



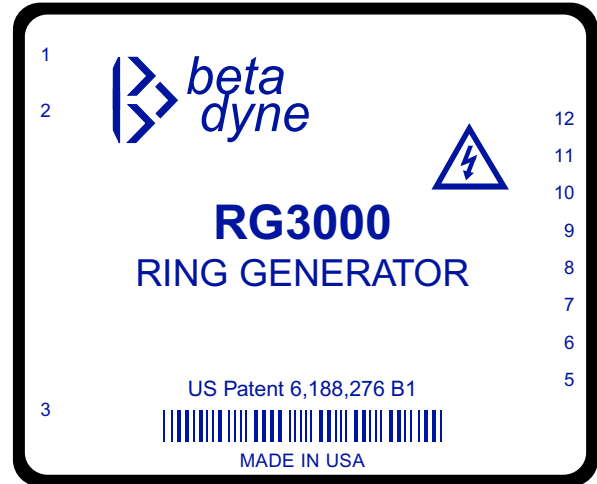
RG3000

RING GENERATOR

US Patent 6,188,276 B1

Key Features

- External frequency selection 18Hz to 80Hz
- External amplitude selection 10Vdc to 220Vdc
- Onboard sinewave programmable reference
- Onboard 5Vdc reference
- Remote ON/OFF control
- 300µA off state current
- Wide input voltage range $40V_{dc} \leq V_{IN} \leq 60V_{dc}$
- Isolated output
- Over/under input voltage protection
- Short circuit protection
- Over temperature protection
- Six-sided shielding



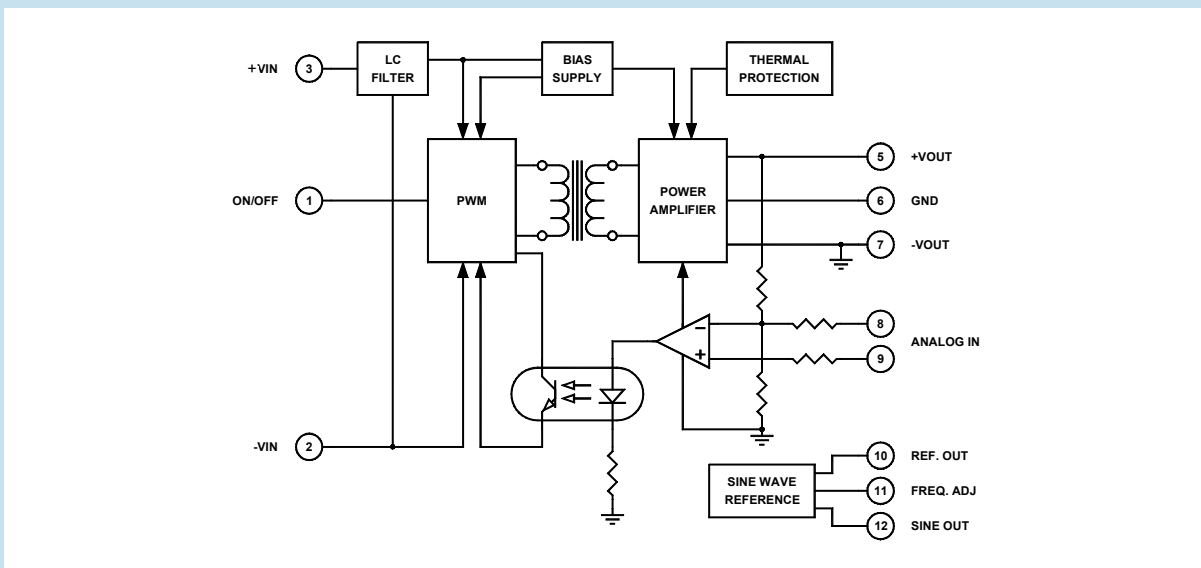
Beta Dyne is protected under various patents, including but not limited to U.S. Patent numbers: 5,777,519; 6,188,276; 6,262,901; 6,452,818; 6,473,3171.

Applications

- PBX, PABX, DLC and Key Systems
- POTS
- Wireless Local Loop Systems
- Short/Long Loop Applications
- Satellite Telephone and VSAT Terminal
- Test Equipment
- Longitudinal Noise Generator

Functional Description

The RG3000 is a power-processing device based on a unique architecture suitable for multiple applications. The RG3000 can operate as a ring generator, DC/DC converter in unipolar or bipolar mode, low-frequency power amplifier, programmable DC or AC power supply or as a high-voltage electronic load for test equipment applications. Key features include isolated output, over/under voltage protection, short circuit protection and thermal protection up to a bandwidth of 2kHz. The input voltage range is from $40V_{IN}$ to $60V_{IN}$.



Typical Block Diagram

Ring Generator

Unless otherwise specified, all parameters are given under typical +25°C with nominal input voltage and under full output load conditions.

PERFORMANCE / FUNCTIONAL SPECIFICATIONS

Specifications typical at: $T_A = +25^\circ\text{C}$, $V_{IN} = 48\text{Vdc}$, Load = 250Ω Resistive, $V_{OUT} = 70V_{RMS}$, $C_1 = 100\mu\text{F}$, $R_3 = 10\text{k}\Omega$, $R_4 = 10\text{k}\Omega$
Setup according to Typical Application 1. See Application Note RG-001.

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
SUPPLY					
Supply Voltage (V_{IN})	Measured between $+V_{IN}$ and $-V_{IN}$ terminals		48		Vdc
Conducted Noise	220kHz, $40\text{Vdc} \leq V_{IN} \leq 60\text{Vdc}$ @ 20W load, Conducted current noise measured through $+V_{IN}$ terminal with DC power source impedance of maximum 0.1Ω .		200		mA_{PP}
Under Voltage Threshold, $V_{IN\ UV}$		40			Vdc
Over Voltage Threshold, $V_{IN\ OV}$		60			Vdc
Recovery from UV/OV				1	S
Current Consumption, Device Off	Pin 1 connected to Pin 2			300	μA
Current Consumption, No Load	Pin 1 = open, Vdc at Pin 1 = 10V		30	40	mA
Current Consumption, Full Load	Pin 1 = open, Vdc at Pin 1 = 10V			1	A
Current Consumption, Peak Current ¹	$V_O = 200V_{PP}$, $R_L = 300\Omega$, $C_L = 100\mu\text{F}$, $F_O = 20\text{Hz}$			1.8	A
Efficiency	$R_L = 330\Omega$, $C_L = 100\mu\text{F}$, $V_{OUT} = 70V_{RMS}$	65	70		%
OUTPUT					
Power	Continuous loading	17	20	25	VA
Power Factor (PF) ($\cos \theta$)	$R_L = 330\Omega$, $C_L = 100\mu\text{F}$	0.5		1	
Output Voltage		0	70	78	V_{RMS}
Amplitude TC	-40° to $+85^\circ\text{C}$, $V_O = 200V_{PP}$		0.08		$V_{PP}/^\circ\text{C}$
Output Capacitance		0.47			μF
Voltage Accuracy			± 3	± 5	%
Line Regulation	$40\text{Vdc} \leq V_{IN} \leq 60\text{Vdc}$		± 1	± 3	%
Load Regulation	$0 \leq P_{OUT} \leq 20\text{VA}$		± 2	± 3	%
Combined Regulation			± 5	± 10	%
Output Frequency, $R_{ADJ} = \infty$			18		Hz
Output Frequency, $R_{ADJ} = 0$	Refer to the Output Frequency Setting table		80		Hz
Frequency Accuracy			1	± 2	%
THD	Selected Frequency, $40\text{Vdc} \leq V_{IN} \leq 60\text{Vdc}$, $0 \leq P_{OUT} \leq 20\text{VA}$, PF > 0.5		1.0	3.0	%
Sinewave Frequency TC	-40°C to $+85^\circ\text{C}$		0.12		$\%FS/^\circ\text{C}$
Turn On Delay			500		mS
Sine Amplitude			6.8		V_{PP}
Offset Voltage		1.4	1.6		V
5Vdc Reference Accuracy	$R_L = 2\text{mA}$		0.1	0.2	%
Reference TC			0.01	0.02	$\%FS/^\circ\text{C}$
Isolation			1500		Vdc
THERMAL					
Operating Temperature Range	$R_L = 330\Omega$, $C_L = 100\mu\text{F}$, $V_{OUT} = 70V_{RMS}$	-40		75	$^\circ\text{C}$
Derating (above 65°C)	$R_L = 330\Omega$, $C_L = 100\mu\text{F}$, $V_{OUT} = 70V_{RMS}$		0.2		$^\circ\text{C/W}$
Thermal Resistance				1.2	$^\circ\text{C/W}$
Thermal Shutdown Case Temperature			88		$^\circ\text{C}$
MTBF	per MIL-HDBK-217F (Ground benign, $+25^\circ\text{C}$)		300,000		hours

TABLE 1. Output frequency settings

F	R _{ADJ}	RANGE
18Hz	∞	
20Hz	300k	±20%
25Hz	47k	±10%
30Hz	22k	±5%
35Hz	13k	±5%

F	R _{ADJ}	RANGE
40Hz	8.2k	±5%
45Hz	6.0k	±5%
50Hz	4.0k	±5%
55Hz	2.7k	±5%
60Hz	2.0k	±5%

F	R _{ADJ}	RANGE
65Hz	1.5k	±5%
70Hz	820Ω	±5%
75Hz	470Ω	±5%
>80Hz	0	

DC/DC Converter

INPUT SPECIFICATIONS (See Application Note RG-001.)

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Supply Voltage Range		40	48	60	Vdc
Input Current, No Load			30		mA
Input Current, Full Load	V _o = 210, I _o = 210mA		1.06		mA
Short Circuit Current		30	50	100	mA
Input Reflected Ripple ²			250		mA _{PP}
Switching Frequency	PWM frequencies		250		kHz
Start Up Threshold			38		Vdc
Under Voltage Shutdown			10		Vdc
Input Filter Type	π Filter				
Off State Input Current			300		μA
Remote ON/OFF Control, ON	Pin open, 10Vdc@100μA, internal pullup				
Remote ON/OFF Control, OFF	Jumper pin to -V _{IN}				
Case Connection	+V _{IN} pin				

OUTPUT SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Voltage, Single Output	Pin 7 = GND, Pin 5 = V _{OUT}	0	100	220	Vdc
Voltage, Dual Output	Pin 6 = GND	0	±50	±110	Vdc
Voltage Imbalance				1	%
Output Current ³				200	mA
Short Circuit Protection	Indefinite				
Load Step Response within 1% of V _{OUT}	50% FL to FL to 50% FL		50	100	μS
Turn On Delay			8		mS
Ripple & Noise	20MHz bandwidth (See App. Note RG-001)		1		% of V _{OUT}
Load Regulation	Minimum to Full Load		1		% of V _o
Line Regulation	Minimum to maximum input voltage			±0.5	%
Temperature Coefficient	Nominal line, Full Load		±0.01	±0.02	%/°C
Efficiency	Full Load	83	85		%
Derating	No derating -40° to +75°C				
Transient Response	50% FL to FL to 50% FL to within 1% of V _{OUT} (See App. Note RG-003)		75		μS
Isolation			1500		Vdc

TABLE 2

V _{OUT}	I _o	P _o
5	1.00A	10W
10	1.00A	20W
30	1.00A	30W
60	0.50A	30W
200	0.15A	30W

Isolated Power Amplifier

The RG3000 can be configured as a unipolar isolated power amplifier with 0V to 10V inputs at either inverting or non-inverting inputs that produces 0V to 220V outputs. See Application Note RG-001.

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Input Voltage Range	Pin 9 short to Pin 7, $V_o = 0V$ to 220V	0.4		3.55	Vdc
Inverting Input (Pin 8)	Pin 9 open, $V_o = 0V$ to 220V	1.25		10.4	Vdc
Non-inverting (Pin 9)	Pin 8 open, Pin 8 RC/V = 6.62	4.5		10	Vdc
Input Resistance Inverting	Pin 8		3.3		k Ω
Input Resistance Non-inverting	Pin 9		5.1		k Ω
Input Offset Voltage	Pin 8 resistive reference		6.62		Vdc
Gain Inverting Input (Pin 8)	Pin 9 short on Pin 7, $V_o = -71V_{IN} + 250$				
	Pin 9 open, $V_o = -24V_{IN} + 250$ (See App. Note RG-003)				
Gain Non-inverting (Pin 9)	Pin 8 open, $V_o = 47V_{IN} - 220$ (See App. Note RG-003)				
Gain Bandwidth Small Sign	Pin 8 = V_{IN} , Pin 9 = open (See App. Note RG-003)			2000	Hz
Gain Bandwidth Full Power	Pin 9 = V_{IN} , Pin 8 = open		200	350	Hz
Slew Rate		1			V/ μ S
Settling Time to $\pm 1\%V_o$	Including Slew Rate		300		μ S
Gain TC	Including Reference TC		0.01	0.025	%/ $^{\circ}$ C
Isolation			1500		Vdc

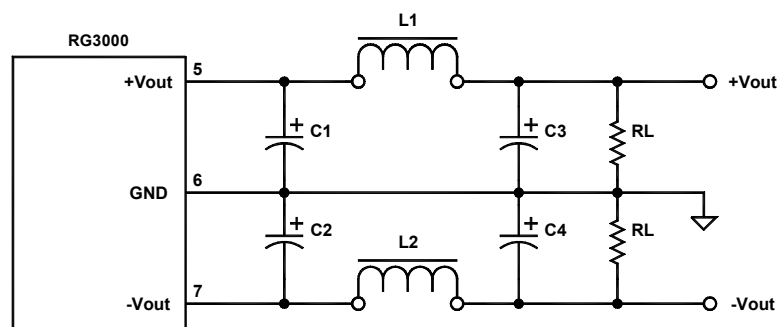
PHYSICAL CHARACTERISTICS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Dimensions (LxWxH)	3.00x2.54x0.77 in. (76.20x64.52x19.43mm)				
Weight	7.48 oz. (212g)				
Case Material	Coated metal				
Shielding Connection	+ V_{IN} (Pin 3)				

¹ When the ARG3000 is used as a DC/DC converter where low ripple & noise is required, an LC differential node filter can be used to reduce ripple & noise (see Figure 1). The same filter can be used in a ringer or power amplification application, however the bandwidth of the unit will be reduced and the internal power dissipation will be increased.

² Measured with $C_{IN} = 100\mu F$ for 12V, $47\mu F$ for 24V, $47\mu F$ for 48V.

³ Due to the power limiting circuit at the input and the wide output voltage range at the output, the maximum output current at any voltage setting is 2A or 30W of output power. See the example in Table 2.



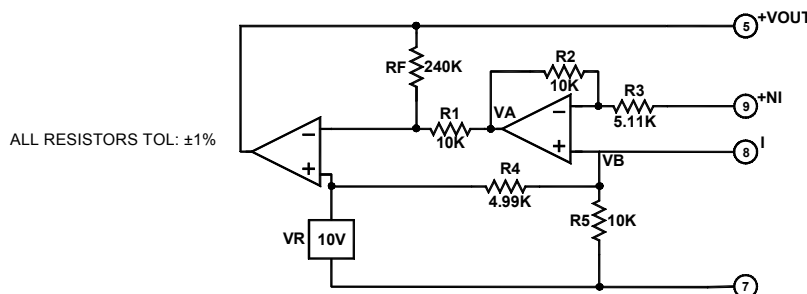
$C1, C2 = 1$ to $3.3\mu F$ @ 200V

$C3, C4 = 1$ to $3.3\mu F$ @ 200V

$L1, L2 = 1$ to $10\mu H$

$I_{Lsat} \geq 1.5I_o$

FIGURE 1. Output filter for Bipolar Adjustable DC/DC Converter



$$V_o = V_R \left(1 + \frac{R_F}{R_1}\right) - \frac{R_F}{R_1} V_A$$

$$V_A = V_B \left(1 + \frac{R_2}{R_3}\right) - \frac{R_2}{R_3} V(NI)$$

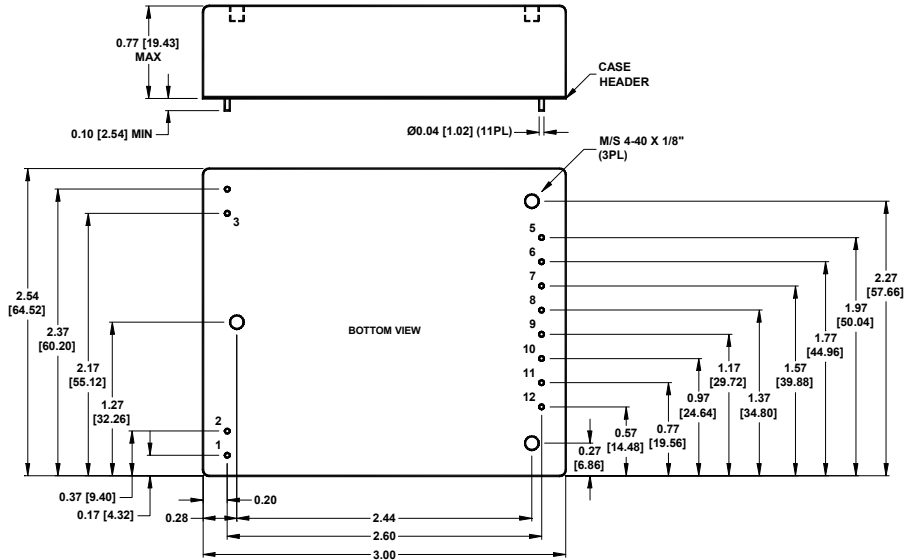
| Pin 8 open

$$V_A = \left(1 + \frac{R_2}{R_3}\right) V_B$$

| Pin 9 shorted to Pin 7

FIGURE 2. Output stage of RG3000

MECHANICAL SPECIFICATIONS
in inches [mm]



Pin	Function
1	ON/OFF
2	$-V_{IN}$
3	$+V_{IN}$
4	No Pin
5	$+V_{OUT}$
6	GND
7	$-V_{OUT}$
8	INV INPUT
9	NON-INV INPUT
10	REF. OUT
11	FREQ. ADJ
12	SINE OUT

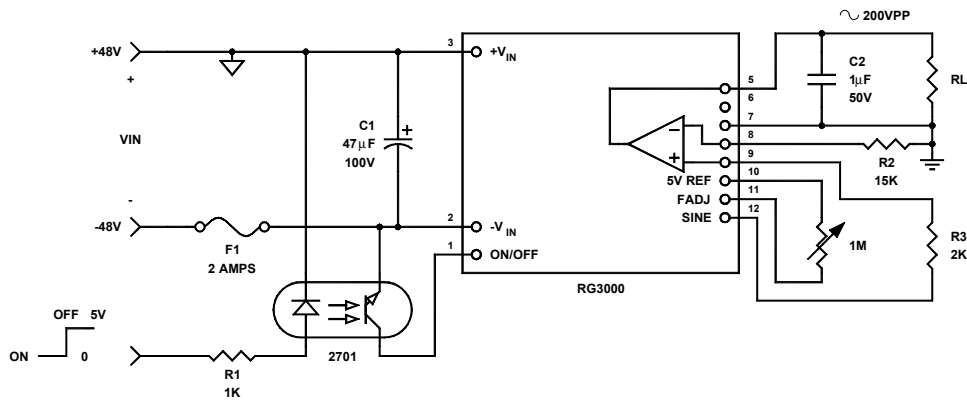


FIGURE 3. Ring Generator with 200V_{pp}, 18 to 80Hz non-inverting input connection

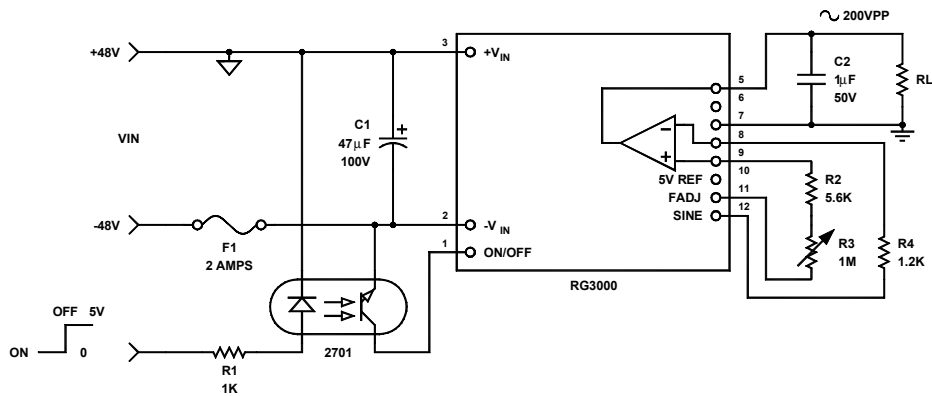


FIGURE 4. Ring Generator with 200V_{pp}, 18 to 80Hz inverting input connection

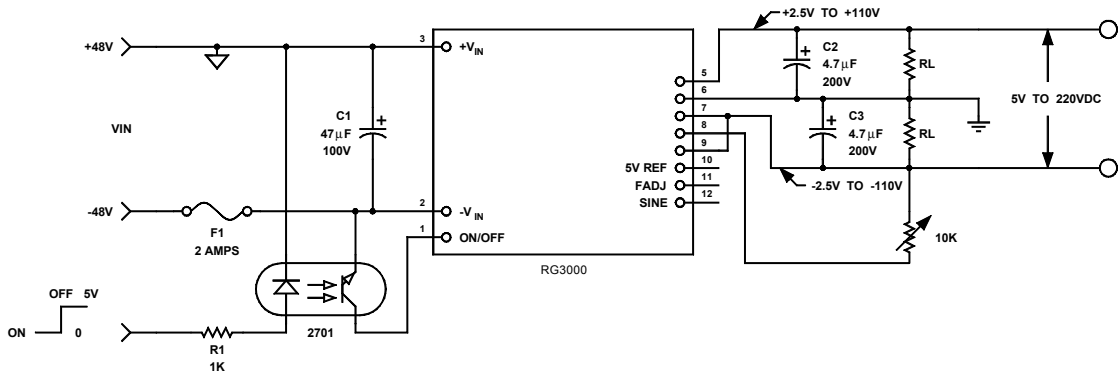


FIGURE 5. Unipolar 20 to 210V, bipolar ±10V to ±105V DC/DC Converter

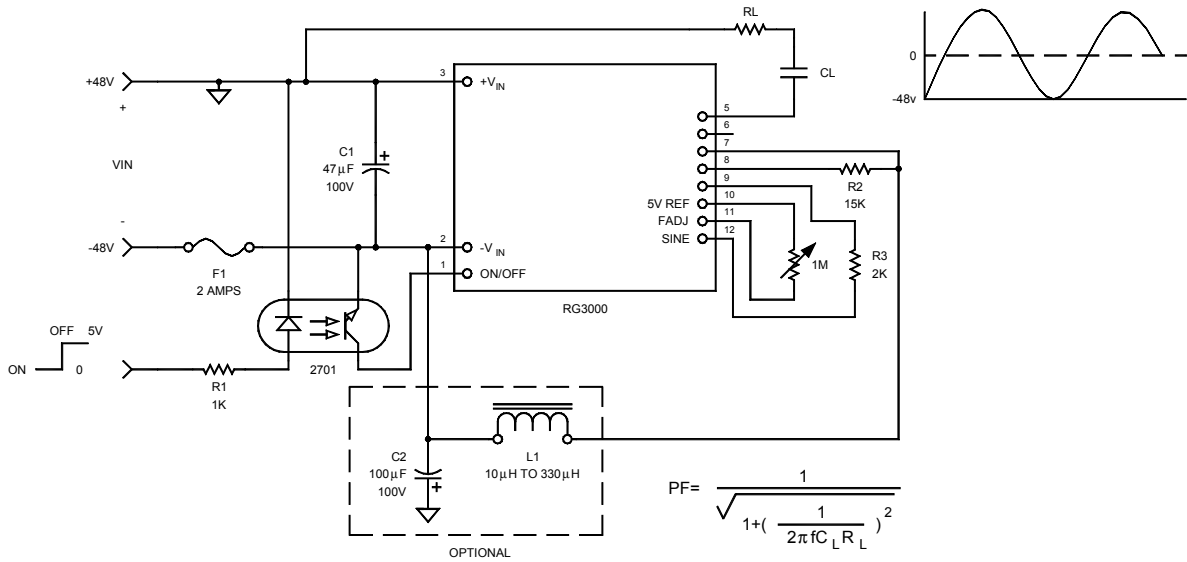


FIGURE 6. 200V_{pp} sine wave on -48V bus

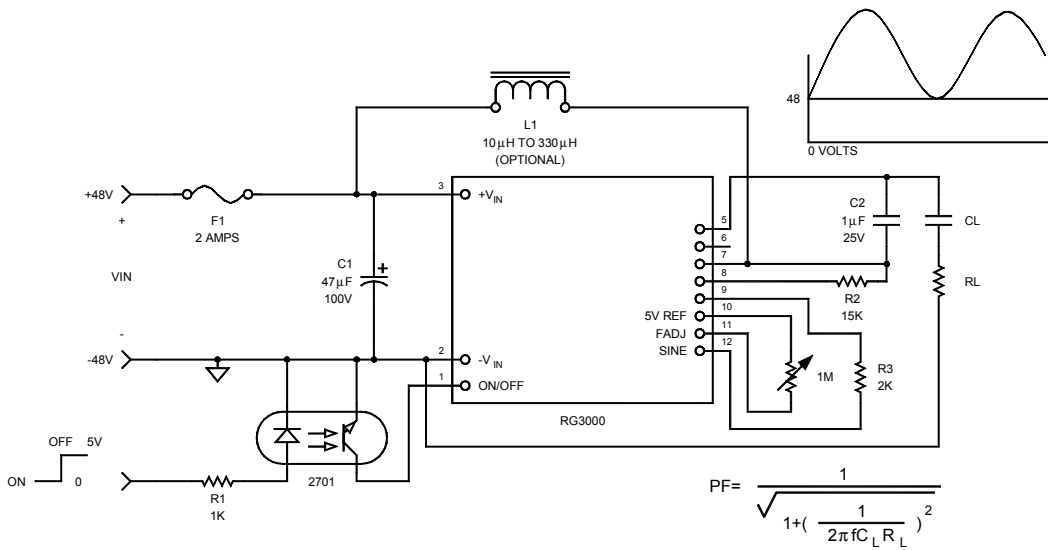


FIGURE 7. 200V_{pp} sine wave on +48V bus

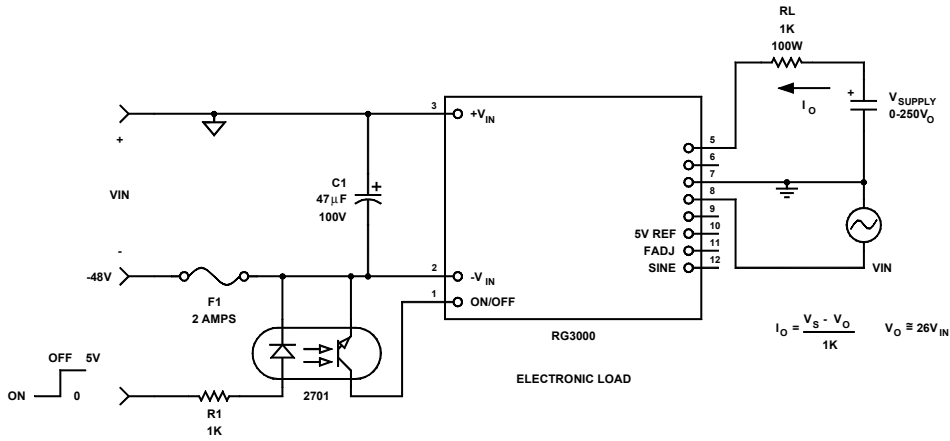


FIGURE 8. Electronic Load

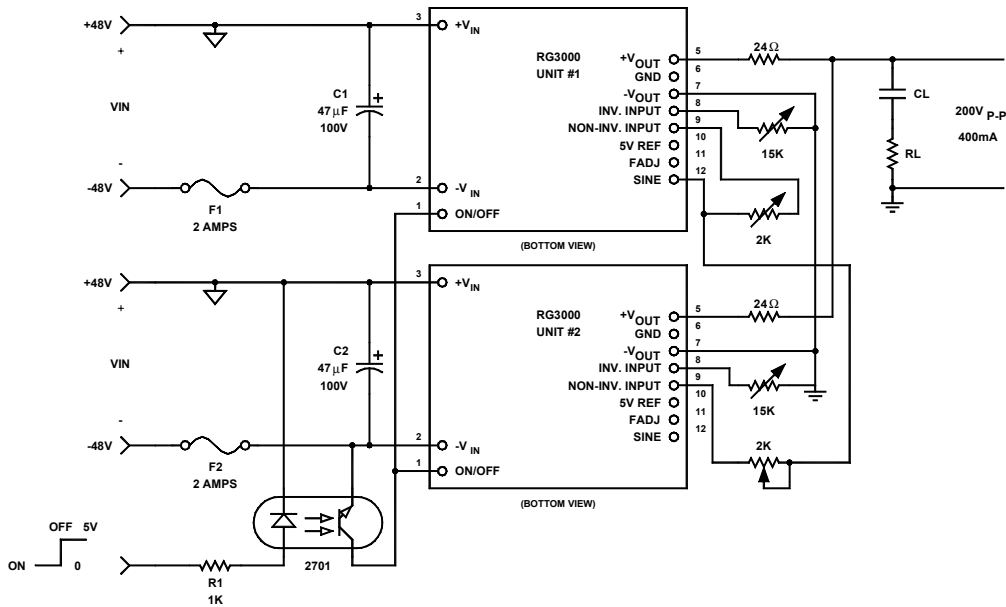


FIGURE 9. Parallel connection diagram of RG3000

NOTE: Only one sine wave reference is used to drive both generators. The 24Ω resistor at the positive outputs is required to compensate for any mismatch in the turn delays, gain, or offset.

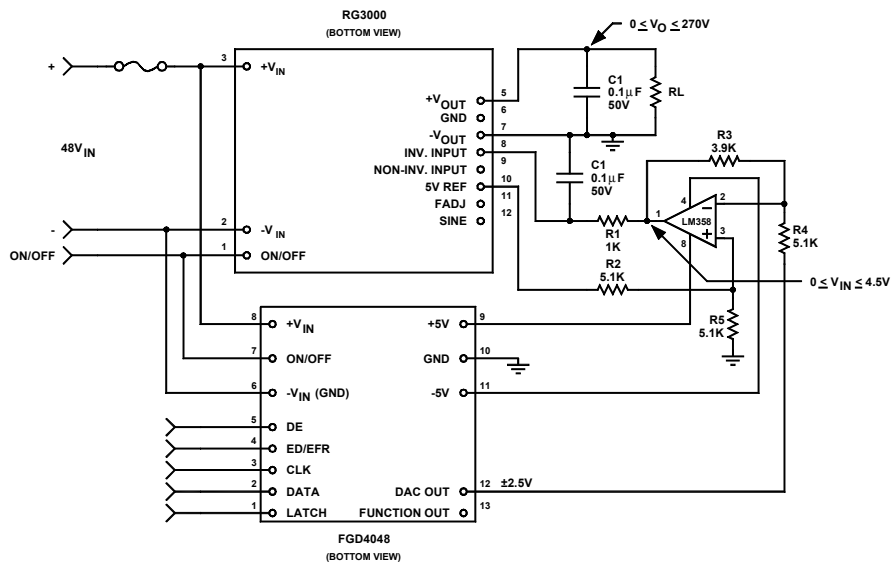


FIGURE 10. Precision high-voltage programmable Function Generator