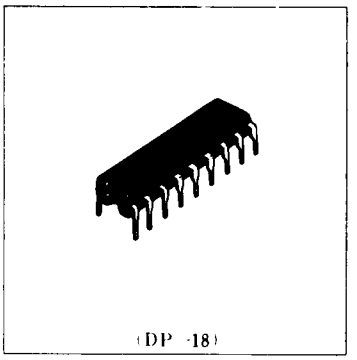
HD61826 Series

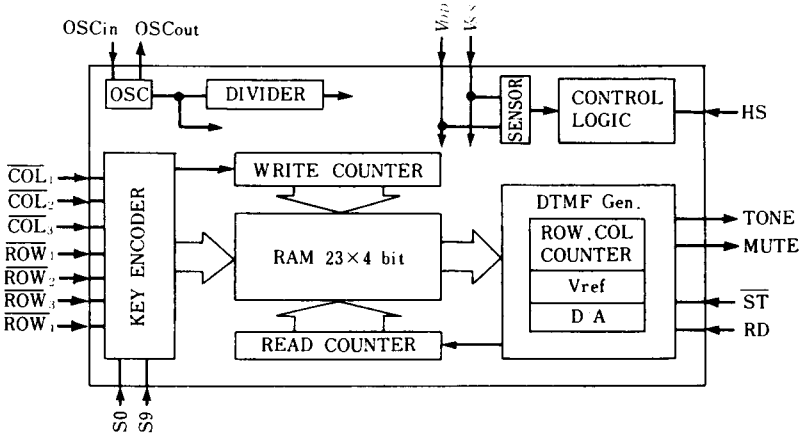
Tone Generator with Redial

■ FEATURES

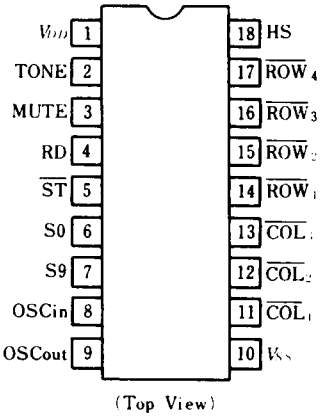
- Direct telephone-line operation
- CMOS process for low-power and low-voltage operation
- Uses either a standard 2-of-7 keyboard or the inexpensive matrix keyboard
- Stable operation by using ceramic resonator
- Redial function (# key)
- Pause input (# key)
- 0 or 9 dialing in inhibition pins for PABX system
- 23-digit redial memory
- Redial memory overflow protection (inhibit redial)
- On chip power supply voltage sense circuit
  - Memory clear voltage
  - Reset voltage
- Internal voltage reference circuit for stable Tone output
- Tone output with low distortion



■ BLOCK DIAGRAM



■ PIN ASSIGNMENT



■ ABSOLUTE MAXIMUM RATINGS (Vss = 0V)

Item	Symbol	Value	Unit
Power supply voltage	V_{DD}	6.0	V
Terminal voltage	V_T	V_{SS} −0.3 to V_{DD} +0.3	V
Operating temperature	T_{opr}	−20 to +75	°C
Storage temperature	T_{stg}	−55 to +125	°C

■ ELECTRICAL CHARACTERISTICS

• **DC Characteristics** (V_{SS} = 0V, V_{DD} = 2.0 to 5.5V, T_a = −20 to +75°C)

Item	Symbol	Test Condition	min.	typ. *1	max.	Unit
Operating voltage (1)	V_{DD}	Tone Out Mode	2.5	–	5.5	V
Operating voltage (2)	V_{DD}	Non Tone Out Mode	1.7	–	5.5	V
Reset voltage	V_{DR}		–	1.5	–	V
Memory clear voltage	V_{DC}		–	1.15	–	V
Operating current	I_{DD}	Tone Out Mode, no load	–	300	–	μA
Memory retention (reset) current	I_{DR}		–	0.5	–	μA
Input High voltage	V_{IH}	except HS pin	80% V_{DD}	–	–	V
		HS pin V_{DD} = 3.0 to 5.5V	90% V_{DD}	–	–	
		HS pin V_{DD} = 2.0 to 3.0V	V_{DD}-0.1	–	–	
Input Low voltage	V_{IL}		–	–	20% V_{DD}	V
Input leak current	$\|I_{LI}\|$	Pull-up MOS off, V_{IN} = 0 to V_{DD}	–	–	1	μA
Input Pull-up MOS current	$-I_P$	V_{IN} = 0 (RD, ST, S0, S9, ROW, COL, HS)	–	10	–	μA
Output High voltage	V_{OH}	$-I_{OH}$ = 0.1mA (MUTE)	V_{DD}-0.5	–	–	V
Output Low voltage	V_{OL}	I_{OL} = 0.1mA (ROW, COL)	–	–	0.3	V
Output leak current	$\|I_{LO}\|$	Output MOS off, V_{IN} = 0 to V_{DD} (TONE MUTE)	–	–	1	μA

• **AC Characteristics** (V_{SS} = 0V, V_{DD} = 2.0 to 5.5V, T_a = −20 to +75°C)

Item		Symbol	Test Condition	min.	typ.*1	max.	Unit
Oscillation frequency		f_{osc}		–	400	–	kHz
Oscillation start up time		t_{str}		–	5	–	ms
Tone Out	ROW TONE	V_{OR}	Single Tone Mode, 600Ω to V_{SS}	200	245	290	mVrms
	COLUM TONE	V_{OC}	V_{DD} = 2.5 to 5.5V, T_a = 25°C	270	310	360	mVrms
Tone Out	ROW TONE	V_{OR}	Single Tone Mode, 10kΩ to V_{SS}	245	270	300	mVrms
	COLUM TONE	V_{OC}	V_{DD} = 2.5 to 5.5V, T_a = 25°C	310	340	370	mVrms
ROW/COLUM Tone Out ratio		dB_{CR}	V_{DD} = 2.5 to 5.5V	–	2	–	dB
Output distortion		D_{is}	10kΩ to V_{SS}, V_{DD} = 2.5 to 5.5V	–	5	7	%

*1 Typ. value is the design value (the standard value at V_{DD} = 2.5V and T_a = 25°C)

■ Description

The HD61826 is specifically designed IC to implement a DTMF (Dual-Tone Multi Frequency) telephone dialing system. With low voltage and low-power consumption CMOS process, it can be operated directly from the telephone line. This IC generates each DTMF signal by digitally synthesizing the sinusoidal waveform for the individual frequencies, using a 400 kHz ceramic oscillation as frequency reference. The last dial numbers can be redialed by the simple key operation using an internal redial memory. The HD61826 can also be used as a normal DTMF dialer without the redial memory by mode select input.

In the HD61826, ON HOOK/OFF HOOK is detected by the HS pin. When the supply voltage is lower than reset voltage, the HD61826 does not accept any key inputs independent of the HS pin. When the power supply voltage is lower than memory clear voltage, the internal memory data is cleared.

While the telephone is in the OFF HOOK and the supply voltage is higher than the reset voltage, the oscillator is enabled by a key input and then this key input is implemented with the key debounce circuit, In this case, if the first key after the reset (note 1) is other than # and *, the internal memory data is cleared, and then this input key is encoded and stored into the memory. The following keys are in turn stored into the memory and converted into DTMF signal outputs. (note 2)

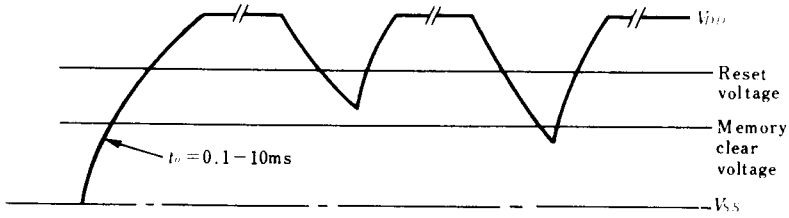
When the HD61826 is reset after dialing, it will be in the redial mode with the first # key. However, if the 24 or more keys have been dialed previously or the memory has already been cleared, it cannot be in the redial mode. During the redial mode, any key input is not accepted, but after the completion of redial, the HD61826 can be used as a usual dialer. The signal output will stop with the pause during the redial and the redial starts again with # key. # key is used to insert the pause data in the memory. In this case, # key does not influence the output of signal but is stored in the memory as one digit.

NOTES:
1. In the HD61826, the reset means the clearing of all logic (counter, etc.) except RAM. HD61826 is reset when the telephone is in the ON HOOK or the supply voltage is lower than the reset voltage.
2. While the key is pushed, the DTMF signal is kept generating.

■ PIN FUNCTION

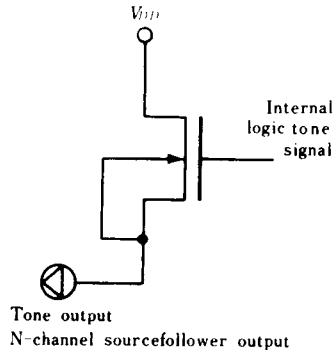
• V_{DD} (Pin 1)

This is a positive voltage supply pin which applies voltage to the basis of the V_{SS} pin. HD61826 provides the internal sense circuit for the supply voltage. To make this circuit operate stable, the following rising time is necessary.

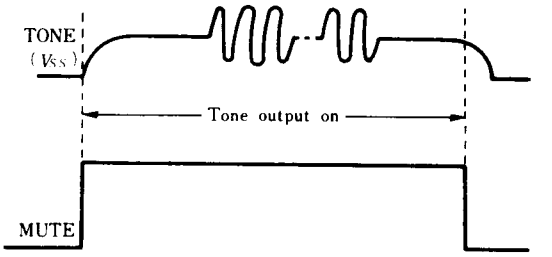


• TONE (Pin 2)

This is a Tone output (DTMF signal output) pin. Output circuit is N-Channel MOS source-follower and the resistor to Vss is necessary. Further, to realize low power consumption in the standby mode, TONE output MOS and internal V_{ref} circuit are turned off after tone output completed. And this is synchronous with MUTE signal. DTMF signal is digitally synthesized by using the 400 kHz oscillation as frequency reference. Tone output frequency of HD61826 and its deviation from standard DTMF are as follows:



		Standard DTMF (Hz)	Tone Output Frequency Using 400 kHz Oscillation	% Deviation from Standard
ROW	f_1	697	694,44	−0.37
	f_2	770	769,23	−0.10
	f_3	852	851,06	−0.11
	f_4	941	938,97	−0.22
COL	f_5	1209	1212,12	0.26
	f_6	1336	1333,33	−0.20
	f_7	1477	1481,48	0.30



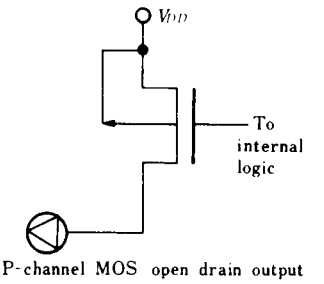
As the HD61826 contains an voltage reference (V_{ref}) circuit, it always generates stable Tone output amplitude even if supply voltage and temperature change.

• MUTE (Pin 3)

This is a pin which mutes the receiver and the transmitter. Output circuit is P-Channel MOS open drain.

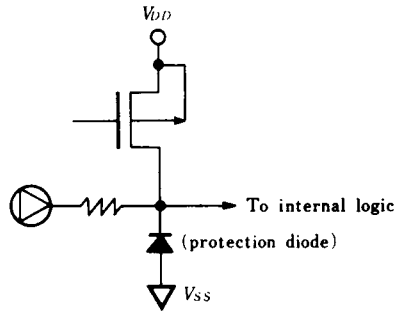
MUTE . . . High level

While reset, the output voltage is held to Low level.



• RD (Pin 4) Redial Operation

This is an input pin which selects HD61826 operations: a tone dialer with redial providing memory function, and a simple tone dialer in which only normal key input is converted into tone output. This pin is implemented with the pull-up MOS, and to realize the low power dissipation on reset, the pull-up MOS is turned off at the reset. (note 1)



RD pin	Operation Mode	Redial	Operation
High (to V_{DD}) or open	Tone Dialer with Redial	available	• no Tone out with * or # • Redial/Pause with #
Low (to V_{SS})	Simple Tone Dialer	not available	• Tone out with * or #

NOTES:
1. The input pins, with pull-up MOS which is turned off at the reset, can be applied to RD, $\overline{ST}$, S0, S9, HS.
2. The logic is positive. PMOS is ON with the low voltage and OFF with the high voltage.

• $\overline{ST}$ (Pin 5) Single Tone Test

This is an input pin to put HD61826 in the single tone mode for tone output test. This pin is implemented with the pull-up MOS which is turned off at the reset. Further, in the single tone mode, digital signal for test is output on MUTE. Usually $\overline{ST}$ pin should be fixed to High level or open.

$\overline{ST}$ pin	S0 pin	S9 pin	Operation Mode	Tone Output
High (to V_{DD}) or open	–	–	Dual Tone	DTMF Tone out
Low (to V_{SS})	Low	High	Single Tone	to ROW Single tone out
	High	Low		to COL Single tone out

NOTE: S0 and S9 pins should not be Low level at the same time.

• S0, S9 (Pin 6, 7) Selection

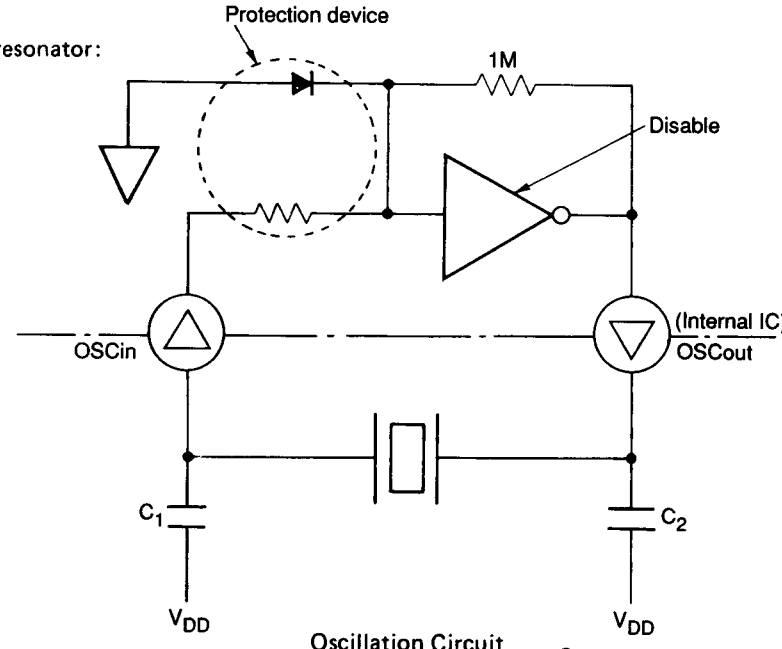
These are input pins to select functions and each of them has pull-up MOS which is turned OFF at the reset. The function of this terminal is to prevent the 0 dialing in and 9 dialing in, which is applied to the telephone subset under the PBX system. When the first key input after the reset is 0 or 9, all the key inputs including the 0 or 9 key become invalid after then. In other words, the signals are not output to TONE and MUTE. Then the telephone is initialized by the reset.

S0 Pin	S9 Pin	Function
High (to V_{DD}) or open	High (to V_{DD}) or open	Normal dialing mode
High (to V_{DD}) or open	Low (to V_{SS})	9 dialing in inhibition mode
Low (to V_{SS})	High (to V_{DD}) or open	0 dialing in inhibition mode
Low (to V_{SS})	Low (to V_{SS})	Test mode (for testing IC. Not use.)

- **OSCin, OSCout (Pin 8, 9) Oscillation Input, Output**

These are the input pins for the oscillator and construct the inverter (with disable function to stop the oscillation). The frequency is stable in the circuit by using the ceramic resonator. Then the oscillator section needs two external capacitors. The ceramic resonator should be 400 kHz and High Q.

Recommended ceramic resonator:
KYOCERA CO.
KBR-400H
ex. ceramic oscillation
C_1 = 100 pF
C_2 = 470 pF



Oscillation Circuit

When OSCout is open, a 400 kHz external pulse can be applied to OSCin.

- **V_{SS} (Pin 10)**

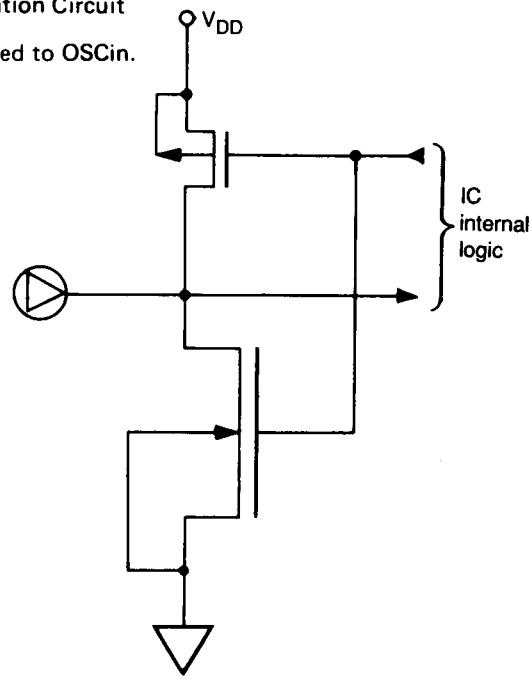
This is a negative power supply pin.

- **$\overline{COL_1}$ to $\overline{COL_3}$ (Pin 11 to 13) Colum Input**
  $\overline{ROW_1}$ to $\overline{ROW_4}$ (Pin 14 to 17) Row Input

These are input/output pins for a key board which consist of PMOS pull-up and NMOS driver. (As a matter of form, these are CMOS.)

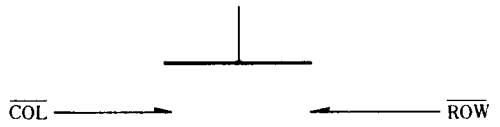
As the row and column are alternately scanned, the HD61826 can be connected both to the matrix-type keyboard and the 2-of-7 keyboard. While waiting for the key input, Rows are High level and Columns are Low level. And in the reset mode, both Row and Column are Low level.

The hold time of the key should be more than 10 ms. (While the oscillation stops, the period for starting oscillation should be added.) (note 1) The key debounce time is 20 ms. Tone is remaining while pushing the key (precisely speaking, after key operation, tone continues during the debounce time). But the key operation should meet the DTMF receiver specification.

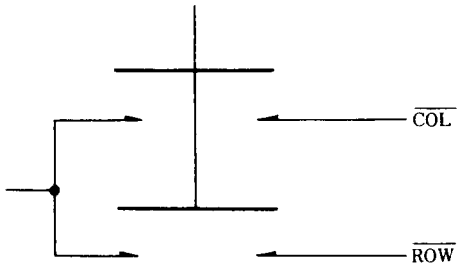


I/O Circuit for Keyboard

NOTES:
1. The oscillation stops in HD61826;
   1. After the reset
   2. After the completkon of Tone output
   3. On Pause



Matrix Keyboard



2–of–7 Keyboard

When two keys are pushed at the same time, the key of the smaller number of ROW and COL is given priority and is entered.

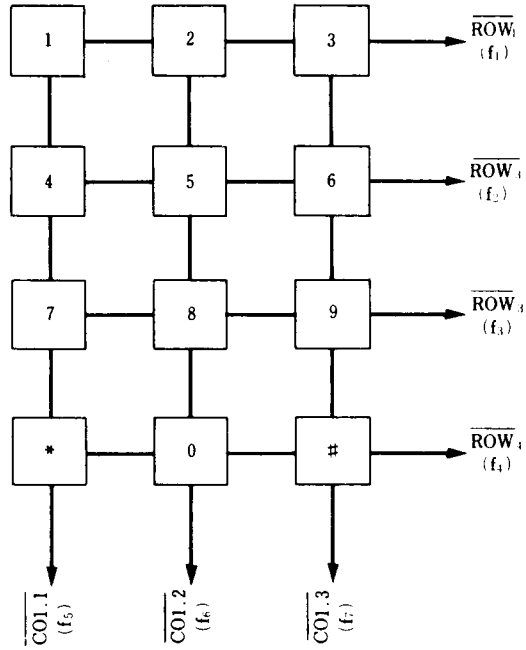
Ex. When 2 and 5 are pushed at the same time, 2 is accepted.

- **HS (Pin 18) Hook Switch**

This is an input pin for detecting ON-HOOK/OFF-HOOK switch. It has a pull-up MOS which is turned off at the reset.

ON HOOK . . . . High (to V_{DD}) or open

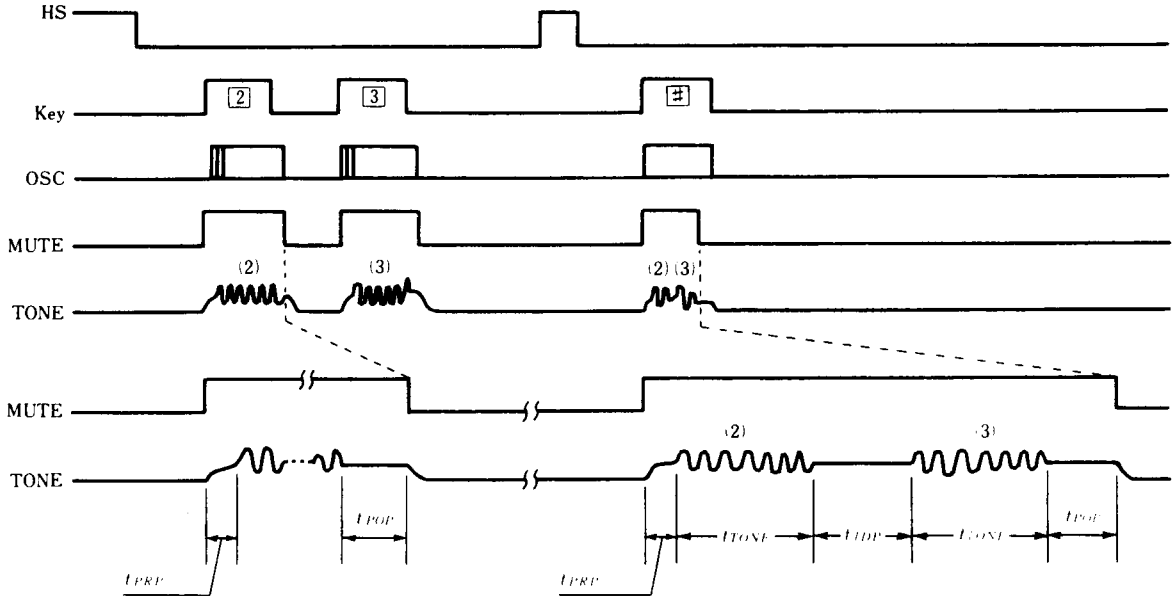
OFF HOOK . . . Low (to V_{SS})



Keyboard Configuration

HD61826 is reset by setting the HS terminal High level. Even if the HS terminal is fixed to Low level, the HD61826 is reset when supply voltage is lower than reset voltage. So without using the HS pin the HD61826 can control the operation mode by the monitor of supply voltage. Then, as the pull-up MOS is turned off with the reset signal, the current does not increase on reset. An external capacitor must be provided between the HS pin and V_{SS} to prevent the switch from chattering.

■ TIMING CHART



Mode	Item	Symbol	min.	typ.	max.	Unit
Normal Dial	Pre-Digital Pause	t_{PRP}	–	5	–	ms
	Post-Digital Pause	t_{POP}	–	44	–	ms
Redial	Pre-Digital Pause	t_{PRP}	–	5	–	ms
	Tone Output time	t_{TONE}	–	133	–	ms
	Inter-Digital Pause	t_{IDP}	–	87	–	ms
	Post-Digital Pause	t_{POP}	–	44	–	ms

■ AN EXAMPLE OF KEY OPERATION (RD = High)

	HOOK	KEY	TONE
	ON		
Normal Dial	OFF	0 1 2 3 4 5 6	0, 1, 2, 3, 4, 5, 6, (note)
	ON		
Redial	OFF	#	0 - 1 - 2 - 3 - 4 - 6 (note)
Dial after Redial		7 8	7, 8,
	ON		
Redial	OFF	#	0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8
	ON		
Normal Dial	OFF	9 # 1 2	9, 1, 2,
(Pause Entry)	ON		
Redial	OFF	#	9,
(including Pause)		#	1 - 2,
	ON		
Dial of 24 digits or more	OFF	1 1 . . . . . 1 24 times	1, 1, ... 1, 24 times
	ON		
Prevention of Over Flow	OFF	# 0 1	0, 1

(0 dialing in inhibition mode with S0 = Low and S9 = High)

ON		
OFF	1 2 3 0	
ON		
OFF	0 4 5 6 7 #	
ON		
OFF	#	1 - 2 - 3 - 0,

NOTE: , shows that after tone output Mute is Low level and - shows that Mute is High level.

■ APPLICATION CIRCUIT