

Features

- Reduces systemic EMI
- Modulates external source clock
- 3–5 Volt power supply
- 14 to 120 MHz operating frequency range
- Output is multiplied or divided by 1, 2 or 4
- Digitally controlled modulation
- TTL and CMOS compatible outputs
- Center and down spread modulation
- Compliant with all major CISC, RISC, and DSP processors
- Low short term jitter
- Synchronous output enable
- Power down mode for low current operation
- Available in 20 pin SSOP and TSSOP packages

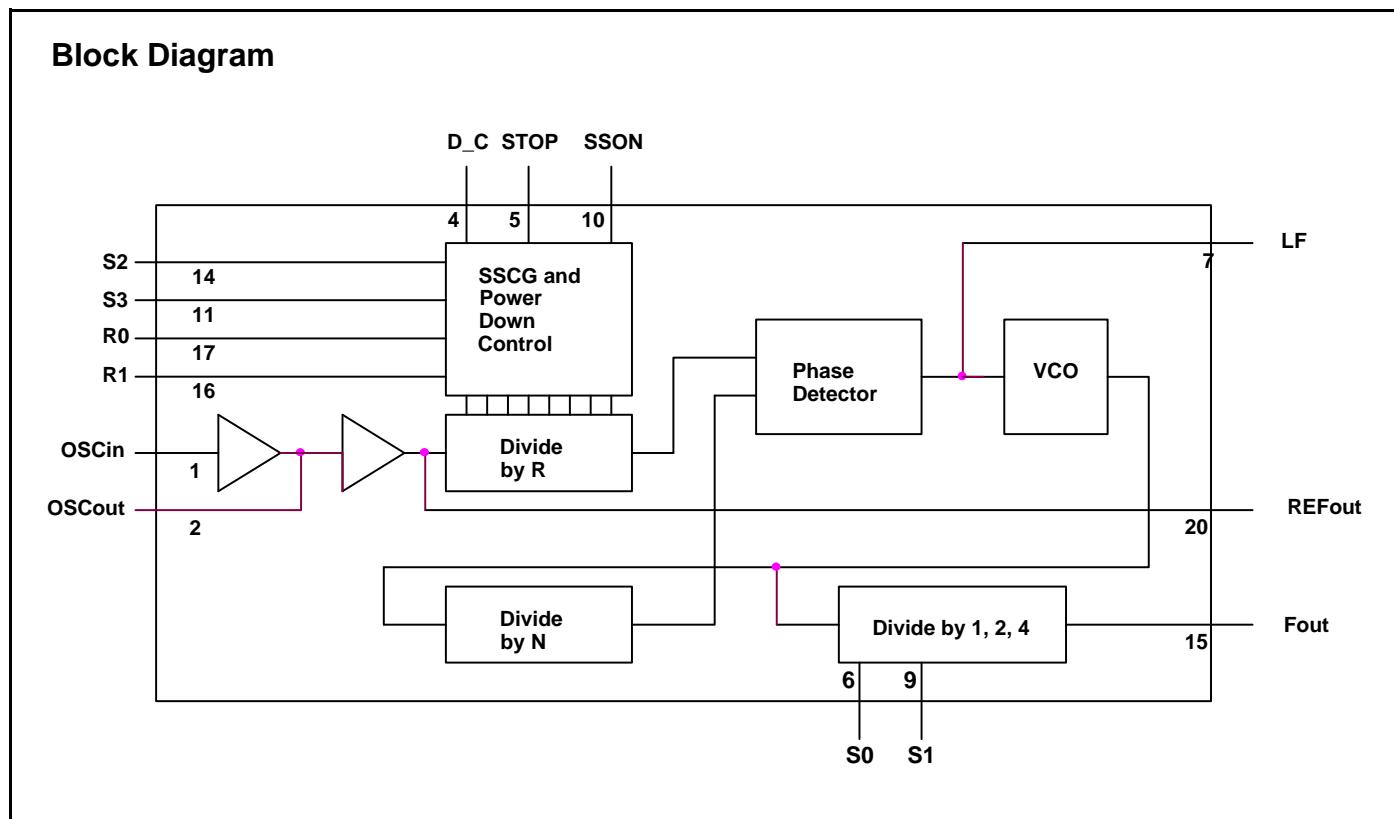
Applications

- Desktop or laptop computers
- Modems
- Scanners, printers, copiers, fax machines, and MFPs
- Disk and CD-ROM drives
- Automotive and embedded systems
- Networking, LAN/WAN
- Digital cameras, games
- LCD displays

Benefits

- Time to market
- Lower cost of compliance
- Programmable EMI reduction
- No degradation in rise and fall times
- Lower component and PCB layer count

Block Diagram



General Description

The SM530 is a Spectrum Spread Clock Modulator designed to reduce the electromagnetic interference (EMI) found in today's high speed digital systems. The SM530 is well suited for a wide range of digital system applications that require a reduction of radiated energy. This unwanted radiated energy is usually found in the odd harmonics of digital system clocks. Increasing the bandwidth of the digital clock, greatly reduces measured EMI at the fundamental and harmonic frequencies. This reduction in radiated energy significantly reduces the cost of complying with regulatory requirements and time to market, without degrading clock and timing signals.

The SM530 is extremely versatile and flexible in that program control is available for each of the operating modes. Program control provides for input frequency, output frequency multipli-

cation, output bandwidth, center/down spread of F_{out} , modulation ON/OFF, and F_{out} state during power down mode.

Depending on the range of operation, the output clock F_{out} is a multiple (1, 2, 4) or a fraction (1, 1/2, 1/4) of the input frequency. The SM530 synchronously stops the modulated output at the low logic level. The power down mode adds the flexibility of operating in a completely static mode for reduced standby current and simplified system board testing.

There are many benefits to using the SM530 Low EMI Clock Modulator. The most important benefit is reducing the amount of clock related EMI by as much as 12–18 dB, depending on the application. Refer to SM532 data sheet for the 16 pin SOIC version, which only supports center spread operation.

Figure 1. SM530 SSOP/TSSOP Package Pin Assignment

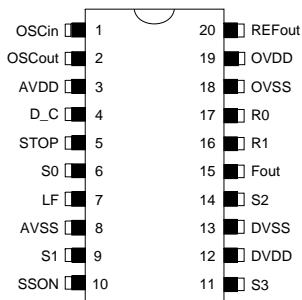


Table 1. Pin Descriptions

| Pin No. | Pin Name | IO | Type | Description |
|---------|-----------------|--------|--------|--|
| 1, 2 | OSCin OSCout | IO | CMOS | These pins form an on-chip reference oscillator when connected to terminals of an external parallel resonant crystal. OSCin connects to a TTL or CMOS external clock source. AC coupling is required. If OSCin connects to an external clock other than a crystal, leave OSCout (pin 2) unconnected. The input frequency range is 14 to 120 MHz @ 5.0 Vdc. |
| 3 | AVDD | Power | Power | Analog circuit positive power supply. |
| 4 | D_C | I | TTL | Input selection pin used to determine the center frequency position of modulated F_{out} (pin 15). Pin 4 has an internal pull down resistor. D_C = 0: Down spread. D_C = 1: Center spread. |
| 5 | STOP | I | TTL | When = 1, pin 5 synchronously stops F_{out} clock at a logic low state. Pin 5 has an internal pull down resistor. |
| 6, 9 | S0, S1 | I | TTL | Input control used to select the frequency multiplication at F_{out} , relative to the reference clock. See Table 2 on page 3. S0 has an internal pull down resistor. S1 has an internal pull up resistor. |
| 7 | LF | O | Analog | Single ended tri-state output of the phase detector. A two pole passive loop filter connects to LF. See Table 5 on page 5 for proper values. |
| 8 | AVSS | Ground | Ground | Analog circuit ground. |
| 10 | SSON | I | TTL | Input control pin used to enable modulation at the F_{out} pin. SSON = 0 = Modulation ON. SSON = 1 = Modulation OFF. SSON has an internal pull down resistor. |

Table 1. Pin Descriptions (continued)

| Pin No. | Pin Name | IO | Type | Description |
|---------|----------|--------|--------|--|
| 11, 14 | S2, S3 | I | TTL | Input control pins. These pins set the amount of modulation at Fout. See Table 2 on page 3 for settings. S2 has an internal pull up resistor. S3 has an internal pull down resistor. |
| 12 | DVDD | Power | Power | Digital positive power supply. Keep separate from analog power for best performance. |
| 13 | DVSS | Ground | Ground | Digital circuit ground. |
| 15 | Fout | O | TTL | Modulated clock output. |
| 16, 17 | R1, R0 | I | TTL | These input pins control the input frequency range as described in Table 2 . R0 and R1 have internal pull up resistor. |
| 18 | OVSS | Ground | Ground | Oscillator circuit ground. Is common to DVSS. |
| 19 | OVDD | Power | Power | Oscillator circuit positive power supply. Is common to DVDD. |
| 20 | REFout | O | TTL | Buffered output of the crystal or external clock input (unmodulated). |

Frequency Selection Table

[Table 2](#) provides the necessary information for setting the control lines for proper operation of the SM530 and for any frequency within its operating range. Note that the table includes operating frequencies at 3.3 and 5.0 Vdc. The 3.3 Vdc columns are lower in frequency than the 5.0 Vdc operation due to the characteristics of the VCO.

Table 2. Frequency Selection

| Vdd = 5 | | Volts | ±10% | | | | | | Vdd = 3.3 | | Volts | ±5% | |
|-------------------|-----|-------------------------|--------------------|-----|---------------------|----|----------------------|----|-------------------|-------------------------|----------|--------------------|------|
| Fin (Range) (MHz) | | Fout/Fin | Fout (Range) (MHz) | | Multiplier Settings | | Input Range Settings | | Fin (Range) (MHz) | | Fout/Fin | Fout (Range) (MHz) | |
| Min | Max | X | Min | Max | S1 | S0 | R1 | R0 | Min | Max | X | Min | Max |
| | | See note ^[1] | | | | 0 | 0 | X | X | See note ^[1] | | | |
| 14 | 30 | 1 | 14 | 30 | 0 | 1 | 0 | 1 | 14 | 22.5 | 1 | 14 | 22.5 |
| 14 | 30 | 2 | 28 | 60 | 1 | 0 | 0 | 1 | 14 | 22.5 | 2 | 28 | 45 |
| 14 | 30 | 4 | 56 | 120 | 1 | 1 | 0 | 1 | 14 | 22.5 | 4 | 56 | 90 |
| | | | | | | | | | | | | | |
| 30 | 60 | 0.5 | 15 | 30 | 0 | 1 | 1 | 0 | 25 | 45 | 0.5 | 12.5 | 22.5 |
| 30 | 60 | 1 | 30 | 60 | 1 | 0 | 1 | 0 | 25 | 45 | 1 | 25 | 45 |
| 30 | 60 | 2 | 60 | 120 | 1 | 1 | 1 | 0 | 25 | 45 | 2 | 50 | 90 |
| | | | | | | | | | | | | | |
| 60 | 120 | 0.25 | 15 | 30 | 0 | 1 | 1 | 1 | 50 | 90 | 0.25 | 12.5 | 22.5 |
| 60 | 120 | 0.5 | 30 | 60 | 1 | 0 | 1 | 1 | 50 | 90 | 0.5 | 25 | 45 |
| 60 | 120 | 1 | 60 | 120 | 1 | 1 | 1 | 1 | 50 | 90 | 1 | 50 | 90 |

Note

1. Selects 'power down state', see [Table 4](#) on page 4. X = don't care condition.

Modulation and Power Down Selections

The two input control lines, S2 and S3, control the bandwidth of the modulation applied to Fout. Also, S2 and S3 control the state the SM530 goes to when the power down mode is selected. Setting both S0 and S1 to a logic state '0', selects the power down mode. Refer to the [Table 3](#) and [Table 4](#) for the proper selection of modulation bandwidth and power down state.

Table 3. Modulation Selection

| | Modulation Settings\ | | D_C = 0 Down Spread | | D_C = 1 Center Spread | |
|-----------------|----------------------|----|------------------------|------|--------------------------|----------|
| | S3 | S2 | Low | High | Low | High |
| Total Bandwidth | | | | | | |
| 1.25% | 0 | 0 | 98.75% | 100% | 99.375% | 100.625% |
| 2.50% | 0 | 1 | 97.50% | 100% | 98.75% | 101.25% |
| 5.00% | 1 | 0 | 95.00% | 100% | 97.50% | 102.50% |
| 10.0% | 1 | 1 | 90.00% | 100% | 95.00% | 105.00% |

Table 4. Power Down Selection^[2]

| Fout State | S3 | S2 |
|--------------|----|----|
| Factory Test | 1 | 0 |
| Hi-Z | 1 | 1 |
| 0 | 0 | 0 |
| 1 | 0 | 1 |

Note The 'Stop' and 'Power Down' functions are two separate operations. Selecting 'Stop' does not place the SM530 in the power down mode. To select 'Power Down', set S0 = 0 and S1 = 0.

Note

2. S0 = 0, S1 = 0. For all other states, see [Table 2](#) on page 3.

Loop Filters

The SM530 requires an external loop filter to provide the proper operation and modulation profile for a given input frequency. The loop filter connects to pin 7 (LF) of the SM530 and is a typical 2 pole low pass filter. Because the SM530 operates over such a wide range of frequencies, the loop filter changes depending on the frequency of operation. Use the following loop filter values for best performance and modulation profile at 3.0 volts and 5.0

volts Vdd. Measure the operating voltage at the Vdd pin of the SM530.

Note The selection of loop filter values only depends on the input frequency and Vdd voltage, and does not depend on the R and S settings.

Figure 2. Recommended Loop Filter

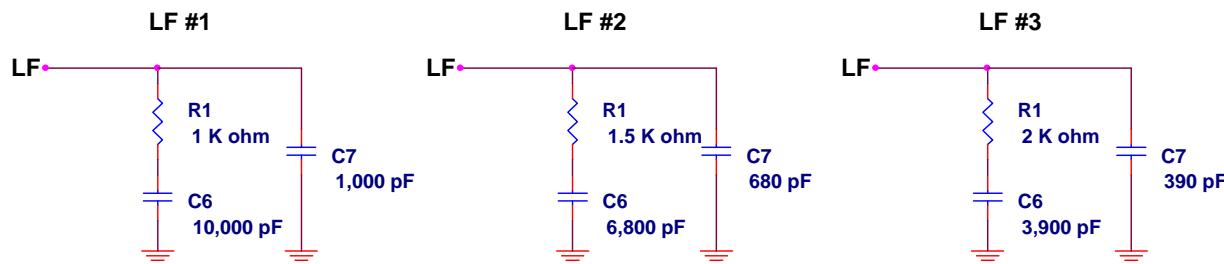


Table 5. Recommended Loop Filter Values

| Input Range | Vdd $\pm 5\%$ | Input Frequency Range (MHz) | R1 (K Ω) | C6 (pF) | C7 (pF) | Loop Filter # |
|---------------|----------------|-----------------------------|------------------|---------|---------|---------------|
| Low | 3.3 | 14.0 to 22.5 | 1.0 | 10,000 | 1,000 | 1 |
| Middle | 3.3 | 25.0 to 45.0 | 1.0 | 10,000 | 1,000 | 1 |
| High | 3.3 | 50.0 to 90.0 | 1.0 | 10,000 | 1,000 | 1 |
| Input Range | Vdd $\pm 10\%$ | Input Frequency Range (MHz) | R1 (K Ω) | C6 (pF) | C7 (pF) | Loop Filter # |
| Low | 5.0 | 14.0 to 19.9 | 1.0 | 10,000 | 1,000 | 1 |
| Low | 5.0 | 20.0 to 24.9 | 1.5 | 6,800 | 680 | 2 |
| Low | 5.0 | 25.0 to 29.9 | 2.0 | 3,900 | 390 | 3 |
| Middle | 5.0 | 30.0 to 39.9 | 1.0 | 10,000 | 1,000 | 1 |
| Middle | 5.0 | 40.0 to 49.9 | 1.5 | 6,800 | 680 | 2 |
| Middle | 5.0 | 50.0 to 59.9 | 2.0 | 3,900 | 390 | 3 |
| High | 5.0 | 60.0 to 79.9 | 1.0 | 10,000 | 1,000 | 1 |
| High | 5.0 | 80.0 to 99.9 | 1.5 | 6,800 | 680 | 2 |
| High | 5.0 | 100.0 to 120.0 | 2.0 | 3,900 | 390 | 3 |

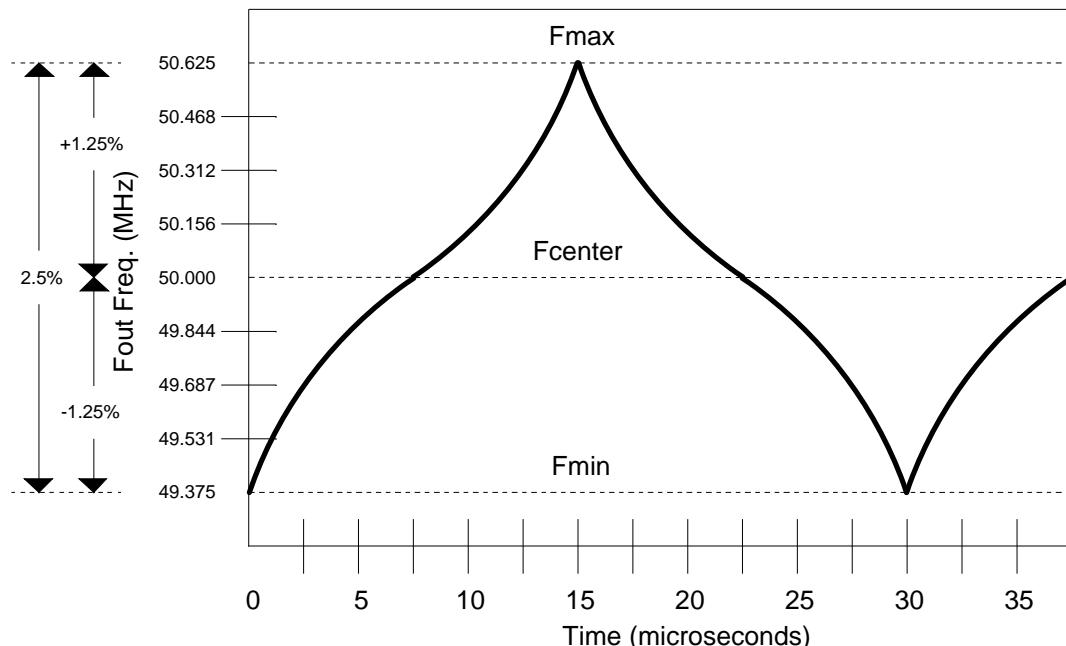
The component values listed in [Table 5](#) are recommended values using commonly manufactured components. Notice that there are actually three different sets of loop filter values. Due to the VCO characteristics, the table distinguishes between the 3-volt operations and 5-volt operations. Referring to the [Table 5](#), it is apparent that the 3-volt operation requires only one set of

loop filter values. In the 5-volt operation, each input operating range is divided into three sections which require a different loop filter for optimal performance. The best loop filter for any application is the one that provides the required EMI reduction, maintains system integrity, has a modulation profile similar to [Figure 3](#) on page 6, and uses commonly available components.

SSCG Modulation Profile

The modulation rate of the SM530 within any range is typically 20–40 kHz. With the correct loop filter connected to pin 7, the following profile provides the best EMI reduction. [Figure 3](#) is the profile that displays on a time domain analyzer.

Figure 3. Modulation Profile



Theory of Operation

The SM530 is a phase-locked loop (PLL) type clock generator that uses direct digital synthesis (DDS). By precisely controlling the bandwidth of the output clock, the SM530 becomes a low EMI clock generator. The sections that follow discuss the theory and detailed operation of the SM530.

EMI

All digital clocks generate unwanted energy in their harmonics. Conventional digital clocks are square waves with a duty cycle that is very close to 50%. Because of the 50/50 duty cycle, digital clocks generate most of their harmonic energy in the odd harmonics, such as 3rd, 5th, 7th, and so on. It is possible to reduce the amount of energy contained in the fundamental and harmonics by increasing the bandwidth of the fundamental clock frequency. Conventional digital clocks have a very high Q factor, which means that all of the energy at that frequency is concentrated in a very narrow bandwidth with consequently, higher energy peaks. Regulatory agencies test electronic equipment by the amount of peak energy radiated from the equipment. By reducing the peak energy at the fundamental and harmonic frequencies, the equipment under test can satisfy agency requirements for electromagnetic interference (EMI). Conventional methods of reducing EMI are to use shielding, filtering, multi-layer PCBs, and others. The SM530 uses the approach of reducing the peak energy in the clock by increasing the clock bandwidth, and lowering the Q.

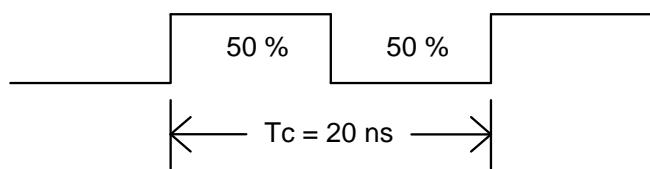
SSCG

SSCG uses a patented technology of modulating the clock over a very narrow bandwidth and controlled rate of change, both peak and cycle to cycle. The SM530 takes a narrow band digital reference clock in the range of 14–120 MHz and produces a clock that sweeps between a controlled start and stop frequency and precise rate of change. The bandwidth of the output clock is programmable. Using two control lines on the SM530, you can control the bandwidth of the modulated clock over four discrete settings: 1.25, 2.50, 5.0, and 10%. To understand what happens to an SSCG clock, consider that we have a 50 MHz clock with a 50% duty cycle. From a 50 MHz clock we know the following:

Clock frequency = $F_c = 50$ MHz

Clock period = $T_c = 1/50$ MHz = 20 ns

Figure 4. Unmodulated Clock



You can apply the 50 MHz clock to the OSCin input of the SM530, either as an externally driven clock or as the result of a parallel resonant crystal connected to pins 1 and 2 of the SM530. The SM530 is programmed for the following operation:

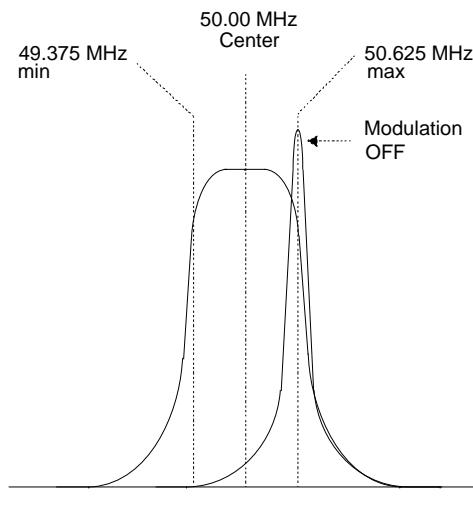
| | | |
|-------------------------|------|-------------------|
| Range (R0, R1) = | 0, 1 | Mid Range |
| Multiplier (S0, S1) = | 0, 1 | X1 |
| D_C = | 1 | Center Spread |
| SSON = | 1 | Modulation is OFF |
| % Modulation (S2, S3) = | 1, 0 | 2.50% Spread |

From these parameters, the output clock at Fout is 50.625 MHz. With modulation turned OFF, the frequency of Fout always rests at the high end of the programmed spectrum. In this case, +1.25% of 50 MHz equals 50.625 MHz.

When you turn modulation ON, the clock at Fout begins sweeping downward to the minimum extreme of -1.25% of 50 MHz which is 50 MHz - 0.625 MHz = 49.375 MHz. When the clock reaches 49.375, the SM530 begins sweeping back up to the maximum extreme of 50.625 MHz. On a spectrum analyzer, the clock looks similar to the picture in [Figure 5](#). Keep in mind that this is a drawing of a perfect clock with no noise.

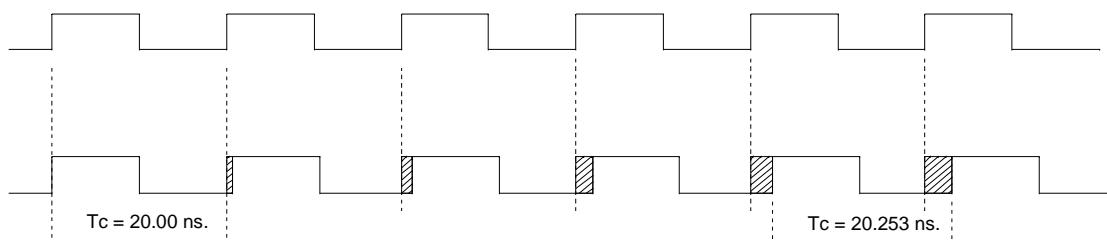
Notice that the original 50 MHz reference clock is at the center frequency, Cf, and the minimum and maximum extremes are positioned symmetrically around the center frequency. This type of modulation is called 'center spread'. [Figure 5](#) illustrates this as it displays on a spectrum analyzer. Notice that when modulation is OFF, the Fout clock is at the maximum extreme of the bandwidth.

Figure 5. Output Clock



[Figure 6](#) shows the 50 MHz clock as it appears on an oscilloscope. The top trace is the non-modulated reference clock, or the REFout clock at pin 20. The bottom trace is the modulated clock at pin 15. From this comparison chart you can see that the frequency is decreasing and the period of each successive clock is increasing. The Tc measurements on the left and right of the bottom trace indicate the period of the clock as it moves from the center frequency at 50 MHz and the minimum frequency at 49.375 MHz extremes of the clock. Intermediate clock changes are small and accumulate to achieve the total period deviation. The reverse of this diagram shows the clock period getting smaller as the frequency increases.

Figure 6. Period Comparison Chart



There are certain cases where center spread modulation is not applicable. If the maximum design frequency of the intended application is 50 MHz and becomes unstable above 50 MHz, then increasing the clock to 50.625 MHz might cause unwanted system problems.

To accommodate this situation, the SM530 has an operating mode where the maximum Fout frequency never exceeds the reference frequency, not including any multiplier. This type of modulation is 'down spread'. The effective center frequency of the Fout clock shifts down by one-half the amount of the applied modulation.

If the amount of clock spread is set for 2.50%, the effective center frequency of Fout is 1.25% less than 50 MHz, or 49.375 MHz,

when modulation is ON. When modulation is OFF, the Fout frequency goes to 50.0 MHz, since this is the maximum extreme of the applied modulation settings. The one drawback to down spread modulation is that the effective center frequency of the clock is, in this case, 1.25% slower. This means that the performance of the system is 1.25% slower.

Using the previous operating parameters for the SM530 and selecting down spread, the operating bandwidth is as follows:

| | | |
|-------------------------|------|------------------|
| Range (R0, R1) = | 0, 1 | Mid Range |
| Multiplier (S0, S1) = | 0, 1 | X1 |
| D_C = | 0 | Down Spread |
| SSON = | 0 | Modulation is ON |
| % Modulation (S2, S3) = | 1, 0 | 2.50% Spread |

To calculate the frequency extremes for these conditions in down spread mode, first determine the effective center frequency, Cf. In this case Cf is:

$$Cf = OSCin - (OSCin \times \% \text{ Spread})$$

$$Cf = 50 \text{ MHz} - (50 \text{ MHz} \times 0.0125)$$

$$Cf = 50 \text{ MHz} - 0.625 \text{ MHz}$$

$$Cf = 49.375 \text{ MHz}$$

With the effective center frequency at 49.375 MHz, you can now determine the minimum and maximum extremes.

$$F_{\max} = Cf + (Cf \times \% \text{ Spread})$$

$$F_{\max} = 49.375 + (49.375 \times 0.0125)$$

$$F_{\max} = 49.375 + .617$$

$$F_{\max} = 49.99 \text{ MHz}$$

$$F_{\min} = Cf - (Cf \times \% \text{ Spread})$$

$$F_{\min} = 49.375 - (49.375 \times 0.0125)$$

$$F_{\min} = 49.375 - 0.617$$

$$F_{\min} = 48.758 \text{ MHz}$$

Another way of calculating the bandwidth in the down spread mode is to use the OSCin frequency as the starting point and multiplying the % spread by '2'. This assumes that the multiplier is '1'. If the multiplier is '2', then use two times the OSCin in the formula.

$$F_{\max} = OSCin$$

$$F_{\min} = OSCin - (OSCin \times (2 \times \% \text{ Spread}))$$

$$F_{\min} = 50 \text{ MHz} - (50 \times (2 \times 0.0125))$$

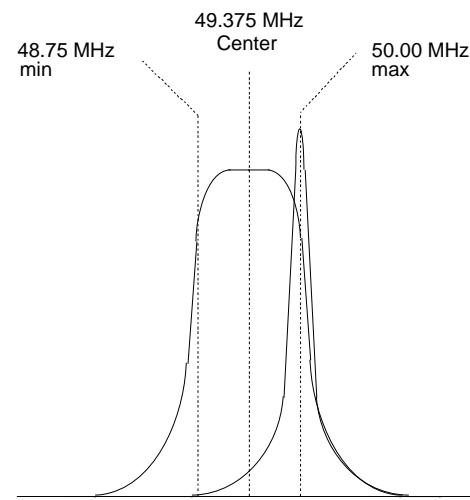
$$F_{\min} = 50 - 1.25$$

$$F_{\min} = 48.75 \text{ MHz}$$

[Figure 7](#) illustrates this. The effective center frequency is 49.375 MHz and the minimum and maximum extremes are 1.25% on either side of the center. Or using the second approach, the OSCin frequency is the maximum frequency and the minimum frequency is 2.5% down from the reference.

Looking at [Figure 7](#), notice that the peak amplitude of the 50 MHz non-modulated clock is higher than the wide band modulated clock. This difference in peak amplitudes between modulated and unmodulated clocks is the reason why SSCG clocks are so effective in digital systems. This and the previous illustrations refer to the fundamental frequency of a clock. A very important characteristic of the SSCG clock is that the bandwidth of the harmonics is multiplied by the harmonic number. In other words, if the bandwidth of a 50 MHz clock is 1.35 MHz, the bandwidth of the 3rd harmonic is three times 1.35, or 4.05 MHz. The amount of bandwidth is relative to the amount of peak energy in the clock. Consequently, the wider the bandwidth, the greater the energy reduction of the clock.

Figure 7. Clock Spread



Most applications do not have a problem meeting agency specifications at the fundamental frequency. It is the higher harmonics that usually cause the most problems. With an SSCG clock, the bandwidth and peak energy reduction increases with the harmonic number. Consider that the 11th harmonic of our 50 MHz clock is 550 MHz. With a total spread of 1.35 MHz at 50 MHz, the spread at the 11th harmonic is 14.85 MHz which greatly reduces the peak energy content. It is typical to see as much as 12 to 18 dB of reduction at the higher harmonics, due to a modulated clock.

Referring to [Figure 5](#) on page 7 and [Figure 7](#), you can see that the peak amplitude of the unmodulated clock is much higher than the peak amplitude of the modulated clock. This is the reason the SM530 is used for EMI reduction. The amount of EMI reduction is dependent on the application. The difference in the peak energy of the modulated clock and the non-modulated clock in typical applications sees a 2–3 dB reduction at the fundamental and as much as 8–10 dB reduction at the intermediate harmonics: 3rd, 5th, 7th, and so on. At the higher harmonics, it is quite possible to reduce the peak harmonic energy, compared to the unmodulated clock, by as much as 12 to 18 dB.

You can calculate the dB reduction for a given frequency and spread using a simple formula. This formula is only helpful in determining a relative dB reduction for a given application. This formula assumes an ideal clock with 50% duty cycle and therefore only predicts the EMI reduction of even harmonics. Other circumstances such as non-ideal clock and noise affects the actual dB reduction. The formula is as follows:

$$dB = 6.5 + 9(\text{Log10}(F)) + 9(\text{Log10}(P))$$

Where, F = frequency in MHz, P = total % spread (2.5% = 0.025).

Using a 50 MHz clock with a 2.5% spread, the theoretical dB reduction is:

$$dB @ 50 \text{ MHz (Fund)} = 6.5 + 15.29 - 14.42 = 7.37$$

$$dB @ 150 \text{ MHz (3rd)} = 6.5 + 19.58 - 14.42 = 11.66$$

$$dB @ 550 \text{ MHz (11th)} = 6.5 + 24.66 - 14.42 = 16.74$$

Modulation Profile

The SM530 moves from maximum to minimum frequencies of its bandwidth at a predetermined rate and profile. You can determine the modulation frequency using the input frequency and an internal divider. All three operating ranges modulate the Fout clock between 20 to 40 kHz. The three operating ranges are 14–30 MHz, 30–60 MHz, and 60–120 MHz. If OSCin = 15 MHz, the modulation rate is 20 kHz. If OSCin is 60 MHz, in mid-range, the modulation rate is 40 kHz. To provide the proper modulation rate, divide the input reference frequency by a fixed number in each range. Divide the input reference frequency by 750 in low range, 1500 in mid range and 3000 in the high range. From these numbers, you can determine the modulation rate for any input frequency.

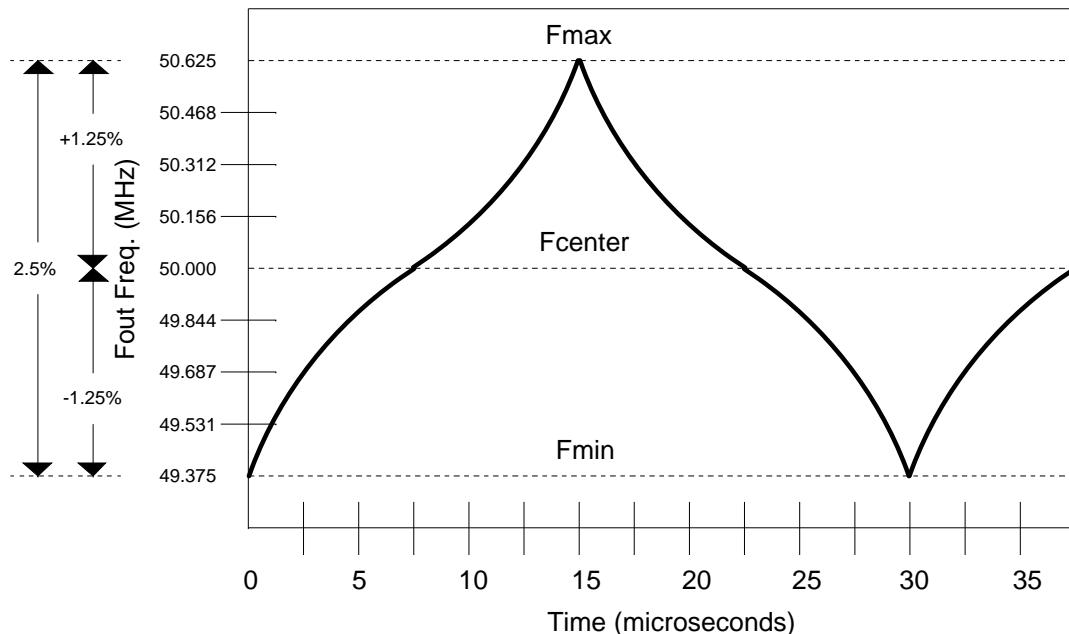
Example

OSCin = 45.378 MHz, Input Range = Mid, Input divisor = 1500
 $F_{mod} = OSCin / 1500$
 $F_{mod} = 30.252$ kHz

If you have a clock frequency that is on the boundary of the mid-range and high range of operation, you can determine which range to use by knowing which modulation you want. If you choose the mid-range, the modulation rate is 40 kHz, while choosing the high range yields a 20 kHz modulation rate. There is some operational overlap between ranges, such that 58 MHz in the mid-range given the same results as 58 MHz in the high range, except for the modulation rate. This type of operation is not recommended.

The modulation profile of the SM530 is not a linear sweep from maximum to minimum and back. The OSCin reference clock determines the modulation frequency but the internal SSCG control logic determines the actual modulation profile. To best describe the modulation profile compare the instantaneous frequency at Fout with time. The illustration in [Figure 8](#) is a representation of the modulation profile of the SM530 that displays on a time domain analyzer.

Figure 8. Frequency Profile in Time Domain



Notice that in [Figure 8](#), the Fout or Time profile progresses through frequencies depending on where it is in the sweep. If the frequency is in the middle of the sweep, the rate of change is slower compared to the rate at the extremes of the band. When the frequency is nearing the end of the band, it is moving through these frequencies faster, because it has to sweep through these

same frequencies again after reversing direction. This modulation profile is one of the key elements to the SM530. Using a linear sweep through all frequencies does not give as good of results in EMI reduction.

Absolute Maximum Ratings

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, take precautions to avoid application of any voltage higher than the absolute maximum rated voltages to this circuit. For proper

operation, constrain Vin and Vout to within the range, $V_{ss} < (V_{in} \text{ or } V_{out}) < V_{dd}$. All digital inputs are tied high or low internally. Refer to the electrical specifications for operating supply range.

Table 6. Supply Range

| Parameter | Item | Min | Max | Units |
|-----------------|-----------------------------------|------|----------------|-------|
| VDD | Supply voltage | 0 | 6.0 | Vdc |
| VIRvss | Input, relative to V_{ss} | -0.3 | $V_{dd} + 0.3$ | Vdc |
| VORvss | Output, relative to V_{ss} | -0.3 | $V_{dd} + 0.3$ | Vdc |
| ΔV_{pp} | V_{AVDD} relative to V_{DVDD} | -100 | +100 | mV |
| ΔV_{ss} | V_{AVSS} relative to V_{DVSS} | -100 | +100 | mV |
| TOP | Temperature, operating | 0 | +70 | °C |
| TST | Temperature, storage | -65 | +150 | °C |

Table 7. Electrical Characteristics [3]

| Parameter | Characteristic | Min | Typ | Max | Units |
|-----------|--|----------------|------|------|-------|
| VIL | Input low voltage | - | - | 0.8 | Vdc |
| VIH | Input high voltage | 2.0 | - | - | Vdc |
| IIL | Input low current | - | - | 100 | µA |
| IIH | Input high current | - | - | 100 | µA |
| VOL | Output low voltage $I_{OL} = 8 \text{ mA}$, $V_{dd} = 5\text{V}$ | - | - | 0.4 | Vdc |
| VOH | Output high voltage $I_{OH} = 8 \text{ mA}$, $V_{dd} = 5\text{V}$ | $V_{dd} - 1.0$ | - | - | Vdc |
| VOL | Output low voltage $I_{OL} = 5 \text{ mA}$, $V_{dd} = 3.3\text{V}$ | - | - | 0.4 | Vdc |
| VOH | Output high voltage $I_{OH} = 3 \text{ mA}$, $V_{dd} = 3.3\text{V}$ | 2.4 | - | - | Vdc |
| C_{in1} | Input capacitance (pin-1) | - | 5 | - | pf |
| C_{in2} | Output capacitance (pin-2) | - | 3 | - | pf |
| Rpu | Pull up resistor values (pins 9, 14, 16, and 17) | 100K | 167K | 300K | Ω |
| Rpd | Pull down resistor values (pins 4, 5, 6, 10, and 11) | 150K | 250K | 350K | Ω |
| IOZ | Tri-state leakage current (pins 7, 15 and 20) | - | 5.0 | - | µA |
| IDD | Static supply current (power down mode) | - | - | 250 | µA |
| ICC | 5 Volt dynamic supply current (operating mode) | - | 25 | 30 | mA |
| ICC | 3 Volt dynamic supply current (operating mode) | - | 18 | 20 | mA |
| ISC | Short circuit current (F_{out}) | - | - | 30 | mA |

Note

3. Test measurements performed at $V_{dd} = 3.3\text{V} \pm 5\%$ and $5\text{V} \pm 10\%$, $TA = 0^\circ\text{C}$ to 70°C .

Table 8. Timing Characteristics ^[4]

| Characteristic | Symbol | Min | Typ | Max | Units |
|---|--------|-----|------|-----|-------|
| Output rise time measured at 10%–90% @ 5 Vdc | tTLH | 3.3 | 3.5 | 3.8 | ns |
| Output fall time measured at 10%–90% @ 5 Vdc | tTHL | 2.1 | 2.3 | 2.5 | ns |
| Output rise time measured at 0.8V–2.0V @ 5 Vdc | tTLH | 0.7 | 0.75 | 0.8 | ns |
| Output fall time measured at 0.8V–2.0 V @ 5 Vdc | tTHL | 0.6 | 0.7 | 0.8 | ns |
| Output rise time measured at 10%–90% @ 3.3 Vdc | tTLH | 4.8 | 5.0 | 5.4 | ns |
| Output fall time measured at 10%–90% @ 3.3 Vdc | tTHL | 2.9 | 3.2 | 3.4 | ns |
| Output rise time measured at 0.8V–2.0V @ 3.3 Vdc | tTLH | 1.6 | 1.75 | 1.9 | ns |
| Output fall time measured at 0.8V–2.0 V @ 3.3 Vdc | tTHL | 1.1 | 1.3 | 1.5 | ns |
| Output duty cycle | TsymF1 | 45 | 50 | 55 | % |
| Peak-to-peak jitter one sigma (SSON = 1) | tj1s | - | 250 | 500 | ps |

Note

 4. Measurements performed at Vdd = 3.3V \pm 5% and 5V \pm 10%, TA = 0°C to 70°C, CL = 15 pF, Fout = 50.0 MHz.

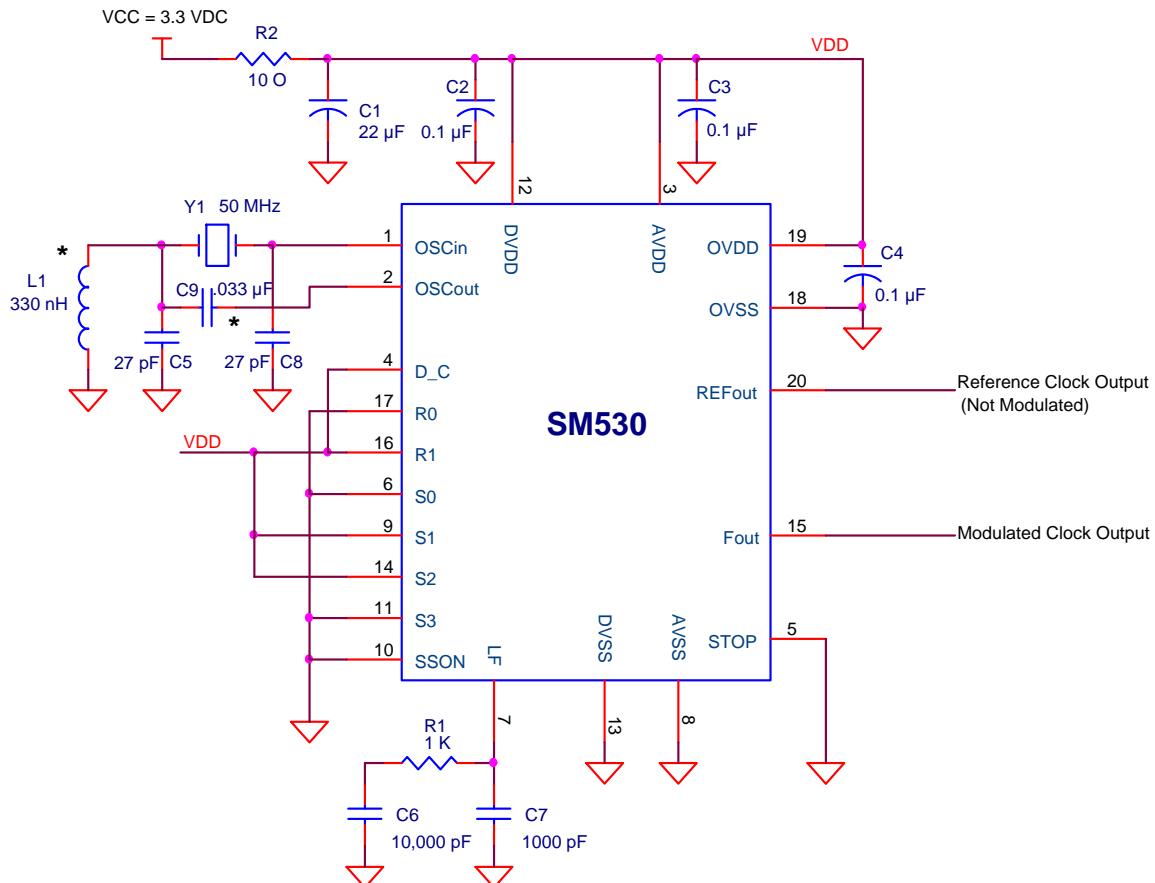
Applications and Schematics

Figure 9 is a simple minimum component application example of an SM530 design. In this example, the configuration of the control lines are for the parameters as follows:

Input frequency: Mid-Range
 Multiplier: X1
 Modulation: 2.50%
 SSON: ON

Refer to loop filter values on [Table 5](#) on page 5 for operation at 3.3 volts DC.

Figure 9. Application Schematic



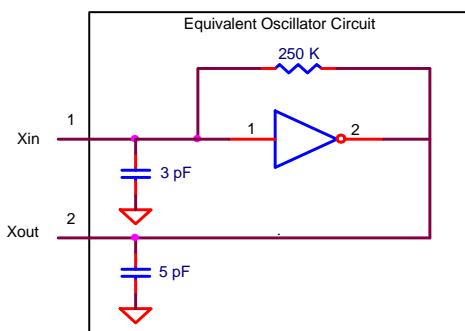
* L1 and C9 are required when Y1 is a 3rd overtone crystal.

The SM530 has an internal analog power and ground and a digital power and ground. In the previous example, the digital and analog circuits are connected together. If noise is a concern, separate the analog and digital power and grounds. Use the loop filter in Figure 9 for operations at 3.0–3.6 Vdc. Use this filter also in 5.0 Vdc operations when operating in the low frequency end of each of the three input frequency ranges. Refer to [Table 5](#) on page 5 for loop filter information. Notice that the crystal, Y1, is a third overtone 50 MHz crystal, which requires an inductor and decoupling capacitor to OSCout.

Figure 10 shows the equivalent internal oscillator circuit for the SM530.

Figure 10. Equivalent Oscillator Circuit

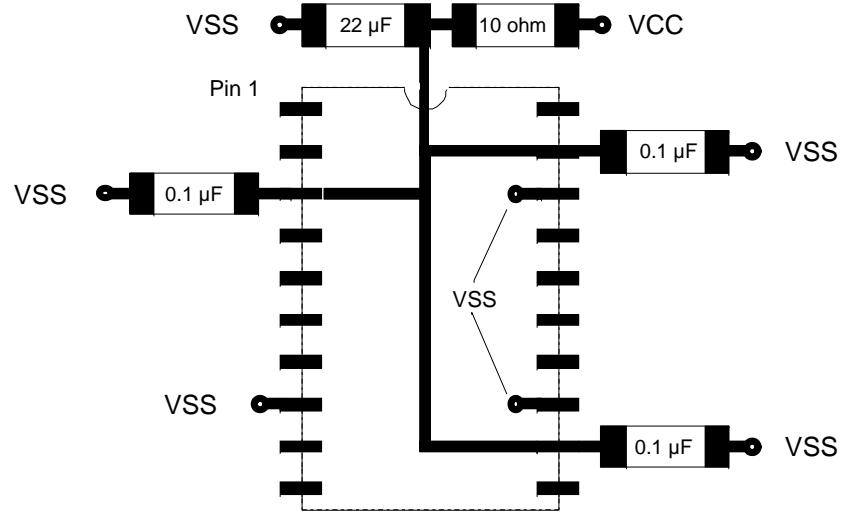
PCB Layout Example



The SM530 Spectrum Spread clock is a PLL type hybrid circuit. This means that it contains both digital and analog circuits on the same die. The phase detector, loop filter and VCO are analog circuits that must operate in a very low noise environment for best performance. There are several ways to keep this noise to a minimum, such as placing bypass capacitors on all power pins and separating the analog and digital power and ground planes.

Figure 11 uses the first approach of placing bypass capacitors as close to every power pin as possible. In addition, make certain to connect all ground pins directly to the ground plane with little or no trace length. Figure 11 shows only the power and ground circuits of the SM530. For best performance, locate other circuits such as the loop filter components as close to the loop filter pin as possible.

Figure 11. M530 Single Power Plane PCB Layout

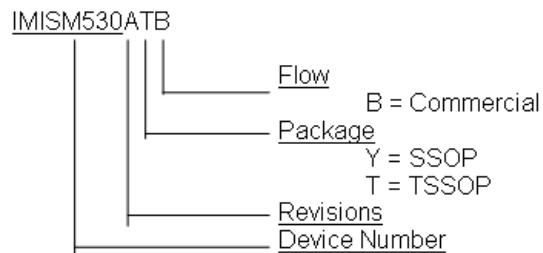


Ordering Information

| Part No | Package | Operating Temperature Range |
|------------------------------|----------------------------|-----------------------------|
| IMISM530AYB | 20 pin SSOP | 0°C to 70°C |
| IMISM530ATB | 20 pin TSSOP | 0°C to 70°C |
| Pb-Free | | |
| CYISM530AYXB ^[5] | 20 pin SSOP | 0°C to 70°C |
| CYISM530AYXBT ^[5] | 20 pin SSOP—Tape and Reel | 0°C to 70°C |
| CYISM530AZXC ^[5] | 20 pin TSSOP | 0°C to 70°C |
| CYISM530AZXCT ^[5] | 20 pin TSSOP—Tape and Reel | 0°C to 70°C |

Figure 12. Marking Example

IMISM530ATB (Line 1: Product Number)
CCC YYWW B 28 (Line 2: Country of Origin, Date Code, Die Rev, Fab Code)
CYP NNNNNN (Line 3: Cypress, 6 Digit Lot No.)



Note

5. B = Commercial (IMI Convention), C = Commercial (Cypress Convention)

Package Dimensions and Drawings

Figure 13. 20 Pin SSOP

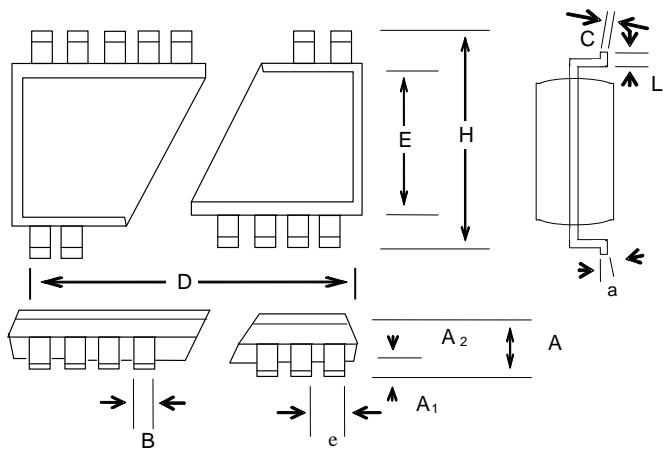


Table 9. 20 PinN SSOP Outline Dimensions

| Symbol | Inches | | | Millimeters | | |
|----------------|------------|-------|-------|-------------|------|------|
| | Min | Nom | Max | Min | Nom | Max |
| A | 0.068 | 0.073 | 0.078 | 1.73 | 1.86 | 1.99 |
| A ₁ | 0.002 | 0.005 | 0.008 | 0.05 | 0.13 | 0.21 |
| A ₂ | 0.066 | 0.068 | 0.070 | 1.68 | 1.73 | 1.78 |
| B | 0.010 | 0.012 | 0.015 | 0.25 | 0.30 | 0.38 |
| C | 0.005 | 0.006 | 0.009 | 0.13 | 0.15 | 0.22 |
| D | 0.278 | 0.284 | 0.289 | 7.07 | 7.20 | 7.33 |
| E | 0.205 | 0.209 | 0.212 | 5.20 | 5.30 | 5.38 |
| e | 0.0256 BSC | | | 0.65 BSC | | |
| H | 0.301 | 0.307 | 0.311 | 7.65 | 7.80 | 7.90 |
| a | 0° | 4° | 8° | 0° | 4° | 8° |
| L | 0.022 | 0.030 | 0.037 | 0.55 | 0.75 | 0.95 |

Figure 14. 20 Pin TSSOP

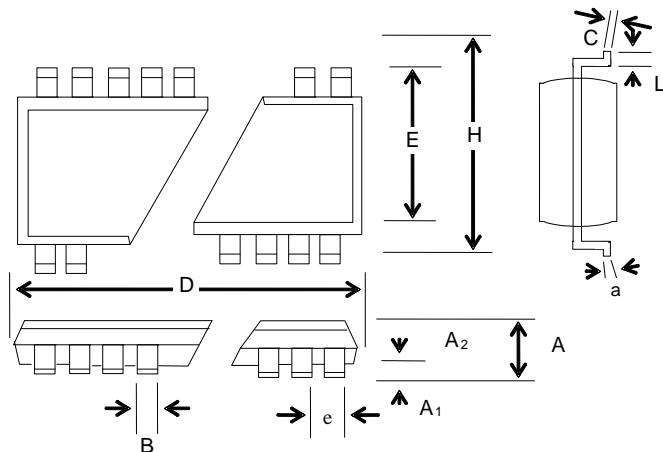


Table 10. 20 Pin TSSOP Outline Dimensions

| Symbol | Inches | | | Millimeters | | |
|----------------|-----------|-------|-------|-------------|-------|------|
| | Min | Nom | Max | Min | Nom | Max |
| A | - | - | 0.047 | - | - | 1.20 |
| A ₁ | 0.002 | 0.004 | 0.006 | 0.05 | 0.10 | 0.15 |
| A ₂ | - | - | 0.035 | - | - | 0.90 |
| B | 0.007 | 0.95 | 0.012 | 0.19 | 0.245 | 0.30 |
| C | - | - | - | - | - | - |
| D | 0.252 | 0.256 | 0.260 | 6.40 | 6.50 | 6.60 |
| E | 0.169 | 0.173 | 0.177 | 4.30 | 4.40 | 4.50 |
| e | 0.026 BSC | | | 0.65 BSC | | |
| H | 0.246 | 0.252 | 0.258 | 6.25 | 6.40 | 6.55 |
| a | 0° | 4° | 8° | 0° | 4° | 8° |
| L | 0.020 | 0.025 | 0.030 | 0.50 | 0.625 | 0.75 |

Document History Page

Document Title: SM530 Low EMI Spectrum Spread Clock
Document Number: 001-10101

| Revision | ECN | Orig. of Change | Description of Change |
|----------|---------|-----------------|-----------------------|
| ** | 1237224 | ARI | New data sheet. |

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