National Semiconductor

PRELIMINARY

microCMOS

TP5600, TP5605, TP5610, TP5615 Ten-Number Repertory Pulse Dialers

General Description

The TP5600, TP5605, TP5610, TP5615 are monolithic integrated circuits built using National's advanced P^2CMOS process (double poly-silicon gate CMOS). They provide all logic necessary to convert keypad inputs into a series of pulses simulating rotary telephone dialing. An on-chip memory provides storage for nine telephone numbers plus the last number dialed, each up to 16 digits in length. The simple control scheme needs only 2 key entries to store a number or initiate automatic dialing of a stored number. This control scheme is the same as that used on the TP5650 repertory DTMF generator so that no user re-education is necessary when converting from pulse to tone dialing. For PBX applications, the first 1 or 2 digits may be overwritten to obtain a second dial tone prior to automatic dialing. Two outputs are provided to control pulsing of the telephone line and muting of the receiver. The low voltage and low current requirements of this device allow direct telephone line powered operation for dialing. A small battery is recommended for on-hook memory retention.

Features

- 2V, 150 μA telephone-line powered operation
- 1 μA memory retention current
- Stores and auto-dials ten 16-digit numbers
- Last-number-redial included
- Scratchpad (number storage without dialing)
- Control key scheme—same as TP5650 DTMF repertory dialer
- 2-digit overwrite for PBX access codes
- Voltage regulator on-chip
- Single-contact or negative-common key inputs
- TP5600, TP5605 for pulsing loop in shunt with speech network
- TP5610, TP5615 for pulsing loop in series with speech network
- TP5600, TP5610 pin compatible with TP50981/2 pulse dialers; ceramic resonator oscillator
- TP5605, TP5615 have RC oscillator and IDP select

Block Diagram

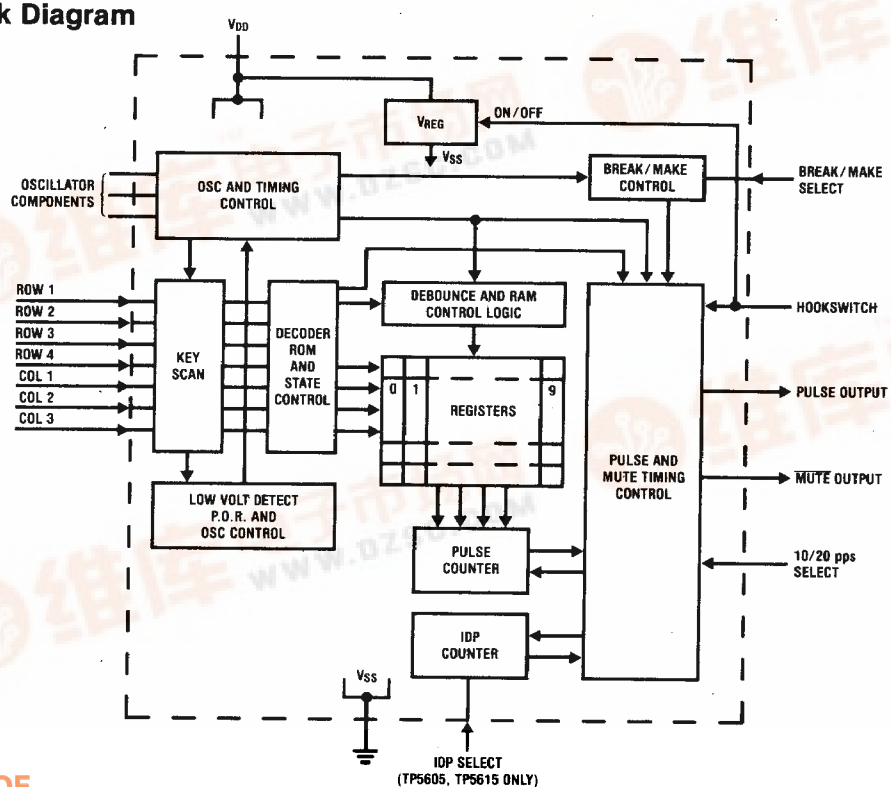


FIGURE 1

Absolute Maximum Ratings

DC Supply Voltage (V_{DD}–V_{SS})	6V
Voltage on Any Pin	V_{DD} + 0.3V to V_{SS} – 0.3V
Operating Temperature (T_A)	– 30°C to + 70°C
Storage Temperature	– 55°C to + 150°C
Maximum Power Dissipation (25°C)	500 mW

DC Electrical Characteristics

T_A within operating temperature range, $2V < V_{DD} - V_{SS} < 5V$ unless otherwise specified

Parameter	Conditions	Min	Typ	Max	Units
DC Operating Current, I_{DD}	V_{DD} = 2V (Note 1)			150	μA
	V_{DD} = 5V (Note 1)	1			mA
Regulator Voltage	I_{DD} = 150 μA		3.5		V
Memory Retention Current	On-Hook, V_{DD} = 2V			1	μA
PULSE Sink Current	V_{DD} = 2V, V_{OUT} = 0.5V	50			μA
PULSE Source Current	V_{DD} = 2V, V_{OUT} = 1.5V	150			μA
MUTE Sink Current	V_{DD} = 2V, V_{OUT} = 0.5V	50			μA
MUTE Source Current	V_{DD} = 2V, V_{OUT} = 1.5V	150			μA
Logic '0' Level Input		V_{SS}		0.2 V_{DD}	
Logic '1' Level Input		0.8 V_{DD}		V_{DD}	
Keyscan Pull-Up Resistance			100		kΩ
Keyscan Pull-Down Resistance			4		kΩ
Keypad Contact Resistance				1	kΩ
Keypad Capacitance				30	pF
HOOKSWITCH Pull-Up Resistance			100		kΩ
Input Leakage Current B/M SELECT, tDP SELECT, 10/20 pps SELECT	$V_{SS} < V_{IN} < V_{DD}$		0.1		μA

AC Electrical Characteristics

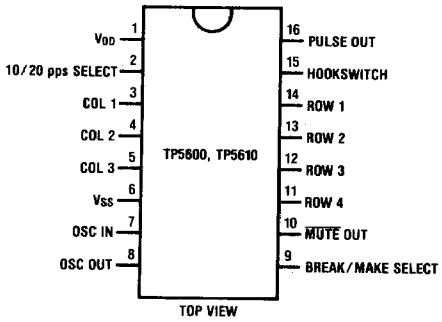
T_A within operating temperature range, $2V < V_{DD} - V_{SS} < 5V$ unless otherwise specified

Parameter	Conditions	Min	Typ	Max	Units
TP5600, TP5610 Oscillator Frequency	*Figure 3* Component Values		480		kHz
TP5605, TP5615 Oscillator Frequency	*Figure 4* Component Values		16		kHz
Oscillator Stability	Internal Regulator Connected, 150 μA < I_{DD} < 300 μA	– 3		3	%
All Parts					
Keypad Debounce Time	OSC IN = Nominal Frequency	9		12	ms
Key Closure Time		25			ms
Oscillator Start-Up Time	V_{DD} = 2V		5		ms
Pulse Rate			10		pps
BREAK Time, t_B	BREAK/MAKE = V_{DD}		60		ms
	BREAK/MAKE = V_{SS}		66		ms

Note 1: Off-hook, HOOKSWITCH pin connected to V_{SS}, all outputs open.

Connection Diagrams

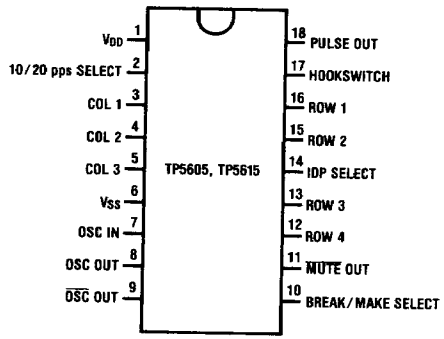
Dual-In-Line Package



TOP VIEW

Order Number TP5600N or TP5610N
See NS Package N16A

Dual-In-Line Package



TOP VIEW

Order Number TP5605N or TP5615N
See NS Package N18A

Pin Descriptions

V_{DD} (pin 1): This is the positive supply to the device and is referenced to V_{SS} (pin 6). An active zener regulator is connected on-chip between V_{DD} and V_{SS} (see pin 6), and the device is intended to be powered from a current-limited source. This regulator is turned off and effectively disconnected when the device is in the on-hook state in order to minimize current consumption. Power-on reset and low voltage detect circuits ensure correct operation following power-up or reduction of the on-hook supply voltage below that required to retain stored data.

Keypad Inputs: A valid key entry is defined as either connecting a single row to a single column or connecting V_{SS} simultaneously to a single row and a single column. This allows direct interface to an inexpensive single-contact (form A) keypad, the standard 2-of-7 keypad with negative-common, or logic-generated inputs.

V_{SS} (pin 6): This is the negative supply.

OSC IN, OSC OUT (pins 7, 8 on TP5600, TP5610 only): The device contains an on-chip oscillator circuit designed to work with a ceramic resonator at 480 kHz in anti-resonant mode. 2 external capacitors are required, typically 100 pF each *(Figure 3)*. The circuit may also be driven with an external 480 kHz source on OSC IN.

OSC IN, OSC OUT, $\overline{OSC}$ OUT (pins 7, 8 and 9 on TP5605, TP5615 only): The device includes a stable on-chip oscillator circuit designed to work with the component values shown in *Figure 4*. The circuit may also be driven with an external 16 kHz source on OSC IN (pin 7).

On all devices, the oscillator runs only while the device is scanning the keypad and/or timing storage or outpulsing functions.

BREAK/MAKE SELECT: The BREAK/MAKE ratio is selected by connecting this pin as follows (no pull-up resistor is provided):

Input to BREAK/MAKE Pin	PULSE Output	
	BREAK	MAKE
V_{DD}	60%	40%
V_{SS}	66%	34%

$\overline{MUTE}$ OUT: This is an open-drain n-channel outpu designed to drive a simple interface circuit to mute th receiver during outpulsing. See the timing diagram for fu ther details.

HOOKSWITCH: This input has a 100 kΩ internal pull-u resistor to V_{DD}. Allowing this pin to float, or connecting V_{DD} level puts the circuit in the on-hook, low power idl mode. It also turns off the active zener regulator.

Connecting this pin to V_{SS} puts the circuit in the off-hoo mode, ready to accept key inputs and generate outpuls ing. It also turns on the zener regulator to limit the voltag across the device. See Applications Information for fur ther information.

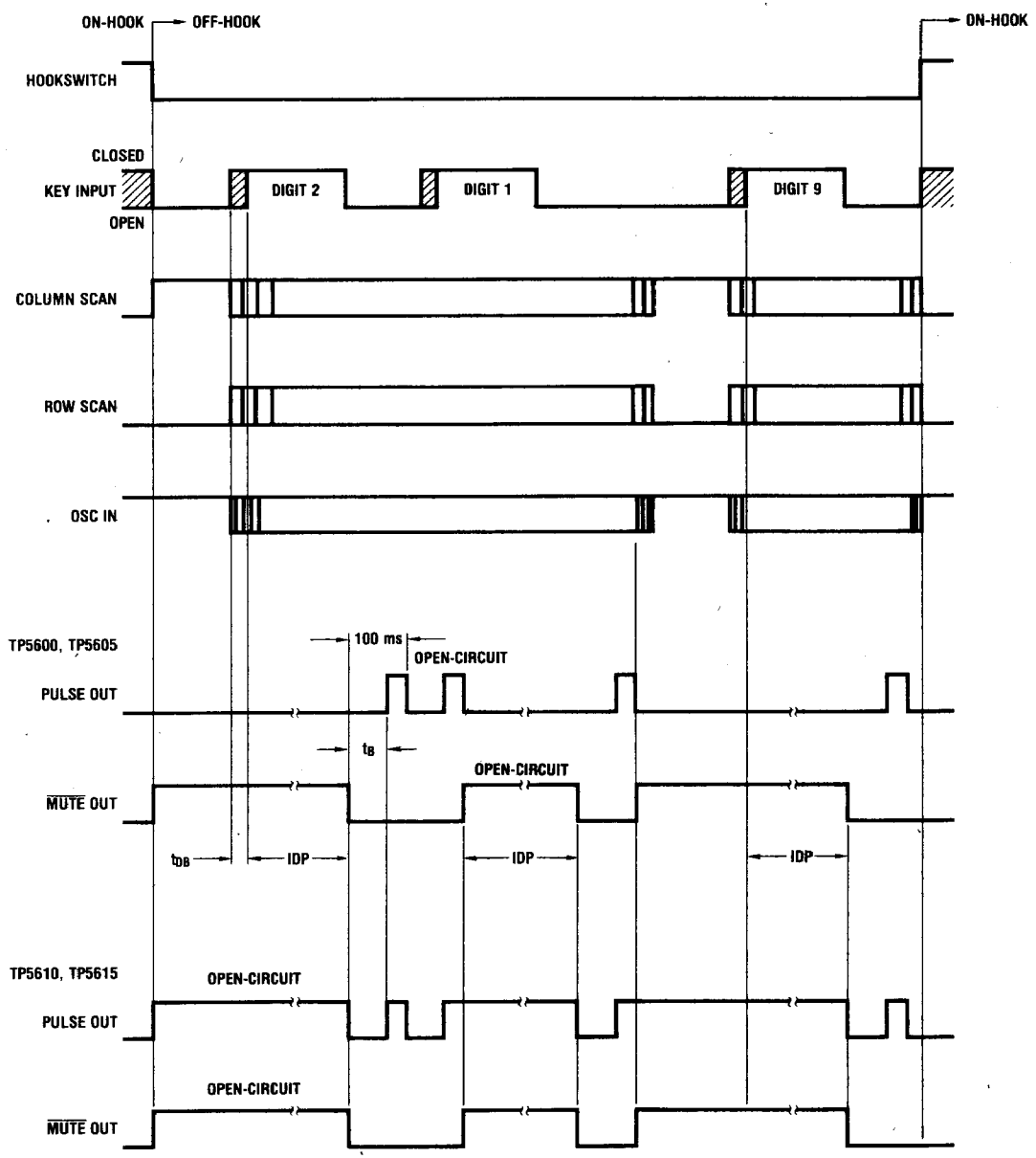
PULSE OUT: This is an open-drain n-channel outpu designed to drive a simple interface circuit to pulse the tele phone line with the correct BREAK/MAKE ratio, IDP timin and pulse rate.

IDP SELECT (TP5605, TP5615 only): The Inter-Digital Pause period is selected by connecting this pin as follows (no pull-up resistor is provided):

Input to IDP Pin	IDP Period
V_{DD}	825 ms
V_{SS}	525 ms

10/20 pps SELECT (pin 2): For normal 10 pps dialing, con nect this pin to V_{SS}. Connecting this pin to V_{DD} doubles the rate of all PULSE OUT and $\overline{MUTE}$ OUT timing. No pull-up resistor is provided.

Timing Diagram



Note 1: PPP is a pre-pulsing pause equal to 1 MAKE period.
Note 2: A mask option of $\overline{\text{MUTE}}$ continuously active low during the IDP is available (TP5610, TP5615 only).

FIGURE 2

Functional Description

The timebase for this family of repertory dialers is derived from an on-chip oscillator connected as shown in *Figure 3 or 4*. In the on-hook condition, the oscillator is stopped and all keypad inputs inhibited. After going off-hook, the oscillator remains off and the keypad inputs go to a static sensing mode. Upon sensing a single key closure, the oscillator starts, and the row and column inputs are alternately scanned at a 500 Hz rate. When a key closure remains valid for the required debounce time, the key is interpreted in accordance with Table I. During manual dialing, valid digit keys are entered into the last-number-dialed register (register 0) in sequence and outpulsed at the nominal 10 pps rate. A manually dialed number may be entered rapidly and may exceed 16 digits without limit, provided no more than 15 digits remain to be outpulsed. Automatic dialing is inhibited, however, if an attempt is made to store more than 16 digits in that register. When no further digits remain to be outpulsed, the oscillator stops and key inputs return to the static sensing mode awaiting further keys or a return to the on-hook condition.

TABLE I. CONTROL SCHEME

Function	Control Sequence
Dial and store in register 0	$D_1 \ldots D_x$
No dial, store in register N only	* N $D_1 \ldots D_x$
Scratchpad	$\ldots D_x$ * N $D_1 \ldots D_y$
Copy last number to register N	$\ldots D_x$ (↓ ↑) * N ↓
Auto-dial register N	# N
Last number redial	# 0
PBX access	↑ (D_1) (D_2) # 0 or N

Note 1: N is a long-term storage register numbered from 1-9. D is a digit.
Note 2: ↑ indicates on-hook to off-hook, ↓ indicates off-hook to on-hook.
Note 3: Entries in brackets may be omitted.

NUMBER STORAGE

Telephone numbers are stored in 10 registers, numbered 0-9. Register contents can only be modified while off-hook. Register 0 always stores the last number which was manually dialed, and remains unchanged during automatic dialing. Numbers for long-term storage in registers 1-9 are entered by *, then N and then the telephone number, where N is the register number. Other registers can be successively modified by entering a new *, N followed by the telephone number. Once a * key is entered, no further outpulsing is possible until after an on-hook reset on the HOOKSWITCH pin. This facilitates the Scratchpad feature, whereby a number can be stored in a register without outpulsing during a conversation. The last number dialed manually is copied from register 0 to any of the long-term storage registers by entering *, N.

An attempt to store more than 16 digits in a register will set an overflow flag to inhibit automatic dialing from that register. The flag is reset following the next *, N entry to reprogram that register.

DIALING

Automatic dialing of the telephone number stored in any register is initiated by entering #, then N. The keypad is then locked out until completion of outpulsing, aft which further manual or automatic dialing is permitted

For PBX applications, a 1 or 2-digit access code may l entered prior to a #, N code. These access digits overwri the previously stored digits at the start of register 0, th last-number-dialed register. The user then waits for a se ond dial-tone before automatically dialing the require number. Note that if a 2-digit access code is entere followed by #, 0, register 0 is automatically dialed fro location 3 onwards. Either a 1 or 2-digit access coc followed by #, N, however, automatically dials register from location 1 onwards. This allows the most flexible us of registers 1-9. Thus, it is not necessary to store acces codes in registers 1-9, either manually or by copying th last number dialed.

Applications Information

The TP5600 and TP5605 PULSE output is designed to driv a pulsing loop circuit in shunt with the speech network, a shown in *Figure 3*. During outpulsing, the MUTE circuit i turned off to isolate the speech network from the line. Q and Q3 conduct during MAKE periods, R1 adjusts tele phone pulsing resistance. Q2 and Q3 turn off durin BREAK periods, loop current is then only the supply cu rent to the device. Q1 provides a current source of 200 μ minimum to ensure that the device will have an adequat supply voltage.

The TP5610 and TP5615 PULSE output is designed for series pulsing loop, as shown in *Figure 4*. In this case, th MUTE circuit isolates only the receiver, so that curren flows through the speech network while outpulsing MAKI periods. Q3 cuts off this current during BREAK periods.

The on-hook current required for the device to retain data is low enough to allow this current to be drawn from the telephone line in certain applications. In this case, it is ad visable to add an external protection zener diode specified for very low leakage, as the internal regulator is turned off when the HOOKSWITCH pin goes high. A low leakage decoupling capacitor should also be specified.

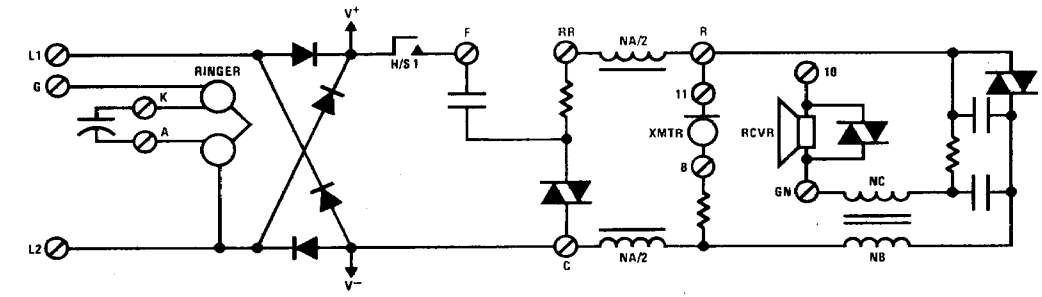
To protect stored data in the event of reduced line voltage (caused by an off-hook extension telephone, for example) a small back-up battery is recommended, as shown in *Figures 3 and 4*. The voltage regulator is turned off in the on-hook state to minimize battery current consumption.

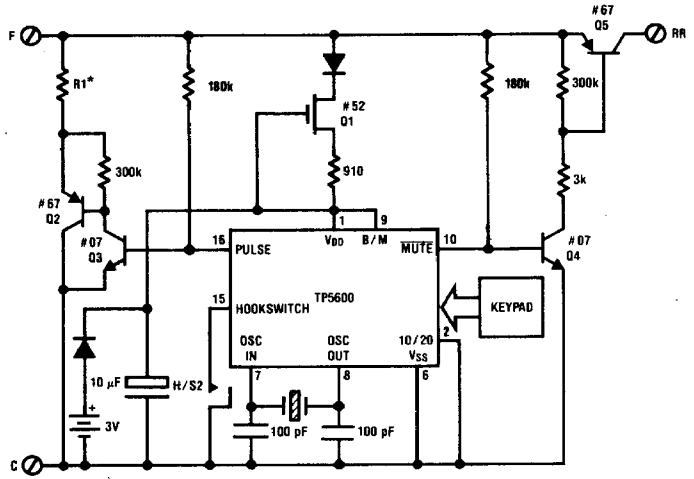
To protect the device against over-voltage during the transition to off-hook, the HOOKSWITCH contacts should be sequenced so that H/S2 closes before H/S1, thus connecting the on-chip regulator before the line power. Alternatively an external zener diode can be used.

Ceramic resonators for the TP5600, TP5610 oscillator circuits can be obtained from various companies including muRata, Toko, Vernitron and Radio Materials Corporation. The anti-resonant frequency, f_a, should be 480 kHz. Note that resonators are often referred to by their resonant frequency, f_r, which is typically 15 kHz-25 kHz lower than f_a. Consult manufacturers' data for specifications and tolerances.

Applications Information (Continued)

Typical Speech Network





Keypad Matrix

	COLUMN 3	COLUMN 2	COLUMN 1
ROW 1	1	2	3
ROW 2	4	5	6
ROW 3	7	8	9
ROW 4	* STORE	0	# REDIAL

* R1 typically 150Ω.

# indicates National Semiconductor Discrete process number.

FIGURE 3. TP5600 Shunt Dialer Application

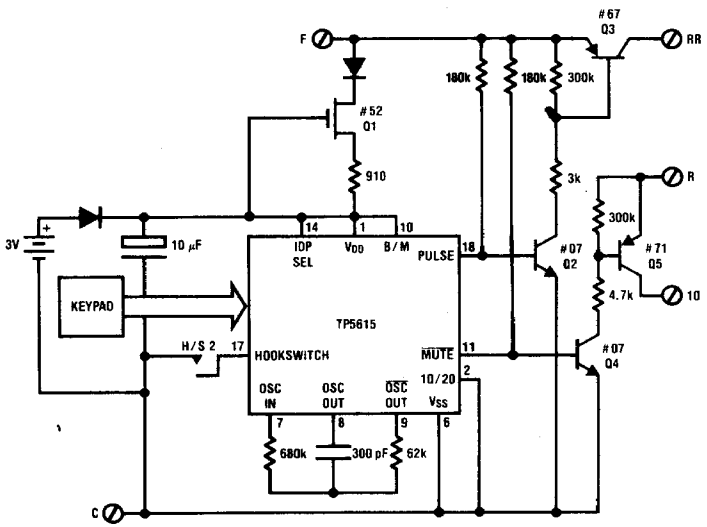


FIGURE 4. TP5615 Series Dialer Application