Supertex inc.

20 REN Ring Generator HV441DB2

Introduction

The Supertex HV441 is a power-efficient, switch-mode ring generator IC requiring minimal external components.

The HV441DB2 demo board contains all the circuitry necessary to drive a 20 REN (North American) ringer load. Simply connect power supplies, ringer load, and enable input as shown below.

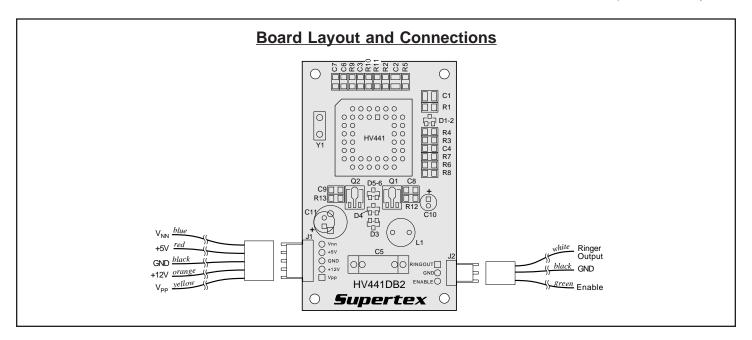
For a more detailed description on using the HV441, please refer to Application Note AN-H35.

Specifications

Ringing Frequency 20Hz \pm 2Hz Ringing Amplitude 58V_{RMS} \pm 5% Ringer THD <10% Output Offset \pm 48V_{DC} \pm 3V

(using a $12V \pm 2.5\%$ supply) ax Ringer Load 20 REN

Max Ringer Load 20 REN (North American)



V_{NN} and V_{PP} Supplies

 V_{PP} is +56.5V ±5%. V_{NN} is -153V ±5%. The voltage difference between these two supplies must not exceed 220 volts. Current draw from each supply is less than 80mA. Output filter capacitance of these supplies must be at least 200 μ F.

The +5V and +12V supplies must always be powered up before the V_{NN} and V_{PP} supplies. See the section on supply sequencing, next page.

+12 Volt Supply

Required tolerance is ±2.5%. Current draw is less than 5mA.

Ringer output offset is referenced to the 12 volt supply and varies 4 volts for every 1 volt change in the supply.

+5 Volt Supply

Required tolerance is $\pm 10\%$. Current draw is less than 5mA.

Enable

This input enables/disables the ringer output. A logic high (5V) turns the output ON, while a low (0V) turns the output OFF. The enable pin must not be left floating. When OFF, the output is in a high impedance state. Both turn-on and turn-off are synchronized to occur when the ringing signal crosses -48 volts.

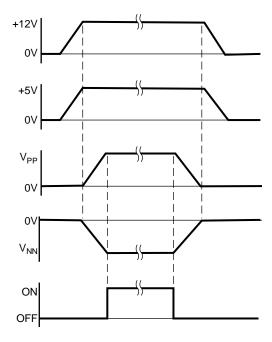
The output must be enabled only after the supplies are stable.

Ringer Output

Connect the ringer load between this output and ground. The load need not be AC coupled, although current draw from the V_{NN} supply will increase to about 140mA with a DC coupled load, due to the -48V $_{\rm DC}$ output offset.

Supply Sequencing

The +5V and +12V supplies must always be powered up before the V_{NN} and V_{PP} supplies. In addition, the Enable input should be ON only after the supplies have stabilized, and should be OFF before the supplies are powered-down. The following sequencing is recommended.



5 REN Capability

Supertex has available a demo board designed to drive 5 RENs (HV441DB1) without the need for discrete transistors and using smaller components. The supplied board (HV441DB2) is certainly capable of driving 5 RENs, but may be modified for 5 REN applications, as outlined below. Refer to the board layout and connection diagram at the beginning of this note for component locations.

- 1. Remove Q1 and Q2
- 2. Solder a BAV99 in the D5-6 location
- 3. Change L1 to 1.5mH (150mA rating)*
- 4. Change C5 to 220nF (200VDC rating)
- Change C10 and C11 to 2.2μF (100VDC and 200VDC ratings respectively)
- 6. Change R12 and R13 to 4.3Ω (1/8W rating)
- 7. Ensure the V_{NN} and V_{PP} supplies are capable of 20mA and have at least $47\mu F$ of output capacitance
- * Not all inductors behave similarly, especially at higher frequencies.

 The recommended inductor is a Toko 187LY-152J.

Other Ringing Frequencies

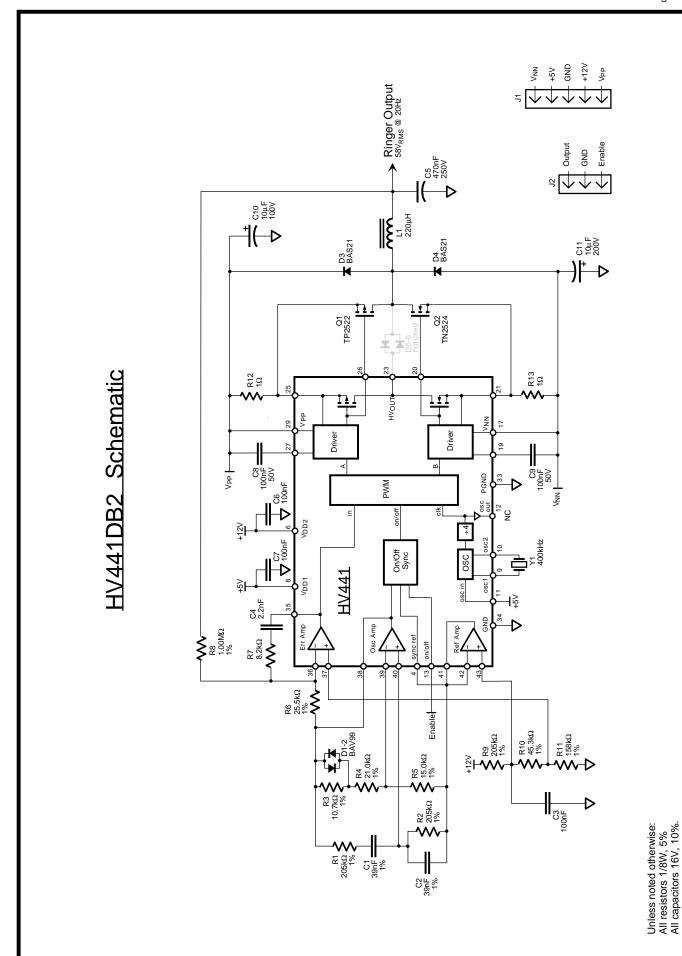
By simply changing two resistors, the supplied circuit may be modified to provide ringing frequencies other than 20Hz. The following table lists the resistors to change for some standard ringing frequencies. Please refer to the board layout and connection diagram at the beginning of this note for component locations.

Ringing Frequency ¹	R1 & R2	Accuracy ²
16.7Hz	243kΩ	0.6%
20Hz	205kΩ	-0.5%
25Hz	162kΩ	0.8%
30Hz	137kΩ	-0.7%
33.3Hz	121kΩ	1.3%
40Hz	102kΩ	0.0%
42Hz	97.6kΩ	-0.4%
50Hz	80.6kΩ	1.3%
54Hz	75.0kΩ	0.8%
60Hz	68.1kΩ	-0.1%
66.7Hz	60.4kΩ	1.3%

- 1 Values for other frequencies may be determined from $f_{rine} = (2\pi RC)^{-1}$ where R=R1=R2 and C=C1=C2.
- 2 Not including component tolerances.

Output Ripple Reduction

As supplied, the HV441DB2 has less than $1V_{RMS}$ of output ripple. To obtain even lower ripple, C5 may be increased. However, do not exceed $2\mu F$, as distortion of the ringing signal may result. The capacitor should be rated for 200VDC, non-polarized.



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B2		20	REN Ring	Generat	or Demo	20 REN Ring Generator Demo Board BOM	
Description	Value	C	Rating	Package	Ž	Mfg DN	

Description Value Tol Rating Header, Spin, ight angle, 0.1", tin 1 1 1 Connector, 3-wire, 24AWG, 0.1" 1 1 1 Connector, 3-wire, 24AWG, 0.1" 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 10.7K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 2.05K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 8.2K 5% 1/8W Resistor 8.2K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 8.2K 5% 1/8W Resistor 1.00M 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 2.00K 1/9W 50V Capacitor, film 3.00K 2.00K 2.00K </th <th></th> <th>7001</th> <th></th> <th>Í</th> <th>20 NEW NILLY Generator Denno Board Born</th> <th>פוופומו</th> <th></th> <th></th>		7001		Í	20 NEW NILLY Generator Denno Board Born	פוופומו		
Header, S-pin, right angle, 0.1*, tin Header, S-pin, right angle, 0.1*, tin Header, S-pin, right angle, 0.1*, tin Connector, S-wire, 24AWG, 0.1* Connector, S-wire, 24AWG, 0.1* 200K Connector, S-wire, 24AWG, 0.1* 100K Connector, S-wire, 24AWG, 0.1* 205K Resistor 205K 1% Resistor 10.7K 1% Resistor 21.0K 1% Resistor 15.0K 1% Resistor 25.5K 1% Resistor 1.0M 1% Resistor 25.K 1/8W Resistor 1.0M 1% Capacitor, film 39nF 1% Capacitor, caramic XTR 100NF 10% Capacitor, caramic XTR 100NF 10%	Desig	Description	Value	Tol	Rating	Package	Mfg	Mfg PN
Header, 3-pin, right angle, 0.1*, tin Connector, 5-wire, 24AWG, 0.1* Connector, 5-wire, 24AWG, 0.1* Connector, 3-wire, 24AWG, 0.1* Connector, 3-wire, 24AWG, 0.1* 1.6 Connector, 3-wire, 24AWG, 0.1* 1.6 1.6 Connector, 3-wire, 24AWG, 0.1* 205K 1% 1.6WW Resistor 1.0 1.7 1.6WW Resistor 2.05K 1% 1.6WW Resistor 1.0 1.7 1.6WW Resistor 2.5,5K 1.6 1.6WW Resistor 1.00M 1% 1.6WW Resistor 1.00M 1% 1.6WW Resistor 1.00M 1% 1.6WW Resistor 1.00M 1% 1.6WW Resistor 1.0 1.0 1.6WW Resistor 1.0 5% 1.6WW Resistor 1.0 1.0 5% 1.6WW Resistor 1.0 5% 1.6WW 1.6WW Resistor Capacitor, ceramic XTR 1.0 5% <td< td=""><td>٦</td><td>Header, 5-pin, right angle, 0.1", tin</td><td></td><td></td><td></td><td></td><td>Molex</td><td>22-05-3051</td></td<>	٦	Header, 5-pin, right angle, 0.1", tin					Molex	22-05-3051
Connector, 5-wire, 24AWG, 0.1" Connector, 5-wire, 24AWG, 0.1" Connector, 3-wire, 24AWG, 0.1" Connector, 3-wire, 24AWG, 0.1" Connector, 3-wire, 24AWG, 0.1" 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 10.7K 1% 1/8W Resistor 15.0K 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 1.00M 1/8 1/8W Capacitor, film 2.00M 2.00K 1/8W <t< td=""><td>JZ</td><td>Header, 3-pin, right angle, 0.1", tin</td><td></td><td></td><td></td><td></td><td>Molex</td><td>22-05-3031</td></t<>	JZ	Header, 3-pin, right angle, 0.1", tin					Molex	22-05-3031
Connector, 3-wire, 24AWG, 0.1" Connector, 3-wire, 24AWG, 0.1" Connector terminals, tin QTY 8 Connector terminals, tin QTY 8 Resistor 205K 1% 1/8W Resistor 10.7K 1% 1/8W Resistor 205K 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 1.0M 1% 1/8W Resistor 2.0E 1/8W 1/8W Capacitor, film 3.0E 1/8W 1/8W Capacitor, film 2.	J3	Connector, 5-wire, 24AWG, 0.1"					Molex	22-01-2061
Connector terminals, fin QTY 8 Connector terminals, fin QTY 8 Connector terminals, fin QTY 8 Socket, 44-pin PLCC 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 21.0K 1% 1/8W Resistor 10.7K 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 1.00M 1% 1/8W Resistor 205K 1/8W 1/8W Resistor 1.00M 1% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 2.0 5% 1/8W Capacitor, film 2.0 5% 1/8W Capacitor, film 2.0 5% 1/8W Capacitor, ceramic X7R 1.00 5% 1/8	ا ل	Connector, 3-wire, 24AWG, 0.1"					Molex	22-01-2031
Socket, 44-pin PLCC 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 10.7K 1% 1/8W Resistor 21.0K 1% 1/8W Resistor 25.5K 1% 1/8W Resistor 205K 1% 1/8W Resistor 205K 1% 1/8W Resistor 1.0M 1% 1/8W Capacitor, film 39hF 1% 1/8W Capacitor, ceramic X7R 100hF 10% 50V Capacitor, seramic X7R <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Molex</td> <td>08-50-0114</td>							Molex	08-50-0114
Resistor 205k 1% 1/8W Resistor 205k 1% 1/8W Resistor 205k 1% 1/8W Resistor 21.0k 1% 1/8W Resistor 25.5k 1% 1/8W Resistor 25.5k 1% 1/8W Resistor 205k 1% 1/8W Resistor 205k 1% 1/8W Resistor 205k 1% 1/8W Resistor 205k 1/8W 1/8W Resistor 100M 1% 1/8W Resistor 205k 1/8W 1/8W Resistor 205k 1/8W 1/8W Resistor 205k 1/8W 1/8W 1/8W Resistor 205k 1/8W 1/8W 1/8W 1/8W Capacitor, ceramic X7R 100h 10h 5% 1/8W 1/8W Capacitor, ceramic X7R 100h 10h 50h 100h 20h	J5	Socket, 44-pin PLCC					Any	I
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Resistor 25.5K 1% 1/8W Resistor 8.2K 5% 1/8W Resistor 1.00M 1% 1/8W Resistor 206K 1% 1/8W Resistor 1.0 1.0 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 1/8W Capacitor, ceramic XTR 100hF 10% 50V Capacitor, ceramic XTR 100hF 20m	R5	Resistor	15.0k	1%	1/8W	1206	Any	I
Resistor 8.2k 5% 1/8W Resistor 1.00M 1% 1/8W Resistor 205k 1% 1/8W Resistor 45.3k 1% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 1/8W Capacitor, ceramic XTR 100nF 1% 50V Capacitor, ceramic XTR 100nF 10% 50V Capacitor, ceramic XTR 100nF 20% 10 Capacitor, ceramic XTR 100nF </td <td>R6</td> <td>Resistor</td> <td>25.5k</td> <td>1%</td> <td>1/8W</td> <td>1206</td> <td>Any</td> <td>I</td>	R6	Resistor	25.5k	1%	1/8W	1206	Any	I
Resistor 1.00M 1% 1/8W Resistor 205k 1% 1/8W Resistor 45.3k 1% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39hF 1% 50V Capacitor, film 470hF 10% 50V Capacitor, ceramic X7R 100hF 10% 50V Capacitor, ceramic X7R 100hF 10% 50V Capacitor, ceramic X7R 100hF 20% 10A	R7	Resistor	8.2k	2%	1/8W	1206	Any	I
Resistor 205k 1% 1/8W Resistor 45.3k 1% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 250V Capacitor, aluminum electrolytic 10µF 20% 10V Capacitor, aluminum electrolytic 10µF 20% 250V Capacitor, aluminum electrolytic 10µF 20%	R8	Resistor	1.00M	1%	1/8W	1206	Any	I
Resistor 45.3k 1% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 10M Capacitor, aluminum electrolytic 10µF 20% 250V Capacitor, aluminum electrolytic 10µF 20% 250V Capacitor, aluminum electrolytic 10µF 20%	R9	Resistor	205k	1%	1/8W	1206	Any	I
Resistor 158k 1% 1/8W Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 1A Capacitor, aluminum electrolytic 10µF 20% 1A Capacitor, aluminum electrolytic 10µF 20% 1A Diode, array, general purpose Diode, fast recovery <td>R10</td> <td>Resistor</td> <td>45.3k</td> <td>1%</td> <td>1/8W</td> <td>1206</td> <td>Any</td> <td>I</td>	R10	Resistor	45.3k	1%	1/8W	1206	Any	I
Resistor 1.0 5% 1/8W Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 10mF 20% 100 Capacitor, aluminum electrolytic 10mC 20%		Resistor	158k	1%	W8/1	1206	Any	1
Resistor 1.0 5% 1/8W Capacitor, film 39nF 1% 50V Capacitor, caramic XTR 100nF 1% 50V Capacitor, ceramic XTR 2.2nF 10% 50V Capacitor, ceramic XTR 470nF 10% 50V Capacitor, ceramic XTR 100nF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 70V, 100mA Diode, array, general purpose 220µH 20% 70V, 100mA Diode, fast rec	R12	Resistor	1.0	5%	1/8W	1206	Any	1
Capacitor, film 39nF 1% 50V Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 10mF 10% 50V Capacitor, ceramic X7R 10mF 20% 100V Capacitor, duminum electrolytic 10mF 20% 100V Capacitor, aluminum electrolytic 10mF 20% 1A Inductor 220µH 20% 1A Capacitor, aluminum electrolytic 10mF 20% 1A Capacitor, aluminum electrolytic 10mF 20% 1A Ceramic Resonator 220µH 20% 1A Diode, fast recovery 250V, 200mW <td>R13</td> <td>Resistor</td> <td>1.0</td> <td>5%</td> <td>1/8W</td> <td>1206</td> <td>Any</td> <td>I</td>	R13	Resistor	1.0	5%	1/8W	1206	Any	I
Capacitor, film 39nF 1% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, duminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 10N Capacitor, aluminum electrolytic 10µF 20% 10N Capacitor, aluminum electrolytic 10µF 20% 10N Capacitor, aluminum electrolytic 10m 20% 10N Ceramic Resonator 20m 10m 20% 10m	C1	Capacitor, film	39nF	1%	200	1210	Any	1
Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, metallized polyester film 470nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 10mF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 250V Inductor 20mH 20% 250V Inductor 20mH 250V 250V Diode, fast recovery 250v 250v 250V Inductor	C2	Capacitor, film	39nF	1%	Λ09	1210	Any	Ι
Capacitor, ceramic X7R 2.2nF 10% 50V Capacitor, metallized polyester film 470nF 10% 250V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10μF 20% 250V Capacitor, aluminum electrolytic 10μF 20% 250V Capacitor, aluminum electrolytic 10μF 20% 250V Inductor 220μH 20% 250V Inductor 400kHz 0.3% — Diode, fast recovery 250V, 200mW 250V, 200mW (not used) — — — MOSFET, P-channel — — — Ring Generator IC Ring Generator IC — —	C3	Capacitor, ceramic X7R	100nF	10%	200	1206	Any	_
Capacitor, metallized polyester film 470hF 10% 250V Capacitor, ceramic X7R 100hF 10% 50V Capacitor, ceramic X7R 100hF 10% 50V Capacitor, ceramic X7R 100hF 10% 50V Capacitor, aluminum electrolytic 10μF 20% 100V Capacitor, aluminum electrolytic 10μF 20% 150V Capacitor, aluminum electrolytic 10μF 20% 160V Capacitor, aluminum electrolytic 10μF 20% 160V Capacitor, aluminum electrolytic 10μF 20% 170V Inductor 220μH 20% 170V Diode, fast recovery 250µH 250V, 200mW (not used) — — MOSFET, P-channel — — Ring Generator IC Ring Generator IC 220V, 17A	C4	Capacitor, ceramic X7R	2.2nF	10%	200	1206	Any	_
Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10μF 20% 100V Capacitor, aluminum electrolytic 10μF 20% 14A Inductor 2220μH 20% 1A Ceramic Resonator 400kHz 0.3% — Diode, fast recovery 250V, 200mW 250V, 200mW Inot used) — — — MOSFET, P-channel — — — MOSFET, N-channel Rina Generator IC Rina Generator IC 220V, 17A	C2	Capacitor, metallized polyester film	470nF	10%	720V	1	Any	1
Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 10mF 20% 100V Capacitor, aluminum electrolytic 10μF 20% 250V Inductor 220μH 20% 1A Ceramic Resonator 400kHz 0.3% — Diode, fast recovery 250V, 200mW 250V, 200mW Inductor — — — Moshert, P-channel — — — MOSFET, P-channel — — — Ring Generator IC Ring Generator IC 220V, 17A	90	Capacitor, ceramic X7R	100nF	10%	Λ09	1206	Any	Ι
Capacitor, ceramic X7R 100nF 10% 50V Capacitor, ceramic X7R 100nF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 250V Inductor 220µH 20% 1A Ceramic Resonator 400kHz 0.3% — Diode, fast recovery 770V, 100mA 250V, 200mW Inductor — — — Moshert, P-channel — — — MOSFET, P-channel 220V, 0.75A Ring Generator IC Ring Generator IC 240V, 1A	C2	Capacitor, ceramic X7R	100nF	10%	200	1206	Any	1
Capacitor, ceramic X7R 100hF 10% 50V Capacitor, aluminum electrolytic 10µF 20% 100V Capacitor, aluminum electrolytic 10µF 20% 250V Inductor 400kHz 0.3% — Diode, array, general purpose 400kHz 0.3% — Diode, fast recovery 250V, 100mA 250V, 200mW (not used) — — — MOSFET, P-channel 220V, 0.75A Ring Generator IC Ring Generator IC 220V, 1A 220V, 1A	C8	Capacitor, ceramic X7R	100nF	10%	200	1206	Any	1
Capacitor, aluminum electrolytic 10μF 20% 100V Capacitor, aluminum electrolytic 10μF 20% 250V Inductor 220μH 20% 1A Ceramic Resonator 400kHz 0.3% — Diode, array, general purpose 70V, 100mA 250V, 200mW Diode, fast recovery 250V, 200mW 250V, 200mW (not used) — — — MOSFET, P-channel 220V, 0.75A Ring Generator IC Ring Generator IC 240V, 1A	60	Capacitor, ceramic X7R	100nF	10%	50V	1206	Any	1
Capacitor, aluminum electrolytic 10µF 20% 250V Inductor 220µH 20% 1A Ceramic Resonator 400kHz 0.3% — Diode, array, general purpose 70V, 100mA 250V, 200mW Diode, fast recovery 250V, 200mW — (not used) — — MOSFET, P-channel 220V, 0.75A Ring Generator IC 220V, 1A	C10	Capacitor, aluminum electrolytic	10µF	20%	100V		Panasonic	ECA-2AM100
Inductor	C11	Capacitor, aluminum electrolytic	10µF	20%	250V	I	Panasonic	ECA-2EM100
Ceramic Resonator 400kHz 0.3% — Diode, array, general purpose 70V, 100mA 70V, 100mA Diode, fast recovery 250V, 200mW 250V, 200mW (not used) — — MOSFET, P-channel — — MOSFET, N-channel 220V, 0.75A Ring Generator IC 240V, 1A	L	Inductor	220µH	20%	1A		J. W. Miller	6000-221K
Diode, array, general purpose 70V, 100mA Diode, fast recovery 250V, 200mW Diode, fast recovery 250V, 200mW (not used) — MOSFET, P-channel 220V, 0.75A Ring Generator IC 240V, 1A	۲۱	Ceramic Resonator	400kHz	0.3%			Murata	CSB400J
Diode, fast recovery 250V, 200mW Diode, fast recovery 250V, 200mW (not used) — MOSFET, P-channel 220V, 0.75A Ring Generator IC 240V, 1A	D1-2	Diode, array, general purpose			70V, 100mA	SOT-23	Any	BAV99
Diode, fast recovery 250V, 200mW (not used) — — MOSFET, P-channel 220V, 0.75A Ring Generator IC 240V, 1A	D3	Diode, fast recovery			250V, 200mW	SOT-23	Any	BAS21
(not used) — — — MOSFET, P-channel 220V, 0.75A MOSFET, N-channel 240V, 1A Ring Generator IC 240V, 1A	D4	Diode, fast recovery			250V, 200mW	SOT-23	Any	BAS21
MOSFET, P-channel 220V, 0.75A MOSFET, N-channel 240V, 1A Ring Generator IC 240V, 1A	D2-6	(not used)			I	1	1	1
MOSFET, N-channel Ring Generator IC	Q	MOSFET, P-channel			220V, 0.75A	SOT-89	Supertex	TP2522N8
Ring Generator IC	Q 2	MOSFET, N-channel			240V, 1A	SOT-89	Supertex	TP2524N8
	IC1	Ring Generator IC				PLCC-44	Suptertex	HV441PJ