GOULD

AMI Semiconductors

Pulse Dialer

S2560A

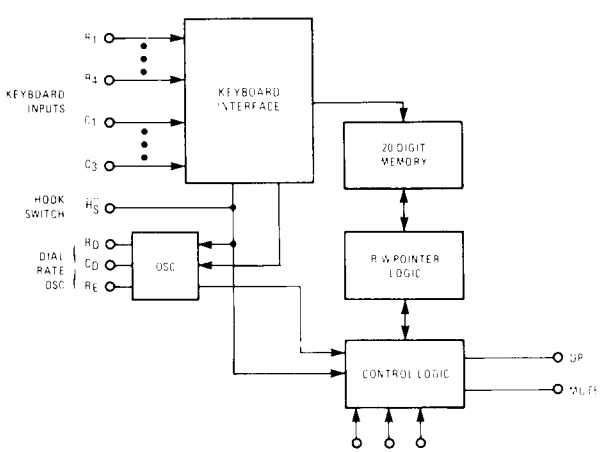
Features

- Low Voltage CMOS Process for Direct Operation from Telephone Lines
- Inexpensive R-C Oscillator Design Provides Better than ± 5% Accuracy Over Temperature and Unit to Unit Variations
- Dialing Rate Can be Varied by Changing the Dial Rate Oscillator Frequency
- Dial Rate Select Input Allows Changing of the Dialing Rate by a 2:1 Factor Without Changing Oscillator Components
- Two Selections of Mark/Space Ratios (33⅓/66⅔ or 40/60)
- Twenty Digit Memory for Input Buffering and for Redial with Access Pause Capability
- Mute and Dial Pulse Drivers on Chip
- Accepts DPCT Keypad with Common Arranged in a 2 of 7 Format; Also Capable of Interface to SPST Switch Matrix

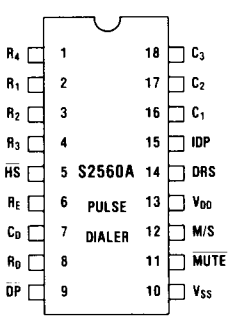
General Description

The S2560A Pulse Dialer is a CMOS integrated circuit that converts pushbutton inputs to a series of pulses suitable for telephone dialing. It is intended as a replacement for the mechanical telephone dial and can operate directly from the telephone lines with minimum interface. Storage is provided for 20 digits, therefore, the last dialed number is available for redial until a new number is entered. IDP is scaled to the dialing rate such as to produce smaller IDP at higher dialing rates. Additionally, the IDP can be changed by a 2:1 factor at a given dialing rate by means of the IDP select input.

Block Diagram



Pin Configuration



Absolute Maximum Ratings

Supply Voltage	+5.5V
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Voltage at any Pin	V_{SS} − 0.3V to V_{DD} + 0.3V
Lead Temperature (Soldering, 10sec)	300°C

Electrical Characteristics

Specifications apply over the operating temperature and $1.5V \leq V_{DD} - V_{SS} \leq 3.5V$ unless otherwise specified.

Symbol	Parameter	V_{DD}-V_{SS} (Volts)	Min.	Max.	Units	Conditions
	Output Current Levels					
I_{OLDP}	DP Output Low Current (Sink)	3.5	125		µA	V_{OUT} = 0.4V
I_{OHDP}	DP Output High Current (Source)	1.5 3.5	20 125		µA µA	V_{OUT} = 1V V_{OUT} = 2.5V
I_{OLM}	MUTE Output Low Current (Sink)	3.5	125		µA	V_{OUT} = 0.4V
I_{OHM}	MUTE Output High Current (Source)	1.5 3.5	20 125		µA µA	V_{OUT} = 1V V_{OUT} = 2.5V
I_{OLT}	Tone Output Low Current (Sink)	1.5	20		µA	V_{OUT} = 0.4V
I_{OHT}	Tone Output High Current (Source)	1.5	20		µA	V_{OUT} = 1V
V_{DR}	Data Retention Voltage		1.0		V	"On Hook" $\overline{HS}$ = V_{DD}. Keyboard open, all other input pins to V_{DD} or V_{SS}
I_{DD}	Quiescent Current	1.0		750	nA	
I_{DD}	Operating Current	1.5 3.5		100 500	µA µA	$\overline{DP}$, $\overline{MUTE}$ open, $\overline{HS}$ = V_{SS} ("Off Hook") Keyboard processing and dial pulsing at 10 pps at conditions as above
fo	Oscillator Frequency	1.5		10	kHz	
Δfo/fo	Frequency Deviation	1.5 to 2.5 2.5 to 3.5	−3 −3	+3 +3	% %	Fixed R-C oscillator components $50K\Omega \leq R_D \leq 750K\Omega$; $100pF \leq C_D^* \leq 1000pF$; $750K\Omega \leq R_E \leq 5M\Omega$ *300pF most desirable value for C_D
	Input Voltage Levels					
V_{IH}	Logical "1"		80% of ($V_{DD} - V_{SS}$)	V_{DD} + 0.3	V	
V_{IL}	Logical "0"		V_{SS} − 0.3	20% of ($V_{DD} - V_{SS}$)	V	
C_{IN}	Input Capacitance Any Pin			7.5	pF	

The device power supply should always be turned on before the input signal sources, and the input signals should be turned off before the power supply is turned off ($V_{SS} \leq V_I \leq V_{DD}$ as a maximum limit). This rule will prevent over-dissipation and possible damage of the input-protection diode when the device power supply is grounded. When power is first applied to the device, the device should be in "On Hook" condition ($\overline{HS} = 1$). This is necessary because there is no internal power or reset on chip and for proper operation all internal latches must come up in a known state. In applications where the device is hard wired in "Off Hook" ($\overline{HS} = 0$) condition, a momentary "On Hook" condition can be presented to the device during power up by use of a capacitor resistor network as shown in Figure 6.

Functional Description

The pin function designations are outlined in Table 1.

Oscillator

The device contains an oscillator circuit that requires three external components: two resistors (R_D and R_E) and one capacitor (C_D). All internal timing is derived from this master time base. To eliminate clock interference in the talk state, the oscillator is only enabled during key closures and during the dialing state. It is disabled at all other times including the "on hook" condition. For a dialing rate of 10pps the oscillator should be adjusted to 2400Hz. Typical values of external components for this are R_D and $R_E = 750k\Omega$ and $C_D = 270pF$. It is recommended that the tolerance of resistors to be 5% and capacitor to be 1% to insure a 10% tolerance of the dialing rate in the system.

Keyboard Interface (S2560A)

The S2560A employs a scanning technique to determine a key closure. This permits interface to a DPCT keyboard with common connected to V_{DD} (Figure 1), logic interface (Figure 2) and interface to a SPST switch matrix (Figure 7). A high level on the appropriate row and column inputs constitutes a key closure for logic interface. When using a SPST switch matrix, it is necessary to add small capacitors (30pF) from the column inputs to V_{SS} to insure that the oscillator is shut off after a key is released or after the dialing is complete.

OFF Hook Operation: The device is continuously powered through a 150kΩ resistor during Off hook operation. The DP output is normally high and sources base drive to transistor Q_1 to turn ON transistor Q_2. Transistor Q_2 replaces the mechanical dial contact used in the rotary dial phones. Dial pulsing begins when the user enters a number through the keyboard. The $\overline{DP}$ output goes low shutting the base drive to Q_1 OFF causing Q_2 to open during the pulse break. The $\overline{MUTE}$ output also goes low during dial pulsing allowing muting of the receiver through transistors Q_3 and Q_4. The relationship of dial pulse and mute outputs are shown in Figure 3.

ON Hook Operation: The device is continuously powered through a 10-20MΩ resistor during the ON hook operation. This resistor allows enough current from the tip and ring lines to the device to allow the internal memory to hold and thereby providing storage of the last number dialed.

The dialing rate is derived by dividing down the dial rate oscillator frequency. Table 2 shows the relationship of the dialing rate with the oscillator frequency and the dial rate select input. Different dialing rates can be derived by simply changing the external resistor value. The dial rate select input allows changing of the dialing rate by a factor of 2 without the necessity of changing the external component values. Thus, with the oscillator adjusted to 2400Hz, dialing rates of 10 or 20pps can be achieved. Dialing rates of 7 and 14pps similarly can be achieved by changing the oscillator frequency to 1680Hz.

The Inter-Digit Pause (IDP) time is also derived from the oscillator frequency and can be changed by a factor of 2 by the IDP select input. With IDP select pin wired to V_{SS}, an IDP of 800ms is obtained for dial rates of 10 and 20pps. IDP can be reduced to 400ms by wiring the IDP select pin to V_{DD}. At dialing rates of 7 and 14pps, IDP's of 1143ms and 572ms can be similarly obtained. If the IDP select is connected to the dial rate select pin, the IDP is scaled to the dial rate such that at 10pps an IDP of 800ms is obtained and at 20pps an IDP of 400ms is obtained.

The user can enter a number up to 20 digits long from a standard 3x4 double contact keypad with common (Figure 1). It is also possible to use a logic interface as shown in Figure 2 for number entry. Antibounce protection circuitry is provided on chip (min. 20ms) to prevent false entry.

Any key depressions during the on-hook condition are ignored and the oscillator is inhibited. This insures that the current drain in the on-hook condition is very low and used to retain the memory.

Normal Dialing

The user enters the desired numbers through the keyboard after going off hook. Dial pulsing starts as soon as the first digit is entered. The entered digits are stored sequentially in the internal memory. Since the device is designed in a FIFO arrangement, digits can be entered at a rate considerably faster than the output rate. Digits can be entered approximately once every 50ms while the dialing rate may vary from 7 to 20pps. The number entered is retained in the memory for future redial. Pauses may be entered when required in the dial sequence by pressing the "#" key, which provides access pauses for future redial. Any number of access pauses may be entered as long as the total entries do not exceed twenty.

Auto Dialing

The last number dialed is retained in the memory and therefore can be redialed out by going off hook and pressing the "#" key. Dial pulsing will start when the key is depressed and finish after the entire number is dialed out unless an access pause is detected. In such a case, the dial pulsing will stop and will resume again only after the user pushes the "#" key.

Table 1. S2560A/S2560B Pin/Function Descriptions

Pin	Number	Function
Keyboard (R_1, R_2, R_3, R_4, C_1, C_2, C_3)	2, 3, 4, 1, 16, 17, 18	These are 4 row and 3 column inputs from the keyboard contacts. These inputs are open when the keyboard is inactive. When a key is pushed, an appropriate row and column input must go to V_{DD} or connect with each other. A logic interface is also possible as shown in Figure 2. Active pull up and pull down networks are present on these inputs when the device begins keyboard scan. The keyboard scan begins when a key is pressed and starts the oscillator. Debouncing is provided to avoid false entry (typ. 20ms).
Inter-Digit Pause Select (IDP)	15	One programmable line is available that allows selection of the pause duration that exists between dialed digits. It is programmed according to the truth table shown in Table 3. Note that preceding the first dialed pulse is an inter-digit time equal to the selected IDP. Two pauses either 400ms or 800ms are available for dialing rates of 10 and 20 pps. IDP's corresponding to other dialing rates can be determined from Tables 2 and 3.
Dial Rate Select (DRS)	14	A programmable line allows selection of two different output rates such as 7 or 14 pps, 10 or 20 pps, etc. See Tables 2 and 3.
Mark/Space (M/S)	12	This input allows selection of the mark/space ratio, as per Table 3.
Mute Out ($\overline{MUTE}$)	11	A pulse is available that can provide a drive to turn on an external transistor to mute the receiver during the dial pulsing.
Dial Pulse Out ($\overline{DP}$)	9	Output drive is provided to turn on a transistor at the dial pulse rate. The normal output will be "low" during "space" and "high" otherwise.
Dial Rate Oscillator (R_E, C_D, R_D)	6, 7, 8	These pins are provided to connect external resistors R_D, R_E and capacitor C_D to form an R-C oscillator that generates the time base for the Key Pulser. The output dialing rate and IDP are derived from this time base.
Hook Switch ($\overline{HS}$)	5	This input detects the state of the hook switch contact; "off hook" corresponds to V_{SS} condition.
Power (V_{DD}, V_{SS})	13, 10	These are the power supply inputs. The device is designed to operate from 1.5V–3.5V.

Figure 1. Standard Telephone Pushbutton Keyboard

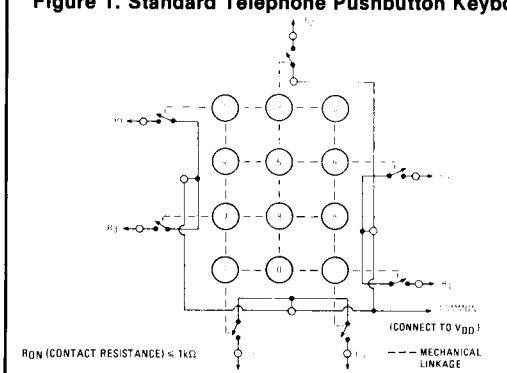


Figure 2. Logic Interface for the S2560

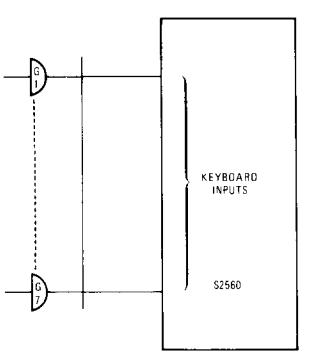


Figure 3. Timing

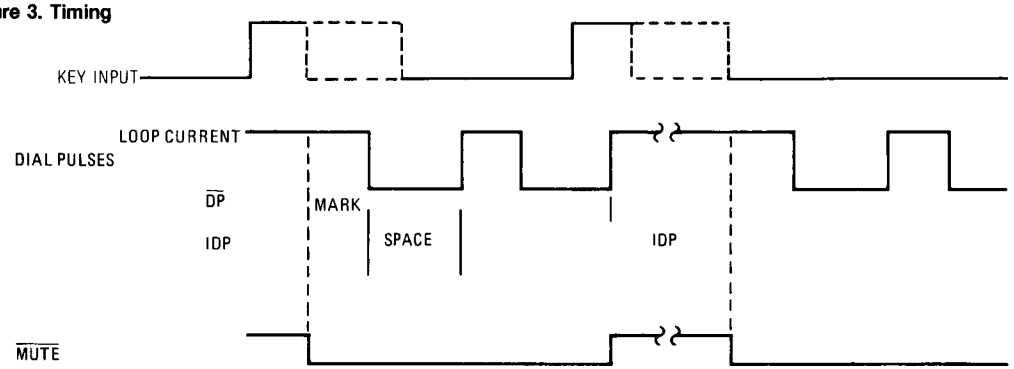


Table 2. Table for Selecting Oscillator Component Values for Desired Dialing Rates and Inter-Digit Pauses

Dial Rate Desired	Osc. Freq. (Hz)	R_D (kΩ)	R_E (kΩ)	C_D (pF)	Dial Rate (pps)		IDP (ms)	
					DRS = V_{SS}	DRS = V_{DD}	IPS = V_{SS}	IPS = V_{DD}
5.5/11	1320				5.5	11	1454	727
6/12	1440				6	12	1334	667
6.5/13	1560				6.5	13	1230	615
7/14	1680	Select components in the			7	14	1142	571
7.5/15	1800	ranges indicated in table			7.5	15	1066	533
8/16	1920	of electrical specifications			8	16	1000	500
8.5/17	2040				8.5	17	942	471
9/18	2160				9	18	888	444
9.5/19	2280				9.5	19	842	421
10/20	2400	750	750	270	10	20	800	400
$(f_d/240)/(f_d/120)$	f_d				$(f_d/240)$	$(f_d/120)$	$\frac{1920}{f_i} \times 10^3$	$\frac{960}{f_i} \times 10^3$

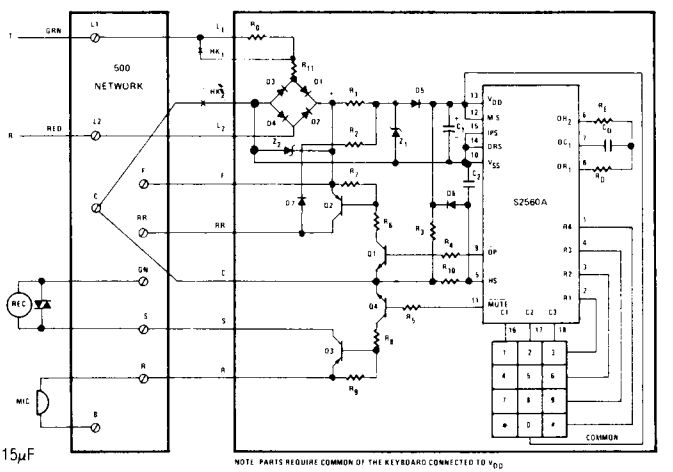
NOTE: IDP is dependent on the dialing rate selected. For example, for a dialing rate of 10pps, an IDP of either 800ms or 400ms can be selected. For a dialing rate of 14pps, and IDP of either 1142ms or 571ms can be selected.

Table 3.

Function	Pin Designation	Input Logic Level	Selection
Dial Pulse Rate Selection	DRS (14)	V_{SS} V_{DD}	(f/240)pps (f/120)pps
Inter-Digit Pause Selection	IDP (15)	V_{DD} V_{SS}	$\frac{960}{f}$ s $\frac{1920}{f}$ s
Mark/Space Ratio	M/S (12)	V_{SS} V_{DD}	33⅓/66⅔ 40/60
On Hook/Off Hook	$\overline{HS}$ (5)	V_{DD} V_{SS}	On Hook Off Hook

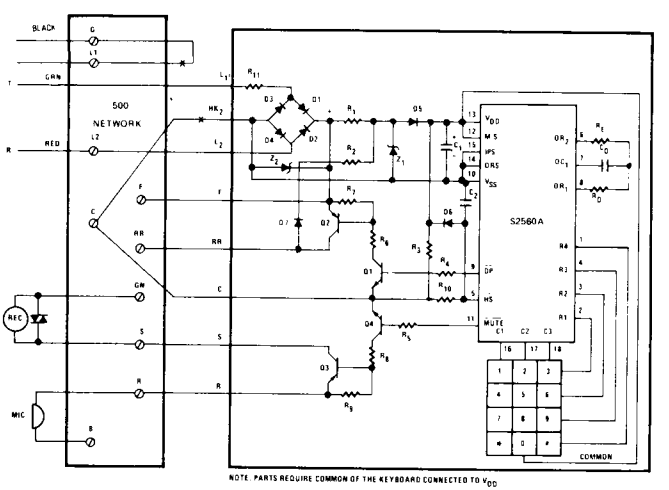
NOTE: f is the oscillator frequency and is detemined as shown in Figure 5.

Figure 4. Pulse Dialer Circuit with Redial



R_0 = 10-20MΩ, R_1 = 150kΩ, R_2 = 2kΩ
R_3 = 470kΩ, R_4, R_5 = 10kΩ, R_{10} = 47kΩ
R_6, R_8 = 2kΩ, R_7, R_9 = 30kΩ, R_{11} = 20Ω, 2W
Z_1 = 3.9V, D_1—D_4 = IN4004, D_5, D_6, D_7 = IN914, C_1 = 15μF
R_E = R_D = 750kΩ, C_D = 270pF, C_2 = 0.01μF
Q_1, Q_4 = 2N5550 TYPE Q_2, Q_3 = 2N5401 TYPE
Z_2 = IN5379 110V ZENER OR 2XIN4758

Figure 5. Pulse Dialer Circuit with Redial (Single Hook Switch Contact Application for PABX)



R_1 = 10-20MΩ, R_2 = 2kΩ
R_3 = 470kΩ, R_4, R_5 = 10kΩ
R_6, R_8 = 2kΩ, R_7, R_9 = 30kΩ
R_{10} = 47kΩ, R_{11} = 20Ω, 2W
Z_1 = 3.9V, D_1—D_4 = IN4004
D_5, D_6, D_7 = IN914, C_1 = 15μF
R_E, R_D = 750kΩ, C_D = 270pF
C_2 = 0.01μF, Q_1, Q_4 = 2N5550
Q_2, Q_3 = 2N5401
Z_2 = 150V ZENER OR VARISTOR TYPE GE MOV150

Figure 6. Circuit for Applying Momentary "ON Hook" Condition During Power Up

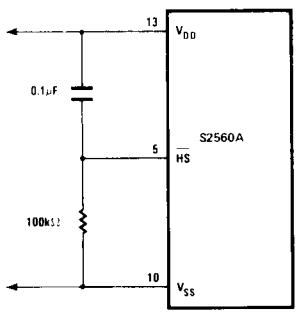


Figure 7. SPST Switch Matrix Interface