

# Resonant Ring Generator Controller

## FEATURES

- Novel Topology for Low-Cost, Efficient Generation of Ring Voltage
- Suitable for Multi-Line Operation
- Selectable 20, 25 and 50 Hz Ring Frequency
- Secondary (AC) Current Limiting Generates an Off-Hook Detect Signal
- Primary Current Limiting to Turn Power Stage Off Under Fault Conditions
- Operates from a Single 12V Supply

## DESCRIPTION

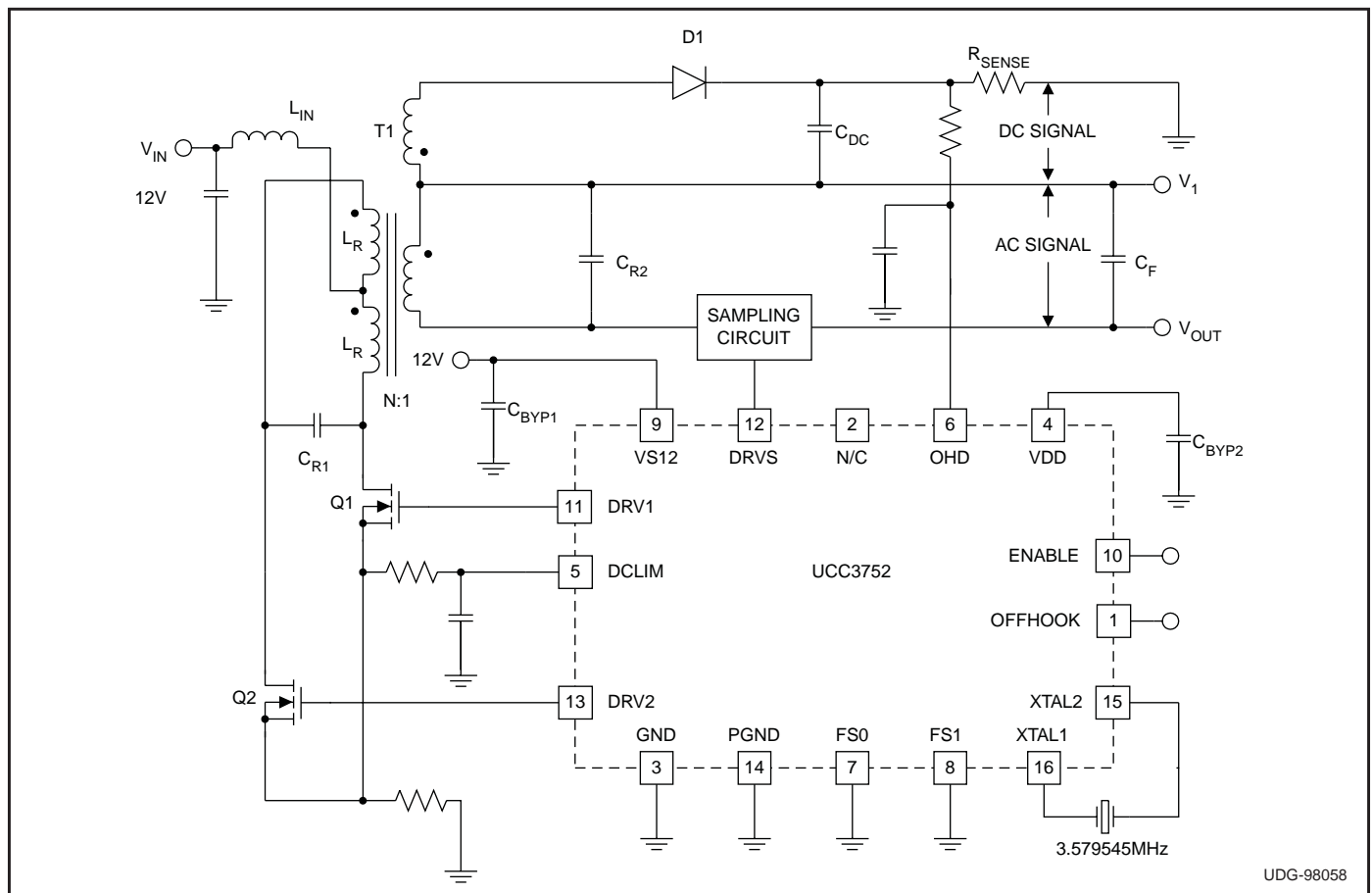
The UCC3752 controller is designed for driving a power stage that generates low frequency, high voltage sinusoidal signals for telephone ringing applications. The controller and the power stage are most suitable for up to 5 line applications where low cost, high efficiency and minimum parts count are critical. A semi-regulated DC voltage is added as an offset to the ringing signal. The ring generator operation is non-isolated and open loop.

The UCC3752 directly drives primary side switches used to implement a push-pull resonant converter topology and transformer coupled sampling switches located on the secondary of the converter. For normal ring signal generation, the primary switching frequency and secondary sampling frequency are precisely offset from each other by the ringing frequency to produce a high voltage low frequency alias signal at the output. The off-hook condition is detected by sensing the AC current and when AC limit is exceeded, a flag is generated on the OFFHOOK pin.

The drive signal frequencies are derived from a high frequency (3579545 Hz) crystal. The primary switching frequency is 89.489 kHz and the sampling frequency is 20, 25 or 50 Hz less depending on the status of frequency select pins FS0 and FS1.

*The circuits described in this datasheet are covered under US Patent #5,663,878 and other patents pending.*

## TYPICAL APPLICATION



## ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage ..... 13.2V  
 Analog Inputs (OHD, DCLIM, XTAL1, XTAL2)  
 Maximum Forced Voltage ..... -0.3 to 5V  
 Logic Inputs  
 Maximum Forced Voltage ..... -0.3 to 7.5V  
 Reference Output Current (VDD) ..... Internally Limited  
 Output Current (DRV1, DRV2, DRVS) Pulsed ..... 1.5A  
 Operating Junction Temperature ..... -40°C to +125°C  
 Storage Temperature ..... -65°C to +150°C

*Note: Unless otherwise indicated, voltages are referenced to ground and currents are positive into, negative out of, the specific terminals. Pulsed is defined as a less than 10% duty cycle with a maximum duration of 500 S.*

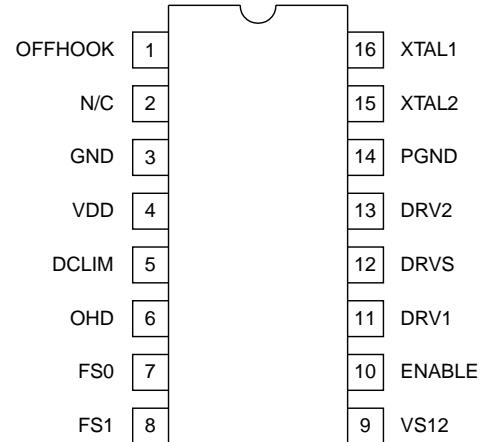
**Table 1. Frequency selectability decoding.**

FS1	FS0	MODE	Sine Wave Frequency (Hz)
0	0	1	20
0	1	1	25
1	0	1	50
1	1	3	0

FS1	FS0	FDRVS	FDRV – FDRVS
0	0	89.469kHz	20Hz
0	1	89.464kHz	25Hz
1	0	89.439kHz	50Hz

## CONNECTION DIAGRAMS

**(TOP VIEW) DIL-16, SOIC-16  
N or D Packages**



**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, these specifications hold for  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for the UCC3752 and  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  for the UCC2752,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>V12 Supply Current Section</b>					
Supply Current	ENABLE = 0V		0.5	3	mA
	ENABLE = 5V		0.5	3	mA
<b>Internal Reference with External Bypass Section</b>					
Output Voltage (VDD)		4.85	5	5.15	V
Load Regulation	$0\text{mA} \leq I_{VDD} \leq 2\text{mA}$		5	20	mV
Line Regulation	$10\text{V} < V_{S12} < 13\text{V}$ , $I_{VDD} = 1\text{mA}$		3	20	mV
Short Circuit Current	VDD = 0	5	10		mA
<b>Output Drivers Section (DRV1, DRV2)</b>					
Pull Up Resistance	$I_{LOAD} = 10\text{mA}$ to $20\text{mA}$		6	15	
Pull Down Resistance	$I_{LOAD} = 10\text{mA}$ to $20\text{mA}$		6	15	
Rise Time	$C_{LOAD} = 1\text{nF}$		50	100	nS
Fall Time	$C_{LOAD} = 1\text{nF}$		50	100	nS
<b>Output Drivers Section (DRVS)</b>					
Pull Up Resistance	$I_{LOAD} = 10\text{mA}$ to $20\text{mA}$		4	10	
Pull Down Resistance	$I_{LOAD} = 10\text{mA}$ to $20\text{mA}$		4	10	
Sample Pulse-Width	Mode 1 (Table 1)	240	280	320	nS
Rise Time	$C_{LOAD} = 1\text{nF}$		50	100	nS
Fall Time	$C_{LOAD} = 1\text{nF}$		50	100	nS

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, these specifications hold for  $T_A = 0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  for the UCC3752 and  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  for the UCC2752,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Current Limit Section</b>					
DCLIM Threshold		250	300	350	mV
DCLIM Input Current	$V_{DCLIM} = 0\text{V}$	-900	-100		nA
<b>OffHook Detect Section</b>					
OHD Threshold		250	300	350	mV
OHD Input Current	$V_{OHD} = 0\text{V}$	-900	-100		nA
Offhook $V_{OH}$	$I_{OFFHOOK} = 1\text{mA}$	3.0	4.0		V
Offhook $V_{OL}$	$I_{OFFHOOK} = -1\text{mA}$		1.0	1.5	V
Offhook Pull-Up Impedance	$I_{LOAD} = 0\text{mA}$ to $1\text{mA}$	100	400	900	
Offhook Pull-Down Impedance	$I_{LOAD} = 0\text{mA}$ to $1\text{mA}$	100	250	900	
<b>Frequency Section (Table 1)</b>					
Primary Switching Frequency	All cases 3.579545 MHz Crystal		89489		Hz
Sampling Switching Frequency	$FS0 = 0$ , $FS1 = 0$ , Mode 1, (Table 1)		89469		Hz
	$FS0 = 1$ , $FS1 = 0$ , Mode 1		89464		Hz
	$FS0 = 0$ , $FS1 = 1$ , Mode 1		89439		Hz

## PIN DESCRIPTIONS

**DCLIM:** Primary current sense input. Signal proportional to the primary switch current. All outputs are turned off when a threshold of 300mV is exceeded on this pin. This current-limit works on a cycle-by-cycle basis.

**DRV1, DRV2:** Low impedance driver outputs for the primary switches. DRV1 and DRV2 are complimentary and have 50% duty cycle.

**DRVS:** Low impedance driver output for the sampling switch(es). The pulse width of this output is 280ns. Typically, a pulse transformer is used to couple the short sampling pulses at DRVS to the floating sampling switch(es).

**ENABLE:** Logic input which turns off the outputs when low.

**FS0, FS1:** Frequency select pins for determining the difference frequency between primary and secondary pulses under normal operation. These pins can be hard-wired to GND or VDD to get one of the available output frequencies (20,25 and 50 Hz). See Table 1 in the spec table.

**GND:** Reference point for all the internal voltages and common return for the device.

**OFFHOOK:** Output indicating the off-hook condition. This signal can be used by an external circuit to switch to a line from the ring generator output to the DC voltage.

**OHD:** Off-Hook Detect. Voltage proportional to output current DC level is fed into this pin and compared to an internal threshold of 300mV. If the threshold is exceeded, the OFFHOOK output goes high.

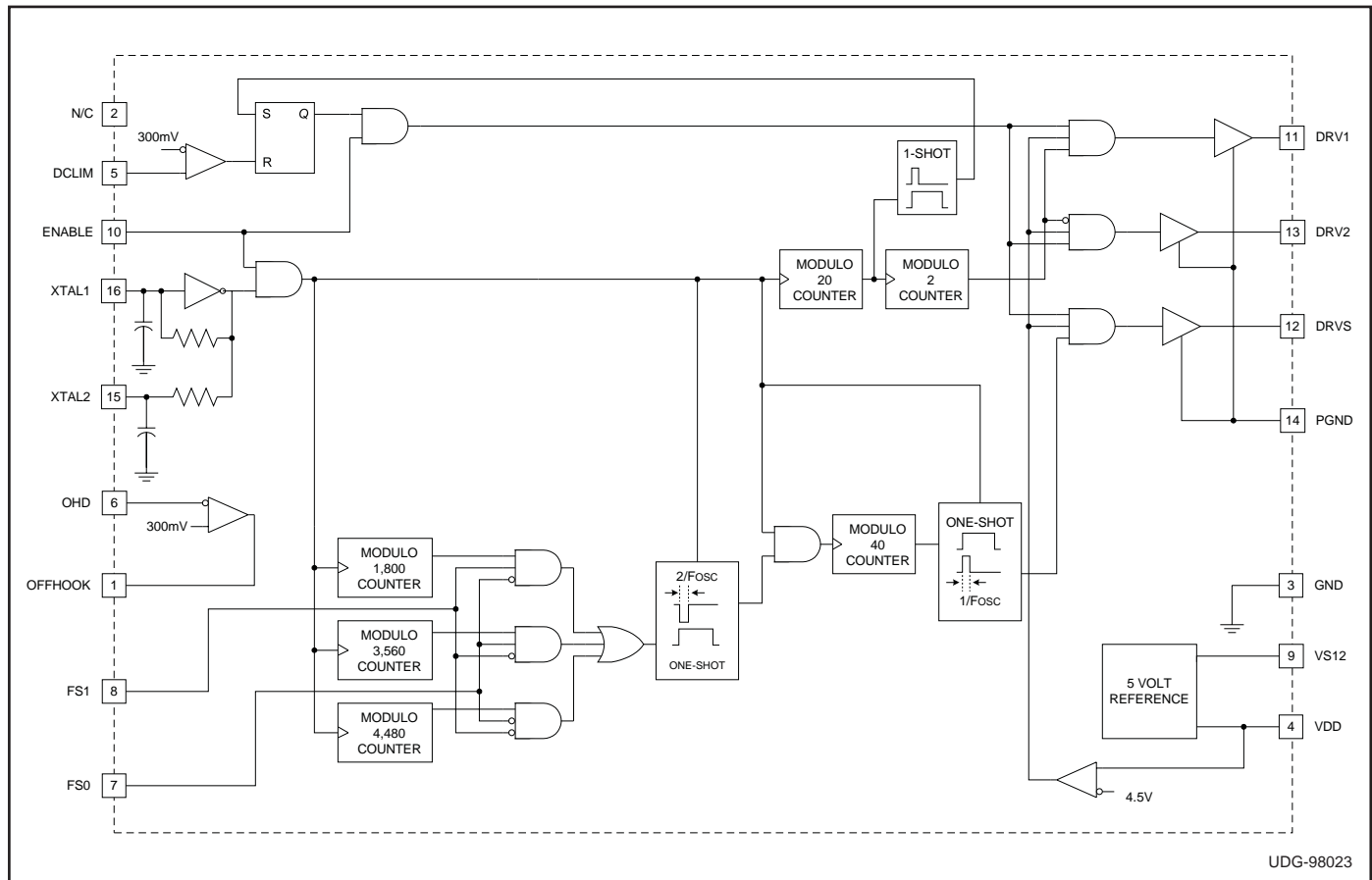
**PGND:** Return point for the output drivers. Connect to GND at a single point in the circuit.

**VDD:** Internal regulated 5V supply. This voltage is used to power all the internal precision circuits of the IC. This pin needs to be bypassed to GND with ceramic capacitor.

**VS12:** External 12V power supply for the IC. Powers VDD and provides voltage for the output drivers.

**XTAL1, XTAL2:** Pins for connecting precision Crystal to attain the accurate output frequencies. An external square-wave pulse can also be applied to XTAL2 if XTAL1 is tied to VDD/2.

## BLOCK DIAGRAM



## APPLICATION INFORMATION

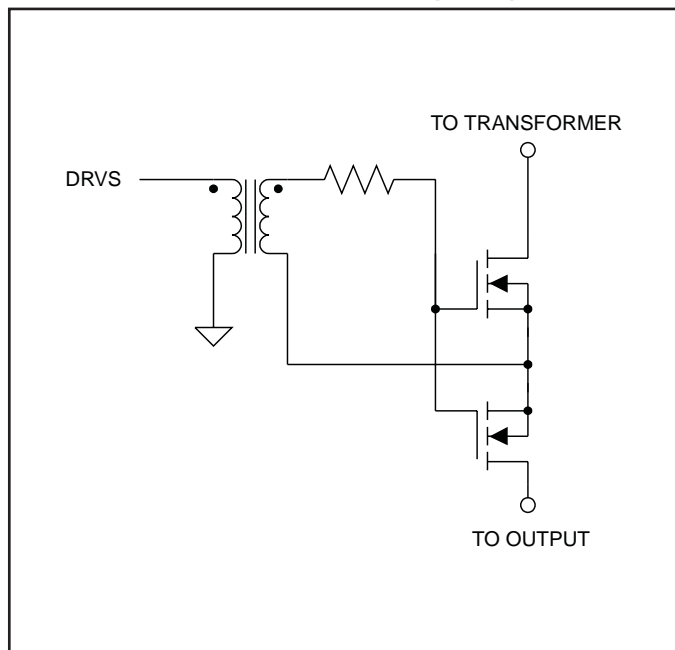
### Power Stage Operation

The power stage used for the UCC3752 application has two distinct switching circuits which together produce the required low frequency signal on the output. The primary side switching circuit consists of a current fed push-pull resonant circuit that generates the high frequency sinusoidal waveform across the transformer winding. The operation of this type of circuit is extensively covered in Unitrode Application notes U-141 and U-148. Resonant components  $C_{R1}$ ,  $C_{R2}$ ,  $L_R$ ,  $N$  should be chosen so that the primary and secondary resonances are well matched. Also, for the UCC3752 operation, switching frequency is fixed by crystal selection. So, the resonant components must be selected to yield a resonant frequency close enough to the switching frequency to get a low distortion sine-wave. Practically, since it is impossible to get an exact match between the two frequencies, the switching frequency should always be higher than the resonant frequency to ensure low distortion and take advantage of ZVT operation. Switches Q1 and Q2 are pulsed at 50% duty cycle at the switching frequency (89.489 kHz) determined by a crystal (3.579545 MHz) connected to the UCC3752. The input voltage for the resonant stage (typically 12V) determines the voltage

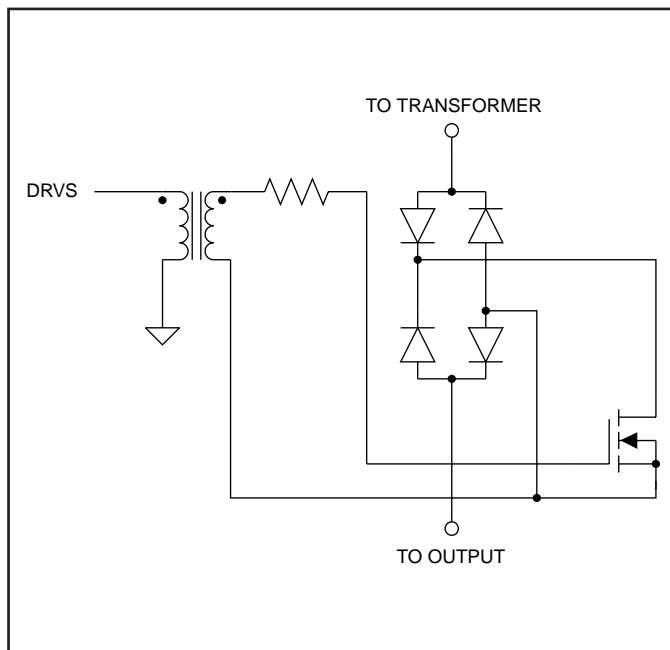
stress of Q1 and Q2. Transformer turns ratio is determined by the output voltage requirements. On the secondary side, the high frequency waveform is sampled at a predetermined frequency (e.g. 89.469 kHz) which differs from the primary switching frequency by the desired output frequency (e.g. 20 Hz). The sampling is accomplished using a bi-directional switching circuit as shown in Figure 1 and Figure 2. Figure 1 shows the sampling mechanism consisting of two back-to-back FET switches allowing current flow in both directions. The sampling can also be done with a single active switch and a full-bridge rectifier as shown in Fig. 2. The DRVS pin of the UCC3752 provides the drive signal for the sampling switch(es) and this signal is coupled through a pulse transformer. Typical pulsewidth of the sampling signal is 280nS. As a result of sampling, the resultant output signal matches the secondary voltage in amplitude and has a low output frequency desired for ring generation.

The secondary winding of the power transformer also has a tap (or a separate winding) to generate a loosely regulated DC voltage. This DC voltage can be used to offset the ring generator output. It can also be used as a power supply for supplying talk battery voltage in some applications.

# APPLICATION INFORMATION (cont.)



**Figure 1. Sampling circuit with two FETs.**



**Figure 2. Sampling circuit with single FET and full-bridge rectifier.**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
UCC3752D	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	0 to 70	UCC3752D	
UCC3752DG4	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	0 to 70		
UCC3752N	OBSOLETE	PDIP	N	16		TBD	Call TI	Call TI	0 to 70	UCC3752N	
UCC3752NG4	OBSOLETE	PDIP	N	16		TBD	Call TI	Call TI	0 to 70		

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Only one of markings shown within the brackets will appear on the physical device.

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