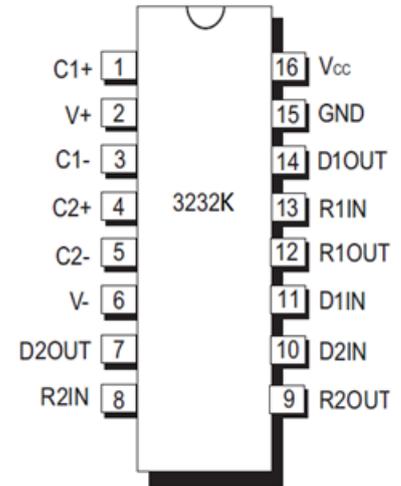


GENERAL DESCRIPTION

The 3232K is an RS-232 transceiver solution intended for portable or hand-held applications such as notebook or laptop computers. The 3232K has a high-efficiency, charge-pump power supply that requires only 0.1µF capacitors in 3.3V operation. This charge pump allows the 3232K to deliver true RS-232 performance from a single power supply ranging from +3.0V to +5.5V. The 3232K is 2-driver/2-receiver devices. The ESD tolerance of the 3232K device is over +/- 15kV for both Human Body Model and IEC61000-4-2 Air discharge test methods.

PIN CONFIGURATION



FEATURES

- Meets true EIA/TIA-232-F Standards from a +3.0V to +5.5V power supply
- 250kbps Transmission Rate Under Load
- Interoperable with RS-232 down to a +2.7V power source
- Enhanced ESD Specifications:
 - +15kV Human Body Model
 - +15kV IEC61000-4-2 Air Discharge
 - +8kV IEC61000-4-2 Contact Discharge

APPLICATIONS

- Computers
- Notebooks
- Laptop computers
- Battery-Powered Equipment
- Hand-Held Equipment

PIN FUNCTION

| Pin | Symbol | Function |
|-----|-----------------|--|
| 1 | C1+ | Positive terminal of the voltage doubler charge-pump capacitor |
| 2 | V+ | +5.5V output generated by the charge pump |
| 3 | C1- | Negative terminal of the voltage doubler charge-pump capacitor |
| 4 | C2+ | Positive terminal of the inverting charge-pump capacitor |
| 5 | C2- | Negative terminal of the inverting charge-pump capacitor |
| 6 | V- | -5.5V output generated by the charge pump |
| 7 | D2OUT | RS-232 driver output |
| 8 | R2IN | RS-232 receiver input |
| 9 | R2OUT | TTL/CMOS receiver output |
| 10 | D2IN | TTL/CMOS driver input |
| 11 | D1IN | TTL/CMOS driver input |
| 12 | R1OUT | TTL/CMOS receiver output |
| 13 | R1IN | RS-232 receiver input |
| 14 | D1OUT | RS-232 driver output |
| 15 | GND | Ground |
| 16 | V _{cc} | +3.0V to +5.5V supply voltage |

ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability or cause permanent damage to the device.

| Parameter | Symbol | Ratings |
|---|---|----------------------------------|
| Supply Voltage | V _{cc} | -0.3V to +6.0V |
| V+ * | | -0.3V to +7.0V |
| V- * | | +0.3V to -7.0V |
| V+ + V- * | | +13V |
| I _{cc} (DC V _{cc} or GND Current) | | ±100mA |
| Input Voltages DxIN | V _{D1IN} , V _{D2IN} | -0.3V to +6.0V |
| Input Voltages RxIN | V _{R1IN} , V _{R2IN} | ± 15V |
| Output Voltages DxOUT | V _{D1OUT} , V _{D2OUT} | ±13.2V |
| Output Voltages RxOUT | V _{R1OUT} , V _{R2OUT} | -0.3V to (V _{cc} +0.3V) |
| Short-Circuit Duration DxOUT | | Continuous |
| Power Dissipation 16-pin NSOIC ** | P _D | 1086mW |
| Power Dissipation 16-pin PDIP *** | | 600mW |
| Junction Temperature | T _J | -40°C to +125°C |
| Storage Temperature | T _{STG} | -65°C to +150°C |

* V+ and V- can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V

** derate 13.57mW/°C above +70°C

*** derate 24.26mW/°C above +70°C

RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Ratings |
|-------------------------------------|------------------|----------------|
| Supply Voltage | V _{cc} | 3.3V to 5.0V |
| Operating Ambient Temperature Range | T _{OPR} | -40°C to +85°C |

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, the following specifications apply for $V_{CC} = +3.0V$ to $+5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, $C_1 - C_4 = 0.1\mu F$.

| Parameter | Conditions | Min | Typ | Max | Unit |
|--|--|----------------|----------------|----------|-----------|
| DC CHARACTERISTICS | | | | | |
| Supply Current | No load, $DxIN = GND$ or V_{CC} | | 0.3 | 1.0 | mA |
| LOGIC INPUTS AND RECEIVER OUTPUTS | | | | | |
| Input Logic Threshold LOW | Note 1 | GND | | 0.8 | V |
| Input Logic Threshold HIGH | $V_{CC} = 3.3V$, Note 1 | 2.0 | | V_{CC} | V |
| Input Logic Threshold HIGH | $V_{CC} = 5.0V$, Note 1 | 2.4 | | V_{CC} | V |
| Output Voltage LOW | $I_{OUT} = 1.6mA$ | | | 0.4 | V |
| Output Voltage HIGH | $I_{OUT} = -1.0mA$ | $V_{CC} - 0.6$ | $V_{CC} - 0.1$ | | V |
| DRIVER OUTPUTS | | | | | |
| Output Voltage Swing | All driver outputs loaded with $3k\Omega$ to GND, $T_A = +25^{\circ}C$ | ± 5.0 | ± 5.4 | | V |
| Output Resistance | $V_{CC} = V+ = V- = 0V$, $V_{OUT} = \pm 2V$ | 300 | | | Ω |
| Output Short-Circuit Current | $V_{OUT} = 0V$ | | ± 35 | ± 60 | mA |
| RECEIVER INPUTS | | | | | |
| Input Voltage Range | | -15 | | 15 | V |
| Input Threshold LOW | $V_{CC} = 3.3V$ | 0.6 | 1.2 | | V |
| Input Threshold LOW | $V_{CC} = 5.0V$ | 0.8 | 1.5 | | V |
| Input Threshold HIGH | $V_{CC} = 3.3V$ | | 1.5 | 2.4 | V |
| Input Threshold HIGH | $V_{CC} = 5.0V$ | | 1.8 | 2.4 | V |
| Input Hysteresis | | | 0.3 | | V |
| Input Resistance | | 3 | 5 | 7 | $k\Omega$ |
| TIMING CHARACTERISTICS | | | | | |
| Maximum Data Rate | $R_L = 3k\Omega$, $C_L = 1000pF$, one driver active | 250 | | | kbps |
| Receiver Propagation Delay, t_{PHL} | Receiver input to Receiver output, $C_L = 150pF$ | | 0.15 | | μs |
| Receiver Propagation Delay, t_{PLH} | Receiver input to Receiver output, $C_L = 150pF$ | | 0.15 | | μs |
| Driver Skew | $ T_{PHL} - T_{PLH} $, $T_A = +25^{\circ}C$ | | 100 | | ns |
| Receiver Skew | $ T_{PHL} - T_{PLH} $ | | 50 | | ns |
| Transition-Region Slew Rate | $R_L = 3k\Omega$, $C_L = 1000pF$, measurements taken from $-3.0V$ to $+3.0V$ or $+3.0V$ to $-3.0V$ | | | 30 | $V/\mu s$ |

Note 1: Driver Input hysteresis is typically 250mV

TYPICAL PERFORMANCE CHARACTERISTICS

Unless otherwise noted, the following performance characteristics apply for $V_{CC} = +3.3V$, 1000kbps data rate, all drivers loaded with 3k Ω , 0.1 μF charge pump capacitors, and $T_A = +25^\circ C$.

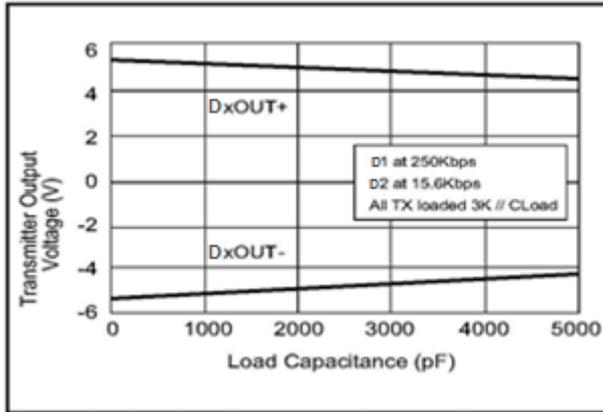


Figure 1. Transmitter Output Voltage vs Load Capacitance

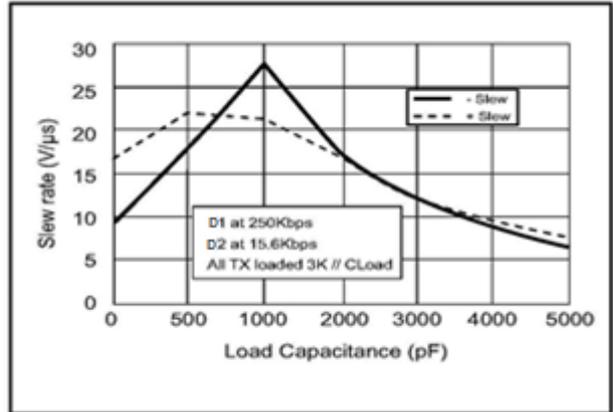


Figure 2. Slew Rate vs Load Capacitance

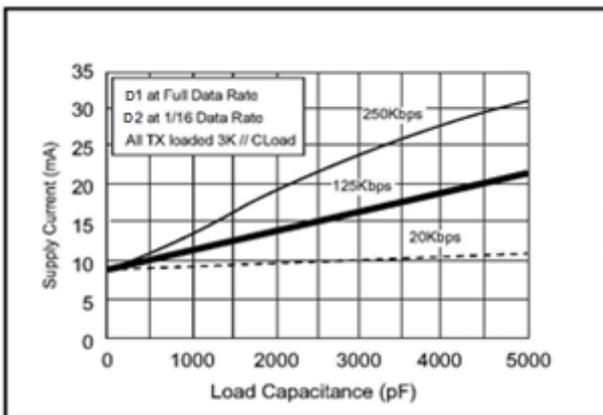


Figure 3. Supply current vs Load Capacitance when Transmitting Data

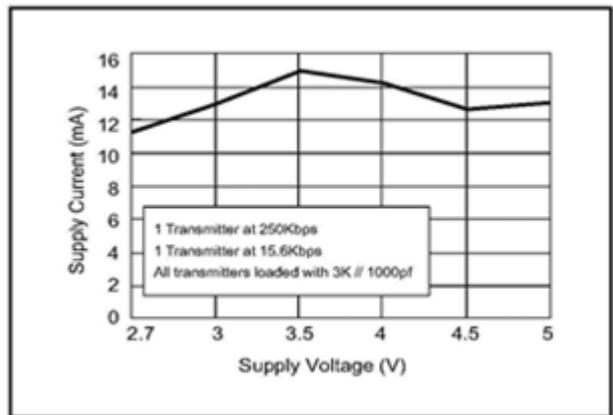


Figure 4. Supply Current vs Supply Voltage

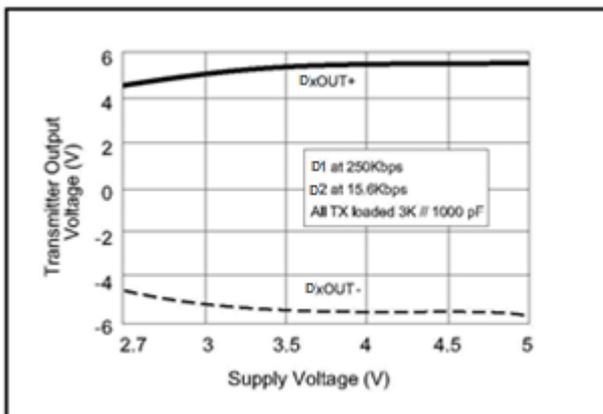


Figure 5. Transmitter Output Voltage vs Supply Voltage

DESCRIPTION

The 3232K transceiver meets the EIA/TIA-232 and ITU-T V.28/V.24 communication protocols and can be implemented in battery-powered, portable, or hand-held applications such as notebook or palmtop computers. The 3232K device has on-board charge pump circuitry that generates $\pm 5.5V$ for RS-232 voltage levels from a single +3.0V to +5.5V power supply. The 3232K is ideal for +3.3V-only systems, mixed+3.3Vto+5.5V systems, or+5.0V-only systems that require true RS-232 performance. The 3232K device can operate at a data rate of 250kbps when fully loaded.

The 3232K is 2-driver/2-receiver devices ideal for portable or hand-held applications.

THEORY OF OPERATION

The 3232K is made up of three basic circuit blocks:

1. Drivers
2. Receivers
3. Charge pump

DRIVERS

The drivers are inverting level transmitters that convert TTL or CMOS logic levels to $\pm 5.0V$ EIA/TIA-232 levels with an inverted sense relative to the input logic levels. Typically, the RS-232 output voltage swing is +5.4V with no load and +5V minimum fully loaded. The driver outputs are protected against infinite short-circuits to ground without degradation in reliability. Driver outputs will meet EIA/TIA-562 levels of $\pm 3.7V$ with supply voltages as low as 2.7V.

The drivers can guarantee a data rate of 250kbps fully loaded with 3k Ω in parallel with 1000pF, ensuring compatibility with PC-to-PC communication software.

The slew rate of the driver is internally limited to a maximum of 30V/ μs in order to meet the EIA standards (EIA RS-232D 2.1.7, Paragraph 5). The transition of the loaded output from HIGH to LOW also meet the monotonicity requirements of the standard.

Figure 6 shows a loopback test circuit used to test the RS-232 Drivers. Figure 7 shows the test results of the loopback circuit with all drivers active at 120kbps with RS-232 loads in parallel with a 1000pF capacitor. Figure 8 shows the test results where one driver was active at 250kbps and all drivers loaded with an RS-232 receiver in parallel with 1000pF capacitors. A solid RS-232 data transmission rate of 250kbps provides compatibility with many designs in personal computer peripherals and LAN applications.

RECEIVERS

The Receivers convert EIA/TIA-232 levels to TTL or CMOS logic output levels.

Since receiver input is usually from a transmission line where long cable lengths and system interference can degrade the signal, the inputs have a typical hysteresis margin of 300mV. This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal 5k Ω pulldown resistor to ground will commit the output of the receiver to a HIGH state.

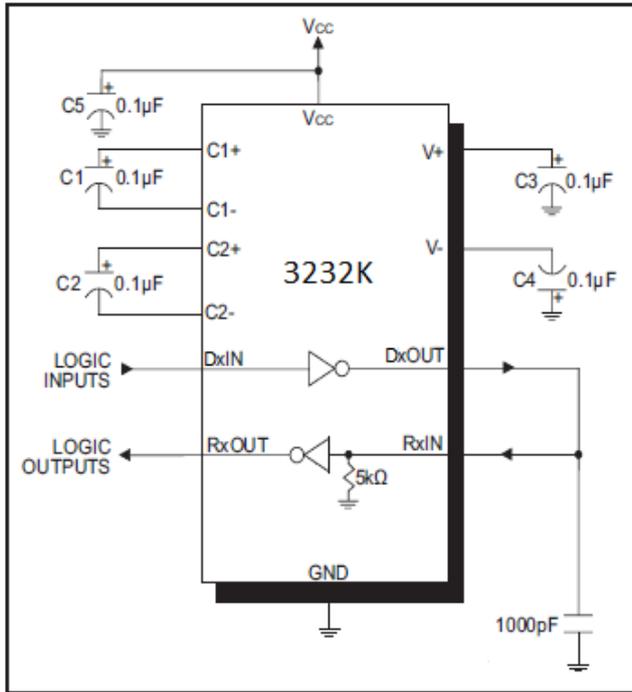


Figure 6. 3232K Driver Loopback Test Circuit

CHARGE PUMP

The charge pump requires four external capacitors, and allows attaining symmetrical 5.5V power supplies. The internal power supply consists of a regulated dual charge pump that provides output voltages of +/-5.5V regardless of the input voltage (V_{CC}) over the +3.0V to +5.5V range. In most circumstances, decoupling the power supply can be achieved adequately using a 0.1µF bypass capacitor at C5 (refer to figure 6). In applications that are sensitive to power-supply noise, decouple V_{CC} to ground with a capacitor of the same value as charge-pump capacitor C1. Physically connect bypass capacitors as close to the IC as possible. The charge pump operates in a discontinuous mode using an internal oscillator. If the output voltages are less than a magnitude of 5.5V, the charge pump is enabled. If the output voltages exceed a magnitude of 5.5V, the charge pump is disabled.

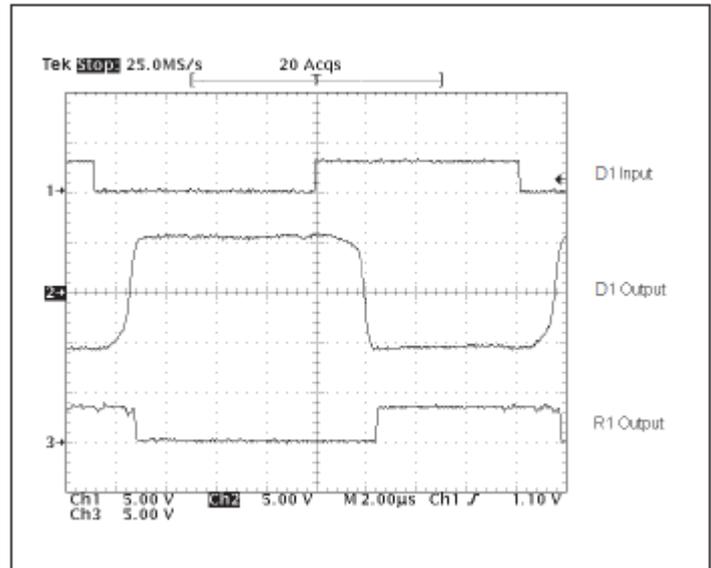


Figure 7. Loopback Test results at 120kbps

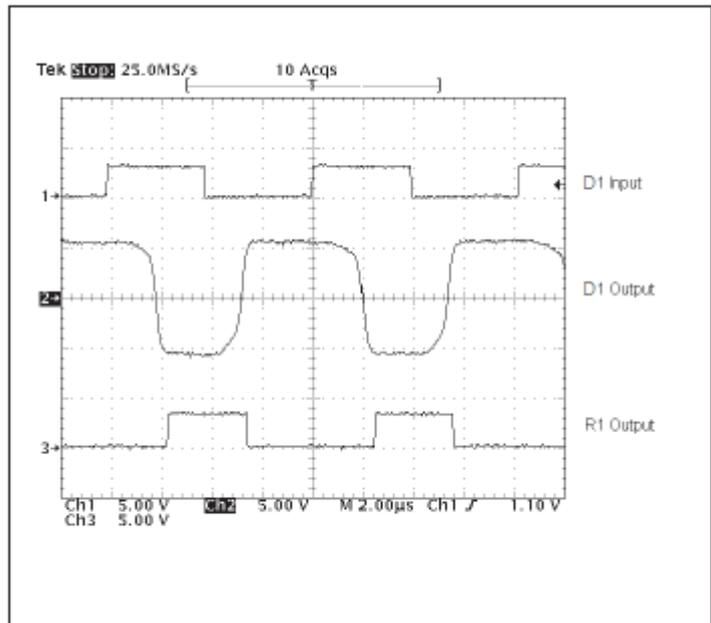
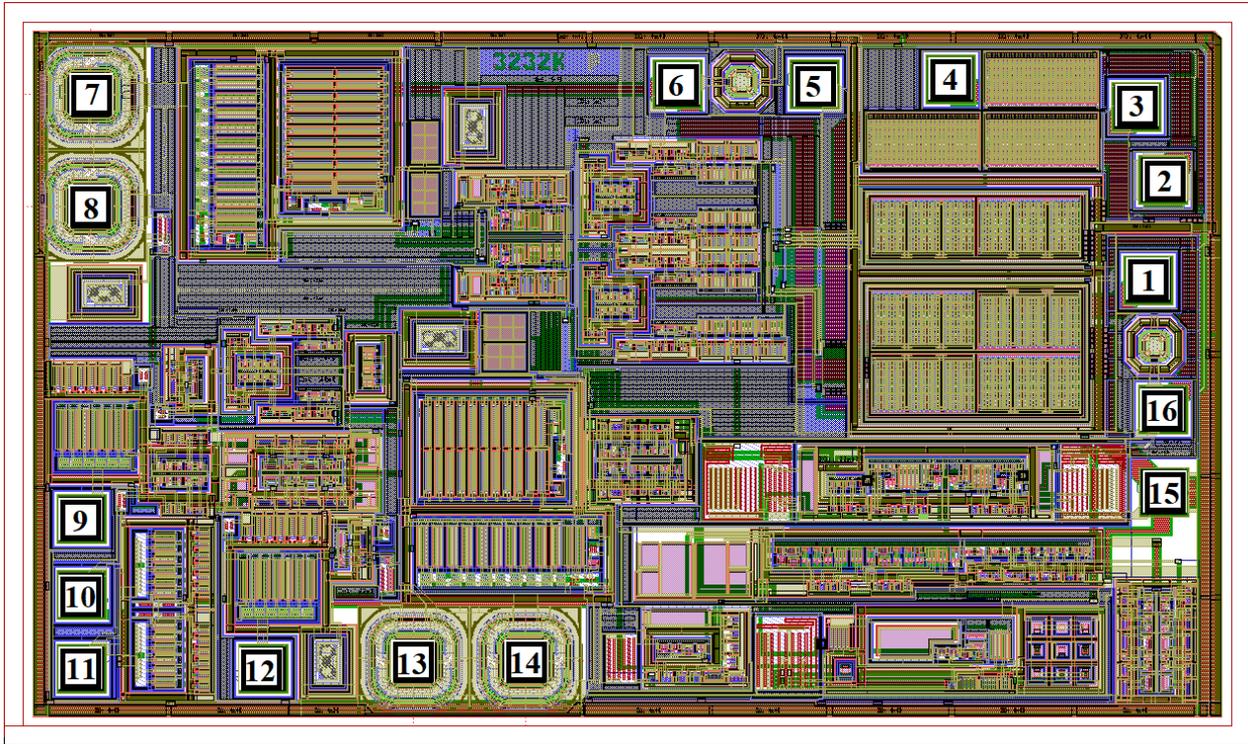


Figure 8. Loopback Test results at 250kbps

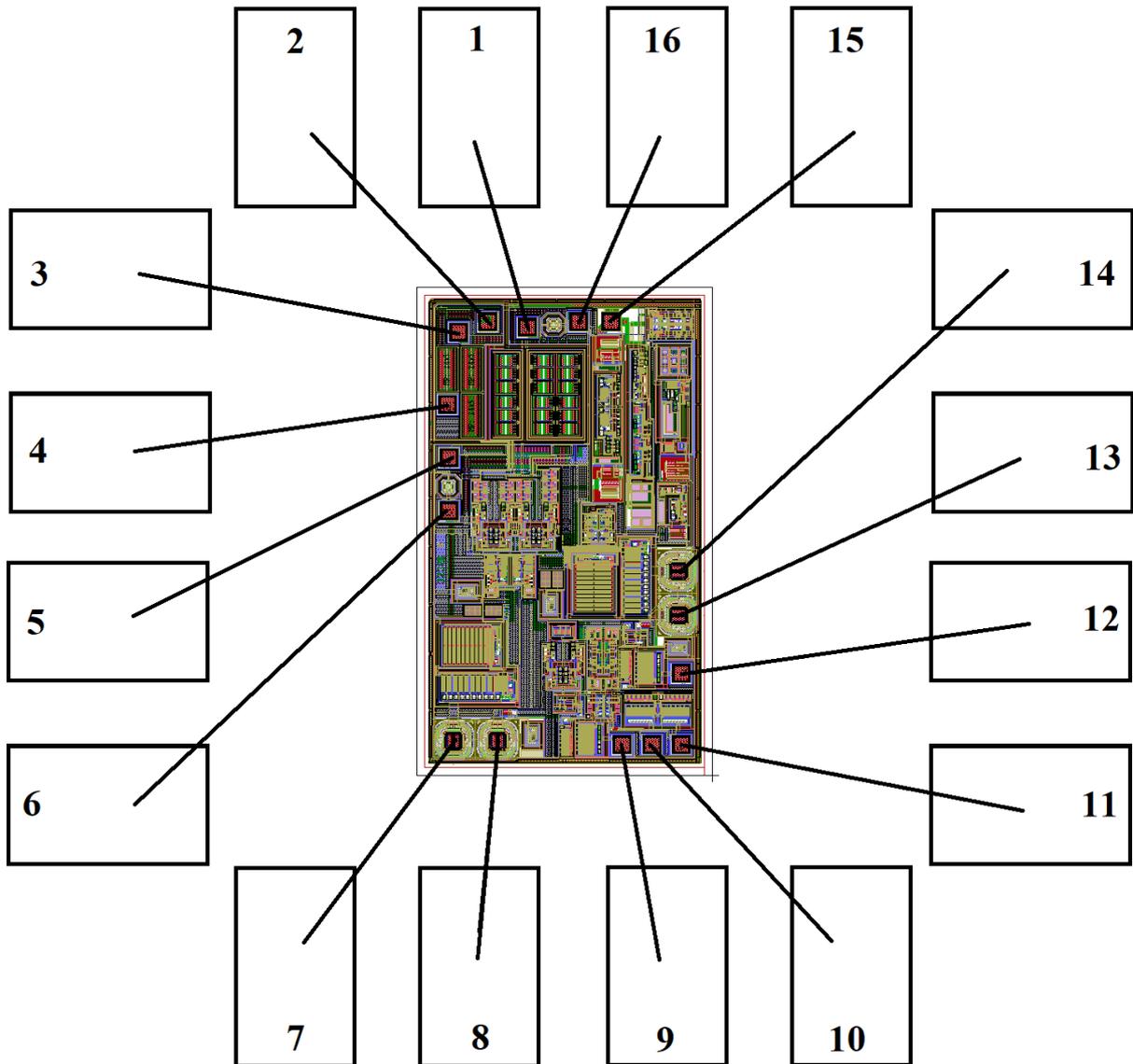
PAD LOCATION AND COORDINATES



Die size (including scribe line): 2.53mm×1.52mm

| # Pad | Pin Name (Package) | Pad centers coordinates (μm) | | Pad Size (μm×μm) |
|-------|-----------------------|------------------------------|------|------------------|
| | | X | Y | |
| 1 | C1+ | 2320 | 955 | 90×90 |
| 2 | V+ | 2350 | 1160 | 90×90 |
| 3 | C1- | 2295 | 1310 | 90×90 |
| 4 | C2+ | 1920 | 1360 | 90×90 |
| 5 | C2- | 1640 | 1355 | 90×90 |
| 6 | V- | 1365 | 1355 | 90×90 |
| 7 | D2OUT | 175 | 1330 | 90×90 |
| 8 | R2IN | 175 | 1105 | 90×90 |
| 9 | R2OUT | 155 | 465 | 90×90 |
| 10 | D2IN | 155 | 310 | 90×90 |
| 11 | D1IN | 155 | 160 | 90×90 |
| 12 | R1OUT | 525 | 160 | 90×90 |
| 13 | R1IN | 830 | 175 | 90×90 |
| 14 | D1OUT | 1060 | 175 | 90×90 |
| 15 | GND | 2350 | 520 | 90×90 |
| 16 | V _{cc} | 2350 | 690 | 90×90 |

BONDING DIAGRAM



ASSEMBLY CHARACTERISTICS

| No. | Assembly Characteristics | Value |
|-----|-----------------------------------|-------------------------------|
| 1 | Wafer Size | 6 Inch |
| 2 | Wafer Thickness before Grinding | 675 +/-20 µm |
| 3 | Scribe Street Width | 80 µm |
| 4 | Chip Size (including Scribe Line) | 2.53×1.52 mm ² |
| 5 | Die Attach Material | Substrate is connected to Gnd |
| 6 | Quantity of Bond Pad Metal Layers | 2 |
| 7 | Pad Thickness | 1.2 µm |
| 8 | Composition of Metal Layers | Al+Si(1.0%)+Ti(0.5%) |
| 9 | Min. Bond Pad Opening Size | 90 ×90 µm |
| 10 | Min. Bond Pad Pitch | 150 µm |
| 11 | Min. Wire Diameters | 1 mil (25.4µm) |
| 12 | Circuit Under Pad Design (CUP) | No |

ADDITIONAL INFORMATION

Pb-free products:

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.

Green products:

- Lead-free (RoHS compliant).
- Halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Utilization:

- The management and disposal of these products shall be conducted in accordance with local legislative requirements and guidance.

The appearance complies with the requirements of the company standards.