

**FEATURES**

- DTMF generator and receiver
- Excellent speech immunity
- Tri-State outputs (4-bit hexadecimal) from receiver
- AC-Coupled, internally-biased analog input
- Analog input -32 to -2 dBm
- DTMF output -8 dBm (low band) and -5.5 dBm (high band)
- Microprocessor dialing
- Call progress detection

**GENERAL DESCRIPTION**

Sierra Semiconductor's new SC11290 is a complete Dual Tone Multiple Frequency (DTMF) Transceiver that can both generate and detect all 16 standard Touch-Tone digits. The SC11290 circuit integrates the performance proven SC11202 DTMF Receiver with a new DTMF generator circuit.

The DTMF Receiver electrical characteristics are identical to the standard SC11202 device charac-

teristics. The DTMF generator provides performance similar to the Mostek MK5380, but with an improved (tighter) output amplitude range specification and with the addition of independent latch and reset controls.

An additional feature of the SC11290 is "imprecise" call progress detector. The detector detects the presence of signals in the 305-640 Hz band.

**22-PIN DIP PACKAGE**



SC11290CN  
SC11290EN\*

**28-PIN PLCC PACKAGE**



SC11290CV  
SC11290EV\*

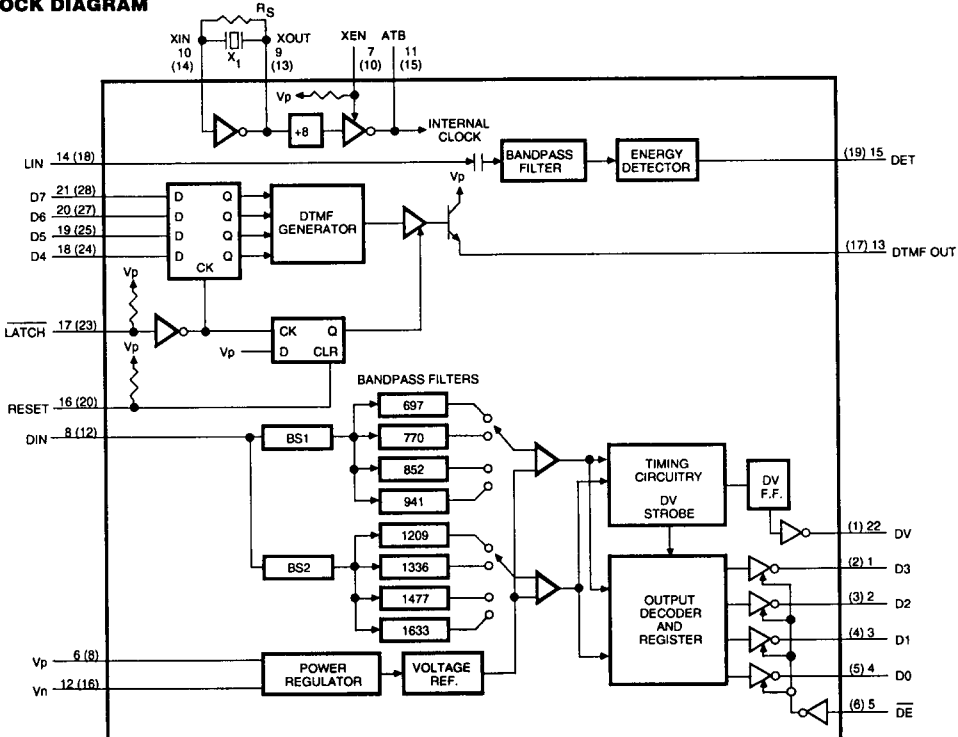
\*Special Order

The only external components necessary for the SC11290 are a 3.58 MHz "colorburst" crystal with a parallel 1M  $\Omega$  resistor. This provides the time base for digital functions and switched capacitor filters in the device. No external filtering is required.

SC11290 DTMF Transceiver With Call Progress Detection



**BLOCK DIAGRAM**



NOTE: NUMBERS NEXT TO SIGNAL NAMES ARE DIP PACKAGE PINS; NUMBERS IN ( ) ARE PLCC PINS. PINS (7), (9), (11), (21), (22), & (26) ARE NOT CONNECTED.

Rev 11290.22A

## CIRCUIT OPERATION

### Receiver

The DTMF receiver in the SC11290 detects the presence of a valid tone pair (indicating a single dialed digit) on a telephone line or other transmission medium. The analog input is pre-processed by 60 Hz reject and band splitting filters, then hard-limited to provide automatic gain control. Eight bandpass filters detect the individual tones. The digital post processor times the tone durations and provides the correctly coded digital outputs. The outputs will drive standard CMOS circuitry, and are three-state enabled to facilitate bus-oriented architectures.

### DIN

This pin accepts the analog input. It is internally biased so that the input signal may be AC coupled. The input may be DC coupled as long as it does not exceed the positive supply. Proper input coupling is illustrated in Figure 1.

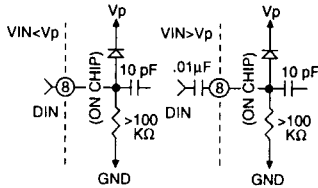


Figure 1.

The SC11290 is designed to accept sinusoidal input waveforms but will operate satisfactorily with any input that has the correct fundamental frequency with harmonics greater than 20 dB below the fundamental.

### Crystal Oscillator

The SC11290 contains an onboard inverter with sufficient gain to provide oscillation when connected to a low-cost television "color-burst" crystal. The crystal is placed between XIN and XOUT in parallel with a 1M Ω resistor, while

XEN is tied high. Since the switched-capacitor-filter time base is derived from the crystal oscillator, the frequency accuracy of all portions of the SC11290 depends on the time base tolerance. The Sierra Semiconductor DTMF receiver frequency response and timing is specified for a time base accuracy of at least  $\pm 0.005\%$ . ATB is a clock frequency output. Other devices 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, XOUT is left floating. XOUT is designed to drive a resonant circuit only and is not intended to drive additional devices. Ten devices may run off a single crystal-connected SC11290 as shown in Figure 2.

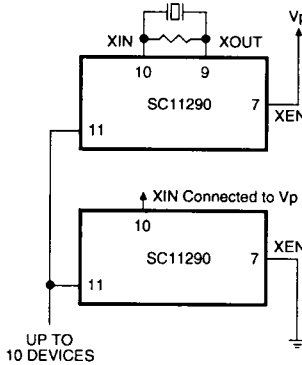


Figure 2.

### Receiver Outputs and the $\overline{DE}$ Pin

Outputs D0, D1, D2, D3 are CMOS push-pull when enabled ( $\overline{DE}$  low) and open-circuited (high impedance) when disabled ( $\overline{DE}$  high). These digital outputs provide the hexadecimal code corresponding to the detected digit. Table 1 shows that code.

The digital outputs become valid and DV signals a detection after a valid tone pair has been sensed. The outputs and DV are cleared when a valid pause has been timed.

### Generator

The DTMF generator on the SC11290 responds to a hexadecimal code input with a valid tone pair. Pins D4–D7 are the data inputs for the generator. A high to low transition on  $\overline{LATCH}$  causes the hexadecimal code to be latched internally and generation of the appropriate DTMF tone pair to begin. The DTMF output is disabled by a high on RESET and will not resume until new data is latched in.

### Digital Inputs

The D4, D5, D6, D7,  $\overline{LATCH}$ , RESET inputs to the DTMF generator may be interfaced to open-collector TTL with a pull-up resistor or standard CMOS. These inputs follow the same hexadecimal code format as the DTMF receiver output. Table 1 shows the code for each digit. Figure 3 shows the dialing matrix and detection frequency table.

### DTMF OUT

The output amplitude characteristics listed in the specifications are given for a supply voltage of 5.0 V. However, the output level is directly proportional to the supply, so variations in it will affect the

Table 1.

Digit	Hexadecimal code							
	Input: D7	D6	D5	D4	Output: D3	D2	D1	D0
1	0	0	0	1				
2	0	0	1	0				
3	0	0	1	1				
4	0	1	0	0				
5	0	1	0	1				
6	0	1	1	0				
7	0	1	1	1				
8	1	0	0	0				
9	1	0	0	1				
0	1	0	1	0				
*	1	0	1	1				
#	1	1	0	0				
A	1	1	0	1				
B	1	1	1	0				
C	1	1	1	1				
D	0	0	0	0				

**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

Note: Column 3 is for special applications and is not normally used in telephone dialing.

**Detection Frequency**

Low Group fo	High Group fo
Row 0=697 Hz	Column 0=1209 Hz
Row 1=700 Hz	Column 1=1336 Hz
Row 2=852 Hz	Column 2=1477 Hz
Row 3=941 Hz	Column 3=1633 Hz

Figure 3.

**ABSOLUTE MAXIMUM RATINGS\***

DC Supply Voltage (Vp-Vn)	+7 V
Voltage at any Pin (Vn=0)	-0.3 to Vp+0.3 V
DIN Voltage	Vp+0.5 to Vp-10 V
Current through any protection device	±20 mA
Operating Temp. Range	-40°C to +85°C
Storage Temperature	-65°C to 150°C

\* Operation above absolute maximum ratings may damage the device.

**DIGITAL AND DC REQUIREMENTS**

The following electrical specifications apply to the digital input and output signals over the recommended operating range unless

DTMF output. A recommended line interface for this output is shown in Figure 4.

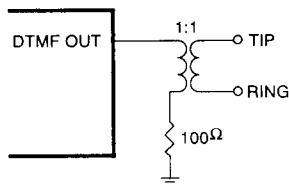


Figure 4.

**Call Progress Detection**

The call progress detector consists of a bandpass filter and an energy detector for turning the on/off

cadences into a microprocessor compatible signal.

**LIN Input**

This analog input accepts the call progress signal and should be used in the same manner as the receiver input DIN.

**DET Output**

This output is TTL compatible and will be of a frequency corresponding to the various cadences of call progress signals such as, on 0.5 sec/off 0.5 sec for a busy tone, on 0.25 sec/off 0.25 sec for a reorder tone and on 0.8-1.2 sec/off 2.7-3.3 sec for an audible ring tone.

**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	MIN.	MAX.	UNIT
Supply voltage	4.5	5.5	V
Power supply noise (wide band)	—	10	mV pp
Ambient temperature	-40	+85	°C
	0	+70	°C
Crystal Frequency (F Nominal = 3.579545 MHz)	-0.01	+0.01	%
Crystal shunt resistor	0.8	1.2	MΩ
DTMF OUT load resistance	100	—	Ω

otherwise noted. The specifications do not apply to the following pins: LIN, DIN, XIN, XOUT, and DTMF

OUT. Positive current is defined as entering the circuit. Vn=0 unless otherwise stated.

PARAMETER	TEST CONDITIONS	MIN.	MAX.	UNIT
Supply current*	—	—	30	mA
Power dissipation	—	—	225	mW
Input voltage high	—	0.7 Vp	—	V
Input voltage low	—	—	0.3 Vp	V
Input current high	—	—	10	μA
Input current low	—	-10	—	μA
Output voltage high	Ioh = -0.2 mA	Vp-0.5	—	V
Output voltage low	Iol = +0.4 mA	—	Vn+0.5	V

\*With DTMF output disabled

**DTMF RECEIVER**

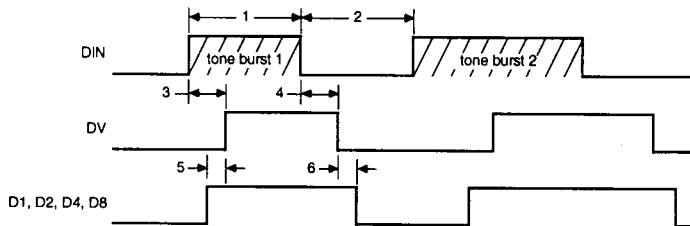
**Electrical Characteristics**

PARAMETER	TEST CONDITIONS	MIN.	Typ.	MAX.	UNIT
Frequency detect bandwidth	—	$\pm(1.5+2 \text{ Hz})$	$\pm 2.3$	$\pm 3.5$	%Fo
Amplitude for detection	—	-32	—	-2	dBm/tone
Twist tolerance	—	-10	—	+10	dB
60 Hz tolerance	—	—	—	0.8	Vrms
Dial tone tolerance	Precise dial tone	—	—	0	dB*
Speech immunity	MITEL Tape #CM7290	—	2	—	hits
Noise tolerance	MITEL Tape #CM7290	—	—	-12	dB*
Input impedance	—	100	—	—	K $\Omega$

\* Referenced to lowest amplitude tone.

**Timing Characteristics**

NO.	SYMBOL	PARAMETER	MIN.	MAX.	UNIT
1	ton	Tone time for detect	40	—	ms
1	ton	Tone time for no detect	—	20	ms
2	toff	Pause time for redetection	40	—	ms
2	toff	Pause time for bridging	—	20	ms
3	td1	Detect time	25	46	ms
4	tr1	Release time	35	50	ms
5	tsu1	Data set up time	7	—	$\mu$ s
6	thd1	Data hold time	4.2	5.0	ms
	—	Output enable time	—	200	ns
	—	Output disable time	—	200	ns



**DTMF GENERATOR**

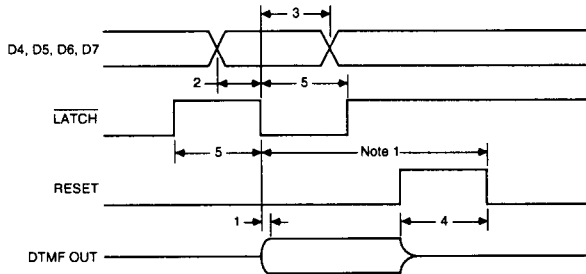
**Electrical Characteristics**

PARAMETER	TEST CONDITIONS	MIN.	MAX.	UNIT
Frequency accuracy	—	-1.0	+1.0	%Fo
Output amplitude	R1 = 100 $\Omega$ to Vn, Vp-Vn = 5.0 V	—	—	—
Low Band	—	-9.2	-7.2	dBm
High Band	—	-6.6	-4.6	dBm
Output distortion	DC to 50 KHz	—	-20	dB

**DTMF GENERATOR (Cont.)**

**Timing Characteristics**

NO.	SYMBOL	PARAMETER	MIN.	MAX.	UNIT
1	tstart	Start-up time	—	2.5	μs
2	tsu2	Data set-up time	100	—	ns
3	thd2	Data hold time	50	—	ns
4	trp	RESET pulse width	100	—	ns
5	tpw	LATCH pulse width	100	—	ns



Note 1: The indicated time may be as small as 0 sec meaning that the LATCH and RESET lines may be tied together

**CALL PROGRESS DETECTOR**

**Electrical Characteristics**

PARAMETER	TEST CONDITIONS	MIN.	MAX.	UNIT
Amplitude for detection	305 Hz—640 Hz	-40	0	dBm
Amplitude for no detection	305 Hz—640 Hz	—	-50	dBm
	160 Hz > f > 2200 Hz	—	-25	dBm
Detect output	Logic 0	—	.5	V
	Logic 1	4.5	—	V
“LIN” input	Max voltage	V <sub>DD</sub> -10	V <sub>DD</sub>	V
Input impedance	500 Hz	100	—	KΩ

**Timing Characteristics**

NO.	SYMBOL	PARAMETER	MIN.	MAX.	UNIT
1	ton	Signal time for detect	40	—	ms
1	ton	Signal time for no detect	—	10	ms
2	toff	Interval time for detect	40	—	ms
2	toff	Interval time for no detect	—	20	ms
3	td2	Detect time	—	40	ms
4	tr2	Release time	—	40	ms

