CMOS Transimpedance Amplifier with AGC for Fiber Optic Networks up to 622 Mbps

Applications
- APON
- BPON
- ATM/SONET

Features
- Typical –34 dBm sensitivity, +6 dBm saturation at 622 Mb/s when used with 0.9 A/W InGaAs PIN.
- (Cpd ≤ 0.5 pF, BER 10^-10)
- Typical differential transimpedance: 65 kΩ
- Fabricated in standard CMOS
- Differential output
- Standard +3.3 Volt supply
- Available in die form only
- Monitor output
- AGC provides dynamic range of 40 dB
- Internal or external bias for photodiode
- PIN or APD sensor
- Same pad layout and die size as M02013/14/15/16

The M02011 is a CMOS transimpedance amplifier with AGC. The AGC gives a wide dynamic range of 40 dB. The high transimpedance gain of 66 kΩ ensures good sensitivity.

For optimum system performance, the M02011 die should be mounted with a GaAs or InGaAs PIN photodetector inside a lensed TO-Can or other optical sub-assembly.

The M02011 can either bias the PIN diode from the internal regulator, or use an externally biased PIN diode.

A replica of the average photodiode current is available at the MON pad for photo-alignment and 'Loss of Signal' monitoring.

Typical Applications Diagram
**M02011**

**CMOS Transimpedance Amplifier with AGC for Fiber Optic Networks up to 622 Mbps**

**Ordering Information**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Operating Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>M02011-XX*</td>
<td>Waffle Pack</td>
<td>–40 °C to 95 °C</td>
</tr>
<tr>
<td>M02011-XX*</td>
<td>Expanded whole wafer on a ring</td>
<td>–40 °C to 95 °C</td>
</tr>
</tbody>
</table>

*NOTE:* *For full ordering number please contact sales*

**Revision History**

<table>
<thead>
<tr>
<th>Revision</th>
<th>Level</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V5</td>
<td>Released</td>
<td>May 2015</td>
<td>Updated logos and page layout. No content changes.</td>
</tr>
<tr>
<td>D (V4)</td>
<td>Released</td>
<td>August 2007</td>
<td>Production release. Revised Absolute Maximum Ratings Table, Table 1-1.</td>
</tr>
<tr>
<td>C (V3)</td>
<td>Released</td>
<td>May 2007</td>
<td>Production release. Increased max operating temperature, updated specifications based on full device characterization and included information on assembly, $I_{MON}$ and using the device with externally biased detectors in the Applications Information section.</td>
</tr>
</tbody>
</table>

**Top Level Diagram**

![Top Level Diagram](image)

**Pad Configuration**

![Pad Configuration](image)

Die size = 1090 x 880 µm
1.0 Product Specification

1.1 Absolute Maximum Ratings

These are the absolute maximum ratings at or beyond which the IC can be expected to fail or be damaged. Reliable operation at these extremes for any length of time is not implied.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>Power supply ($V_{CC}$-GND)</td>
<td>-0.4 to +4</td>
<td>V</td>
</tr>
<tr>
<td>$T_A$</td>
<td>Operating ambient</td>
<td>-40 to +95</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{STG}$</td>
<td>Storage temperature</td>
<td>-65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>PINA input current</td>
<td>8 $^{(1, 2)}$</td>
<td>mA$_{pp}$</td>
</tr>
<tr>
<td>$V_{PINA}$</td>
<td>Maximum input voltage at PINA</td>
<td>-0.4 to +2.0 $^{(2)}$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{PINK}$</td>
<td>Maximum average current sourced out of PINK</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>$V_{PINK}, V_{DOUT}, V_{MON}$</td>
<td>Maximum input voltage at PINK, Dout, DoutB, AGC and MON</td>
<td>-0.4 to Vcc +0.4</td>
<td>V</td>
</tr>
<tr>
<td>$I_{DOUT, DoutB}$</td>
<td>Maximum average current sourced out of Dout and DoutB</td>
<td>10</td>
<td>mA</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Equivalent to 4.9 mA average current.
2. Do not exceed either the $I_{IN}$ or $V_{PINA}$ rating. PINA damage will result in performance degradation which is difficult to detect.

1.2 Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CC}$</td>
<td>Power supply ($V_{CC}$ - GND)</td>
<td>3.3 ± 10%</td>
<td>V</td>
</tr>
<tr>
<td>$C_{PD}$</td>
<td>Max. Photodiode capacitance ($V_i = 1.8$ V), for 622 Mbps data rate</td>
<td>1.0</td>
<td>pF</td>
</tr>
<tr>
<td>$T_A$</td>
<td>Operating ambient temperature</td>
<td>-40 to +95</td>
<td>°C</td>
</tr>
</tbody>
</table>
1.3 **DC Characteristics**

**Table 1-3. DC Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_B$</td>
<td>Photodiode bias voltage (PINK – PINA)</td>
<td>1.7</td>
<td>2.0</td>
<td>2.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{CM}$</td>
<td>Common mode output voltage</td>
<td>0.7</td>
<td>1</td>
<td>1.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{CC}$</td>
<td>Supply current (no loads)</td>
<td>20</td>
<td>28</td>
<td>35</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$R_{LOAD}$</td>
<td>Recommended differential output loading</td>
<td>85</td>
<td>100</td>
<td>—</td>
<td>W</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
1. 100Ω is the load presented by the limiting amplifier.

1.4 **AC Characteristics**

**Table 1-4. AC Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{OUT}$</td>
<td>Output impedance (single ended)</td>
<td>30</td>
<td>50</td>
<td>70</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>LFC</td>
<td>Low frequency cutoff</td>
<td>—</td>
<td>13</td>
<td>17</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>$V_D$</td>
<td>Differential output voltage</td>
<td>—</td>
<td>250</td>
<td>450</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>DCD</td>
<td>Duty cycle distortion</td>
<td>622 Mbps</td>
<td>—</td>
<td>80</td>
<td>ps</td>
<td></td>
</tr>
<tr>
<td>DJ</td>
<td>Deterministic jitter (includes DCD)</td>
<td>622 Mbps, 2$^{23}$ – 1 PRBS</td>
<td>—</td>
<td>120</td>
<td>pspp</td>
<td></td>
</tr>
<tr>
<td>PDJ</td>
<td>Pattern Dependent Jitter (at crossing point), with no DCD</td>
<td>622 Mbps, 2$^{23}$ – 1 PRBS</td>
<td>—</td>
<td>55</td>
<td>pspp</td>
<td></td>
</tr>
<tr>
<td>$I_{rms}$</td>
<td>Total input RMS noise</td>
<td>DC to 467 MHz (Bessel Filter), $C_{IN} = 0.5$ pF</td>
<td>—</td>
<td>50</td>
<td>60</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{rms}$</td>
<td>Total input RMS noise</td>
<td>DC to 467 MHz (Bessel Filter), $C_{IN} = 1$ pF</td>
<td>—</td>
<td>56</td>
<td>70</td>
<td>nA</td>
</tr>
<tr>
<td>$PIN_{mean_min}$</td>
<td>Optical Sensitivity</td>
<td>—33</td>
<td>—34</td>
<td>—</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>$I_{mon_off}$</td>
<td>Monitor Output Offset</td>
<td>$V_{MON} = 0$ to 2V</td>
<td>—</td>
<td>—</td>
<td>1.3</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{mon_ratio}$</td>
<td>Monitor Output Gain Ratio</td>
<td>$V_{MON} = 0$ to 2V</td>
<td>—</td>
<td>0.7</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>$I_{mon_error}$</td>
<td>Monitor Output Accuracy</td>
<td>$V_{MON} = 0$ to 2V</td>
<td>—</td>
<td>—</td>
<td>±2</td>
<td>dB</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Die designed to operate over an ambient temperature range of –40°C to +85°C, $T_A$ and $V_{CC}$ range from 3.0 – 3.6V. Typical values are tested at $T_A = 25°$ C and $V_{CC} = 3.3V$.
2. Input ~33 dBm, Extinction Ratio = 10, Temp = 25°C.
3. Input current < 1 mA average.
4. BER $10^{-10}$, PD capacitance = 0.5 pF, Responsivity 0.9 A/W, Extinction Ratio = 10, Temp = 25°C.
5. Offset and slope adjustment necessary to achieve rated accuracy.
## 1.5 Dynamic Characteristics

### Table 1-5. Dynamic Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Transimpedance</td>
<td>26.5</td>
<td>32.5</td>
<td>38</td>
<td>kΩ</td>
</tr>
<tr>
<td></td>
<td>Single ended</td>
<td>53</td>
<td>65</td>
<td>76</td>
<td>kΩ</td>
</tr>
<tr>
<td></td>
<td>Differential</td>
<td></td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
<tr>
<td>BW</td>
<td>Bandwidth to –3 dB point @ –33 dBm, 0.9A/W, 0.5 pF PD</td>
<td>450</td>
<td>600</td>
<td>—</td>
<td>MHz</td>
</tr>
<tr>
<td></td>
<td>Bandwidth to –3 dB point @ –33 dBm, 0.9A/W, 1 pF PD</td>
<td>—</td>
<td>460</td>
<td>—</td>
<td>MHz</td>
</tr>
<tr>
<td>RC</td>
<td>AGC loop time constant</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>µs</td>
</tr>
<tr>
<td>I\text{AGC}</td>
<td>AGC threshold</td>
<td>—</td>
<td>5</td>
<td>—</td>
<td>µA\text{pp}</td>
</tr>
<tr>
<td>I\text{OVL}</td>
<td>Maximum functional input current</td>
<td>3.6 (1)</td>
<td>—</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>PSRR</td>
<td>Power supply rejection, f &lt; 1 MHz</td>
<td>—</td>
<td>22</td>
<td>—</td>
<td>dB</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Equivalent to +3.4 dBm input optical power at Extinction Ratio = 10, Responsivity = 1.0 A/W.
1.6 Typical Performance

$V_{CC} = 3.3V$, Temperature = 25°C, $L_{IN} = 1$ nH, unless otherwise stated.

*Figure 1-1. Typical Performance Diagrams 1 of 3*
V\(_{CC}\) = 3.3V, Temperature = 25°C, L\(_{IN}\) = 1 nH, unless otherwise stated.

**Figure 1-2. Typical Performance Diagrams 2 of 3**
V_{CC} = 3.3V, Temperature = 25°C, L_{IN} = 1 nH, unless otherwise stated.

**Figure 1-3. Typical Performance Diagrams 3 of 3**

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**M02011 Imon Characteristics After Calibration**

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**M02011 Imon Error After Calibration**

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# 2.0 Pin Definitions

## Table 2-1. Pad Description

<table>
<thead>
<tr>
<th>Die Pad No</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AGC</td>
<td>Monitor or force AGC voltage</td>
</tr>
<tr>
<td>2</td>
<td>$V_{CC}$</td>
<td>Power pin. Connect to most positive supply</td>
</tr>
<tr>
<td>3</td>
<td>PINK</td>
<td>Common PIN input. Connect photo diode cathode here and a 470 pF capacitor to Gnd (^{(1)})</td>
</tr>
<tr>
<td>4</td>
<td>PINA</td>
<td>Active PIN input. Connect to photo diode anode</td>
</tr>
<tr>
<td>5</td>
<td>$V_{CC}$</td>
<td>Power pin. Connect to most positive supply (only one $V_{CC}$ pad needs to be connected)</td>
</tr>
<tr>
<td>6</td>
<td>MON</td>
<td>Analog current source output. Current matched to average photodiode current</td>
</tr>
<tr>
<td>7</td>
<td>DOUT</td>
<td>Differential data output (goes low as light increases)</td>
</tr>
<tr>
<td>8</td>
<td>DOUTGND</td>
<td>Ground return for DOUT pad (^{(2)})</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Ground pin. Connect to the most negative supply (^{(2)})</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground pin. Connect to the most negative supply (^{(2)})</td>
</tr>
<tr>
<td>11</td>
<td>DOUTGND</td>
<td>Ground return for DOUT pad (^{(2)})</td>
</tr>
<tr>
<td>12</td>
<td>DOUT</td>
<td>Differential data output (goes high as light increases)</td>
</tr>
<tr>
<td>NA</td>
<td>Backside</td>
<td>Backside. Connect to the lowest potential, usually ground</td>
</tr>
</tbody>
</table>

Notes:
1. Alternatively the photodiode cathode may be connected to a decoupled positive supply, e.g. $V_{CC}$.
2. All ground pads are common on the die. Only one ground pad needs to be connected to the TO-Can ground. However, connecting more than one ground pad to the TO-Can ground, particularly those across the die from each other can improve performance in noisy environments.
Figure 2-1. Bare Die Layout
3.0 Functional Description

3.1 Overview

The M02011 is a CMOS transimpedance amplifier with AGC. The AGC gives a wide dynamic range of 40 dB. The high transimpedance gain of 66 kΩ ensures good sensitivity.

For optimum system performance, the M02011 die should be mounted with a GaAs or InGaAs PIN photodetector inside a lensed TO-Can or other optical sub-assembly.

The M02011 can either bias the PIN diode from the internal regulator, or use an externally biased PIN diode.

A replica of the average photodiode current is available at the MON pad for photo-alignment and 'Loss of Signal' (LOS) monitoring.

Figure 3-1. M02011 Block Diagram
3.2 General Description

3.2.1 TIA (Transimpedance Amplifier)

The transimpedance amplifier consists of a high gain single-ended CMOS amplifier (TIA), with a feedback resistor. The feedback creates a virtual earth low impedance at the input and virtually all of the input current passes through the feedback resistor, defining the voltage at the output. Advanced CMOS design techniques are employed to maintain the stability of this stage across all input conditions.

An on-chip low dropout linear regulator has been incorporated into the design to give excellent noise rejection up to several MHz. Higher frequency power supply noise is removed by the external 470 pF decoupling capacitor connected to PINK.

The circuit is designed for PIN photodiodes in the “grounded cathode” configuration, with the anode connected to the input of the TIA and the cathode connected to AC ground, such as the provided PINK terminal. Reverse DC bias is applied to reduce the photodiode capacitance. Avalanche photodiodes can be connected externally to a higher voltage.

3.2.2 AGC

The M02011 has been designed to operate over the input range of +6 dBm to –34 dBm. This represents a ratio of 1:10000 whereas the acceptable dynamic range of the output is only 1:30 which implies a compression of 333:1 in the transimpedance. The design uses a MOS transistor operating in the triode region as a “voltage controlled resistor” to achieve the transimpedance variation.

Another feature of the AGC is that it only operates on signals greater than –26 dBm (@0.9 A/W). This knee in the gain response is important when setting “signal detect” functions in the following post amplifier. It also aids in active photodiode alignment.

The AGC pad allows the AGC to be disabled during photodiode alignment by grounding the pad through a low impedance. The AGC control voltage can be monitored during normal operation at this pad by a high impedance (>10 MΩ) circuit.

3.2.3 Output Stage

The signal from the TIA enters a phase splitter followed by a DC-shift stage and a pair of voltage follower outputs. These are designed to drive a differential (100Ω) load. They are stable for driving capacitive loads, such as interstage filters. Each output has its own GND pad, all four GND pads on the chip should be connected for proper operation. Since the M02011 exhibits rapid roll-off (3 pole), simple external filtering is sufficient.

3.2.4 Monitor O/P

High impedance output sources a replica average photodiode current for monitoring purposes. This output is compatible with the DDMI Receive Power Specification (SFP-8472) and MACOM’s range of DDMI controllers. Ensure that the voltage on VMON is in the range of 0 to 2V. Refer to Figure 4-1.
4.0 Applications Information

4.1 Recommended Pin Diode Connections

Figure 4-1. Suggested PIN Diode Connection Methods

Note:
Selection of Rm depends on the maximum input current as detailed in Table 4-1.
4.2 Monitor Calibration

To achieve the best monitor accuracy, both the slope and calibrated offset should be used. The offset calibration is achieved by measuring the dark current from the MON output. The calibrated monitor value is usually determined by $y = mx + b$ or:

$$I_{MON\_CALIBRATED} = (Slope \times I_{MON\_READING}) + I_{MON\_OFFSET}$$

Where $Slope = 1/I_{mon\_ratio}$ (Table 1-4) $= 1/0.7 = 1.43$ and $I_{MON\_OFFSET} = I_{INPUT@CAL} - (I_{MON\_READING@CAL} \times Slope)$

4.3 Selecting the Monitor Resistor

As described earlier the high impedance monitor output sources a replica average photodiode current for monitoring purposes. If detected by converting the current to a voltage through an external resistor (Figure 4-1), ensure that the voltage on $V_{MON}$ is in the range of 0 to 2V. The table below provides suggested values for the monitor resistor.

<table>
<thead>
<tr>
<th>$I_{IN}$ Max (mA)</th>
<th>Optical Power (dBm)</th>
<th>$R_m$ (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>+6</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>+3</td>
<td>1000</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>2000</td>
</tr>
<tr>
<td>0.5</td>
<td>−3</td>
<td>4000</td>
</tr>
</tbody>
</table>
4.4 TO-Can Layout

Figure 4-2. Typical Layout Diagram with Photodiode Mounted on PINK Capacitor (5 pin TOCAN)

NOTES:
Typical application inside of a five lead TO-Can.
Only one of the VCC pads and all of the GND pads need to be connected. The backside must be connected to the lowest potential, usually ground, with conductive epoxy or a similar die attach material. If a monitor output is not required then a four lead TO-Can may be used.
4.5 Treatment of PINK

PINK requires bypassing to ground with a capacitor when powering a photo diode. If PINK is not used to bias the photo diode, then it is not necessary to bypass an unused PINK.

NOTE:
Typical application inside of a five lead TO-Can. Only one of the VCC pads and all of the GND pads need to be connected. The backside must be connected to the lowest potential, usually ground, with conductive epoxy or a similar die attach material. If a monitor output is not required then a four lead TO-Can may be used.
4.6 T0-Can Assembly Recommendations

Figure 4-4. TO-Can Assembly Diagram
4.6.1 Assembly

The M02011 is designed to work with a wirebond inductance of 1 nH ± 0.25 nH. Many existing TO-Can configurations will not allow wirebond lengths that short, since the PIN diode submount and the TIA die are more than 1 mm away in the vertical direction, due to the need to have the PIN diode in the correct focal plane. This can be remedied by raising up the TIA die with a conductive metal shim. This will effectively reduce the bond wire length. Refer to Figure 4-4 for details.

MACOM recommends ball bonding with a 1 mil (25.4 µm) gold wire. For performance reasons the PINA pad is smaller than the others and also has less via material connected to it. It therefore requires more care in setting of the bonding parameters. **For the same reason PINA has no ESD protection.**

In addition, please refer to the MACOM Product Bulletin (document number 0201x-PBD-002-A). Care must be taken when selecting chip capacitors, since they must have good low ESR characteristics up to 1.0 GHz. It is also important that the termination materials of the capacitor be compatible with the attach method used.

For example, Tin/Lead (Pb/Sn) solder finish capacitors are incompatible with silver-filled epoxies. Palladium/Silver (Pd/Ag) terminations are compatible with silver filled epoxies. Solder can be used only if the substrate thick-film inks are compatible with Pb/Sn solders.

4.6.2 Recommended Assembly Procedures

For ESD protection the following steps are recommended for TO-Can assembly:

- Ensure good humidity control in the environment (to help minimize ESD).
- Consider using additional ionization of the air (also helps minimize ESD).
- As a minimum, it is best to ensure that the body of the TO-Can header or the ground lead of the header is grounded through the wire-bonding fixture for the following steps. The wire bonder itself should also be grounded.

1. Wire bond the ground pad(s) of the die first.
2. Then wire bond the VCC pad to the TO-Can lead.
3. Then wire bond any other pads going to the TO-Can leads (such as DOUT, DOUT̅ and possibly MON)
4. Next wire bond any capacitors inside the TO-Can.
5. Inside the TO-Can, wire bond PINK.
6. The final step is to wire bond PINA.
4.7 TIA Use with Externally Biased Detectors

In some applications, MACOM TIAs are used with detectors biased at a voltage greater than available from TIA PIN cathode supply. This works well if some basic cautions are observed. When turned off, the input to the TIA exhibits the following I/V characteristic:

Figure 4-5. TIA Use with Externally Biased Detectors, Powered Off
In the positive direction after about 700 mV, the impedance of the input is relatively high. After the TIA is turned on, the DC servo and AGC circuits attempt to null any input currents (up to the absolute maximum stated in Table 1-1) as shown by the I/V curve in Figure 4-6.

**Figure 4-6. TIA Use with Externally Biased Detectors, Powered On**

![Graph showing I/V curve for TIA use with externally biased detectors](image)

It can be seen that any negative voltage below 200 mV is nulled and that any positive going voltage above the PINA standing voltage is nulled by the DC servo. The DC servo upper bandwidth varies from part to part, but is generally at least 30 kHz.

When externally biasing a detector such as an APD where the supply voltage of the APD exceeds that for PINA Table 1-1, care should be taken to power up the TIA first and to keep the TIA powered up until after the power supply voltage of the APD is removed. Failure to do this with the TIA unpowered may result in damage to the input FET gate at PINA. In some cases the damage may be very subtle, in that nearly normal operation may be experienced with the damage causing slight reductions in bandwidth and corresponding reductions in input sensitivity.
5.0 Die Specification

Figure 5-1. Bare Die Layout

Notes:
- Process technology: CMOS, Silicon Nitride passivation
- Die thickness: 300 µm
- Pad metallization: Aluminium
- Die size: 880 µm x 1090
- Pad opening: 86 µmsq.
- Octagonal pad: 70 µm across flat PINA (70 µm x 70 µm)
- Pad Centers in µm referenced to center of device
- Connect backside bias to ground

<table>
<thead>
<tr>
<th>Pad Number</th>
<th>Pad</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AGC</td>
<td>−329</td>
<td>−76</td>
</tr>
<tr>
<td>2 (¹)</td>
<td>VCC</td>
<td>−329</td>
<td>−228</td>
</tr>
<tr>
<td>3</td>
<td>PINK</td>
<td>−124</td>
<td>−434</td>
</tr>
<tr>
<td>4</td>
<td>PINA</td>
<td>124</td>
<td>−434</td>
</tr>
<tr>
<td>5 (¹)</td>
<td>VCC</td>
<td>329</td>
<td>−228</td>
</tr>
<tr>
<td>6</td>
<td>MON</td>
<td>329</td>
<td>−76</td>
</tr>
<tr>
<td>7</td>
<td>DOUT</td>
<td>329</td>
<td>76</td>
</tr>
<tr>
<td>8 (¹)</td>
<td>DOUTGND</td>
<td>329</td>
<td>228</td>
</tr>
<tr>
<td>9c (¹, ²)</td>
<td>GND</td>
<td>329</td>
<td>360</td>
</tr>
<tr>
<td>9b (¹, ²)</td>
<td>GND</td>
<td>255</td>
<td>434</td>
</tr>
<tr>
<td>9a (¹, ²)</td>
<td>GND</td>
<td>124</td>
<td>434</td>
</tr>
<tr>
<td>10a (¹, ²)</td>
<td>GND</td>
<td>−124</td>
<td>434</td>
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<tr>
<td>10b (¹, ²)</td>
<td>GND</td>
<td>−255</td>
<td>434</td>
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<tr>
<td>10c (¹, ²)</td>
<td>GND</td>
<td>−329</td>
<td>360</td>
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<tr>
<td>11 (¹)</td>
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<td>228</td>
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<tr>
<td>12</td>
<td>DOUT</td>
<td>−329</td>
<td>76</td>
</tr>
</tbody>
</table>

NOTES:
1. It is only necessary to bond one $V_{CC}$ pad and one GND pad. However, bonding one of each pad (if available) on each side of the die is encouraged for improved performance in noisy environments.
2. Each location is an acceptable bonding location.
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