SIERRA SEMICONDUCTOR April 1986

SC11202, SC11203 and SC11204 DTMF Receivers

FEATURES

- Built-in dial tone rejection
- Single 5-volt supply
- Three-state outputs
- Narrow 14 or 18 pin package

BENEFITS

- No external filters required
- Minimum system overhead
- Simple bus interface
- Minimum board space

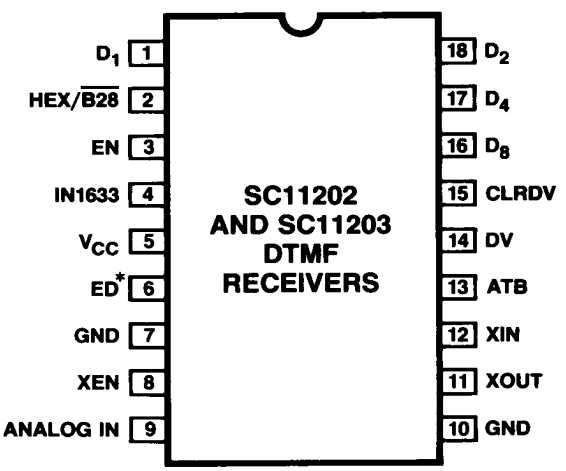
GENERAL DESCRIPTION

The SC11202, SC11203 and SC11204 are central office quality dual-tone, multi-frequency (DTMF) – touch tone – receivers built with Sierra's proprietary 3-micron CMOS process. They receive analog DTMF signals and decode them into the 16 standard digits. The SC11202 and SC11203 provide either a 4-bit hexadecimal code or binary coded 2 of 8, while the SC11204 provides 4-bit hex code only. The outputs are three state, CMOS logic compatible, facilitating bus interfaces. A built-in dial-tone rejection circuit eliminates the need for any front-end or prefiltering. The only external components required are an inexpensive 3.58 MHz crystal and a bias resistor for the time base. Up to ten DTMF receivers may be operated from a single crystal through the Alternate Time Base (ATB) pin.

The SC11202 is pin and function compatible to Silicon Systems' 202 (18-pin), the SC11203 is pin and function compatible with Silicon Systems' 203 (18-pin with an Early Detect output) and the SC11204 is a 14-pin device compatible with SSI's 204.

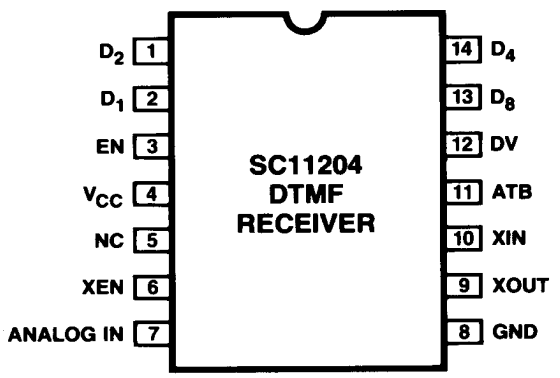
Applications include central office switches, PBXs, auto dialers for redialing a number over an alternate carrier, subscriber equipment such as telephone answering machines, remote banking or other transaction systems that employ DTMF signals for remote operation and voice/DTMF response systems.

CONNECTION DIAGRAMS



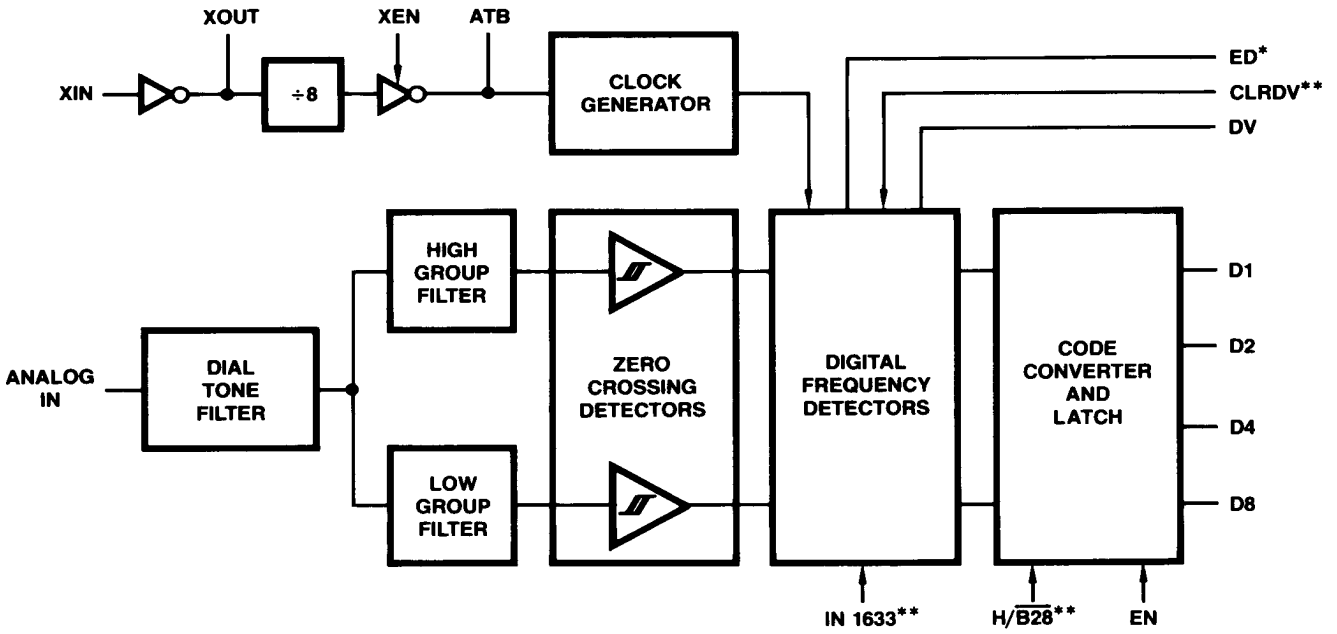
*SC11203 only
NC on SC11202

Order Number: SC11202CN
or SC11203CN



Order Number: SC11204CN

BLOCK DIAGRAM



*SC11203 only
**SC11202 and SC11203

SC11202, SC11203 AND SC11204 DTMF RECEIVERS

DESCRIPTION OF PIN FUNCTIONS

Pin Number	Pin Name	Function
1, 18, 17, 16	D1, D2 D4, D8	Digital outputs that provide the code corresponding to the detected digit. These outputs are push-pull CMOS when EN (pin 3) is high and are a high impedance, open circuit, when EN is low. In the SC11202 and SC11203, the digital output format is programmed by the HEX/$\overline{B28}$ pin (2) to be either hexadecimal or binary coded 2 of 8 (see Table 3). In the SC11204, the output is hexadecimal and is on pins 2, 1, 14 and 13. These outputs become valid after a tone pair has been detected and they are cleared when a valid pause is timed.
2	HEX/$\overline{B28}$	Selects the digital output format on the SC11202 and SC11203. When HEX/$\overline{B28}$ is high, the outputs on D1, D2, D4 and D8 are hexadecimal; when it is low, the outputs are binary coded 2 of 8. See table 3 for the hexadecimal and binary 2 of 8 codes.
3	EN	Enables the digital outputs D1, D2, D4 and D8.
4	IN1633	When tied high, this pin inhibits the detection of tone pairs containing the 1633 Hz component. To detect all 16 standard digits, IN1633 must be tied low. It has an internal pull-down to ground.
5	V_{CC}	Positive supply; 5 volts.
6	ED	Provided only on the SC11203, the ED output goes high as soon as a DTMF tone pair begins to be detected, and goes low when a pause begins to be detected. D1, D2, D4 and D8 outputs are guaranteed to be valid when DV is high, but are not necessarily valid when ED is high.
7, 10	GND	Ground; 0 volts. Pin 10 must be tied to ground; pin 7 is optional.
8	XEN	Enables the crystal oscillator. When high, the crystal oscillator is enabled. This pin should be tied low if the device is driven by an external oscillator through the ATB input.
9	Analog IN	Accepts the analog input. This pin is internally biased so that the input signal may be AC

DESCRIPTION OF PIN FUNCTIONS

Pin Number	Pin Name	Function
		coupled through a 0.01μF capacitor. The input may be DC coupled as long as it does not exceed the positive supply.
11, 12	XOUT, XIN	Crystal oscillator output and input. A 3.58 MHz crystal in parallel with a 1 megohm, 10% resistor is connected between these pins. The oscillator is enabled by tying XEN (pin 8) high. In this mode, the clock frequency is also provided at the ATB output (pin 13).
13	ATB	Alternate time-base. For a device with a crystal and a resistor connected between pins 11 and 12, and XEN tied high, ATB is a 447.5 kHz clock output that can be used to drive up to ten other DTMF receivers. For these devices, XEN must be tied low and ATB is an input.
14, 15	DV, CLRDV	Data valid and clear data valid. DV goes high after a valid tone pair is sensed and decoded at the output of pins D1, D2, D4 and D8. DV remains high until a valid pause occurs or until the CLRDV input is taken high, whichever occurs first.
NC		NC indicates that no internal connection is made to the pin and it may be left floating.

TABLE 1. DTMF DIALING MATRIX

	Col 0	Col 1	Col 2	Col 3
Row 0	1	2	3	A
Row 1	4	5	6	B
Row 2	7	8	9	C
Row 3	*	0	#	D

TABLE 2. DETECTION FREQUENCY

Low Group f_o	High Group f_o
Row 0 = 697 Hz	Column 0 = 1209 Hz
Row 1 = 770 Hz	Column 1 = 1336 Hz
Row 2 = 852 Hz	Column 2 = 1477 Hz
Row 3 = 941 Hz	Column 3 = 1633 Hz

TABLE 3. HEX/$\overline{B28}$ OUTPUT CODES

	Hexadecimal				Binary Coded 2 of 8			
Digit	D8	D4	D2	D1	D8	D4	D2	D1
1	0	0	0	1	0	0	0	0
2	0	0	1	0	0	0	0	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	0	0
5	0	1	0	1	0	1	0	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	1	0	0	0
8	1	0	0	0	1	0	0	1
9	1	0	0	1	1	0	1	0
0	1	0	1	0	1	1	0	1
*	1	0	1	1	1	1	0	0
#	1	1	0	0	1	1	1	0
A	1	1	0	1	0	0	1	1
B	1	1	1	0	0	1	1	1
C	1	1	1	1	1	0	1	1
D	0	0	0	0	1	1	1	1

ABSOLUTE MAXIMUM RATINGS (Notes 1 and 2)

Supply Voltage, V_{CC}	7V
DC Input Voltage	-0.5 to $V_{CC} + 0.5V$
Analog Input Voltage	$V_{CC} - 10V$ to $V_{CC} + 0.5V$
Storage Temperature Range	$-65°C$ to $150°C$
Power Dissipation (Note 3)	500mW
Lead Temperature (soldering, 10 sec.)	300°C

OPERATING CONDITIONS

Parameter	Description	Conditions	Min	Typ	Max	Units
T_A	Ambient Temperature		0		70	°C
V_{CC}	Positive Supply Voltage		4.5		5.5	V
GND	Ground			0		V
F_C	Crystal Frequency		3.576	3.579545	3.583	MHz

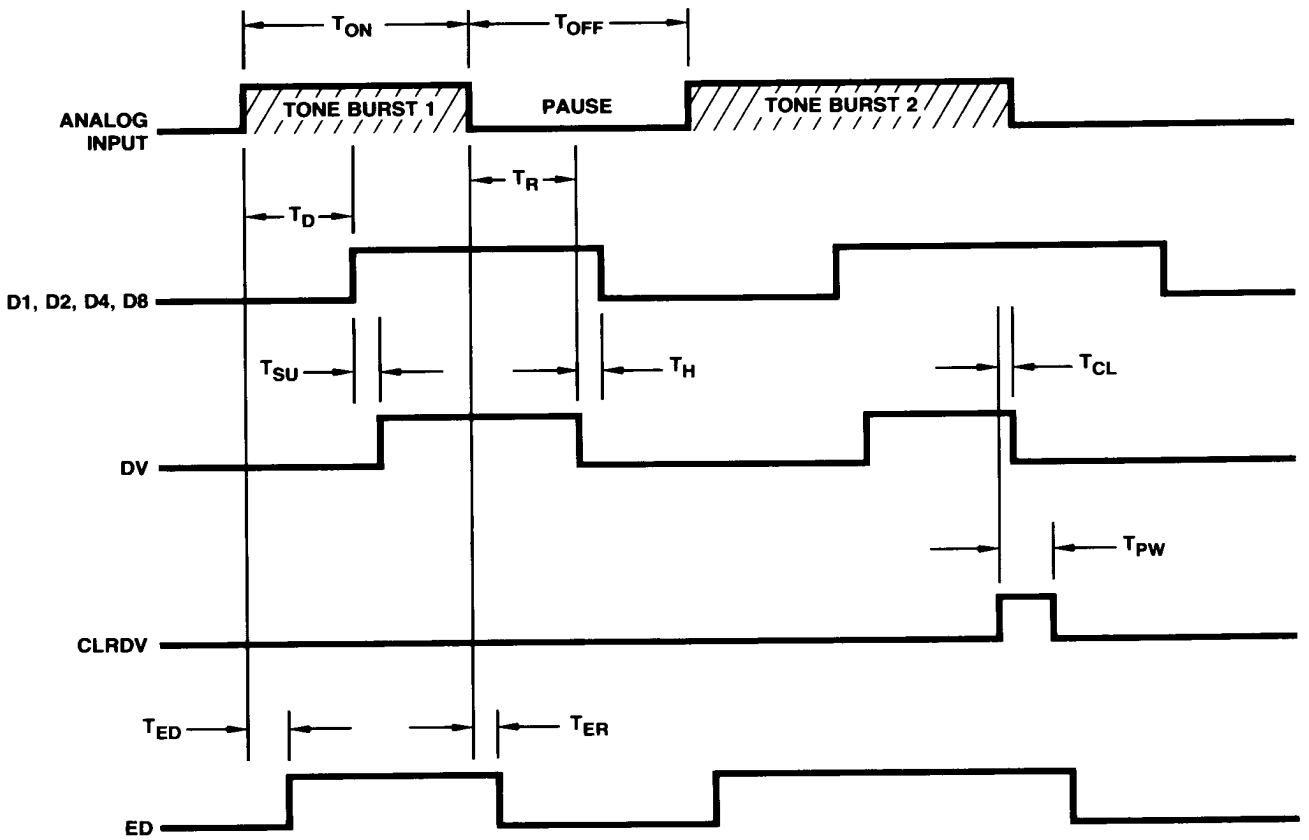
ELECTRICAL CHARACTERISTICS (Note 4)

Parameter	Conditions	Min	Typ	Max	Units
Frequency Detect Bandwidth		$\pm(1.5 + 2Hz)$	±2.3	±3.5	% of f_o
Amplitude for Detection	Each Tone SC11202 & SC11203	-32		-2	dBm Referenced to 600Ω
Amplitude for Detection	Each Tone SC11204	-18		-2	dBm Referenced to 600Ω
Minimum Acceptable Twist	Twist = $\frac{\text{High Tone}}{\text{Low Tone}}$	-10		$+10$	dB
60 Hz Tolerance				0.8	Vrms
Dial Tone Tolerance	"Precise" Dial Tone			0dB	dB Referenced to Lower Amplitude Tone
Talk Off	MITEL Tape #CM 7291		2		Hits
Digital Outputs (except XOUT)	"0" Level, 400μA Load	0		0.5	Volts
	"1" Level, 200μA Load	$V_{CC} - 0.5$		V_{CC}	Volts
Digital Inputs	"0" Level	0		0.3 V_{CC}	Volts
	"1" Level	0.7 V_{CC}		V_{CC}	Volts
Power Supply Noise	Wide Band			10	mV p-p
Supply Current	$T_A = 25°C$		10	16	mA
Noise Tolerance	MITEL Tape #CM 7291			-12	dB Referenced to Lowest Amplitude Tone
Input Impedance	$V_{CC} \geq V_{IN} \geq V_{CC}-10$	100kΩ//15pF			

Notes: 1. Absolute maximum ratings are those values beyond which damage to the device may occur.
2. Unless otherwise specified, all voltages are referenced to ground.
3. Power dissipation temperature derating –
Plastic package: -12mW/C from 65°C to 85°C
Ceramic package: -12mW/C from 100°C to 125°C
4. Min and max values are valid over the full temperature and operating voltage range. Typical values are for 25°C and 5 volt operation.

TIMING CHARACTERISTICS (at 25°C and 5V supply)

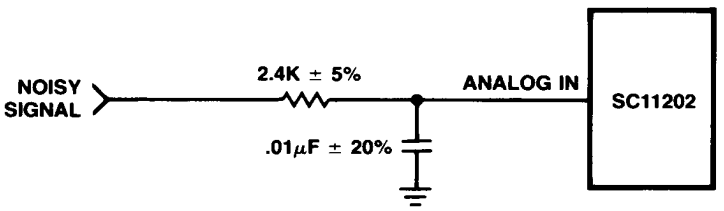
Parameter	Description	Conditions	Min	Typ	Max	Units
T_{ON}	Tone Time for Detection		40			ms
T_{ON}	Tone Time for Rejection				20	ms
T_{OFF}	Pause Time for Detection		40			ms
T_{OFF}	Pause Time for Rejection				20	ms
T_D	Detect Time		25		46	ms
T_R	Release Time		35		50	ms
T_{SU}	Data Setup Time		7			μs
T_H	Data Hold Time		4.2		5.0	ms
T_{CL}	DV Clear Time			160	250	ns
T_{PW}	CLRDV Pulse Width		200			ns
T_{ED}	ED Detect Time		7		22	ms
T_{ER}	ED Release Time		2		18	ms
T_{OE}	Output Enable Time	C_L = 50pF R_L = 1kΩ		200	300	ns
T_{OD}	Output Disable Time	C_L = 35pF R_L = 500Ω		150	200	ns
T_{OR}	Output Rise Time	C_L = 50pF		200	300	ns
T_{OF}	Output Fall Time	C_L = 50pF		160	250	ns



DTMF RECEIVER TIMING

APPLICATION NOTES

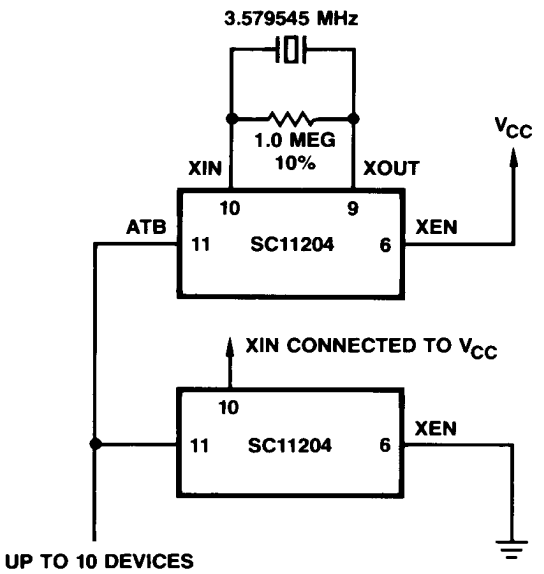
The DTMF receiver will tolerate total input rms noise up to 12dB below the lowest amplitude tone. For most telephone applications, the combination of the high frequency attenuation of the telephone line and internal band-limiting make special circuitry at the input to the DTMF receiver unnecessary. However, noise near the 74.6 kHz internal sampling frequency will be aliased (folded back) into the audio spectrum; if excessive noise is present above 37.3 kHz, the simple RC filter shown below can be employed to band limit the incoming signal. Noise will also be reduced by placing a ground trace around the XIN and XOUT pins on the circuit board layout when using a crystal. XOUT is not intended to drive an additional device. XIN may be driven externally in which case XOUT must be left floating.



For use in extreme high frequency input noise environment.

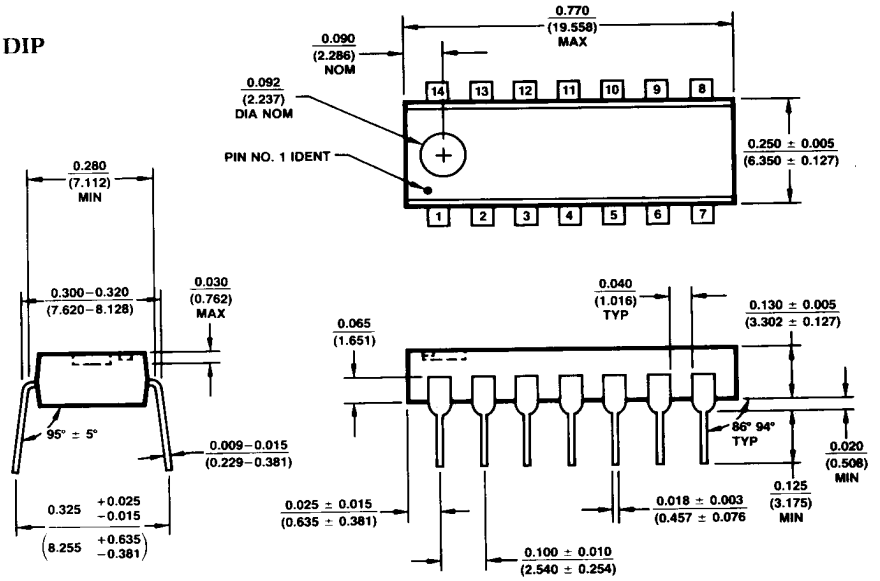
CRYSTAL OSCILLATOR

The DTMF receivers contain an onboard inverter with sufficient gain to provide oscillation when connected to a low-cost television color-burst crystal. The crystal oscillator is enabled by tying XEN high. The crystal is connected between XIN and XOUT. A 1 megohm 10% resistor is also connected between these pins. In this mode, ATB is a clock frequency output. Other DTMF receivers may use the same frequency reference by tying their ATB pins to the ATB of a crystal connected device. XIN and XEN of the auxiliary devices must then be tied high and low respectively. Ten devices may run off a single DTMF receiver with a crystal as shown below.



PHYSICAL DIMENSIONS – Inches (Millimeters)

PACKAGE N14A (N)
14-LEAD MOLDED DIP



PACKAGE N18A (N)
18-LEAD MOLDED DIP