

### Tone Dialer with Built-in Piezo Driver

#### OVERVIEW

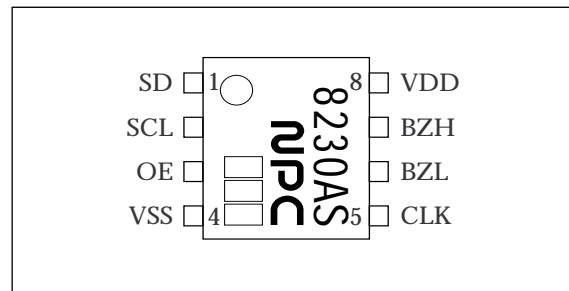
The SM8230A is a dual-tone signal generator LSI developed for DTMF (dual tone multi-frequency) dialing. It features a built-in piezo-electric speaker driver for direct connection to a piezo-electric buzzer.

The DTMF frequencies can be set to correspond to the DTMF standards of any country. The output level is also adjustable under software control. These features, combined with its small package and low power dissipation, make the SM8230A a very use device to use.

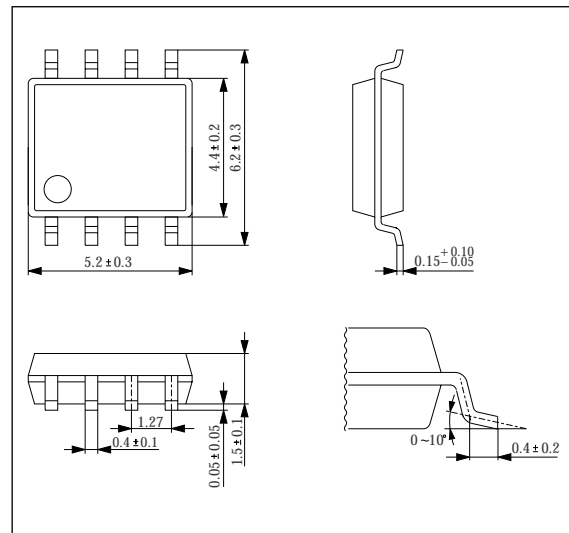
#### FEATURES

- 3-line serial interface to external CPU
- 2 independent, adjustable frequency outputs
- Piezo driver for direct connection to a piezo-electric buzzer
- 4 system clock frequencies selectable (480 kHz, 960 kHz, 1.92 MHz, 3.84 MHz)
- 2.6 to 3.3 V supply voltage
- Low current consumption
  - 3.0 mA (max) operating current
  - 1  $\mu$ A (max) standby current
- 8-pin plastic SOP

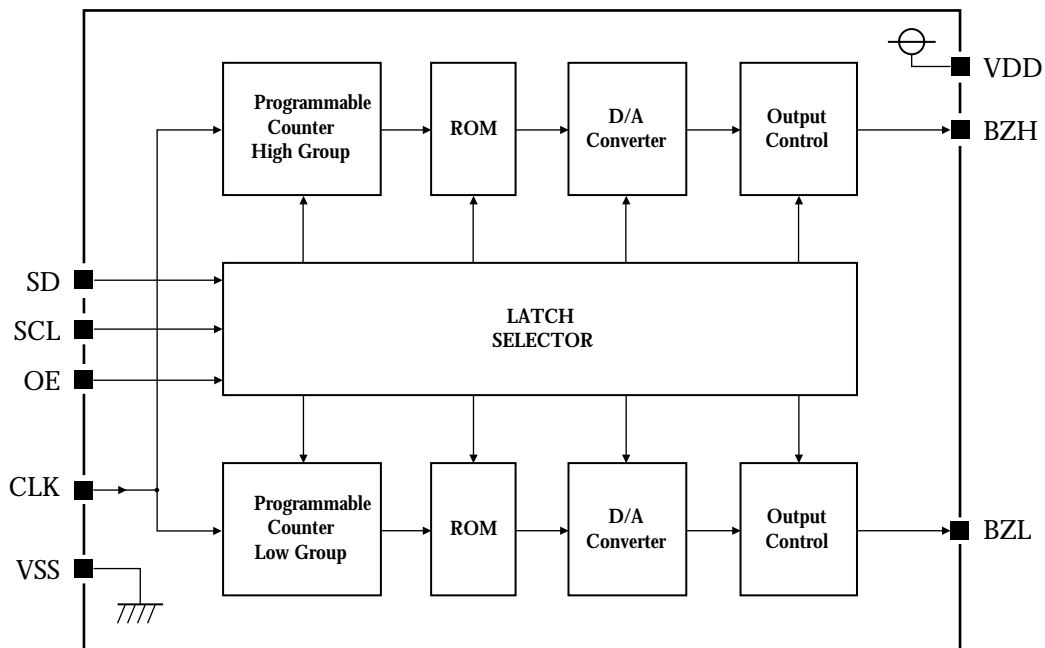
#### PINOUT



#### PACKAGE DIMENSIONS



## BLOCK DIAGRAM



## PIN DESCRIPTION

Number	Name	I/O	Description
1	SD	I	Serial data input
2	SCL	I	Serial data transfer clock input. (For valid transfer, OE must stay LOW for 16 clock cycles.)
3	OE	I	DTMF output enable/serial data transfer select input. Serial data transfer is selected when LOW.
4	VSS	-	Ground
5	CLK	I	System clock input. The clock can be set to one of four frequencies (480 kHz, 960 kHz, 1.92 MHz, 3.84 MHz).
6	BZL	O	DTMF low-frequency group analog output
7	BZH	O	DTMF high-frequency group analog output
8	VDD	-	Supply voltage

## SPECIFICATIONS

### Absolute Maximum Ratings

$V_{SS} = 0\text{ V}$

Parameter	Symbol	Rating	Unit
Supply voltage range	$V_{DD}$	-0.3 to 7.0	V
Input voltage range	$V_{IN}$	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Output voltage range	$V_{OUT}$	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Storage temperature range	$T_{stg}$	-55 to 125	°C
Power dissipation	$P_D$	250	mW
Soldering temperature	$T_{sld}$	255	°C
Soldering time	$t_{sld}$	10	s

### Recommended Operating Conditions

$V_{SS} = 0\text{ V}$

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage range	$V_{DD}$		2.6	3.0	3.3	V
Operating temperature	$T_{opr}$		-20	25	70	°C

### DC Characteristics

$V_{DD} = 2.6$  to  $3.3\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -20$  to  $70\text{ °C}$

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Operating current consumption	$I_{DD}$	$V_{DD} = 3.0\text{ V}$ , $T_a = 25\text{ °C}$ , $f_{CLK} = 480\text{ kHz}$	-	1.5	3	mA
Standby current consumption	$I_{ST}$	$V_{DD} = 3.3\text{ V}$ , OE = LOW	-	-	1	μA
Input voltage (all inputs)	$V_{IH}$	HIGH-level input	1.1	-	$V_{DD}$	V
	$V_{IL}$	LOW-level input	$V_{SS}$	-	0.6	
Input leakage current	$I_{IL}$	HIGH/LOW-level input	-1	-	1	μA
BZH/BZL tone output voltage	$V_{BZO}$	0 dB output level	$0.86V_{DD}$	$0.93V_{DD}$	$1.0V_{DD}$	Vp-p
BZH/BZL tone output adjustment step	$D_{RES}$		-	1.0	-	dB
BZH/BZL tone output absolute error	$D_{LIN}$	$V_{ZBO}$ levels	-1	-	1	dB
BZH/BZL tone output impedance	$Z_{OUT}$		100	150	200	Ω

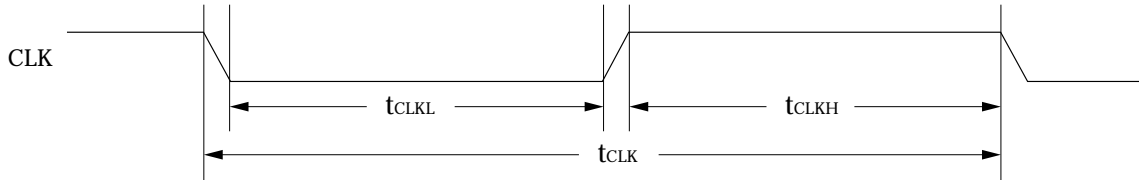
**AC Characteristics**

$V_{DD} = 2.6$  to  $3.3V$ ,  $V_{SS} = 0V$ ,  $T_a = -20$  to  $70\text{ }^\circ\text{C}$

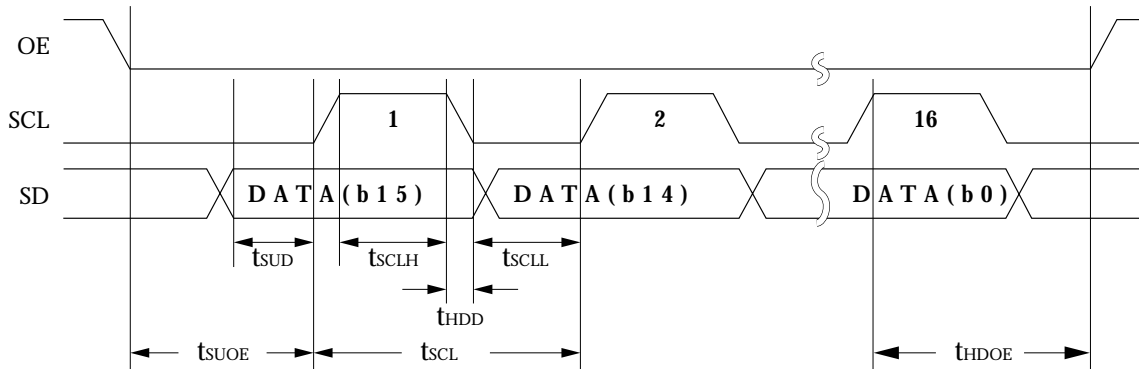
Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Tone output frequency error	$\Delta f$	$f_{CLK} = 3.84\text{ MHz}$ , no deviation	-	-	0.37	%
Tone distortion <sup>1</sup>	DIS	BZH/BZL	-	5	10	%
CLK cycle time	$t_{CLK}$	CLK input waveform	250	-	-	ns
CLK LOW-level pulsewidth	$t_{CLKL}$		100	-	-	ns
CLK HIGH-level pulsewidth	$t_{CLKH}$		100	-	-	ns
OE setup time	$t_{SUOE}$	Between OE and SCL	100	-	-	ns
OE hold time	$t_{HDOE}$		100	-	-	ns
SCL cycle time	$t_{SCL}$	SCL input waveform	1	-	-	$\mu\text{s}$
SCL LOW-level pulsewidth	$t_{SCLL}$		400	-	-	ns
SCL HIGH-level pulsewidth	$t_{SCLH}$		400	-	-	ns
Input data setup time	$t_{SUD}$	Between SD and SCL	100	-	-	ns
Input data hold time	$t_{HDD}$		100	-	-	ns

1.  $T_a = -10$  to  $70\text{ }^\circ\text{C}$ , THD + N (10 Hz to 500 kHz), no load

**System clock input timing**



**Serial data transfer timing**



**FUNCTIONAL DESCRIPTION**

**Serial Interface**

Data is transferred in 16-bit units by writing commands over a 3-line serial interface comprising OE

(output enable), SCL (serial clock) and SD (serial data input). Note that data transfer is unidirectional; no data is output from the SM8230A. The operating sequence is described below.

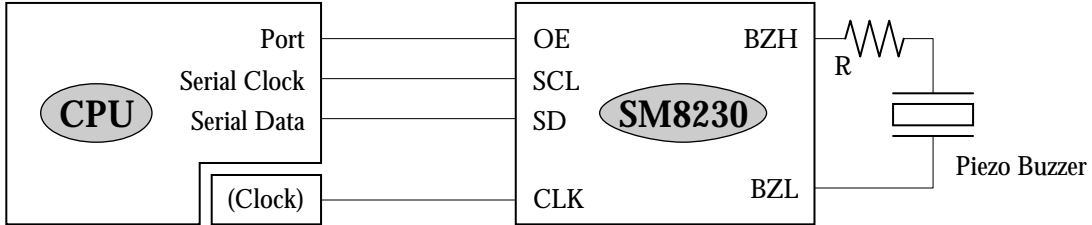


Figure 1. Serial interface connection example

**Command transfer**

Data can be transferred when OE goes LOW. Data is transferred in 16-bit units in sync with the rising edge of the SCL clock.

Note that when OE is LOW and both SD and SCL are tied LOW, the current consumption is less than 1  $\mu$ A (standby mode).

The internal states are undefined when power is first applied.

**DTMF analog signal output**

Data transfer stops and DTMF analog signal output starts when OE goes HIGH, as shown in figure 2.

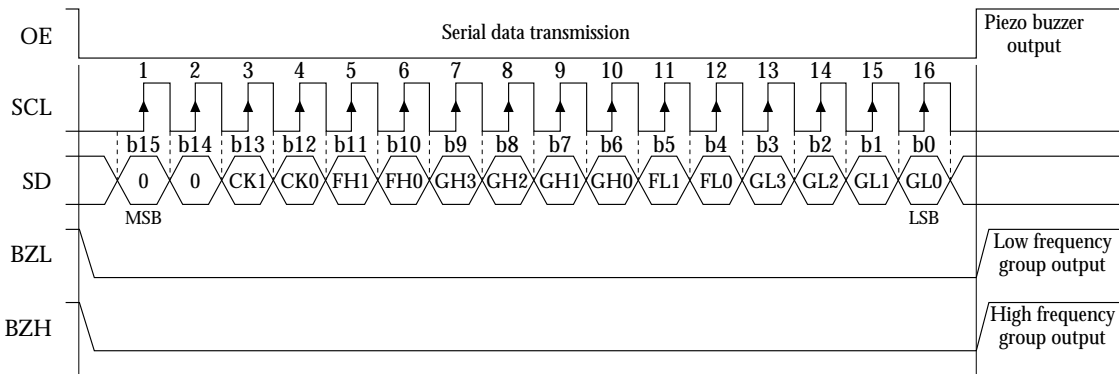


Figure 2. Serial data transfer timing

## Transfer Command Specifications

The transfer data code format is shown in figure 3. Data is transferred with the MSB as the leading bit. The data sets the input clock, high-frequency group and low-frequency group frequencies, and the output levels. The commands are shown in tables 1 to 4.

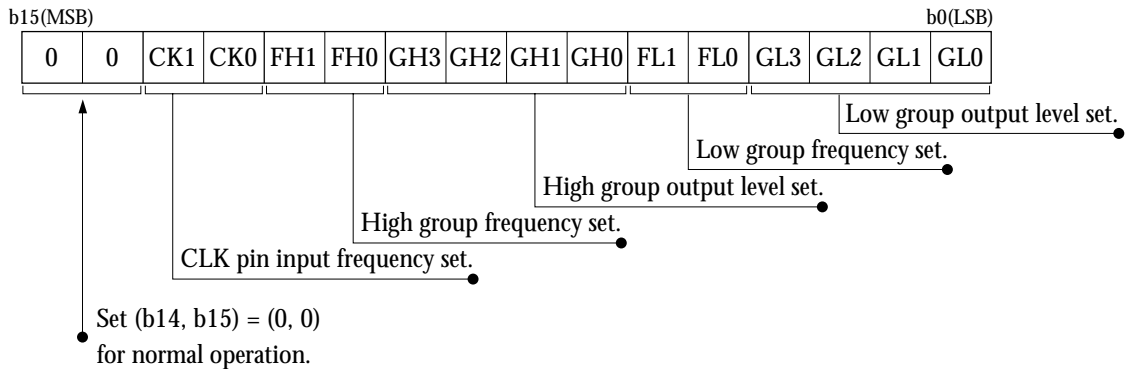


Figure 3. Transfer command format

### CK command (CK1, CK0)

These bits set the frequency of the input clock on CLK. The frequency can be set to 1×, 2×, 4×, and 8× multiples of 480 kHz. The input code and the corresponding clock frequency are shown in table 1.

Table 1. CK command

CK1	CK0	CLK input clock frequency
0	0	480 kHz
0	1	960 kHz
1	0	1.92 MHz
1	1	3.84 MHz

### FH/FL command (FH1, FH0 / FL1, FL0)

These bits set the DTMF signal high-frequency and low-frequency group frequencies, respectively.

The input code, the corresponding group frequency specification, the design value and frequency deviation are shown in tables 2 and 3.

Note that the design value and frequency deviation are calculated values assuming a deviation-free system clock input on CLK.

Table 2. FH command

FH1	FH0	DTMF frequency (Hz)	Design value (Hz)	Deviation (%)
0	0	1209	1212.1	+0.26
0	1	1336	1333.3	-0.20
1	0	1477	1481.5	+0.30
1	1	1633	1632.7	-0.02

Table 3. FL command

FH1	FH0	DTMF frequency (Hz)	Design value (Hz)	Deviation (%)
0	0	697	697.7	+0.10
0	1	770	769.2	-0.10
1	0	852	851.1	-0.11
1	1	941	937.5	-0.37

**GH/GL command (GH3 to GH0, GL3 to GL0)**

These bits set the output levels of the high-frequency group and low-frequency group outputs, respectively. The input code and the corresponding output level are shown in table 4. Note that the 0 dB point is typically 93% of the supply voltage. Any value above 0 dB results in amplitude clipping of the output waveform.

Table 4. GH/GL command

GH3/GL 3	GH2/GL 2	GH1/GL 1	GH0/GL 0	Output level
0	0	0	0	-9 dB
0	0	0	1	-8 dB
0	0	1	0	-7 dB
0	0	1	1	-6 dB
0	1	0	0	-5 dB
0	1	0	1	-4 dB
0	1	1	0	-3 dB
0	1	1	1	-2 dB
1	0	0	0	-1 dB
1	0	0	1	0 dB
1	0	1	0	1 dB
1	0	1	1	2 dB
1	1	0	0	3 dB
1	1	0	1	4 dB
1	1	1	0	5 dB
1	1	1	1	6 dB

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