

# TQM879008

## 1.5-2.7GHz 1/2 W Digital Variable Gain Amplifier



### Applications

- 3G / 4G Wireless Infrastructure
- CDMA, WCDMA, LTE
- Repeaters

### Product Features

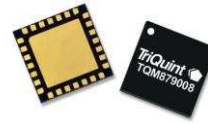
- 1.5-2.7 GHz Frequency Range
- 41.1 dB Maximum Gain at 2.5 GHz
- 31.5 dB Gain Range in 0.5 dB Steps
- +47.5 dBm Output IP3
- +27.3 dBm Output P1dB
- Fully Internally Matched Module
- Integrated Blocking Capacitors, Bias Inductors
- 3-wire SPI Control Programming

### General Description

The TQM879008 is a digital variable gain amplifier (DVGA) featuring high linearity over the entire gain control range. This amplifier module integrates two gain blocks, a digital-step attenuator (DSA), and a high linearity 1/2 W amplifier. The module has the added feature of integrating all matching components, bias chokes and blocking capacitors. The internal 6-bit DSA provides a 31.5 dB gain control range in 0.5 dB steps, and is controlled with a serial periphery interface (SPI™).

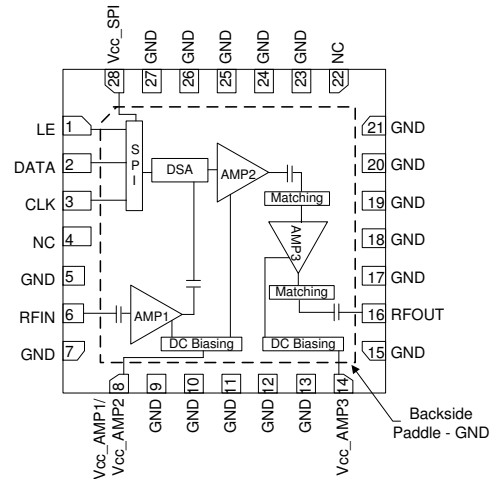
The TQM879008 features variable gain from 10 dB to 41.1dB at 2.5 GHz, +47.5 dBm output IP3, and +27.3 dBm P1dB. The module operates from a single +5V supply and is available in a compact 28-pin 6x6 mm leadless SMT package.

The TQM879008 is pin compatible with the TQM829007 (0.7-1.0GHz, 0.25W DVGA) and TQM879006 (1.4-2.7GHz, 0.25W DVGA). This allows one to size the right type of device for specific system level requirements as well as making the DVGA family ideal for applications where a common PCB layout is used for different frequency bands.



28-pin 6x6mm leadless SMT package

### Functional Block Diagram



### Pin Configuration

| Pin #          | Symbol            |
|----------------|-------------------|
| 1              | LE                |
| 2              | DATA              |
| 3              | CLK               |
| 4, 22          | NC                |
| 6              | RFIN              |
| 8              | VCC_AMP1/VCC_AMP2 |
| 14             | VCC_AMP3          |
| 16             | RFOUT             |
| 28             | VCC_SPI           |
| All Other Pins | GND               |

### Ordering Information

| Part No.      | Description   |
|---------------|---|
| TQM879008     | 1.5-2.7 GHz Digital Variable Gain Amp                             |
| TQM879008-PCB | Fully Assembled Evaluation Board Includes USB control board (EVH) |

Standard T/R size = 2500 pieces on a 13" reel.

### Specifications

#### Absolute Maximum Ratings

| Parameter                         | Rating                 |
|-----------------------------------|------------------------|
| Storage Temperature               | -55 to 150 °C          |
| RF Input Power, CW, 50Ω, T = 25°C | +23 dBm                |
| V <sub>cc</sub> (pins 8, 14, 28)  | +5.5 V                 |
| Digital Input Voltage             | V <sub>cc</sub> + 0.5V |

Operation of this device outside the parameter ranges given above may cause permanent damage.

#### Recommended Operating Conditions

| Parameter                            | Min  | Typ | Max  | Units |
|--------------------------------------|------|-----|------|-------|
| V <sub>cc</sub> (pins 8, 14, 28)     | 4.75 | 5   | 5.25 | V     |
| Case Temperature                     | -40  |     | 85   | °C    |
| Junction Temperature, T <sub>J</sub> |      |     | 170  | °C    |

T<sub>J</sub> specified for >10<sup>6</sup> hours MTTF

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

#### Electrical Specifications

Test conditions unless otherwise noted: 25°C, +5V<sub>cc</sub>, Maximum Gain State.

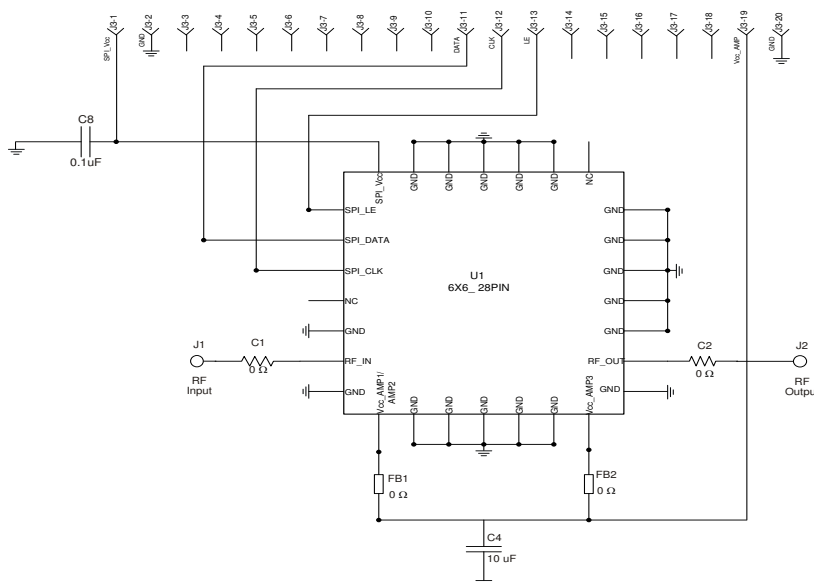
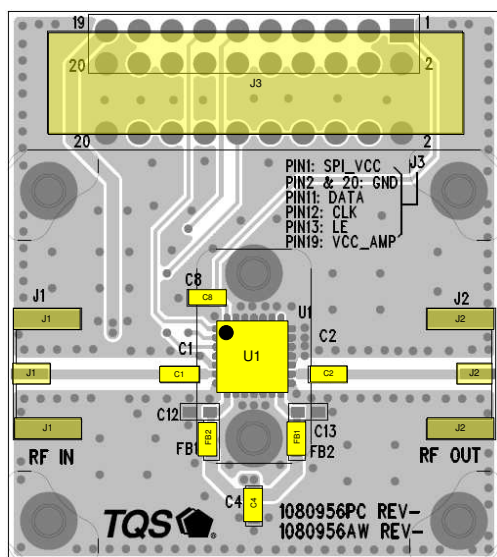
| Parameter                           | Conditions   | Min                                  | Typ   | Max  | Units |
|-------------------------------------|--|--------------------------------------|-------|------|-------|
| Operational Freq Range              |  | 1500                                 |       | 2700 | MHz   |
| Test Frequency                      |  |                                      | 2500  |      | MHz   |
| Gain                                |  | 38                                   | 41.1  | 44   | dB    |
| Gain Control Range                  | 0.5 dB Step Size                                   |                                      | 31.5  |      | dB    |
| Accuracy Error                      | All States, 3 wire SPI, 6 states                   | ±(0.3+5% of Attenuation setting) Max |       |      | dB    |
| Control Interface                   | 3-wire serial interface                            |                                      | 6     |      | Bit   |
| Input Return Loss                   |  |                                      | 16    |      | dB    |
| Output Return Loss                  |  |                                      | 14    |      | dB    |
| Noise Figure                        | Maximum Gain State                                 |                                      | 3.9   |      | dB    |
| Output P1dB                         |  |                                      | +27.3 |      | dBm   |
| Output IP3                          | P <sub>out</sub> = +11 dBm/tone, Δf = 1MHz Spacing | +41                                  | +47.5 |      | dBm   |
| I/O Impedance                       |  |                                      | 50    |      | Ohm   |
| Supply Voltage                      |  |                                      | +5    |      | V     |
| Supply Current                      |  | 220                                  | 285   | 320  | mA    |
| Thermal Resistance, θ <sub>jc</sub> | Module (junction to case)                          |                                      |       | 20.5 | °C/W  |

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1.5-2.7GHz 1/2 W Digital Variable Gain Amplifier



## Application Circuit (TQM879008-PCB)



**Notes:**

1. For PCB Board Layout, see page 9 for more information.
2. All Components are of 0603 size unless stated otherwise.
3. For SPI Timing Diagram, see page 6.
4. 0 Ω jumpers may be replaced with copper traces in the target application layout.
5. Different ground pins are used for SPI (digital) and analog supply voltages.
6. The primary RF microstrip characteristic line impedance is 50 Ω.
7. The single power supply is used to provide supply voltage to AMP1, AMP2 and AMP3.

### Bill of Material: TQM879008-PCB

| Reference Desg.  | Value  | Description                     | Manufacturer | Part Number |
|------------------|--------|---------------------------------|--------------|-------------|
| U1               |        | 1.5 – 2.7 GHz DVGA              | TriQuint     | TQM879008   |
| C8               | 0.1 uF | Cap, Chip, 0603, 16V, X7R, 10%  | various      |             |
| C4               | 10 uF  | Cap, Chip, 0603, 6.3V, X5R, 20% | various      |             |
| C1, C2, FB1, FB2 | 0 Ω    | Res, Chip, 0603, 1/16W, 5%      | various      |             |

### Typical Performance, Maximum Gain State

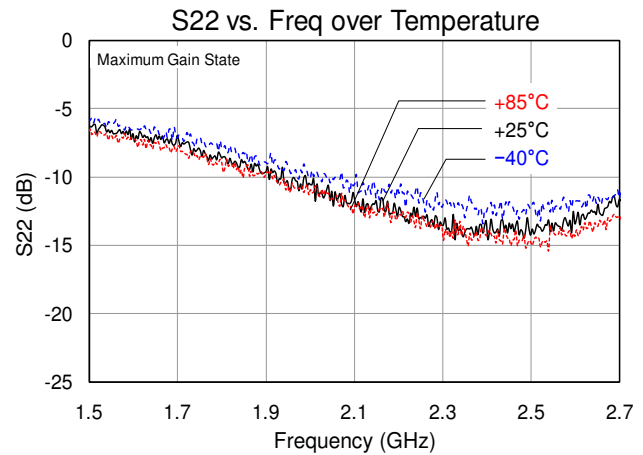
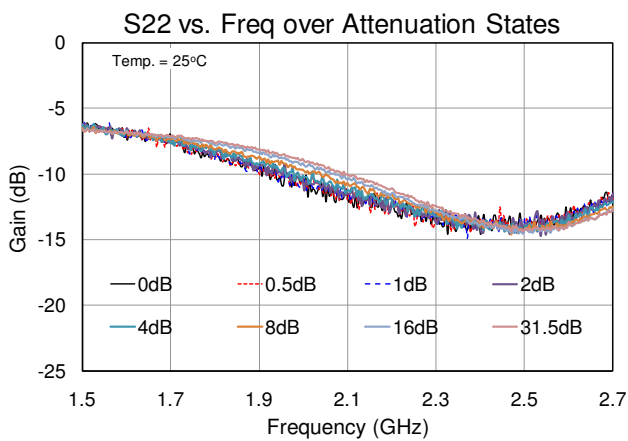
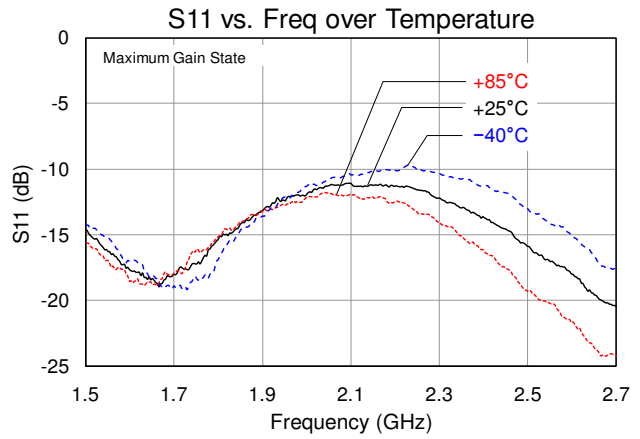
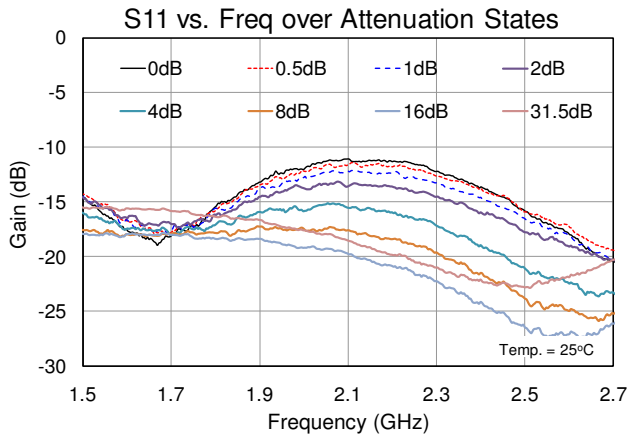
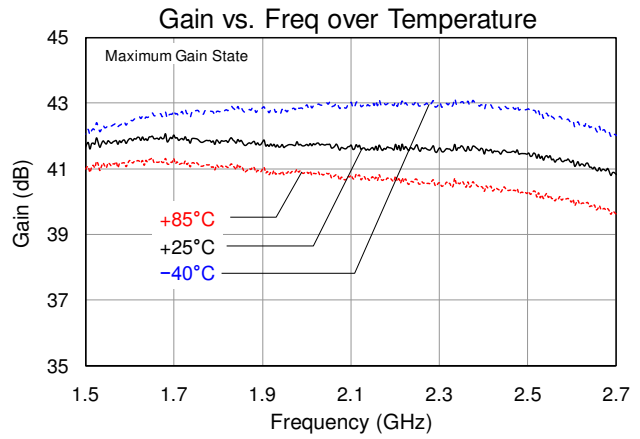
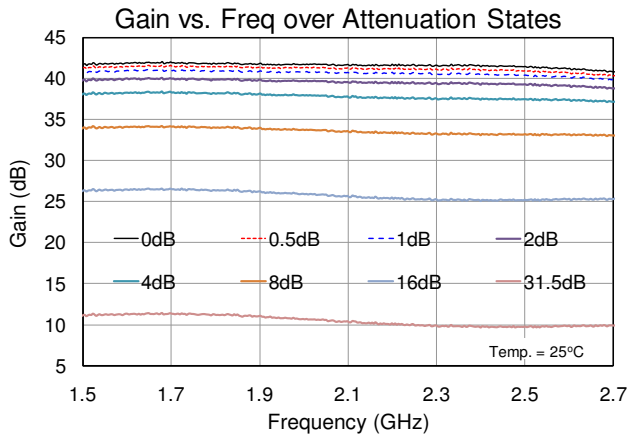
| Frequency                                   | GHz | 1.5   | 1.9   | 2.1   | 2.3   | 2.5   | 2.7 |
|---|-----|-------|-------|-------|-------|-------|-----|
| Gain  | dB  | 41.7  | 41.8  | 41.7  | 41.5  | 41.1  | 41  |
| Input Return Loss                           | dB  | 14.6  | 13.2  | 11    | 12    | 16    | 20  |
| Output Return Loss                          | dB  | 6.2   | 9.2   | 11.7  | 13    | 14    | 12  |
| Output P1dB                                 | dBm | +26.3 | +26.7 | +27.8 | +27.8 | +27.3 | +27 |
| Output IP3 @ Pout = 11 dBm/tone, Δf = 1 MHz | dBm | +43.7 | +40.3 | +40.4 | +43.5 | +48.5 | +45 |
| WCDMA channel power at 50dBc ACLR           | dBm | 17.6  | 17.8  | 18.9  | 18.8  | 18.5  | 18  |
| Supply Voltage                              | V   | +5    |       |       |       |       |     |
| Supply Current                              | mA  | 285   |       |       |       |       |     |

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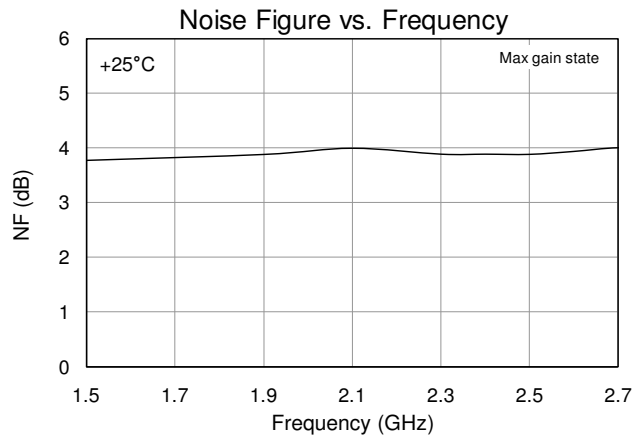
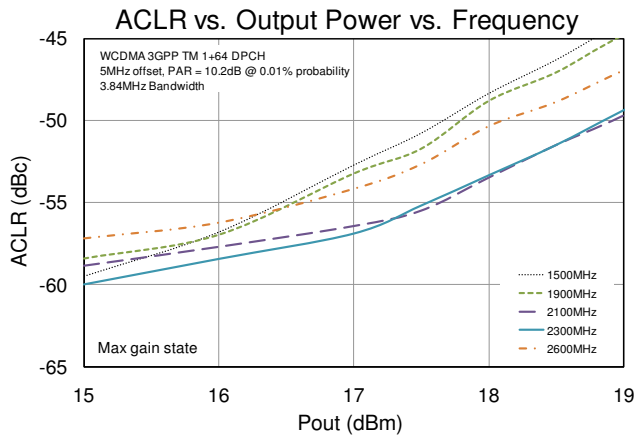
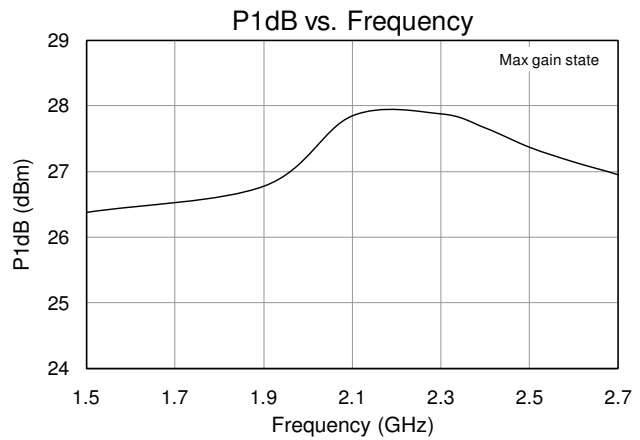
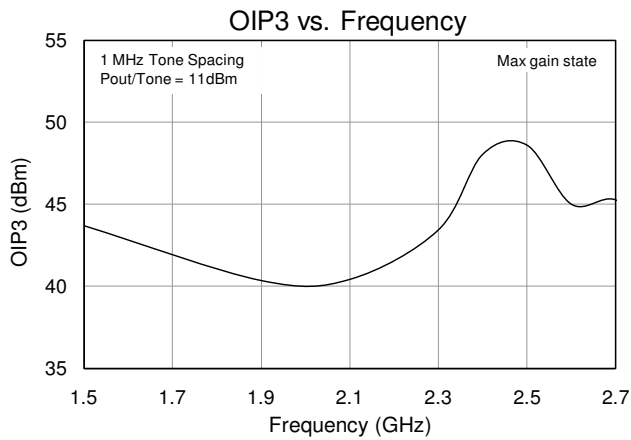
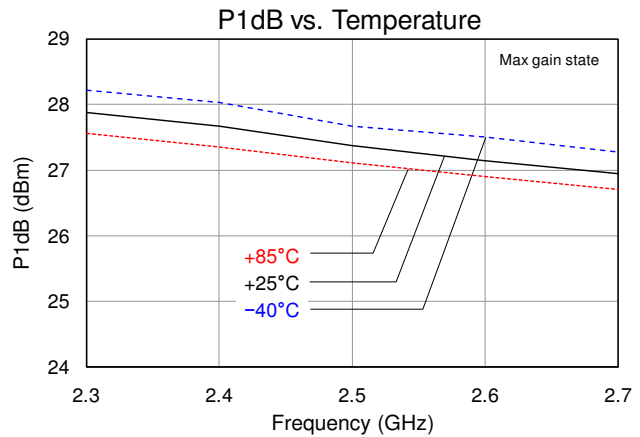
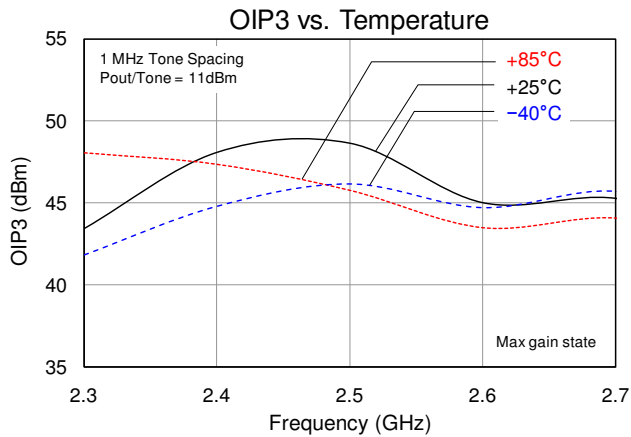


## Typical Performance Plots



# TQM879008

## 1.5-2.7GHz 1/2 W Digital Variable Gain Amplifier



### Serial Control Interface

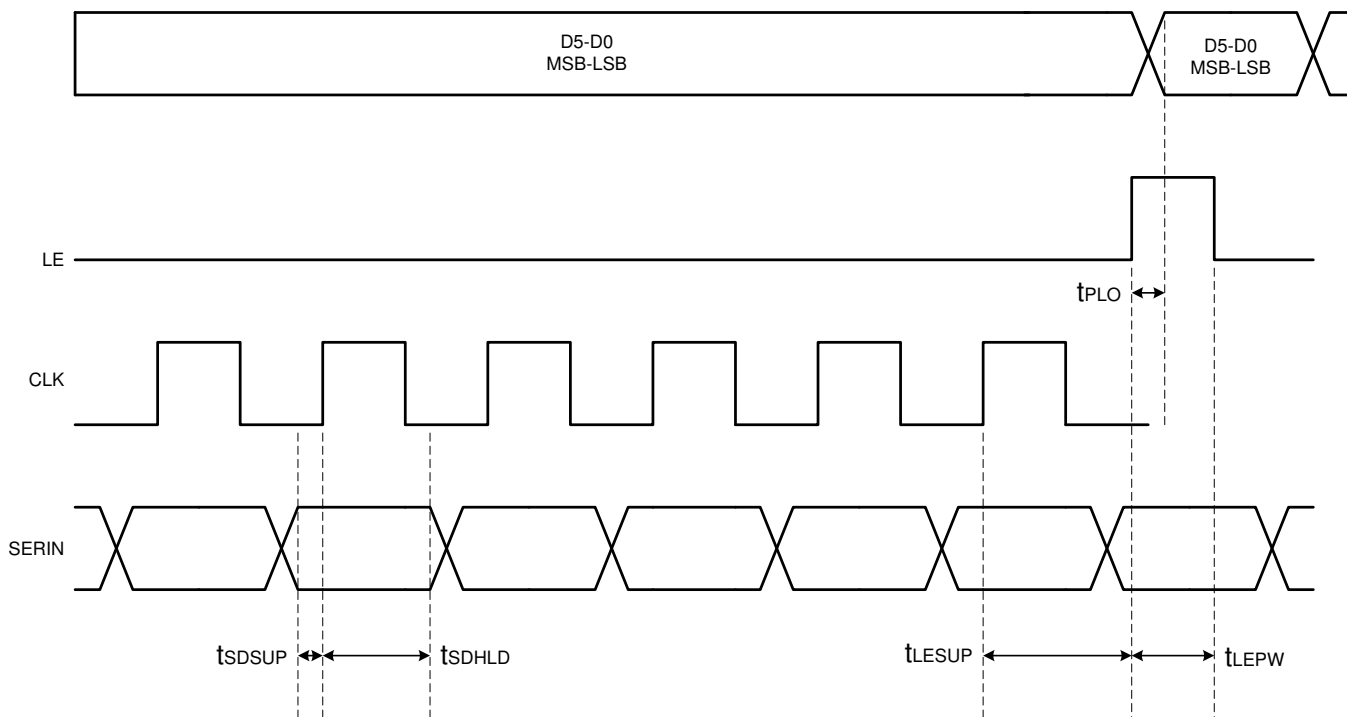
#### SERIN (MSB in First 6-Bit Word) Control Logic Truth Table

| 6-Bit Control Word to DSA |    |    |    |    |     | Attenuation State |
|---------------------------|----|----|----|----|-----|-------------------|
| MSB                       | D4 | D3 | D2 | D1 | LSB |                   |
| D5                        | D4 | D3 | D2 | D1 | D0  |                   |
| 1                         | 1  | 1  | 1  | 1  | 1   | Reference : IL    |
| 1                         | 1  | 1  | 1  | 1  | 0   | 0.5 dB            |
| 1                         | 1  | 1  | 1  | 0  | 1   | 1 dB              |
| 1                         | 1  | 1  | 0  | 1  | 1   | 2 dB              |
| 1                         | 1  | 0  | 1  | 1  | 1   | 4 dB              |
| 1                         | 0  | 1  | 1  | 1  | 1   | 8 dB              |
| 0                         | 1  | 1  | 1  | 1  | 1   | 16 dB             |
| 0                         | 0  | 0  | 0  | 0  | 0   | 31.5 dB           |

Any combination of the possible 64 states will provide an attenuation of approximately the sum of bits selected

#### Serial Control Interface Timing Diagram

CLK is disabled when LE is high



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## Serial Control Timing Characteristics

Test conditions: 25°C

| Parameter                      | Condition                   | Min | Max | Units |
|--------------------------------|-----------------------------|-----|-----|-------|
| Clock Frequency                | 50% Duty Cycle              |     | 10  | MHz   |
| LE Setup Time, $t_{LESUP}$     | after last CLK rising edge  | 10  |     | ns    |
| LE Pulse Width, $t_{LEPW}$     |                             | 30  |     | ns    |
| SERIN set-up time, $t_{SDSUP}$ | before CLK rising edge      | 10  |     | ns    |
| SERIN hold-time, $t_{SDHLD}$   | after CLK rising edge       | 10  |     | ns    |
| LE Pulse Spacing $t_{LE}$      | LE to LE pulse spacing      | 630 |     | ns    |
| Propagation Delay $t_{PLO}$    | LE to Parallel output valid |     | 30  | ns    |

## Serial Control DC Logic Characteristics

Test conditions: 25°C

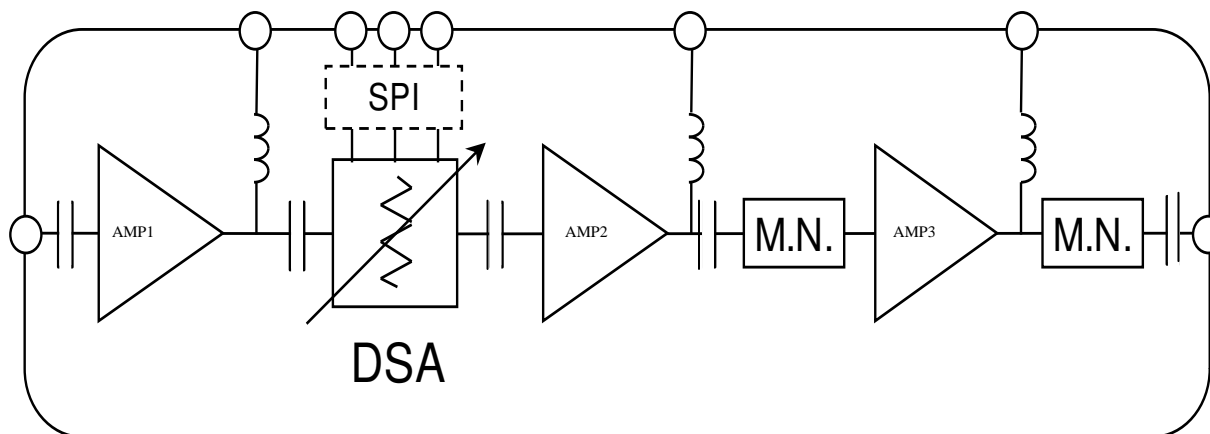
| Parameter                        | Condition            | Min | Max      | Units   |
|----------------------------------|----------------------|-----|----------|---------|
| Input Low Voltage, $V_{IL}$      |                      | 0   | 0.8      | V       |
| Input High Voltage, $V_{IH}$     |                      | 2.1 | $V_{CC}$ | V       |
| Input Current, $I_{IH} / I_{IL}$ | On SERIN, LE and CLK | -10 | +10      | $\mu A$ |

### Detailed Device Description

The TQM879008 is a 50 Ω internally matched digital variable gain amplifier (DVGA) featuring high linearity over the entire gain control range. The amplifier module features the integration of two gain block, a digital-step attenuator (DSA), along with a high linearity 1/2 W amplifier. The module is unconditionally stable. Internal blocking capacitors and bias structures keep external parts count to a minimum. The DVGA has an operational frequency range from 1.5-2.7 GHz.

For any further technical questions, please email to [sicapplications.engineering@tqs.com](mailto:sicapplications.engineering@tqs.com).

### Functional Schematic Diagram



Where M = Matching Network.

### Chain Analysis Table

The chain analysis of DVGA module is shown below in the table. This table provides the typical performance of individual stages in the module as well as overall module performance.

| Function   | Individual Stage Performance |      |      |      | Overall Performance |
|------------|------------------------------|------|------|------|---------------------|
|            | AMP1                         | DSA  | AMP2 | AMP3 |                     |
| Gain (dB)  | 14                           | -1.8 | 14   | 15   | 41.1                |
| NF (dB)    | 3.9                          | 1.8  | 2.0  | 4.5  | 3.9                 |
| OIP3 (dBm) | 30                           | 55   | 40   | 48   | 47.5                |
| P1dB (dBm) | 15                           | 28.5 | 22   | 27.4 | 27.3                |
| Icc (mA)   | 60                           | 2.0  | 85   | 140  | 285                 |

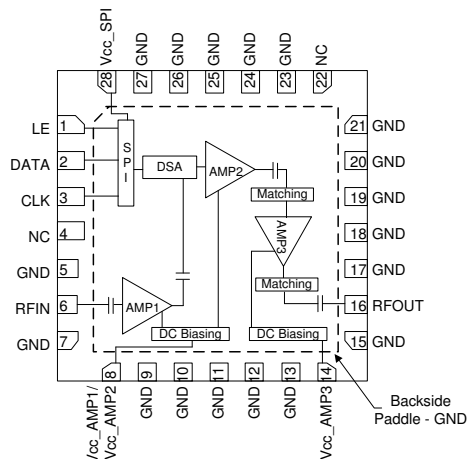


# TQM879008

1.5-2.7GHz 1/2 W Digital Variable Gain Amplifier



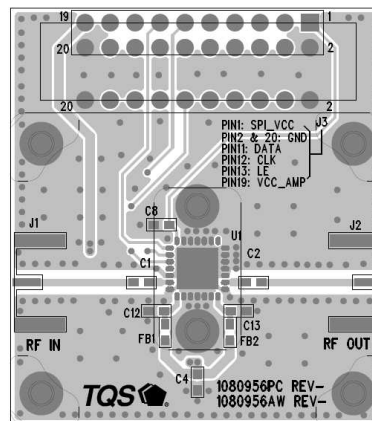
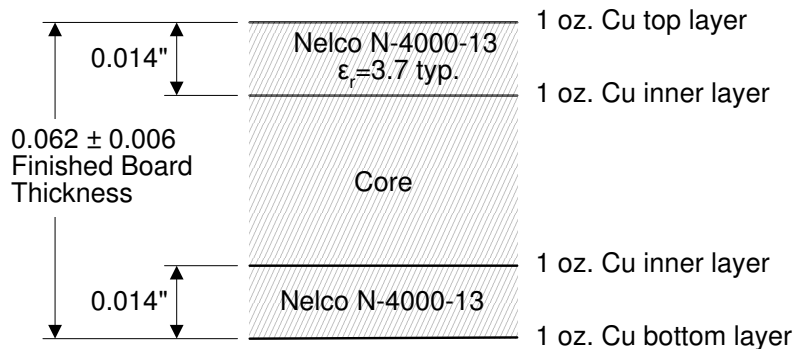
## Pin Configuration and Description



| Pin            | Symbol                | Description   |
|----------------|-----------------------|---|
| 1              | LE                    | Serial Latch Enable Input. When LE is high, latch is clear and content of SPI control the attenuator. When LE is low, data in SPI is latched. |
| 2              | DATA                  | Serial data input. The data and clock pins allow the data to be entered serially into SPI and is independent of Latch state.                  |
| 3              | CLK                   | Serial clock input.   |
| 4, 22          | N/C                   | No connect or open. This pin is not connected in this module  |
| 6              | RFIN                  | Input, matched to 50 ohms. Internally DC blocked.   |
| 8              | VCC_AMP1/<br>VCC_AMP2 | Supply Voltage to AMP1 and AMP2. This pin is connected internally to bypass capacitors followed by inductor inside the module.                |
| 14             | VCC_AMP3              | Supply Voltage to AMP3. This pin is connected internally to bypass capacitors followed by inductor inside the module.                         |
| 16             | RFOUT                 | Output, matched to 50 ohms. Internally DC blocked.  |
| 28             | VCC_SPI               | Supply voltage for SPI and DSA chip. This pin is connected to bypass capacitor internally.  |
| All other Pins | GND                   | RF/DC Ground Connection   |

## PC Board Specifications

### PCB Material and Stack-up



# TQM879008

## 1.5-2.7GHz 1/2 W Digital Variable Gain Amplifier



### Mechanical Information

#### Package Information and Dimensions

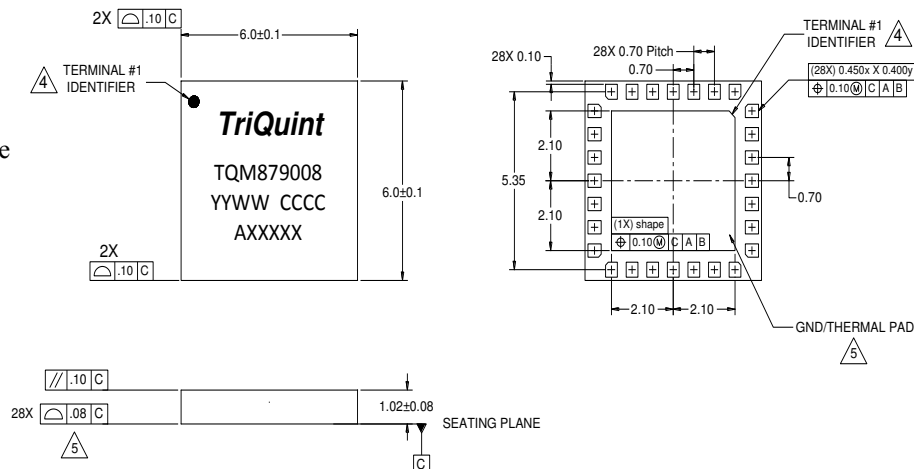
Markings:

Part Number: TQM879008

Lot Code: 'YY' is the year of manufacture

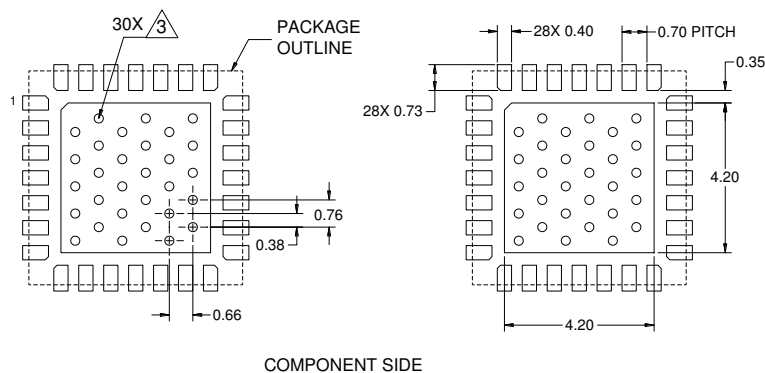
'WW' is the work week

'AaXXXX' is the Assembly code



1. All dimensions are in millimeters. Angles are in degrees.
2. Except where noted, this part outline conforms to JEDEC standard MO-270, Issue B (Variation DAE) for extra thin profile, fine pitch, internal stacking module (ISM).
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The contact pin numbering convention and pin 1 identifier conform to JESD 95-1 SPP-012.
5. Coplanarity applies to the exposed ground/thermal pad as well as the contact pins.

#### PCB Mounting Pattern



Notes:

1. All dimensions are in millimeters. Angles are in degrees.
2. Use 1 oz. copper minimum for top and bottom layer metal.
3. Vias are required under the backside paddle of this device for proper RF/DC grounding and thermal dissipation. We recommend a 0.35mm (#80/.0135") diameter bit for drilling via holes and a final plated thru diameter of 0.25mm (0.10").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

### Product Compliance Information

#### ESD Information



#### Caution! ESD-Sensitive Device

ESD Rating: Class 1C  
Value: Passes  $\geq 1000$  V to  $< 2000$  V  
Test: Human Body Model (HBM)  
Standard: JEDEC Standard JESD22-A114

ESD Rating: Class IV  
Value: Passes  $\geq 1000$  V  
Test: Charged Device Model (CDM)  
Standard: JEDEC Standard JESD22-C101

#### MSL Rating

The part is rated Moisture Sensitivity Level 3 at 260°C per JEDEC standard IPC/JEDEC J-STD-020.

#### Solderability

Compatible with both lead-free (maximum 260 °C reflow temperature) and tin/lead (maximum 245 °C reflow temperature) soldering processes.

This part is compliant with EU 2002/95/EC RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

This product also has the following attributes:

- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C<sub>15</sub>H<sub>12</sub>Br<sub>4</sub>O<sub>2</sub>) Free
- PFOS Free
- SVHC Free

### Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations, and information about TriQuint:

Web: [www.triquint.com](http://www.triquint.com)  
Email: [info-sales@tqs.com](mailto:info-sales@tqs.com)

Tel: +1.503.615.9000  
Fax: +1.503.615.8902

For technical questions and application information:

Email: [sicapplications.engineering@tqs.com](mailto:sicapplications.engineering@tqs.com)

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