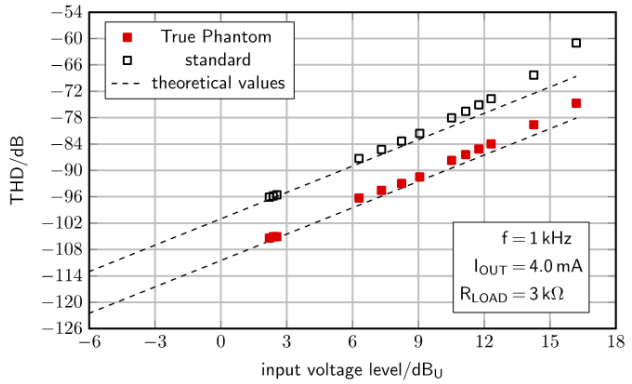


Total harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 1 kΩ

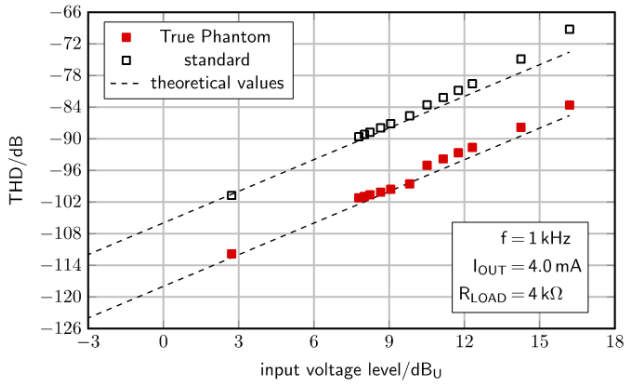


Total harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 2 kΩ

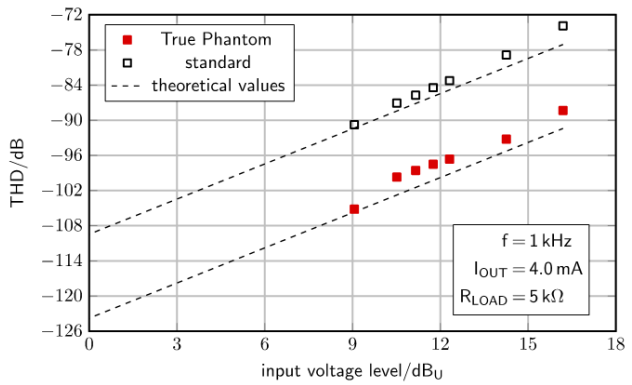
With a standard phantom supply for 1 kΩ loads and for 2 kΩ loads distortion rises steeply as signal levels increase. This distortion is caused by signal clipping. The True Phantom power supply increases signal levels that can be processed before clipping starts.



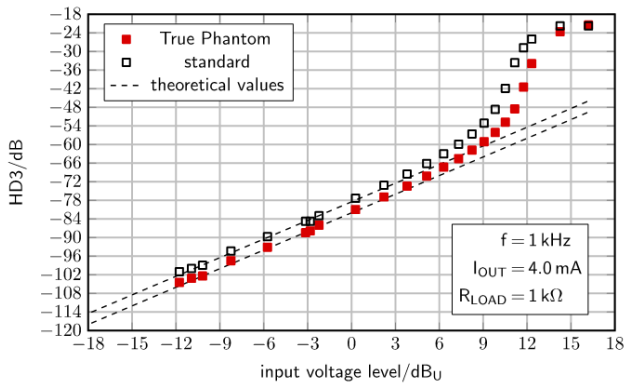
Total harmonic distortion, True Phantom vs. standard phantom supply, RLOAD = 3 kΩ



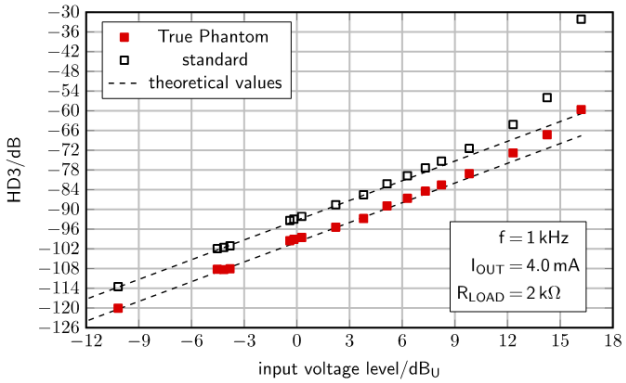
Total harmonic distortion, True Phantom vs. standard phantom supply, RLOAD = 4 kΩ



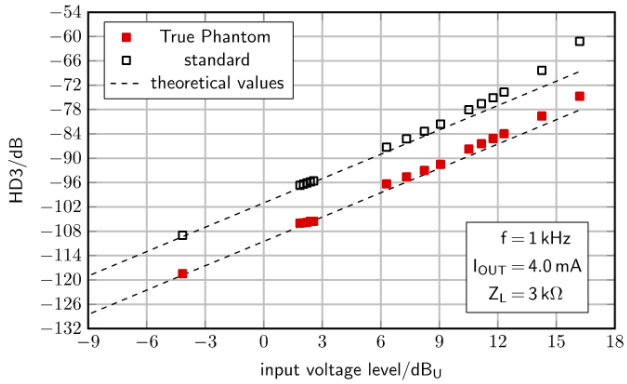
Total harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 5 kΩ



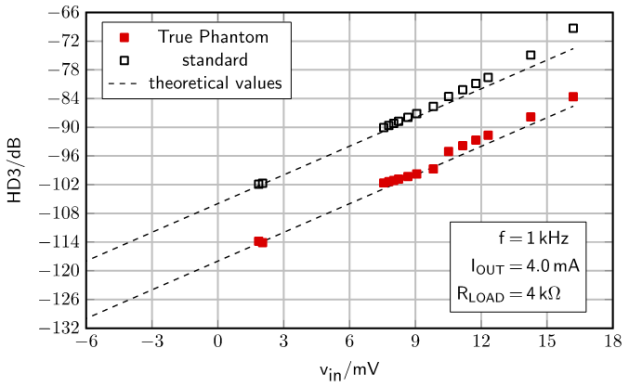
Third harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 1 kΩ



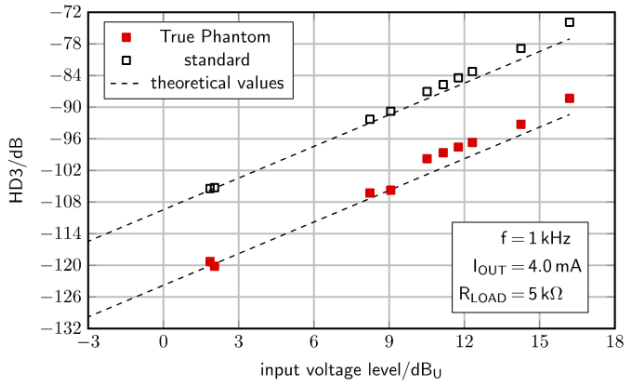
Third harmonic distortion, True Phantom vs. standard phantom supply, RLOAD = 2 kΩ



Third harmonic distortion, True Phantom vs. standard phantom supply, RLOAD = 3 kΩ

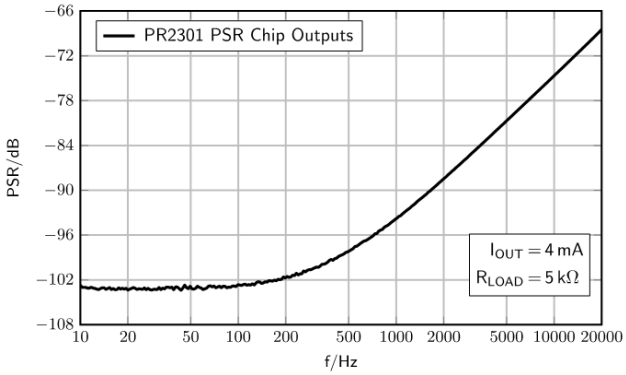


Third harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 4 kΩ

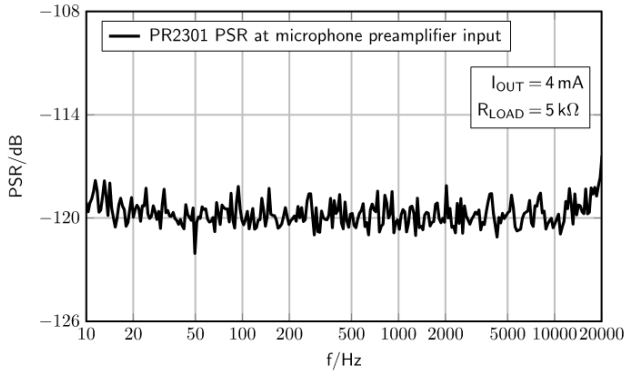


Third harmonic distortion, True Phantom vs. standard phantom supply, R_{LOAD} = 5 kΩ

Power Supply Rejection



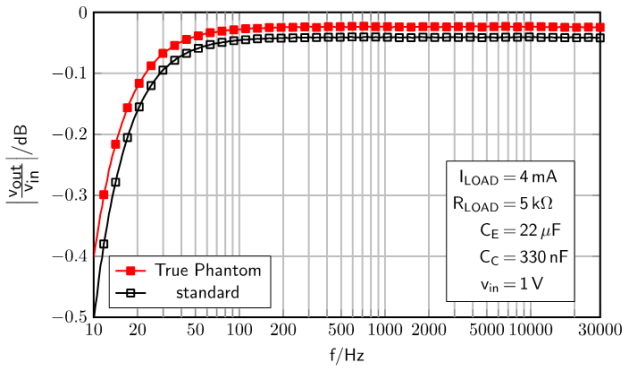
Power supply rejection at chip outputs, I_{OUT} = 4 mA



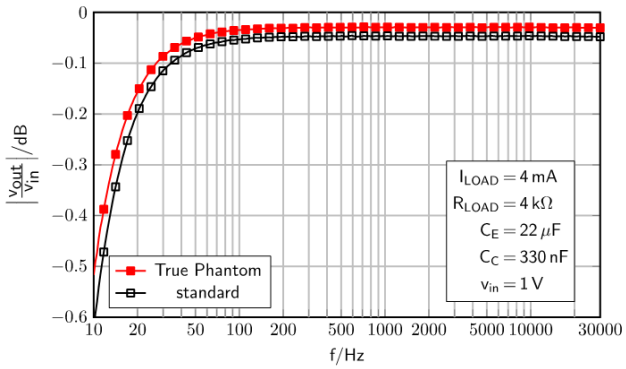
Power supply rejection at microphone output, I_{OUT} = 4 mA, R_{LOAD} 5 kΩ

Frequency Response

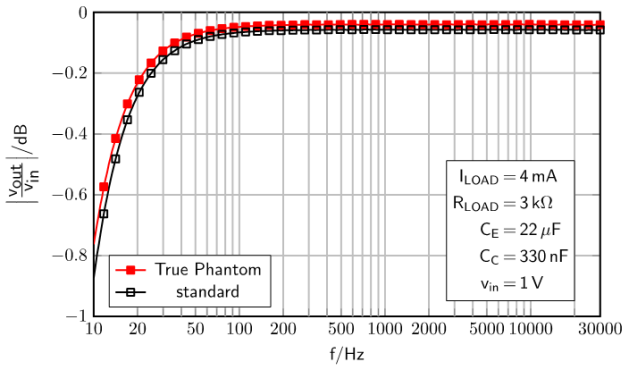
True Phantom Power doesn't affect microphone frequency response negatively.



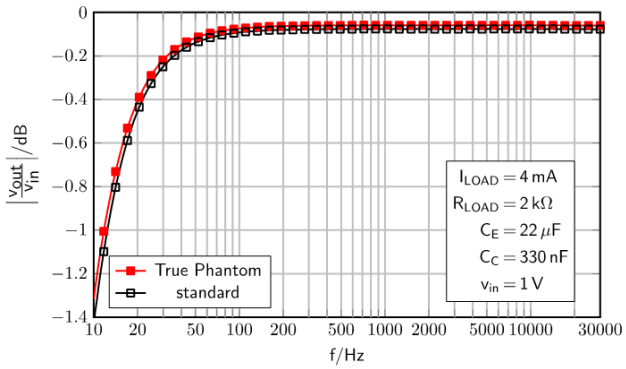
Frequency response, microphone output circuit with True Phantom vs. standard, R_{LOAD} = 5 kΩ



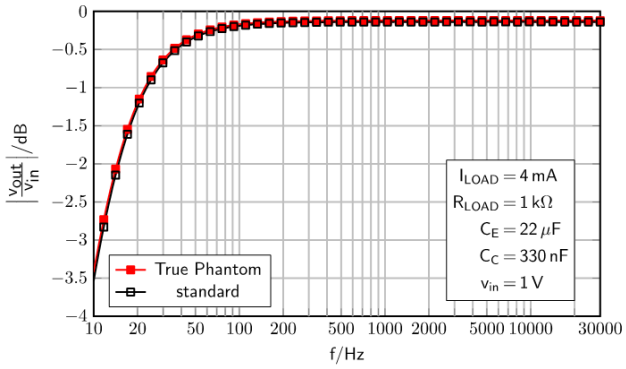
Frequency response, microphone output circuit with True Phantom vs. standard, R_{LOAD} = 4 kΩ



Frequency response, microphone output circuit with True Phantom vs. standard, R_{LOAD} = 3 kΩ



Frequency response, microphone output circuit with True Phantom vs. standard, R_{LOAD} = 2 kΩ



Frequency response, microphone output circuit with True Phantom vs. standard, R_{LOAD} = 1 kΩ

Functional Description

Standard Phantom Power

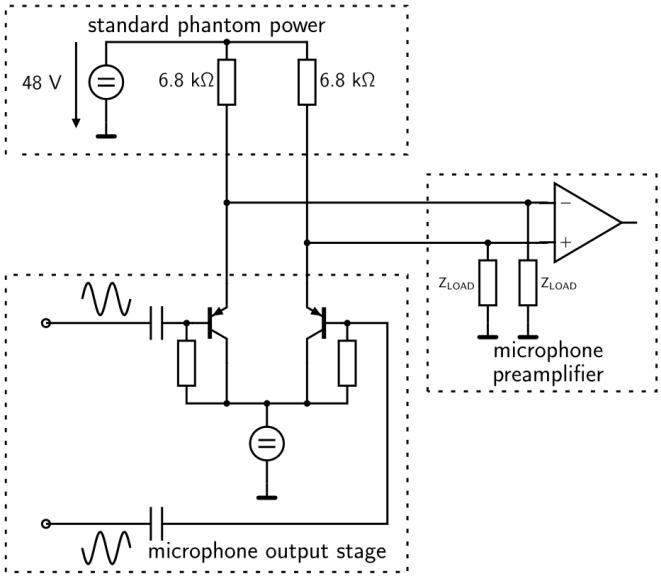


Figure 3: Typical condenser microphone output stage with standard phantom power supply and load (simplified circuit)

A microphone output stage consists generally of two emitter followers.

With a standard phantom power supply the two 6.8 kΩ resistors are in parallel with the microphone amplifier input impedance Z_{LOAD}. Load impedance for the microphone decreases. Harmonic distortion caused by the nonlinearity of the microphone output transistors increases.

Distortion is essentially third harmonic.

True Phantom® Power

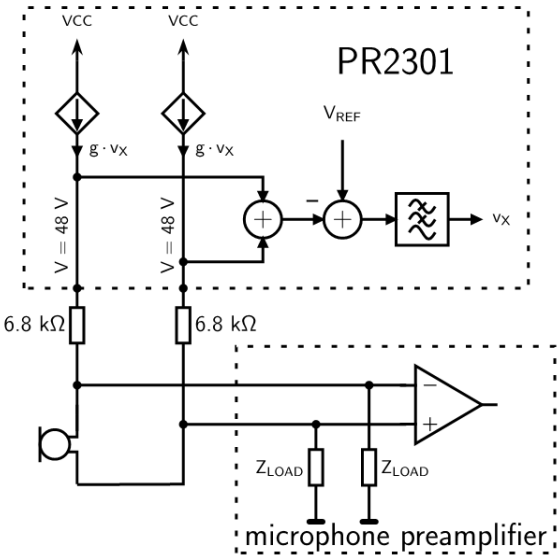


Figure 4: Functional diagram of PR2301 connected to a microphone.

In a True Phantom power supply circuit the voltage source of the standard phantom supply is replaced by a dual controlled current source. Currents are regulated so voltages at both the PR2301 output nodes are 48 V. Each microphone output is connected to a 48 V source as specified by IEC 61938.

For audio frequencies the two chip outputs are high impedance nodes. The 6.8 kΩ resistors don't load the microphone outputs. Load impedance consists solely of the input impedance of the microphone preamplifier. Distortion is kept to the lowest possible amount.

Application Notes and Safety Precautions

Good matching of the 6.8 kΩ resistors decreases distortion and improves power supply rejection. For best performance choose 0.1 % resistors.
Capacitances should be close to chip terminals.

Caution:

- The device must be protected against electrostatic discharge.
- It is advisable to protect the chip terminals against transient voltages.

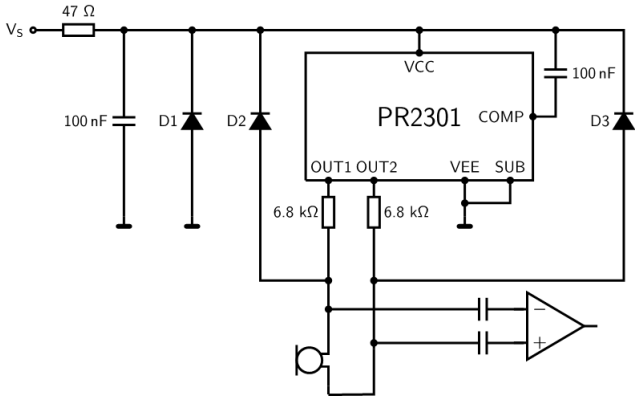


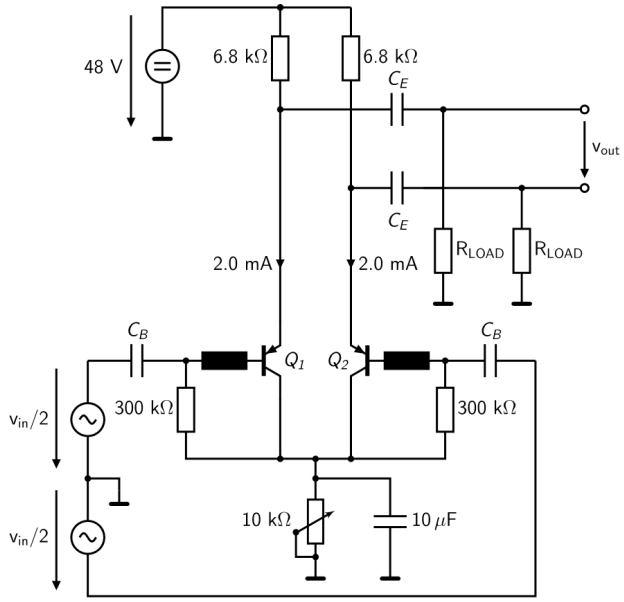
Figure 5: PR2301 with protective circuitry.

D1 fast switching diode, e. g. 1N4936

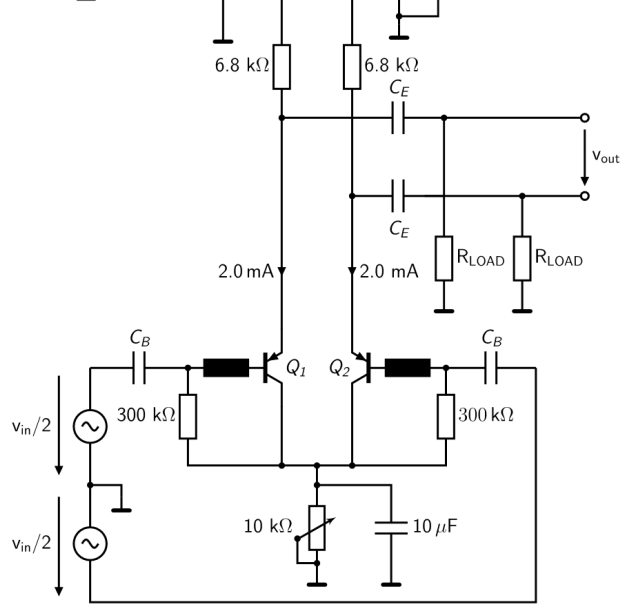
D2, D3 low capacitance diodes.

Pins 7 and 8 must be left unconnected.

Circuits used for parameter measurements



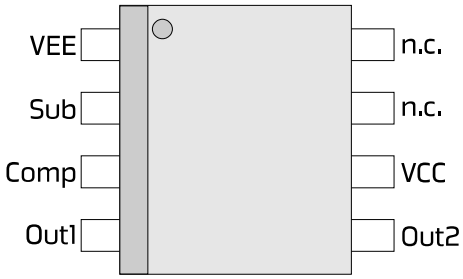
Circuit for measuring distortion and frequency response. Standard phantom.



Circuit for measuring distortion and frequency response. True Phantom.

C_B = 330 nF, C_E = 22 uF if not noted otherwise. VCC = 65 V. Inductances Murata BL01RN1A1 ferrite beads. Tolerances for 6.8 kΩ resistors 0.1 %.

Pinout



Pin Number	Pin Name	Function
1	VEE	negative supply
2	SUB	connect to negative supply
3	COMP	filter
4	OUT1	current output
5	OUT2	current output
6	VCC	positive supply
7	NC	leave unconnected
8	NC	leave unconnected

Appendix

Calculation of distortion of a microphone output stage with True Phantom power supply and standard phantom power supply respectively.

For a microphone output stage with emitter follower outputs and

I_{OUT} sum of DC current through 6.8 kΩ resistors

$\hat{v}$ input signal peak voltage

R_{LOAD} microphone preamplifier input resistance

Total harmonic distortion is approximately

$$THD \approx \frac{\frac{1}{3}\left(\frac{\hat{\imath}}{I_{OUT}}\right)^2 r_e}{R_E - \left(\frac{\hat{\imath}}{I_{OUT}}\right)^2 r_e}$$

with

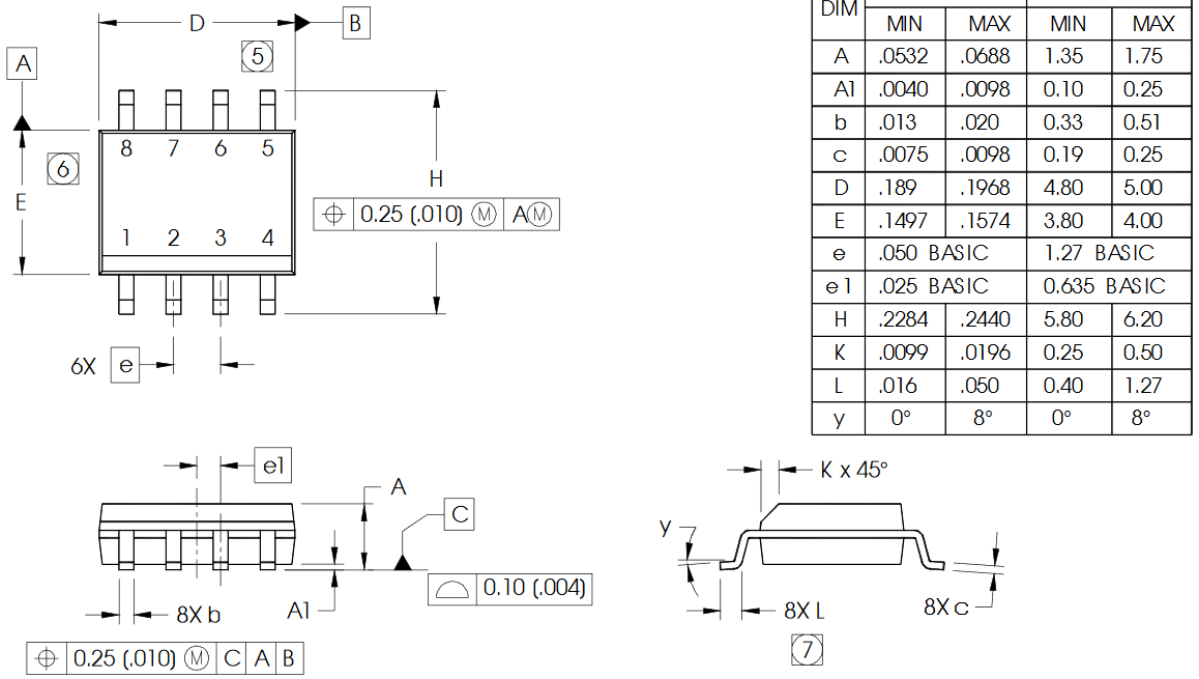
$$R_E = \begin{cases} R_{LOAD} & \text{for True Phantom} \\ \dfrac{1}{\frac{1}{R_{LOAD}} + \frac{1}{6.8\,\mathrm{k}\,\Omega}} & \text{for standard} \end{cases}$$

$$r_e = \frac{26\,\mathrm{mV}}{I_{OUT}}$$

$$\hat{\imath} = \frac{\hat{v}}{R_E + r_e}$$

Package Dimensions

SO-08 package dimensions



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.013	.020	0.33	0.51
c	.0075	.0098	0.19	0.25
D	.189	.1968	4.80	5.00
E	.1497	.1574	3.80	4.00
e	.050 BASIC		1.27 BASIC	
e1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.0099	.0196	0.25	0.50
L	.016	.050	0.40	1.27
y	0°	8°	0°	8°

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