

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Advance Information

Telephone Ring Signal Converter

The TCA3385 is a high efficiency telephone ring signal converter designed for use with the TCA3386 (it can also be used stand-alone). These devices, together with a microprocessor, form the basis for a high-performance feature telephone set.

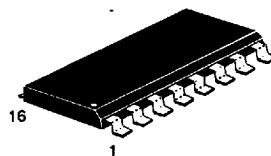
The circuit includes a switching regulator which converts the ring signal from the telephone line into a DC supply signal suitable for powering the other devices in the telephone, e.g. TCA3386 and the MPU, during the ringing phase.

- High efficiency step-down DC/DC converter with linear input impedance
- Power derived from rectified AC ring signal or DC voltage
- Drive output for external PNP transistor
- System supply voltage determined by external transistor, coils and diodes
- Two modes of operation: fixed internal or programmable ring detect threshold (7 to 35V)
- Programmable input impedance between 3K and 15Kohms
- Ring detect output for microprocessor
- Lightning and mains protection
- Applications: telephone set, answering machine, home appliance, etc...

TCA3385



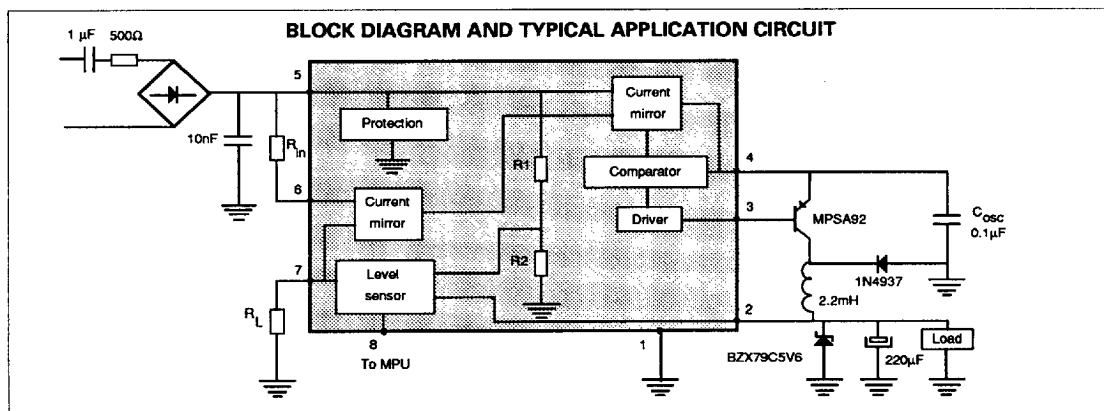
DP SUFFIX
PLASTIC PACKAGE
CASE 626



FP SUFFIX
PLASTIC PACKAGE
CASE 751G

ORDERING INFORMATION

TCA3385-DP Plastic DIP
TCA3385-FP SO package



TCA3385
2-1264

6367253 0096243 TT2

MOTOROLA

TCA3385 PIN DESCRIPTIONS

Pin 1 GND, GROUND

This is the reference ground for the overall system.

Pin 2 V_{cc} POWER SUPPLY

The output is a current which will establish a voltage defined by the load circuit and the voltage regulator (typically 5-6 volts for telephone application).

Pin 3 DRV, DRIVE OUTPUT

This output directly drives the base of the PNP transistor of the switchmode power supply system.

Pin 4 CO, CURRENT OUTPUT

This pin provides constant current output for charging the external capacitor C_{osc} .

Pin 5 LI, LINE INPUT

This pin can be driven either by a DC voltage or a non filtered rectified AC voltage. In a typical telephone application, it is connected to the positive side of a diode bridge before the twisted pair cable.

Pin 6 R_{in}

An external resistor R_{in} connected between this pin and LI sets the input impedance of the circuit.

Pin 7 MS, MODE SELECT

An external resistor R_L connected between this pin and ground sets the value of the ring detect threshold.

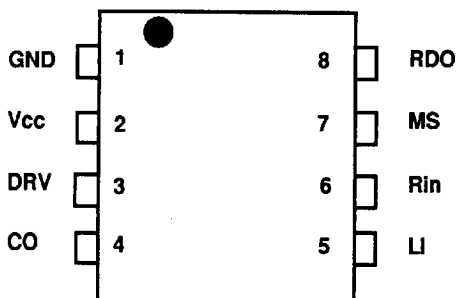
If $R_L = 0$, Mode 1 is selected and a fixed 12 volt level is automatically chosen by the internal level sensor circuitry.

Otherwise Mode 2 is selected and R_L determines the value of the ring detect threshold. In Mode 2 R_L also affects the input impedance of the circuit.

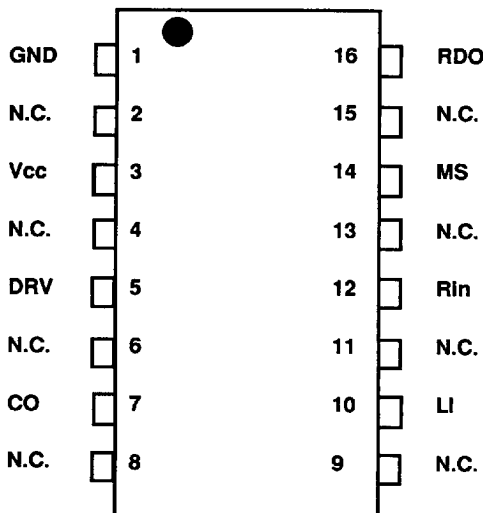
Pin 8 RDO, RING DETECT OUTPUT

This is a digital output for a microprocessor which indicates that a ring signal has been detected. This pin will shift from low to high each time the input voltage passes the preset threshold voltage.

Depending on its load (resistive or capacitive), the signal at this pin can either remain high during the ring time, or be a square wave at twice the ringing signal frequency.



DIL 8 pins



SOIC wide 16 pins

ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Unit
Line Voltage	120	V rms
Input Impedance	3K to 15K	Ohms
Maximum Peak Current (crowbar on)	500	mA
Storage Temperature Range	-65 to +150	°C
Operating Junction Temperature	150	°C

Devices should not be operated at or outside these values. Actual device operation should be restricted to within the "Recommended Operating Limits".

RECOMMENDED OPERATING LIMITS

Parameter	Symbol	Min	Typ	Max	Unit
Operating Ambient Temperature Range	T_a	0		70	°C
Line Voltage	V_{in}			90	V rms
Line Source Impedance	Z_s	500			Ohms

THERMAL DATA

Parameter	Value	Unit
Thermal Resistance Junction-Ambient		°C/W
Plastic Package Case 626	90	
SO Package Case 751G	110	

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Ring Detect Output Voltage High	V_{oh}	V_{cc} -0.93	V_{cc} -0.7	V_{cc} -0.57	V
Ring detect Output Voltage Low	V_{ol}		11	20	mV
Turn-on Threshold Input Voltage (Mode 1, $R_L=0$, $I_{Load}=0$)	V_{d1}	11.2	12	13.0	V
Threshold Temperature Drift (Mode 1, $R_L=0$)	DV_{d1}		-5		mV/°C
On/Off Threshold Hysteresis (Mode 1, $R_L=0$, $I_{Load}=0$)	Hys1	1.2	1.8	2.4	V
Turn-on Threshold Input Voltage (Mode 2, limit fixed by ext res R_L)	V_{d2}	8		35	V
Threshold Temperature Drift (Mode 2)	DV_{d2}		-20		mV/°C
On/Off Threshold Hysteresis (Mode 2)	Hys2	0.5		7	V
Ring Detect Output Pull-up Current ($V_{in} = 15V$)	$I_{d up}$	0.5	1.5	2.5	mA
Ring Detect Output Pull-down Current Low State ($V_{RDO} < V_{cc}/2$) High State ($V_{RDO} > V_{cc}/2$)	$I_{d down}$	60 10	100 20	140 26	μA
V_{cc} Level (Ring Detector Enabled) @ $V_{cc} \text{ max} = 5.5V$	$V_{cc on}$	2.75	3.1	3.45	V
V_{cc} Level (Ring Detector Disabled) @ $V_{cc} \text{ max} = 5.5V$	$V_{cc off}$	1.40	1.8	2.3	V
Ring Detect Output Rise Time (no capacitor)	t_r		1		μs
Ring Detect Output Fall Time (no capacitor)	t_f		4		μs
Ring Detect Output Ripple ($C_{rd} = 0.47\mu F$, $f = 50Hz$, no load)	$V_{d rip}$		0.25	0.5	V pp

SWITCHMODE POWER SUPPLY

Parameter	Symbol	Min	Typ	Max	Unit
V_{cc} Output Voltage ($I_{load} = 36mA$)	V_{cc}	Fixed by Zener diode			
Output Power ($V_{in} = 90V$ rms, $f = 50Hz$)	P_{out}			600	mW
Power Supply Efficiency	Eff	50	55		%
Switching Frequency ($V_{in} = 40V$, $R_{in} = 500K\Omega$)	F_s	25	35	45	KHz
Output Voltage Ripple ($I_{load} = 36mA$, $C_{load} = 220\mu F$, $V_{in} = 90V$ rms)	$V_{cc\ ripple}$		0.5	0.7	V pp
C_{osc} Charge Current ($V_{in} = 20V$, $R_{in} = 500K\Omega$, $R_L = 0$)	I_{charge}	3.1	3.5	4.1	mA
C_{osc} Discharge Current ($V_{in} = 20V$, $R_{in} = 500K\Omega$, $R_L = 0$)	$I_{disch.}$	11	18	25	mA

LINE INPUT AND PROTECTION

Parameter	Symbol	Min	Typ	Max	Unit
Input Impedance Off-state ($V_{in} = 4.5V$, $R_{in} = 500K\Omega$, $R_L = 0$) On-state ($V_{in} > 25V$, Mode 1, $R_L = 0$) Fixed by external resistance R_{in} On-state ($V_{in} > 25V$, Mode 2) Fixed by external resistance R_{in} and R_L	Z_{in}	25 3 3	50 $\frac{R_{in}}{100}$ $\frac{R_{in}+2R_L}{100}$	15 15	Kohm
Non-linearity @ $35 < V_{in} < 75 V$ Mode 1 Mode 2	NL		3 3	8 8	%
Overvoltage Protection Threshold (Crowbar on)	V_{ov}	120	135	147	V
Crowbar-on Input Voltage (Crowbar On, $I_{limit} = 40mA$)	V_{on}	4.3	6.5	8.7	V
Crowbar-on Power Dissipation (Limited by Internal 100 ohms + external res.)	P_d			1.3	W
Crowbar Turn-on Delay (CRD = $0.1\mu F$)	T_{on}		130		μs

INTRODUCTION

The TCA3385 is primarily intended for converting the ring signal delivered by a central office or PABX into a DC voltage which is suitable for powering the other components in an electronic telephone. It will supply the power to enable the use of the features of a sophisticated telephone, such as MPU control, generation and amplification of ringing melodies at a speaker, display short messages of information, etc... while the telephone is on-hook.

The circuit combines a high efficiency DC/DC converter and a level sensor device which acts as a programmable ring detector and indicator for a MPU, thus initiating the operation of the telephone.

Overvoltage protection is also achieved using a "crow-bar" technique.

LINE INPUT AND PROTECTION

The DC/DC converter has linear input impedance, which means that the circuit input impedance is ohmic and constant whenever the input voltage varies above the turn-on threshold voltage inside the tolerated limits. Any value between 3K and 15Kohms can be set using one or two resistors, depending on the mode of operation (see paragraph "RING DETECTOR" below). In Mode 1 the circuit input impedance Z_{in} is a ratio of the resistor R_{in} between pin 5 and pin 6: $Z_{in} = R_{in}/100$. In Mode 2, Z_{in} is a function of R_{in} and the resistor R_L between pin 7 and ground: $Z_{in} = (R_{in} + 2R_L)/100$.

On the other hand, the turn-on input circuitry guarantees that the input impedance is high at low voltages to avoid perturbing the line.

The overvoltage protection device consists of two thyristors in series which are turned-on at a voltage between 120V and 150V. The input current is limited by a 100 ohms internal resistor, but an external resistor is mandatory to prevent excessive currents. A 500 ohms series resistor is recommended as minimum.

RING DETECTOR

The TCA3385 includes a ring detector (also called level sensor) whose function is to provide a digital output for a MPU. It only operates when the circuit is sufficiently powered, i.e. when the DC/DC converter output (V_{cc}) has reached a level greater than 3V. It also has hysteresis which powers the level sensor off at 2V.

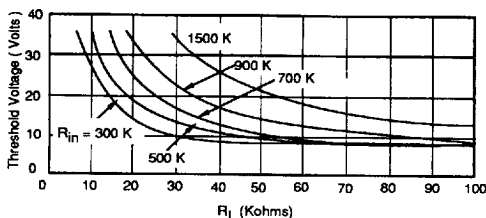


Figure 1. Ring Detection Threshold (Mode 2) vs R_{in} and R_L

The digital output shifts from low to high according to the line input voltage, a preset level for detection and its load at pin 8.

The level for ring detection may be set using one or two modes of operation as previously noted. In Mode 1, where pin 7 is connected to ground, an internally fixed level is set as the ring detect threshold, which is typically 12 Volts. In Mode 2 operation, where an external resistor R_L is connected between pin 7 and ground, the ring detect threshold is programmable. Its value is a function of R_L (see Figure 1).

It should be noted that due to the IC design structure, Mode 1 is not a particular case of Mode 2. In fact, in Mode 2, R_L must be chosen high enough so that the ring detector works efficiently (the minimum limit is fixed by the upper limit of 35V for the ring detect threshold; see Figure 1).

In a telephone application, where the input signal is a rectified AC ringing signal, we can choose between two output modes at pin 8, pulsed or continuous: without a capacitor at pin 8, the output voltage will change state each time the input crosses the ring detect turn-on and turn-off thresholds, thus providing information on the frequency of the ring signal; on the other hand, if the load at pin 8 is a capacitor, the output voltage will shift from low to high only the first time the input crosses the turn-on threshold, and remain high until the end of the ringing pulse. This is permitted by the internal input circuitry at pin 8, which has an emitter-follower transistor for pull-up and a non-linear current generator for pull-down (20 μ A for slow discharge, 100 μ A for fast discharge; see Figure 2).

SWITCHMODE POWER SUPPLY

The TCA3385 is basically a DC/DC converter which works with external components: a PNP transistor, a coil, a zener diode, a capacitor and a holding diode.

The circuit drives the external PNP for switching the current into the coil. This PNP should be a fast switching transistor, with a switching time of less than 2% of the total pulse time $T_0 = 1/f_0$ (where f_0 is the switching frequency). For example, in a 50KHz application ($T_0 = 20\mu s$), rise time and fall time should be less than 400ns; this is mandatory to keep the efficiency of the switchmode greater than 50%. Also, the PNP must withstand voltages as high as 150V. In the suggested application, a MPSA92 (or a BDC06) is used.

The holding diode should also have a low forward voltage drop and fast switching characteristics so that high power output is achieved. It must withstand voltages as high as 150V. The coil as well should have its losses (both magnetic and resistive) minimized.

The DC/DC converter consists of 3 main blocks:

- a current mirror which produces a constant current for charging the external capacitor. This current is dependent on V_{in} .
- a comparator to set the switching frequency of the power supply. The switching frequency is mainly dependent on the input voltage V_{in} and the input impedance Z_{in} .
- a drive stage for the PNP transistor.

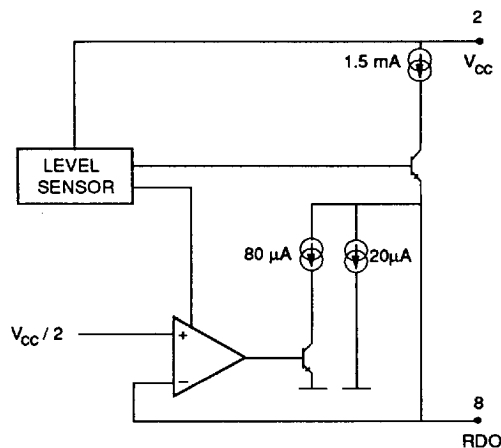


Figure 2. Ring Detect Output Stage

EXTERNAL PROTECTION RESISTOR

This device has been designed to accept overvoltage input signals, by switching ON two serial input thyristors, from levels exceeding 120V between pin 5 and pin 1. In this case the current is limited by an internal 100 ohms series resistor with an external resistor R_v (nominally 500 ohms).

a) Fast input signals

If the slew rate of the overvoltage pulse is much greater than 500V/ms (which is valid for a $1\mu F$ series capacitor with a current limit of 500mA), then the peak current is equal to the applied peak voltage divided by the external resistance R_v .

Under these conditions, the absolute maximum peak current is equal to 500mA, no matter how short the pulse.

For example: for 400V maximum limit, $R_v = 400V/0.5A = 800$ ohms.

b) Slow input signals

For slow signals (eg: ringing signals 25, 50, 100 Hz...) the maximum current must be limited to 250mA. So, for the French standard ringing voltage, R_v is equal to $120V_{max}/0.25A = 500$ ohms.

If the overvoltage is higher, R_v must be calculated for the new maximum input voltage.

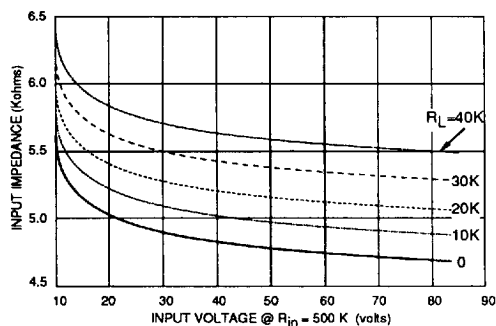


Figure 3. Input Impedance vs V_{in} @ $R_{in} = 500K$

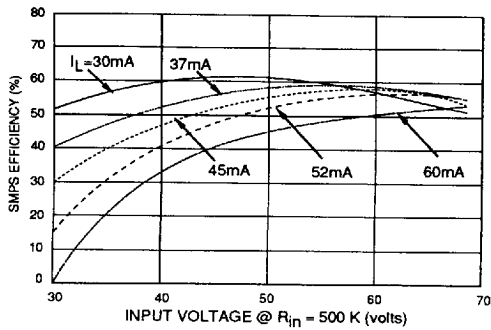


Figure 4. SMPS Efficiency vs V_{in} @ $R_{in} = 500K$

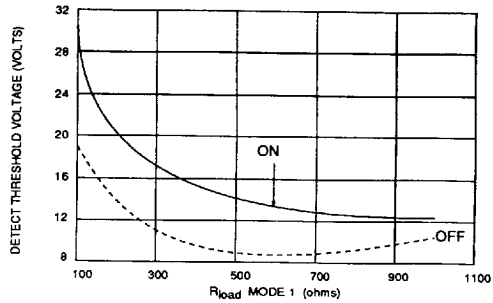


Figure 5. Detect Threshold vs R_{load} (Mode 1)

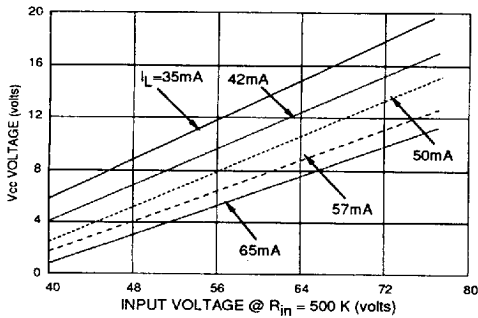


Figure 6. V_{cc} vs V_{in} @ $R_{in} = 500K$ (without Zener)

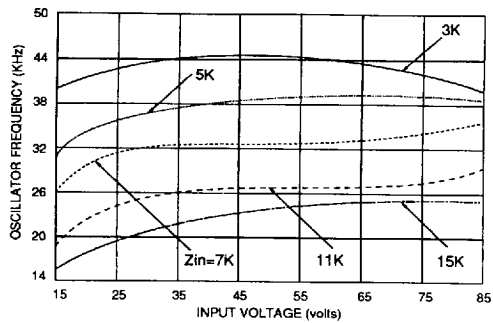


Figure 7. Oscillator frequency vs V_{in}