

PCI-EXPRESS GEN 3 SINGLE OUTPUT CLOCK GENERATOR

Features

- PCI-Express Gen 1, Gen 2, Gen 3, and Gen 4 common clock compliant
- Gen 3 SRNS Compliant
- Low power HCSL differential output buffer
- Supports Serial-ATA (SATA) at 100 MHz
- No termination resistors required
- 25 MHz Crystal Input or Clock input
- Triangular spread spectrum profile for maximum EMI reduction (Si52111-B6)
- Extended Temperature: -40 to 85 °C
- 3.3 V Power supply
- Small package 10-pin TDFN (3x3 mm)
- Si52111-B5 does not support spread spectrum outputs
- Si52111-B6 supports 0.5% down spread outputs

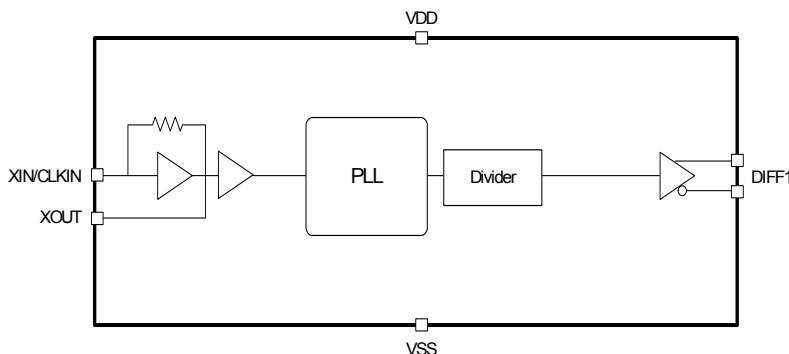
Applications

- Network Attached Storage
- Multi-function Printer
- Wireless Access Point
- Routers

Description

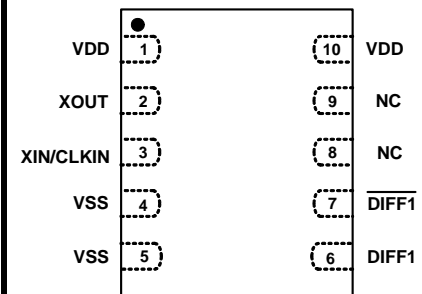
Si52111-B5/B6 is a high-performance, PCIe clock generator that can source one PCIe clock output from a 25 MHz crystal or clock input. The clock output is compliant to PCIe Gen 1, Gen 2, Gen 3, Gen 3 SRNS and Gen 4 common clock specifications. The ultra-small footprint (3x3 mm) and industry leading low power consumption make Si52111-B5/B6 the ideal clock solution for consumer and embedded applications. Measuring PCIe clock jitter is quick and easy with the Silicon Labs PCIe Clock Jitter Tool. Download it for free at www.silabs.com/pcie-learningcenter.

Functional Block Diagram



Ordering Information:
See page 13

Pin Assignments



Patents pending

TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|--|--------------------|
| 1. Electrical Specifications | 4 |
| 2. Crystal Recommendations | 7 |
| 2.1. Crystal Loading | 7 |
| 2.2. Calculating Load Capacitors | 8 |
| 3. Test and Measurement Setup | 9 |
| 4. Pin Descriptions | 11 |
| 4.1. 10-Pin TDFN | 11 |
| 4.2. 8-Pin TSSOP | 12 |
| 5. Ordering Guide | 13 |
| 6. Package Outlines | 14 |
| 6.1. TDFN Package | 14 |
| 6.2. TSSOP Package | 16 |
| 7. Recommended Design Guideline | 18 |
| Document Change List | 19 |

Si52111-B5/B6

1. Electrical Specifications

Table 1. Recommended Operating Conditions

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------------------------|----------------------|-----------------|------|-----|------|------|
| Supply Voltage (extended) | $V_{DD(extended)}$ | 3.3 V \pm 5% | 3.13 | 3.3 | 3.46 | V |
| Supply Voltage (commercial) | $V_{DD(commercial)}$ | 3.3 V \pm 10% | 2.97 | 3.3 | 3.63 | V |

Table 2. DC Electrical Specifications

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|--------------------------|-----------|------------------------|------|------|------|------|
| Operating Voltage | V_{DD} | 3.3 V \pm 10% | 2.97 | 3.30 | 3.63 | V |
| Operating Supply Current | I_{DD} | Full Active | — | — | 13 | mA |
| Input Pin Capacitance | C_{IN} | Input Pin Capacitance | — | 3 | 5 | pF |
| Output Pin Capacitance | C_{OUT} | Output Pin Capacitance | — | — | 5 | pF |

Table 3. AC Electrical Specifications

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------------------------|------------|--|-----|-----|--------------|---------|
| Crystal | | | | | | |
| Long-term Accuracy | L_{ACC} | Measured at $V_{DD}/2$ differential | — | — | 250 | ppm |
| Clock Input | | | | | | |
| CLKIN Duty Cycle | T_{DC} | Measured at $V_{DD}/2$ | 45 | — | 55 | % |
| CLKIN Rise and Fall Times | T_R/T_F | Measured between 0.2 V_{DD} and 0.8 V_{DD} | 0.5 | — | 4.0 | V/ns |
| CLKIN Cycle-to-Cycle Jitter | T_{CCJ} | Measured at $V_{DD}/2$ | — | — | 250 | ps |
| CLKIN Long Term Jitter | T_{LTJ} | Measured at $V_{DD}/2$ | — | — | 350 | ps |
| Input High Voltage | V_{IH} | XIN/CLKIN pin | 2 | — | $V_{DD}+0.3$ | V |
| Input Low Voltage | V_{IL} | XIN/CLKIN pin | — | — | 0.8 | V |
| Input High Current | I_{IH} | XIN/CLKIN pin, $V_{IN} = V_{DD}$ | — | — | 35 | μ A |
| Input Low Current | I_{IL} | XIN/CLKIN pin, $0 < V_{IN} < 0.8$ | -35 | — | — | μ A |
| DIFF Clocks | | | | | | |
| Duty Cycle | T_{DC} | Measured at 0 V differential | 45 | — | 55 | % |
| Skew | T_{SKEW} | Measured at 0 V differential | — | — | 60 | ps |
| Output Frequency | F_{OUT} | $V_{DD} = 3.3$ V | — | 100 | — | MHz |
| Frequency Accuracy | F_{ACC} | All output clocks | — | — | 100 | ppm |
| Slew Rate | $t_{r/f2}$ | Measured differentially from ± 150 mV | 0.6 | — | 4.0 | V/ns |

Notes:

1. Visit www.pcisig.com for complete PCIe specifications.
2. Gen 4 specifications based on the PCI-Express Base Specification 4.0 rev. 0.5
3. Download the Silicon Labs PCIe Clock Jitter Tool at www.silabs.com/pcie-learningcenter.

Table 3. AC Electrical Specifications (Continued)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|--------------------|--|------|------|------|------|
| Cycle-to-Cycle Jitter | T_{CCJ} | Measured at 0 V differential | — | 28 | 70 | ps |
| PCIe Gen 1 Pk-Pk Jitter, Common Clock | $Pk-Pk_{GEN1}$ | PCIe Gen 1 | — | 24 | 86 | ps |
| PCIe Gen 2 Phase Jitter, Common Clock | RMS_{GEN2} | $10\text{ kHz} < F < 1.5\text{ MHz}$ | — | 1.35 | 3.0 | ps |
| | | $1.5\text{ MHz} < F < \text{Nyquist}$ | — | 1.4 | 3.1 | ps |
| PCIe Gen 3 Phase Jitter, Common Clock | RMS_{GEN3} | Includes PLL BW 2–4 MHz, CDR = 10 MHz | — | 0.4 | 1.0 | ps |
| PCIe Gen 3 Phase Jitter, Separate Reference No Spread, SRNS | RMS_{GEN3_SRNS} | PLL BW of 2–4 or 2–5 MHz, CDR = 10 MHz | — | 0.28 | 0.71 | ps |
| PCIe Gen 4 Phase Jitter, Common Clock | RMS_{GEN4} | PLL BW of 2–4 or 2–5 MHz, CDR = 10 MHz | — | 0.4 | 1.0 | ps |
| Crossing Point Voltage at 0.7 V Swing | V_{OX} | | 300 | — | 550 | mV |
| Voltage High | V_{HIGH} | | — | — | 1.15 | V |
| Voltage Low | V_{LOW} | | -0.3 | — | — | V |
| Spread Range | S_{RNG} | Down Spread, -B6 only | — | -0.5 | — | % |
| Modulation Frequency | F_{MOD} | -B6 only | 30 | 31.5 | 33 | kHz |
| Enable/Disable and Set-up | | | | | | |
| Clock Stabilization from Power-up | T_{STABLE} | | — | — | 3 | ms |
| Stopclock Set-up Time | T_{SS} | | 10.0 | — | — | ns |
| Notes: | | | | | | |
| 1. Visit www.pcisig.com for complete PCIe specifications. | | | | | | |
| 2. Gen 4 specifications based on the PCI-Express Base Specification 4.0 rev. 0.5 | | | | | | |
| 3. Download the Silicon Labs PCIe Clock Jitter Tool at www.silabs.com/pcie-learningcenter . | | | | | | |

Si52111-B5/B6

Table 4. Thermal Conditions

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|--|---------------|-----------------|-----|-----|-------|------|
| Temperature, Storage | T_S | Non-functional | -65 | — | 150 | °C |
| Temperature, Operating Ambient | T_A | Functional | -40 | — | 85 | °C |
| Temperature, Junction | T_J | Functional | — | — | 150 | °C |
| Dissipation, Junction to Case (TDFN) | θ_{JC} | JEDEC (JESD 51) | — | — | 38.3 | °C/W |
| Dissipation, Junction to Case (TSSOP) | θ_{JC} | JEDEC (JESD 51) | — | — | 37.0 | °C/W |
| Dissipation, Junction to Ambient (TDFN) | θ_{JA} | JEDEC (JESD 51) | — | — | 90.4 | °C/W |
| Dissipation, Junction to Ambient (TSSOP) | θ_{JA} | JEDEC (JESD 51) | — | — | 124.0 | °C/W |

Table 5. Absolute Maximum Conditions

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|-----------------------------------|----------------|------------------------|------|-----|-----|----------|
| Main Supply Voltage | $V_{DD_3.3V}$ | | — | | 4.6 | V |
| Input Voltage | V_{IN} | Relative to V_{SS} | -0.5 | | 4.6 | V_{DC} |
| ESD Protection (Human Body Model) | ESD_{HBM} | JEDEC (JESD 22 - A114) | 2000 | | — | V |
| Flammability Rating | UL-94 | UL (Class) | V-0 | | | |

Note: While using multiple power supplies, the voltage on any input or I/O pin cannot exceed the power pin during power-up. Power supply sequencing is not required.

2. Crystal Recommendations

If using a crystal input, the device requires a parallel resonance crystal.

Table 6. Crystal Recommendations

| Frequency (Fund) | Cut | Loading | Load Cap | ESR | Drive | Shunt Cap (max) | Motional (max) | Tolerance (max) | Stability (max) | Aging (max) |
|------------------|-----|----------|----------|--------------|--------------|-----------------|----------------|-----------------|-----------------|-------------|
| 25 MHz | AT | Parallel | 12–15 pF | <50 Ω | >150 μ W | 5 pF | 0.016 pF | 35 ppm | 30 ppm | 5 ppm |

2.1. Crystal Loading

Crystal loading is critical in achieving low ppm performance. To realize low ppm performance, use the total capacitance the crystal sees to calculate the appropriate capacitive loading (CL).

Figure 1 shows a typical crystal configuration using two trim capacitors. It is important that the trim capacitors are in series with the crystal.

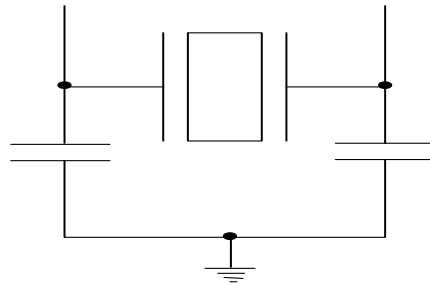


Figure 1. Crystal Capacitive Clarification

2.2. Calculating Load Capacitors

In addition to the standard external trim capacitors, consider the trace capacitance and pin capacitance to calculate the crystal loading correctly. Again, the capacitance on each side is in series with the crystal. The total capacitance on both sides is twice the specified crystal load capacitance (CL). Trim capacitors are calculated to provide equal capacitive loading on both sides.



Figure 2. Crystal Loading Example

Use the following formulas to calculate the trim capacitor values for Ce1 and Ce2.

Load Capacitance (each side)

$$C_e = 2 \times CL - (C_s + C_i)$$

Total Capacitance (as seen by the crystal)

$$CL_e = \frac{1}{\left(\frac{1}{C_{e1} + C_{s1} + C_{i1}} + \frac{1}{C_{e2} + C_{s2} + C_{i2}} \right)}$$

- CL: Crystal load capacitance
- CL_e: Actual loading seen by crystal using standard value trim capacitors
- C_e: External trim capacitors
- C_s: Stray capacitance (terraced)
- C_i: Internal capacitance (lead frame, bond wires, etc.)

3. Test and Measurement Setup

Figures 3 through 5 show the test load configuration for the differential clock signals.

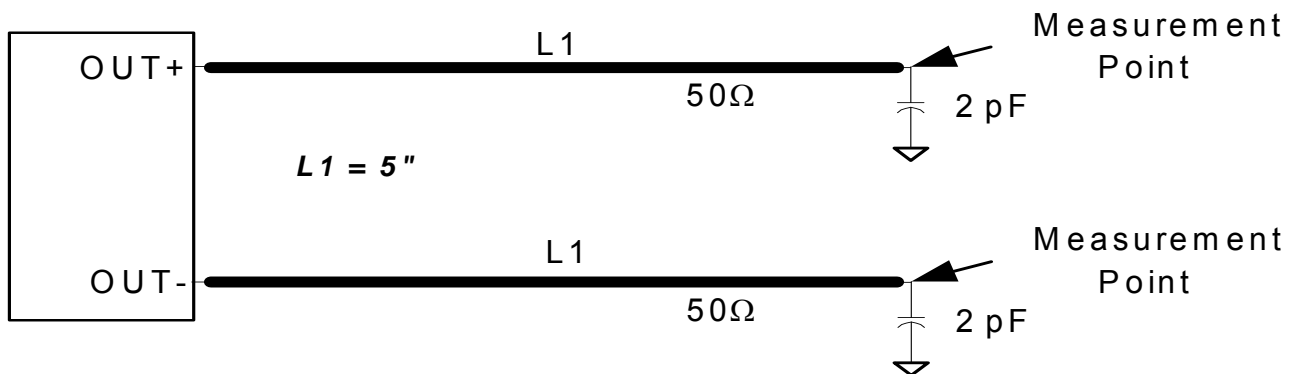
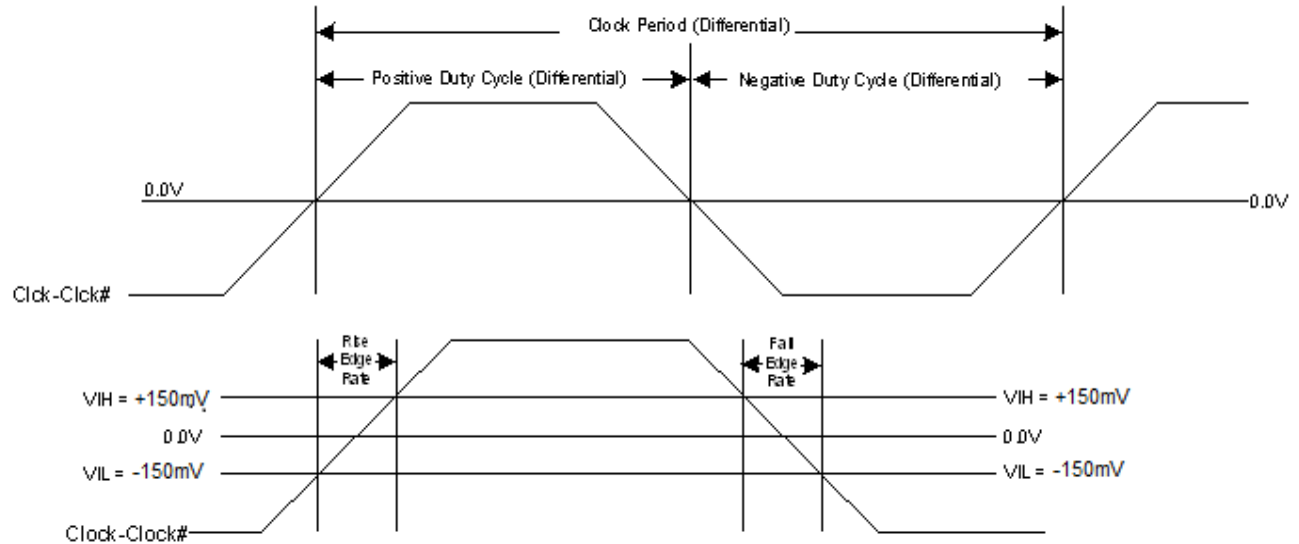


Figure 3. 0.7 V Differential Load Configuration



**Figure 4. Differential Measurement for Differential Output Signals
(for AC Parameters Measurement)**

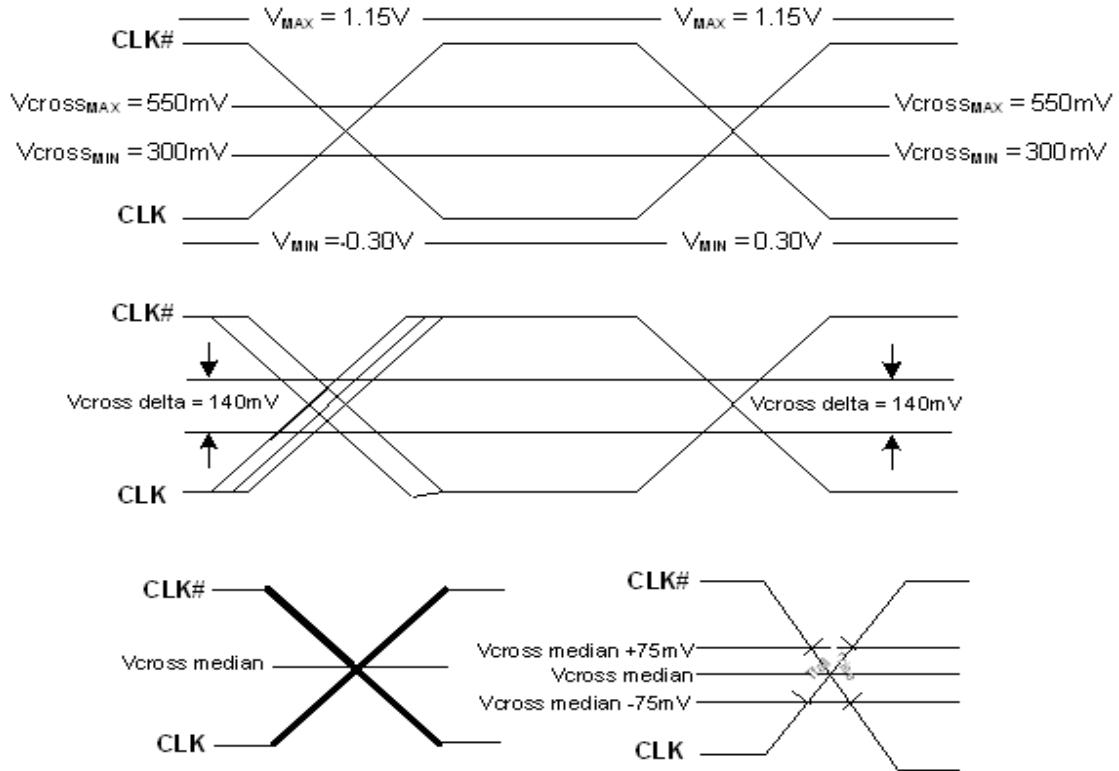


Figure 5. Single-Ended Measurement for Differential Output Signals (for AC Parameters Measurement)

4. Pin Descriptions

4.1. 10-Pin TDFN

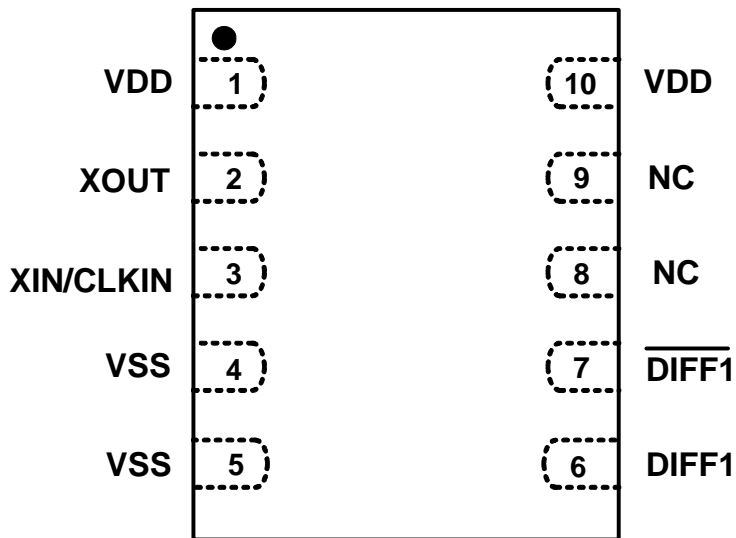


Figure 6. 10-Pin TDFN

Table 7. 10-Pin TDFN Descriptions

| Pin # | Name | Type | Description |
|-------|---------------------------|--------|---|
| 1 | VDD | PWR | 3.3 V Power supply. |
| 2 | XOUT | O | 25.00 MHz crystal output, Float XOUT if using only CLKIN (clock input). |
| 3 | XIN/CLKIN | I | 25.00 MHz crystal input or 3.3 V, 25 MHz clock Input. |
| 4 | VSS | GND | Ground. |
| 5 | VSS | GND | Ground. |
| 6 | DIFF1 | O, DIF | 0.7 V, 100 MHz differentials clock output. |
| 7 | $\overline{\text{DIFF1}}$ | O, DIF | 0.7 V, 100 MHz differentials clock output. |
| 8 | NC | NC | No Connect. Do not connect this pin to anything. |
| 9 | NC | NC | No Connect. Do not connect this pin to anything. |
| 10 | VDD | PWR | 3.3 V Power supply |

Si52111-B5/B6

4.2. 8-Pin TSSOP

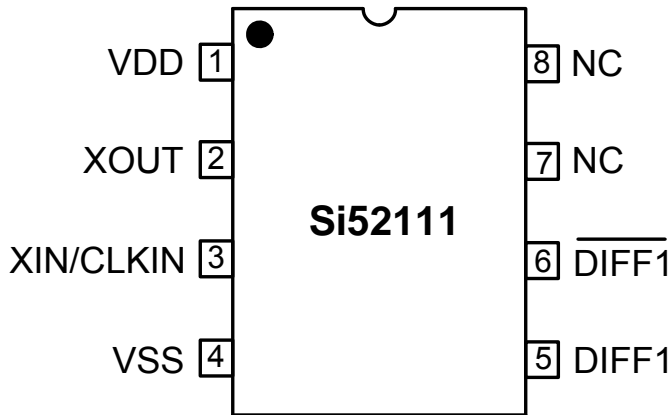


Figure 7. 8-Pin TSSOP

Table 8. 8-Pin TSSOP Descriptions

| Pin # | Name | Type | Description |
|-------|---------------------------|--------|---|
| 1 | VDD | PWR | 3.3 V Power supply. |
| 2 | XOUT | O | 25.00 MHz crystal output, Float XOUT if using only CLKIN (clock input). |
| 3 | XIN/CLKIN | I | 25.00 MHz crystal input or 3.3 V, 25 MHz clock Input. |
| 4 | VSS | GND | Ground. |
| 5 | DIFF1 | O, DIF | 0.7 V, 100 MHz differentials clock. |
| 6 | $\overline{\text{DIFF1}}$ | O, DIF | 0.7 V, 100 MHz differentials clock. |
| 7 | NC | | No Connect. Do not connect this pin to anything. |
| 8 | NC | | No Connect. Do not connect this pin to anything. |

5. Ordering Guide

| Part Number | Spread Option | Package Type | Temperature |
|-----------------|---------------|-----------------------------|------------------------|
| Si52111-B5-GM2 | No Spread | 10-pin TDFN | Extended, -40 to 85 °C |
| Si52111-B5-GM2R | No Spread | 10-pin TDFN—Tape and Reel | Extended, -40 to 85 °C |
| Si52111-B5-GT | No Spread | 8-pin TSSOP | Extended, -40 to 85 °C |
| Si52111-B5-GTR | No Spread | 8-pin TSSOP - Tape and Reel | Extended, -40 to 85 °C |
| Si52111-B6-GM2 | -0.5% Spread | 10-pin TDFN | Extended, -40 to 85 °C |
| Si52111-B6-GM2R | -0.5% Spread | 10-pin TDFN—Tape and Reel | Extended, -40 to 85 °C |
| Si52111-B6-GT | -0.5% Spread | 8-pin TSSOP | Extended, -40 to 85 °C |
| Si52111-B6-GTR | -0.5% Spread | 8-pin TSSOP - Tape and Reel | Extended, -40 to 85 °C |

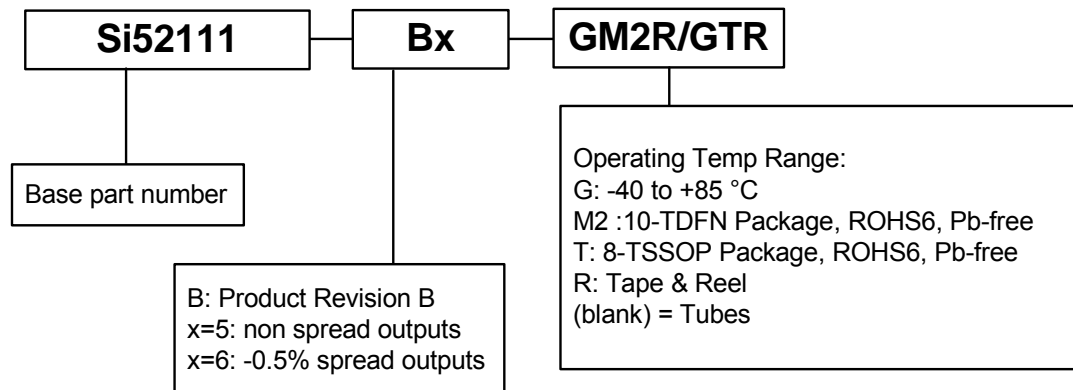


Figure 8. Ordering Information

6. Package Outlines

6.1. TDFN Package

Figure 9 illustrates the package details for the 10-pin TDFN. Table 9 lists the values for the dimensions shown in the illustration.

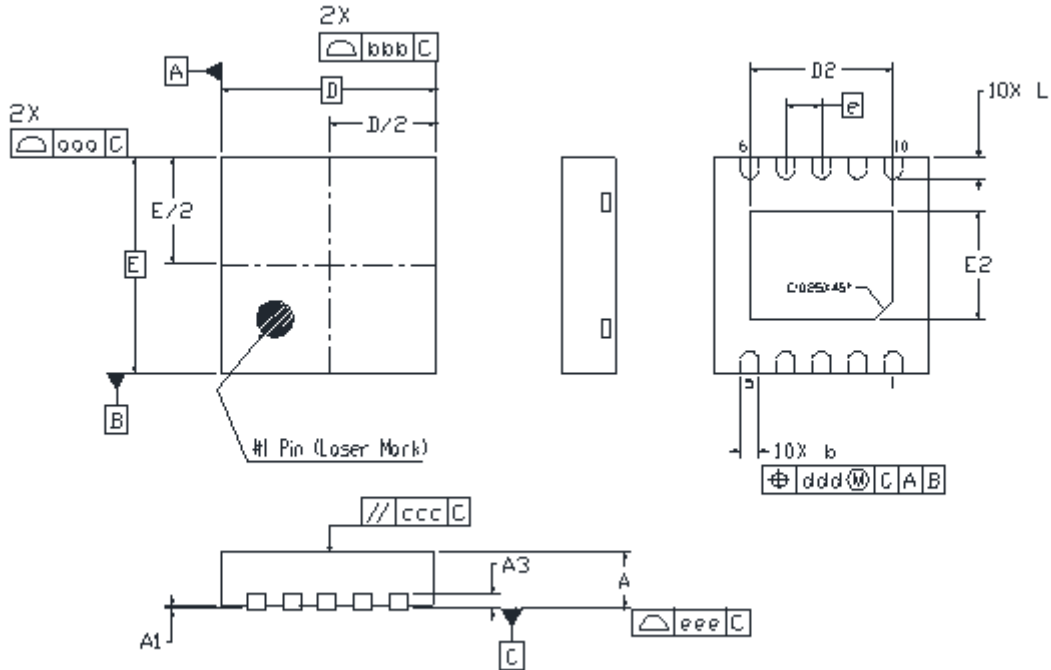


Figure 9. 10-Pin TDFN Package Drawing

Table 9. TDFN Package Diagram Dimensions

| Symbol | Min | Nom | Max |
|--|-----------|------|------|
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | 0.20 REF. | | |
| b | 0.18 | 0.25 | 0.30 |
| D | 3.00 BSC. | | |
| D2 | 1.90 | 2.00 | 2.10 |
| e | 0.50 BSC | | |
| E | 3.00 BSC | | |
| E2 | 1.40 | 1.50 | 1.60 |
| L | 0.25 | 0.30 | 0.35 |
| aaa | 0.10 | | |
| bbb | 0.10 | | |
| ccc | 0.10 | | |
| ddd | 0.10 | | |
| eee | 0.08 | | |
| Notes: | | | |
| 1. All dimensions shown are in millimeters (mm) unless otherwise noted. | | | |
| 2. Dimensioning and Tolerancing per ANSI Y14.5M-1994. | | | |
| 3. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components. | | | |
| 4. This drawing conforms to the JEDEC Solid State Outline MO-229. | | | |

Si52111-B5/B6

6.2. TSSOP Package

Figure 10 illustrates the package details for the 8-pin TSSOP. Table 10 lists the values for the dimensions shown in the illustration.

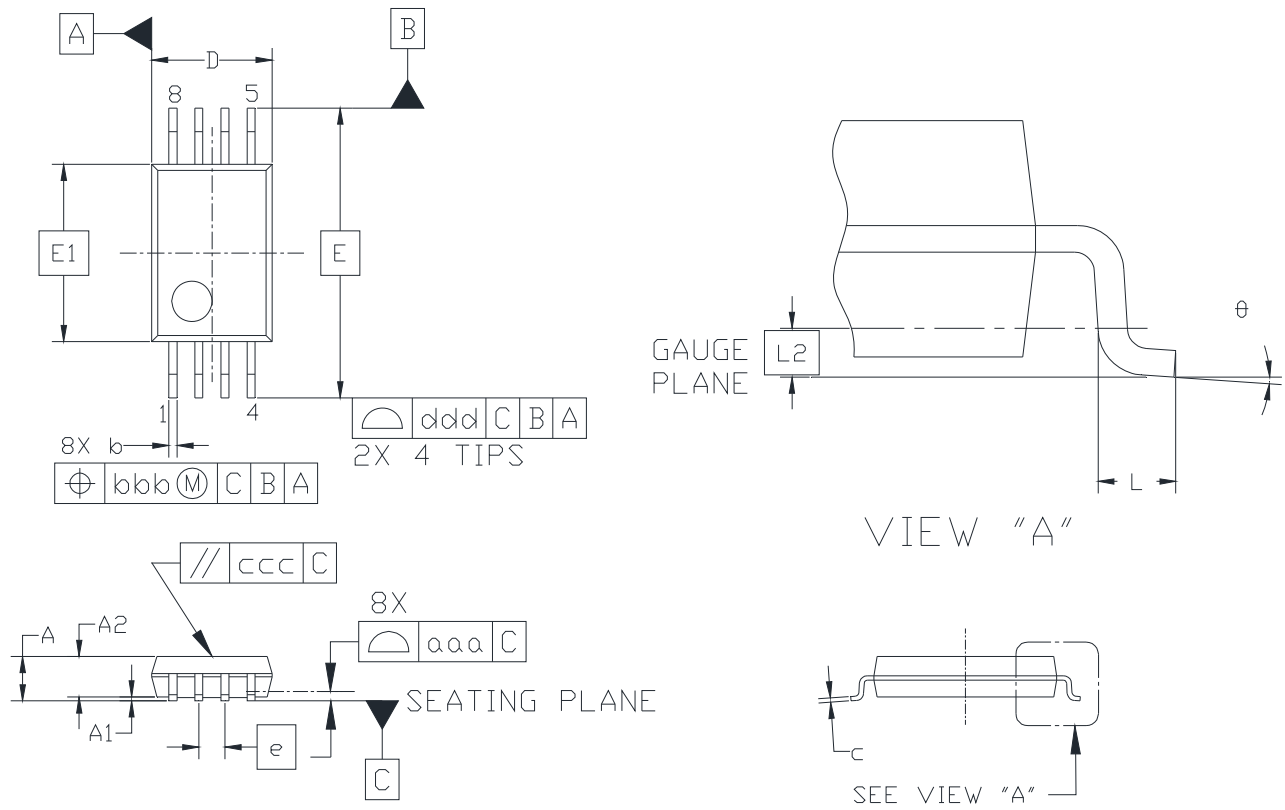
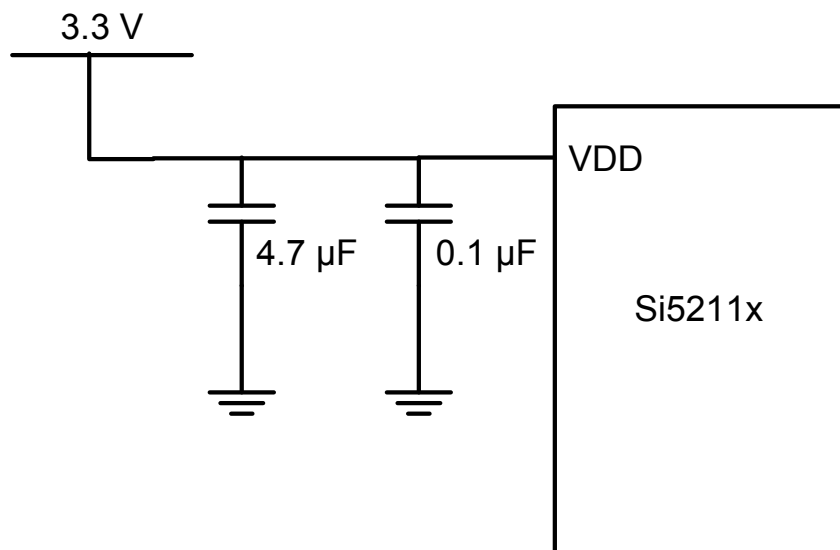


Figure 10. 8-Pin TSSOP Package Drawing

Table 10. TSSOP Package Diagram Dimensions

| Symbol | Min | Nom | Max |
|--|----------|------|------|
| A | — | — | 1.20 |
| A1 | 0.05 | — | 0.15 |
| A2 | 0.80 | 0.90 | 1.05 |
| b | 0.19 | — | 0.30 |
| c | 0.09 | — | 0.20 |
| D | 2.90 | 3.00 | 3.10 |
| E | 6.40 BSC | | |
| E1 | 4.30 | 4.40 | 4.50 |
| e | 0.65 BSC | | |
| L | 0.45 | 0.60 | 0.75 |
| L2 | 0.25 BSC | | |
| θ | 0° | — | 8° |
| aaa | 0.10 | | |
| bbb | 0.10 | | |
| ccc | 0.05 | | |
| ddd | 0.20 | | |
| Notes: | | | |
| <ol style="list-style-type: none"> 1. All dimensions shown are in millimeters (mm) unless otherwise noted. 2. Dimensioning and Tolerancing per ANSI Y14.5M-1994. 3. This drawing conforms to the JEDEC Solid State Outline MO-153, Variation AA. 4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020C specification for Small Body Components. | | | |

7. Recommended Design Guideline



Note: FB Specifications:
DC resistance 0.1–0.3 Ω
Impedance at 100 MHz \geq 1000 Ω

Figure 11. Recommended Application Schematic

DOCUMENT CHANGE LIST

Revision 1.0 to Revision 1.1

- Added “4.2. 8-Pin TSSOP” pin description on page 12.

Revision 1.1 to Revision 1.2

- Updated Features on page 1.
- Updated Description on page 1.
- Updated Table 3, “AC Electrical Specifications,” on page 4.



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