# ACA2604

Fiber-to-the-Home RF Amplifier

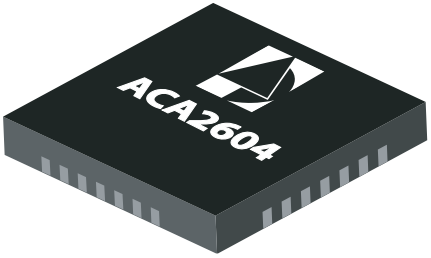
Data Sheet - Rev 2.1

## FEATURES

- 50 - 870 MHz Operating Frequency
- High Linearity: 65 dBc CTB/CSO (79 Chan.)
- Low Equivalent Input Noise: 4.5 pA/rtHz
- 22 dB Gain Adjust
- 400 Ω Differential Input Impedance: No Transformer Required for Interface to Photodiode
- Single +5 V Supply
- 5 mm x 5 mm x 1 mm Surface Mount Package
- RoHS Compliant Package
- Pin Compatible with the ACA2601

## APPLICATIONS

- FTTH RF Amplifier Used in Conjunction With Triplexer in Fiber-Coax Line Terminals




**S29 Package**
**28 Pin QFN**
**5 mm x 5 mm x 1 mm**

## PRODUCT DESCRIPTION

The ANADIGICS ACA2604 amplifier for Fiber-to-the-Home (FTTH) applications is intended to be used in conjunction with the triplexer in fiber-coax line terminals. The device is driven by, and amplifies the output of, the video downstream path photodiode.

The high-impedance input of the ACA2604 eliminates the need for a costly transformer usually needed to interface to the photodiode, and a low equivalent input noise level offers excellent sensitivity. The device provides sufficient linearity to maintain low CTB and CSO levels in full-bandwidth (132 channel) systems, even across a wide gain adjustment range.

The ACA2604 is manufactured using ANADIGICS's proven MESFET technology that offers state-of-the-art reliability, temperature stability and ruggedness. The device operates from a single +5 V supply and is offered in a 5 mm x 5 mm x 1 mm surface mount package.

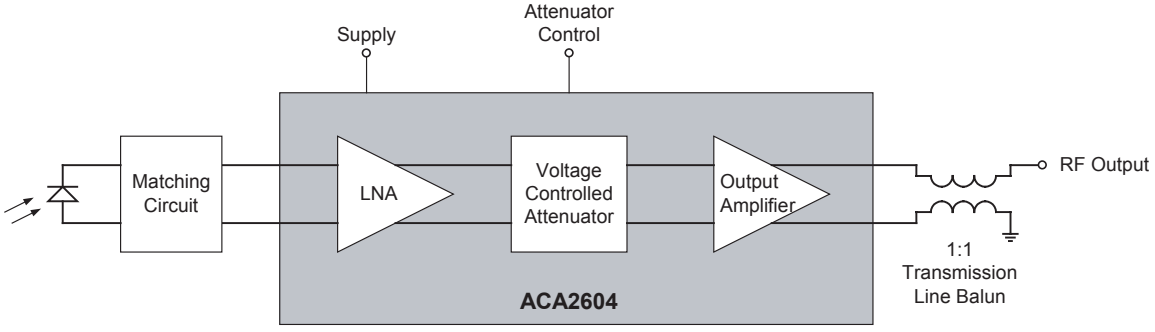



**Figure 1: Application Block Diagram**

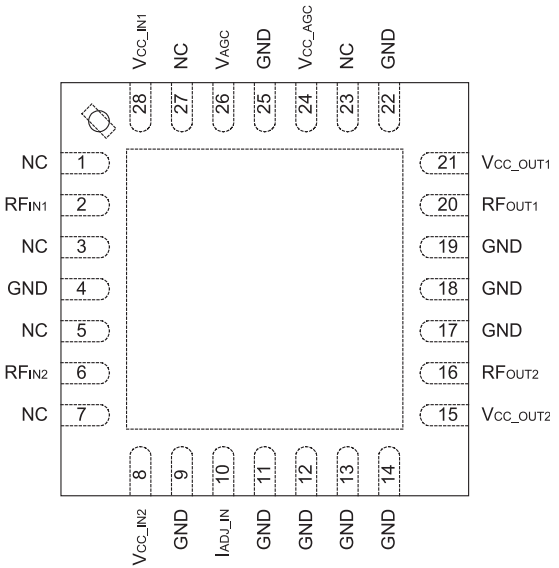



**Figure 2: Pinout (X-ray Top View)**

**Table 1: Pin Description**

| PIN | NAME | DESCRIPTION | PIN | NAME | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | NC | No Connection | 28 | $V_{CC_IN2}$ | Input Stage Supply 1 |
| 2 | $RF_{IN1}$ | RF Input 1 | 27 | NC | No Connection |
| 3 | NC | No Connection | 26 | $V_{AGC}$ | AGC Control Input |
| 4 | GND | Ground | 25 | GND | Ground |
| 5 | NC | No Connection | 24 | $V_{CC_AGC}$ | AGC Supply |
| 6 | $RF_{IN2}$ | RF Input 2 | 23 | NC | No Connection |
| 7 | NC | No Connection | 22 | GND | Ground |
| 8 | $V_{CC_IN2}$ | Input Stage Supply 2 | 21 | $V_{CC_OUT1}$ | Output Stage Supply 1 |
| 9 | GND | Ground | 20 | $RF_{OUT1}$ | RF Output 1 |
| 10 | $I_{ADJ_IN}$ | Input Stage Current Adjust | 19 | GND | Ground |
| 11 | GND | Ground | 18 | GND | Ground |
| 12 | GND | Ground | 17 | GND | Ground |
| 13 | GND | Ground | 16 | $RF_{OUT2}$ | RF Output 2 |
| 14 | GND | Ground | 15 | $V_{CC_OUT2}$ | Output Stage Supply 2 |

## ELECTRICAL CHARACTERISTICS

**Table 2: Absolute Minimum and Maximum Ratings**

| PARAMETER | MIN | MAX | UNIT |
|---|---|---|---|
| Supply Voltage ($V_{CC}$) | 0 | +8 | V |
| AGC Voltage ($V_{AGC}$) | 0 | +5 | V |
| RF Input Power ($P_{IN}$) | - | +25 | dBmV/ch |
| Storage Temperature | -65 | +150 | °C |

**Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability.**

**Table 3: Operating Ranges**

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|---|---|---|---|---|
| Operating Frequency (f) | 50 | - | 870 | MHz | |
| Supply Voltage ($V_{CC}$) | - | +5 | - | V | |
| RF Output Power ($P_{OUT}$) | - | +18 | - | dBmV/ch | |
| Case Temperature ($T_C$) | -40 | - | +110 | °C | |

**The device may be operated safely over these conditions; however, parametric performance is guaranteed only over the conditions defined in the electrical specifications.**

**Table 4: Electrical Specifications**
**($T_A$ = +25 °C, $P_{OUT}$ = +18 dBmV, $V_{CC}$ = +5 V, 75 Ω system, see Figure 3)**

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|---|---|---|---|---|
| RF Gain over Temperature (1) | 22.5 | 24.0 | - | dB | at 550 MHz |
| Gain Tilt (2)<br>$V_{AGC}$ = +3.0 V<br>$V_{AGC}$ = +0.5 V | <br>0.5<br>2.5 | <br>1.5<br>3.5 | <br>2.0<br>4.5 | dB | |
| Gain Tilt over Temperature (1), (2), (4)<br>$V_{AGC}$ = +3.0 V<br>$V_{AGC}$ = +0.5 V | <br>-<br>- | <br>4.5<br>5.8 | <br>-<br>- | dB | |
| Gain Flatness over Temperature (1), (3), (4)<br>$V_{AGC}$ = +3.0 V<br>$V_{AGC}$ = +0.5 V | <br>-<br>- | <br>1.0<br>1.0 | <br>-<br>- | dB | |
| Gain Adjustment Range | 20 | 22 | - | dB | |
| Gain Adjust Control Voltage | +0.5 | - | +3.0 | V | Max. gain at +3.0 V |
| CTB (5) | - | -65 | -60 | dBc | 79 Channels |
| CSO (5) | - | -65 | - | dBc | 79 Channels |
| OIP2 (7) | +47 | - | - | dBm | |
| Equivalent Input Noise (EIN) (4) | - | 4.5 | 5.5 | pA/rtHz | |
| EIN over Temperature (1), (4) | - | 5 | - | pA/rtHz | |
| Input Impedance | - | 400 | - | Ω | differential |
| Output Return Loss (1), (6)<br>-30 °C to +85 °C<br>+85 °C to +100 °C | <br>16<br>15 | <br>18<br>- | <br>-<br>- | dB | differential, 75 Ω system |
| Current Consumption (1) | - | 230 | 295 | mA | |
| Thermal Resistance | - | 18 | 25 | °C/W | |

*Notes:*
*(1) Package slug temperature range of -30 to +100 °C.*
*(2) Recorded tilt of the calculated best fit straight line from 50 to 870 MHz.*
*(3) Flatness is the peak-to-peak deviation from the calculated best fit straight line.*
*(4) Measured using application circuit with photodiode, as shown in Figure 16.*
*(5) Measured at +21 dBmV output power, with 14 dB gain reduction.*
*(6) Over the 50 to 870 MHz Frequency band.*
*(7) Measured using two tones at 379.25 and 301.25 MHz, -12 dBm output power per tone, with 14 dB gain reduction.*

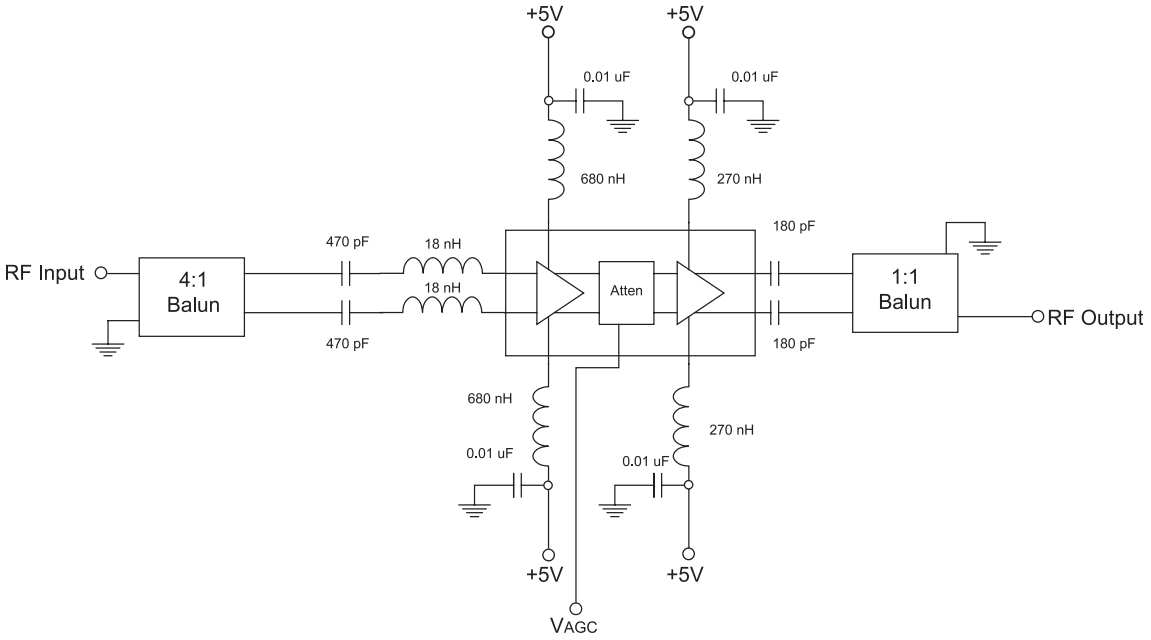



**Figure 3: Test Circuit**

## PERFORMANCE DATA

*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 4: Gain vs. Frequency**
**($T_A$ = +25 °C, $V_{CC}$ = + 5 V)**

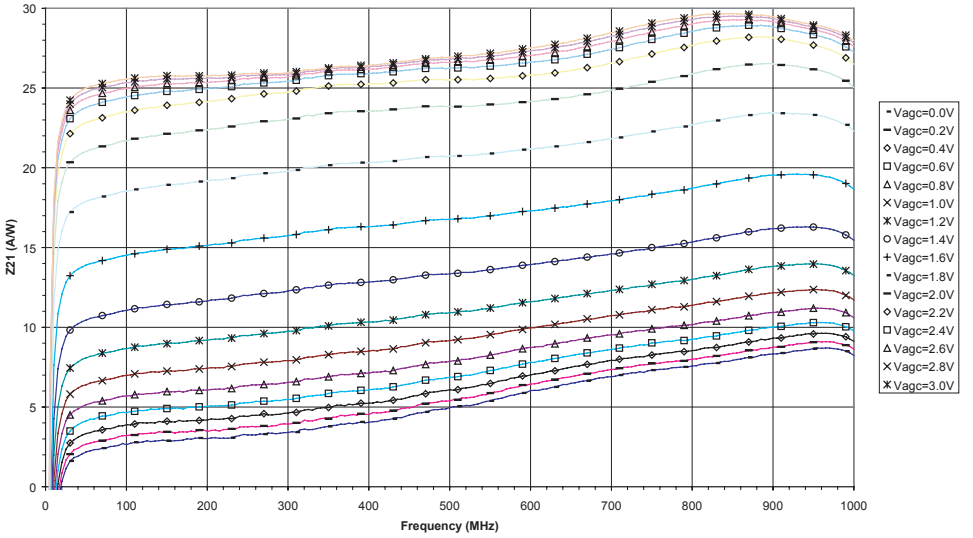
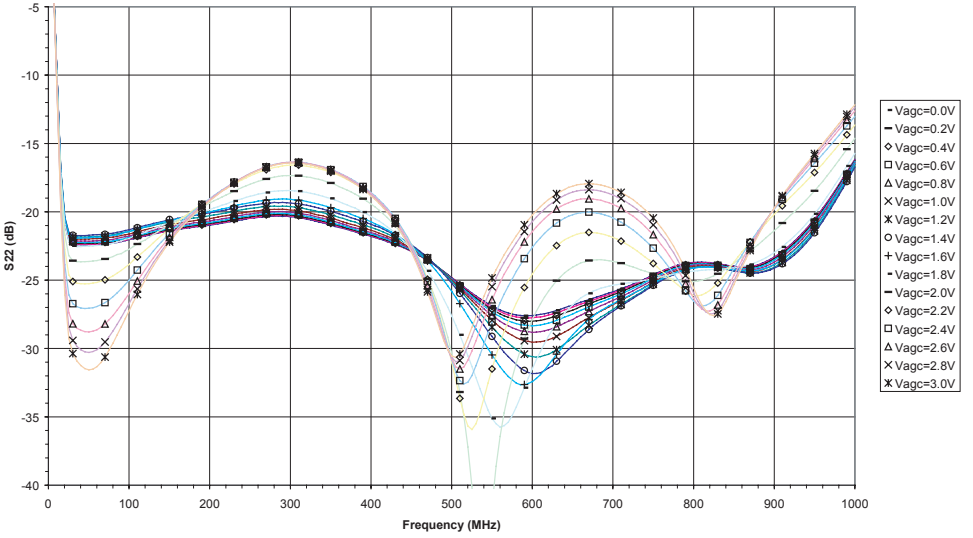



**Figure 5: Output Return Loss vs. Frequency**
**($T_A$ = +25 °C, $V_{CC}$ = + 5 V)**



*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 6: Gain Flatness to Best Fit Line Over Temperature**
**($V_{CC}$ = + 5 V, $V_{AGC}$ = +3.0 V)**

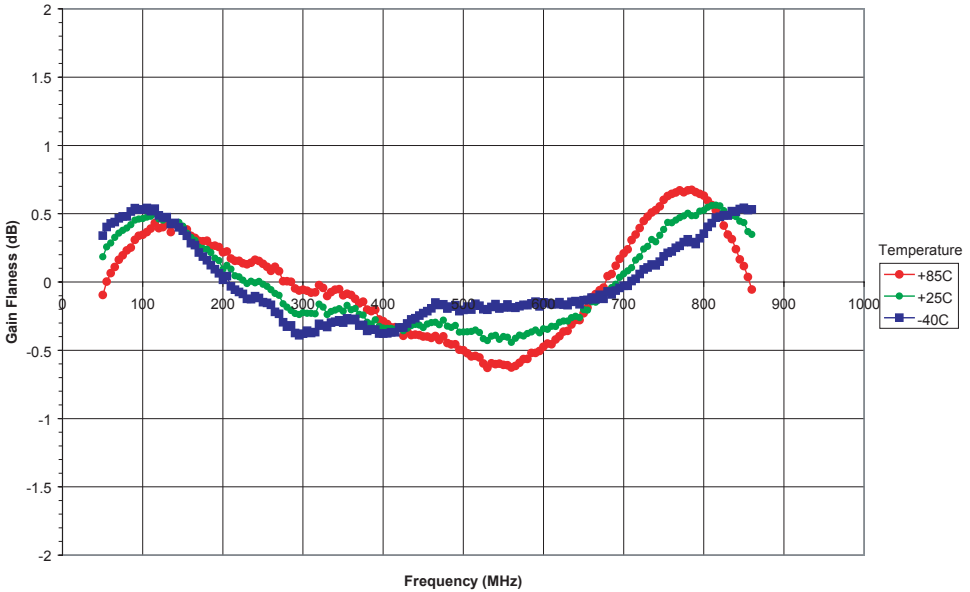



**Table 5: Gain Flatness to Best Fit Line**
**($V_{AGC}$ = +3.0 V)**

| Temp (°C) | Tilt (dB) | Flatness (dB) |
|---|---|---|
| 85 | 3.7 | 1.3 |
| 25 | 4.5 | 1.0 |
| -40 | 5.1 | 0.9 |

*The best fit line is calculated using the least mean squares method:*

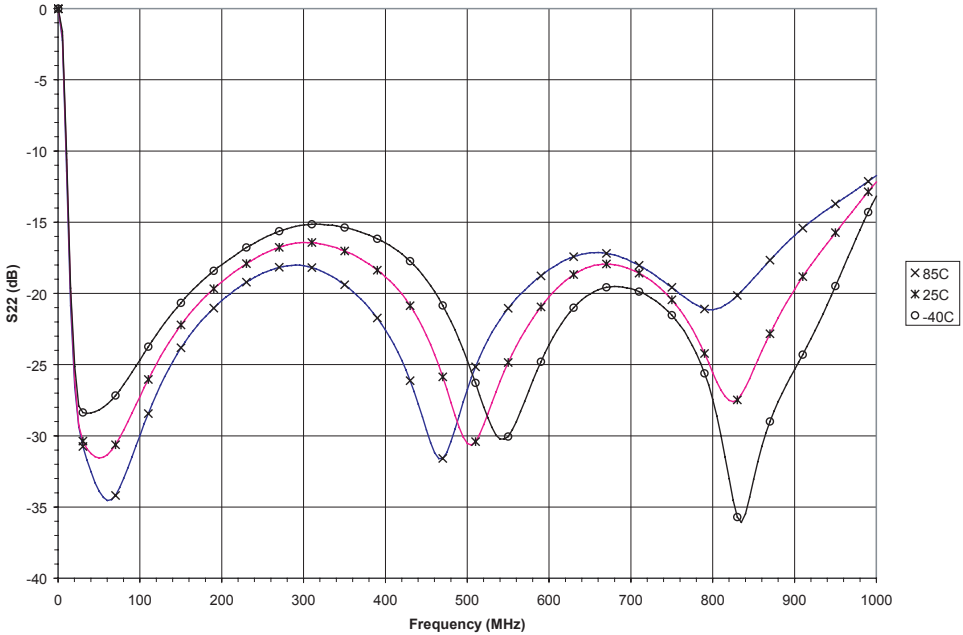
$$y = m \cdot x + b$$

$$m = \frac{\sum (x \cdot y) - \frac{\sum x \cdot \sum y}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}}$$

$$b = \frac{\sum y}{n} - m \cdot \frac{\sum x}{n}$$

*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 7: Output Return Loss Over Temperature**
**($V_{CC}$ = + 5 V, $V_{AGC}$ = +3.0 V)**



*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 8: Gain Flatness to Best Fit Line Over Temperature**
**($V_{CC}$ = + 5 V, $V_{AGC}$ = +1.6 V)**

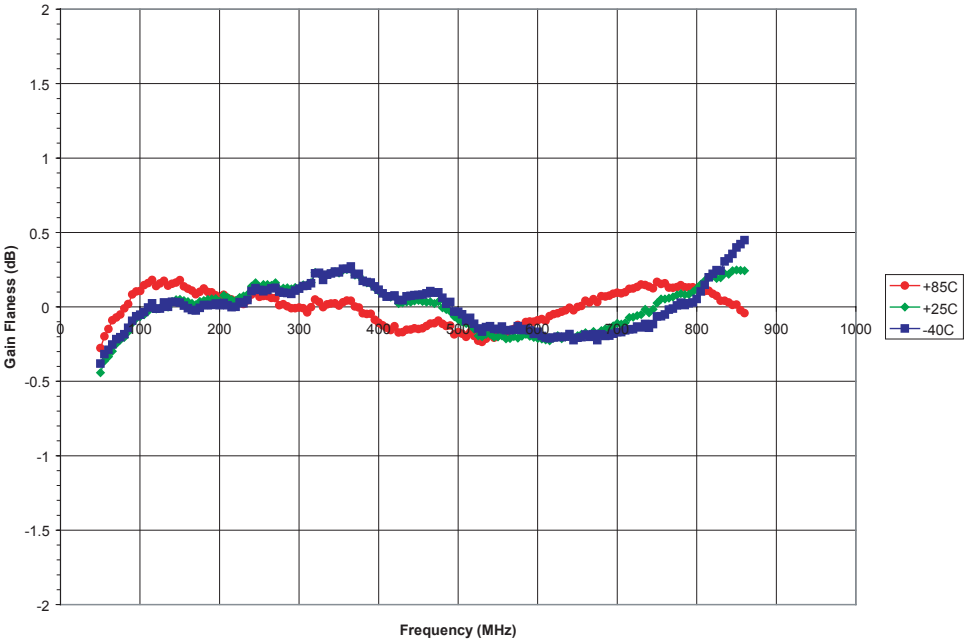



**Table 6: Gain Flatness to Best Fit Line**
**($V_{AGC}$ = +1.6 V)**

| Temp (°C) | Tilt (dB) | Flatness (dB) |
|---|---|---|
| 85 | 4.1 | 0.5 |
| 25 | 4.5 | 0.7 |
| -40 | 5.1 | 0.8 |

*The best fit line is calculated using the least mean squares method:*

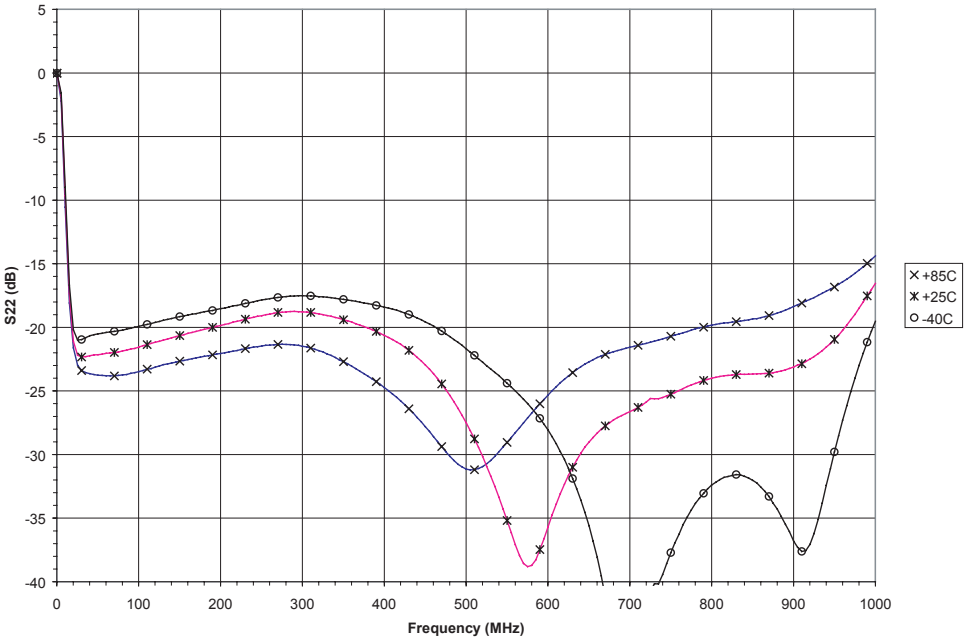
$$y = m \cdot x + b$$

$$m = \frac{\sum (x \cdot y) - \frac{\sum x \cdot \sum y}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}}$$

$$b = \frac{\sum y}{n} - m \cdot \frac{\sum x}{n}$$

*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 9: Output Return Loss Over Temperature**
**($V_{CC}$ = + 5 V, $V_{AGC}$ = +1.6 V)**



*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 10: Gain Flatness to Best Fit Line vs. Frequency Over Temperature ($V_{CC}$ = + 5 V, $V_{AGC}$ = 0 V)**

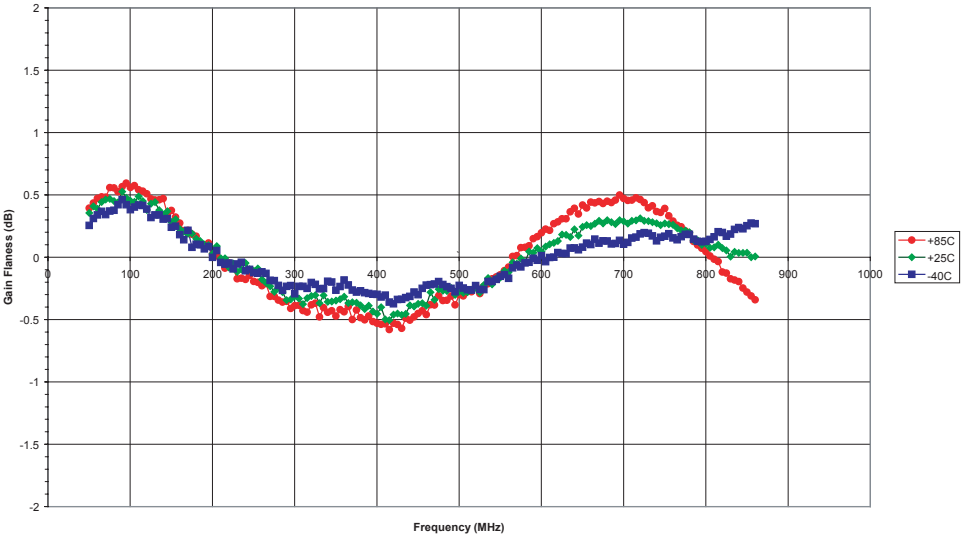



**Table 7: Gain Flatness to Best Fit Line ($V_{AGC}$ = 0 V)**

| Temp (°C) | Tilt (dB) | Flatness (dB) |
|---|---|---|
| 85 | 5.2 | 1.2 |
| 25 | 5.8 | 1.0 |
| -40 | 6.3 | 0.8 |

*The best fit line is calculated using the least mean squares method:*

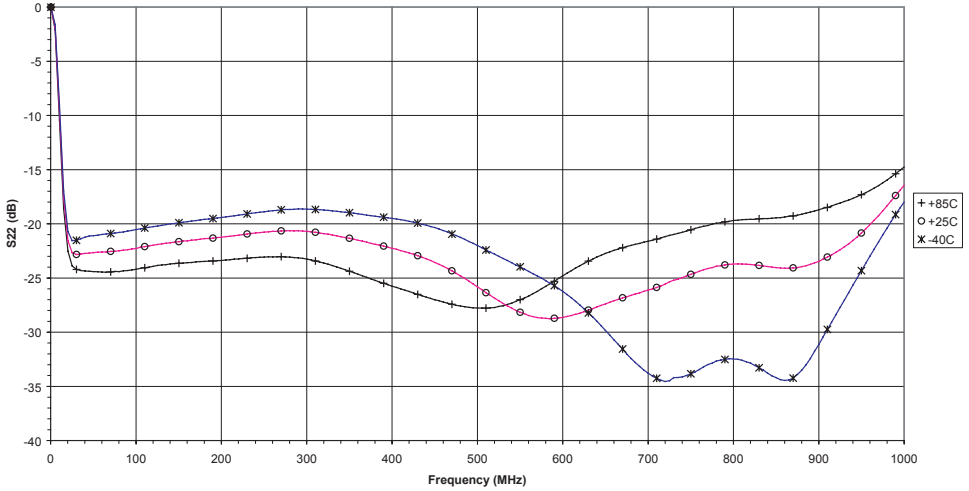
$$y = m \cdot x + b$$

$$m = \frac{\sum (x \cdot y) - \frac{\sum x \cdot \sum y}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}}$$

$$b = \frac{\sum y}{n} - m \cdot \frac{\sum x}{n}$$

*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 11: Output Return Loss Over Temperature**
**($V_{CC}$ = + 5 V, $V_{AGC}$ = 0 V)**



*Performance data on this page measured using test circuit shown in Figure 3.*

**Figure 12: CTB vs. Frequency**
**($T_A$ = +25 °C, $V_{CC}$ = + 5 V, 132 Analog Channel Loading,**
**Optical Input Power = 0 dBm, RF Output Power = +18 dBmV)**

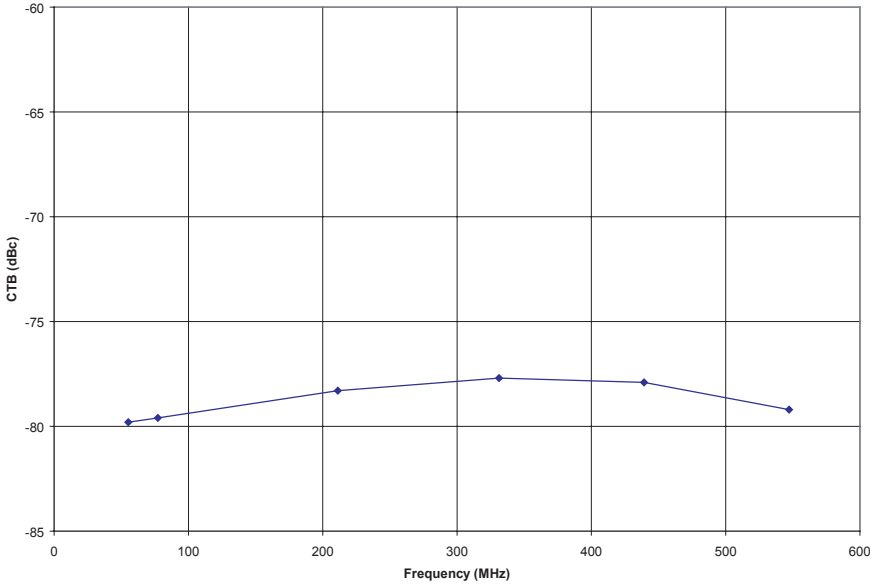
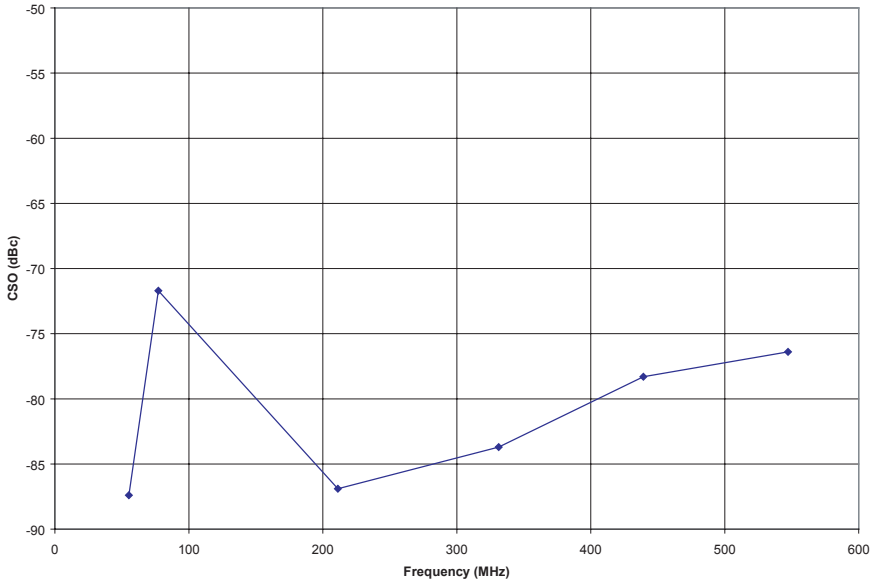
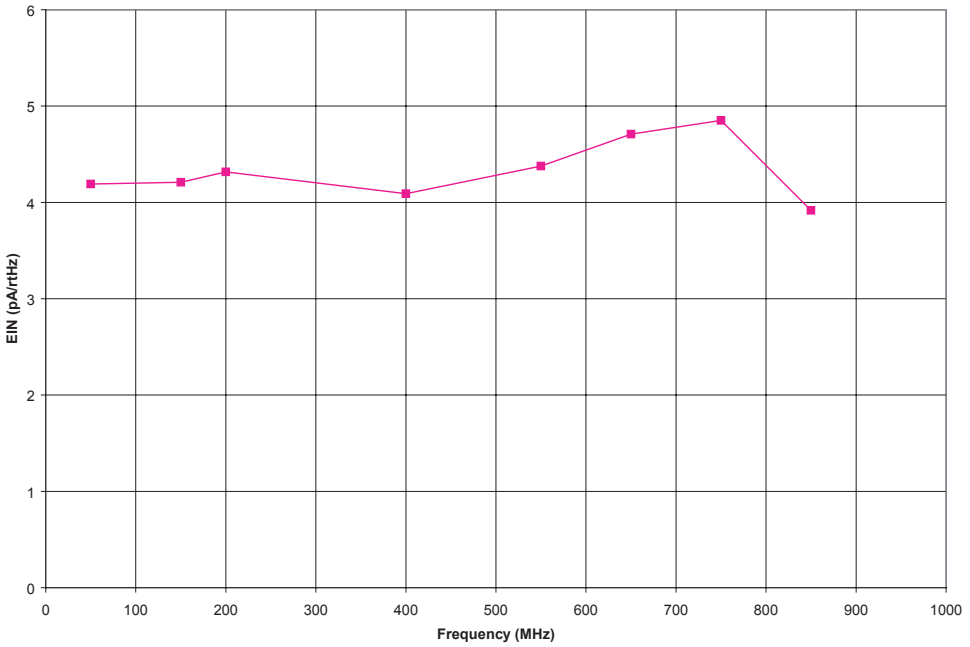



**Figure 13: CSO vs. Frequency**
**($T_A$ = +25 °C, $V_{CC}$ = + 5 V, 132 Analog Channel Loading,**
**Optical Input Power = 0 dBm, RF Output Power = +18 dBmV)**



*Performance data on this page measured using application circuit with input photodiode, as shown in Figure 15.*

**Figure 14: Equivalent Input Noise vs. Frequency**
**($T_A$ = +25 °C, $V_{CC}$ = + 5 V, $V_{AGC}$ = +3.0 V)**



## APPLICATION INFORMATION

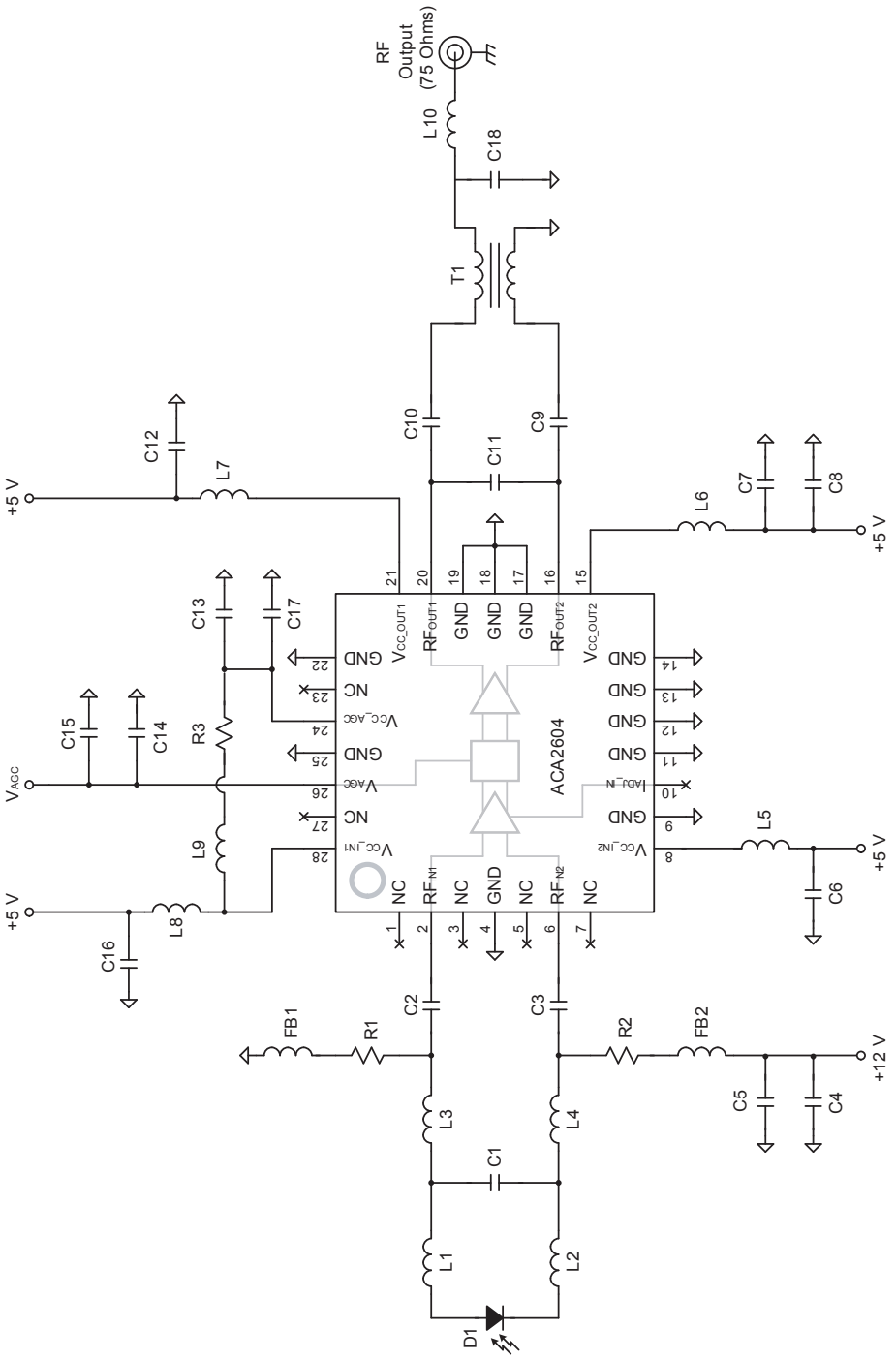
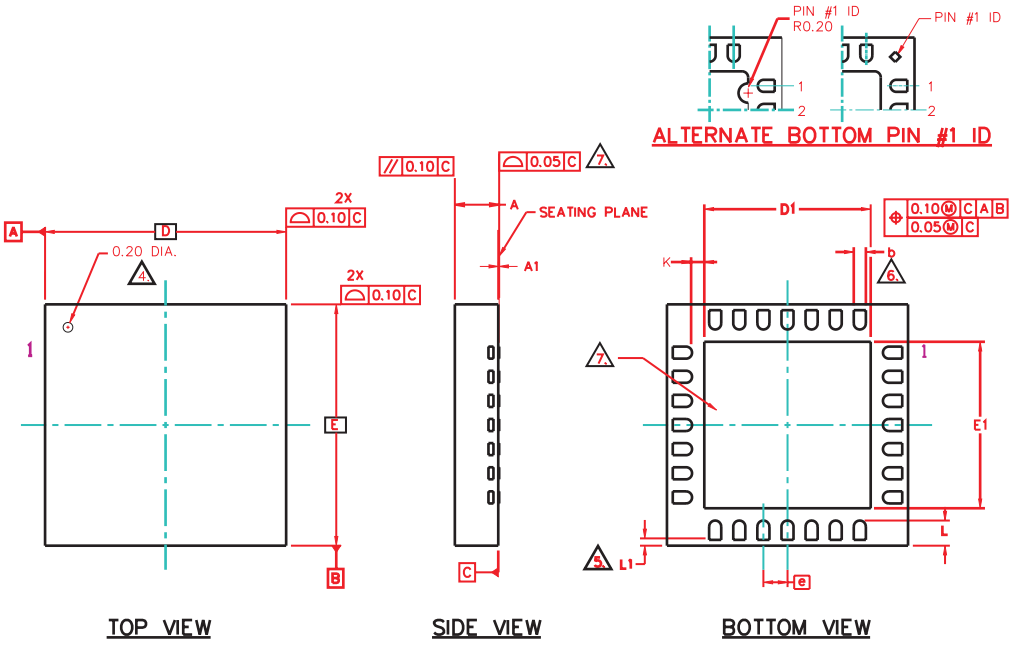



**Figure 15: Application Circuit with Input Photodiode**

**Table 5: Evaluation Board Parts List**

| REF | DESCRIPTION | QTY | VENDOR | VENDOR PART NO. |
|---|---|---|---|---|
| C11, C18 | 0.5 pF; 0603 Cap | 1 | Murata Electronics | GRM1885C1HR50CZ01D |
| C1 | 1 pF; 0603 Cap | 1 | Murata Electronics | GRM1885C1H1R0CZ01D |
| C9, C10 | 270 pF; 0603 Cap | 2 | Murata Electronics | GRM155R7H271KA01D |
| C2, C3 | 470 pF; 0603 Cap | 2 | Murata Electronics | GRM155R71H471KA01D |
| C5 | 1000 pF; 0603 Cap | 1 | Murata Electronics | GRM1885C1H102JA01D |
| C6, C7, C12, C13, C15, C16 | 0.01 μF; 0603 Cap | 6 | Murata Electronics | GRM1885C1HR50CZ01D |
| C4, C17 | 0.1 μF; 0603 Cap | 1 | Murata Electronics | GRM188F51C104ZA01D |
| C14 | 1 μF; 0603 Cap | 1 | Murata Electronics | GRM188R61C105KA93D |
| C8 | 47 μF; Elect. Cap 25 V | 1 | Panasonic-ECG | ECA-1EM470B |
| L1, L2, L3, L4 | 30 nH; 0603 Ind | 4 | Coilcraft | 0603CS-30NXJL |
| L5, L6, L7, L8 | 330 nH; 1008 Ind | 2 | Coilcraft | 1008CS-331XJLB |
| R1, R2 | 1 kΩ; 0603 Res | 2 | Panasonic-ECG | ERJ-2GEJ102X |
| T1 | 1:1 Balun Transformer; 0603 Cap | 1 | M/A-COM | MABAES0029 |
| D1 | Analog Photodiode | 1 | ANADIGICS | PD070-HL1-300 or PD070-HL2-300 |
| Connector | 75 Ω N Male Panel Mount | 1 | Pasternack Enterprises | PE4504 |
| L9 | Ferrite Chip | 1 | Murata | BLM15HD102SN1D |
| L10 | 7.5 nH; 0603 Ind | 1 | Coilcraft | 0603CS-7N5 |
| FB1, FB2 | EMI Ferrite Chip | 2 | Murata Electronics | BLM15HD182SN |
| R3 | 20 Ω 0603 Res | 1 | Panasonic-ECG | ERT-3GEYJ200W |

## PACKAGE OUTLINE




| SYMBOL | DIMENSIONS–MM MIN. | MAX. | NOTE |
|---|---|---|---|
| A | 0.80 | 1.00 | |
| A1 | 0.00 | 0.05 | |
| b | 0.18 | 0.30 | |
| D | 5.00 BSC | | |
| D1 | 3.30 | 3.55 | |
| E | 5.00 BSC | | |
| E1 | 3.30 | 3.55 | |
| e | 0.50 BSC | | |
| K | 0.20 MIN. | | |
| L | 0.30 | 0.57 | |
| L1 | 0.15 MAX. | | |

| SYMBOL | DIMENSIONS–INCHES MIN. | MAX. | NOTE |
|---|---|---|---|
| A | 0.031 | 0.039 | |
| A1 | 0.000 | 0.002 | |
| b | 0.007 | 0.012 | |
| D | 0.197 BSC | | |
| D1 | 0.130 | 0.140 | |
| E | 0.197 BSC | | |
| E1 | 0.130 | 0.140 | |
| e | 0.020 BSC | | |
| K | 0.007 MIN. | | |
| L | 0.012 | 0.022 | |
| L1 | 0.006 MAX. | | |

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. MAX. PACKAGE WARPAGE IS 0.05 mm.
3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
4. PIN #1 ID ON TOP WILL BE LASER MARKED.
5. A MAXIMUM 0.15mm PULL BACK (L1) MAYBE PRESENT. L MINUS L1 TO BE EQUAL TO OR GREATER THAN 0.30mm.
6. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
7. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
8. REFERENCE JEDEC OUTLINE MO–220.

**Figure 16: S29 Package Outline - 28 Pin 5 mm x 5 mm x 1 mm QFN**

## ORDERING INFORMATION

| ORDER NUMBER | TEMPERATURE RANGE | PACKAGE DESCRIPTION | COMPONENT PACKAGING |
|---|---|---|---|
| ACA2604RS29P8 | -40 °C to +110 °C | RoHS-Compliant<br>28 Pin QFN<br>5 mm x 5 mm x 1 mm | Tape and Reel, 2500 pieces per Reel |

**ANADIGICS, Inc.**
141 Mount Bethel Road
Warren, New Jersey 07059, U.S.A.
Tel: +1 (908) 668-5000
Fax: +1 (908) 668-5132

URL: http://www.anadigics.com
E-mail: Mktg@anadigics.com

**IMPORTANT NOTICE**

ANADIGICS, Inc. reserves the right to make changes to its products or to discontinue any product at any time without notice. The product specifications contained in Advanced Product Information sheets and Preliminary Data Sheets are subject to change prior to a product's formal introduction. Information in Data Sheets have been carefully checked and are assumed to be reliable; however, ANADIGICS assumes no responsibilities for inaccuracies. ANADIGICS strongly urges customers to verify that the information they are using is current before placing orders.

**WARNING**

ANADIGICS products are not intended for use in life support appliances, devices or systems. Use of an ANADIGICS product in any such application without written consent is prohibited.