

# TQM879006A

## 1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier



### Applications

- 3G / 4G Wireless Infrastructure
- CDMA, TD-CDMA, WCDMA, LTE
- Repeaters
- PTP Radio IF Chains

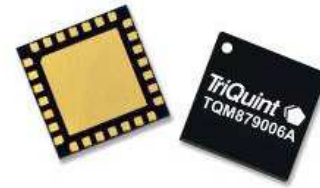
### Product Features

- 1.4-2.7 GHz Frequency Range
- 31.7 dB Maximum Gain at 2 GHz
- 31.5 dB Gain Range in 0.5 dB Steps
- +43 dBm Output IP3
- +24.5 dBm Output P1dB
- 1.5 dB Noise Figure at Max. Gain State
- Fully Internally Matched Module
- Integrated Blocking Capacitors, Bias Inductors
- 3-wire SPI Control Programming

### General Description

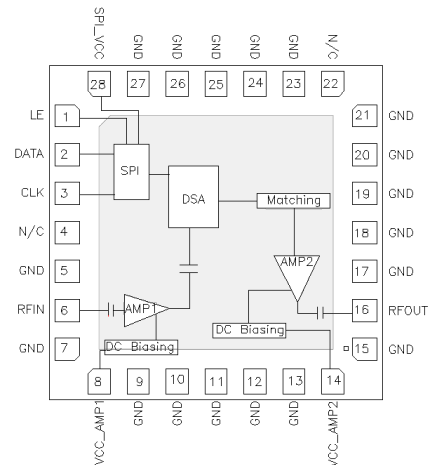
The TQM879006A is a digital variable gain amplifier (DVGA) featuring high linearity over the entire gain control range. The amplifier module features the integration of a low noise amplifier gain block, a digital-step attenuator (DSA), along with a high linearity 1/4W amplifier. The module has the added features of integrating all matching components with bias chokes and blocking capacitors. The internal DSA offers 0.5 dB step, 6-bit, and 31.5 dB range and is controlled with a serial periphery interface (SPI™).

The TQM879006A features variable gain from 0 dB to 31.7 dB at 2 GHz, has +43 dBm Output IP3, and +24.5 dBm P1dB. The amplifier also has a very low 1.5 dB Noise Figure (at maximum gain) allowing it to be an ideal DVGA for both receiver and transmitter applications. The amplifier operates from a single +5V supply and is available in a compact 28-pin 6x6 mm leadless SMT package.



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 |
| 14             | VCC_AMP2 |
| 16             | RFOUT    |
| 28             | VCC_SPI  |
| All Other Pins | GND      |

### Ordering Information

| Part No.       | Description   |
|----------------|---|
| TQM879006A     | 1.4-2.7 GHz Digital Variable Gain Amp                             |
| TQM879006A-PCB | Fully Assembled Evaluation Board Includes USB control board (EVH) |

Standard T/R size = 2500 pieces on a 7" reel.

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### Absolute Maximum Ratings

| Parameter                         | Rating                 |
|-----------------------------------|------------------------|
| Storage Temperature               | -55 to 150 °C          |
| RF Input Power, CW, 50Ω, T = 25°C | +23 dBm                |
| Vcc (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 |
|--|-------|-----|-------|-------|
| Vcc (pins 8, 14, 28)                             | +4.75 | +5  | +5.25 | V     |
| Case Temperature                                 | -40   |     | +85   | °C    |
| T <sub>J</sub> (for >10 <sup>6</sup> hours MTTF) |       |     | 170   | °C    |

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, Vcc = +5V, Maximum Gain State

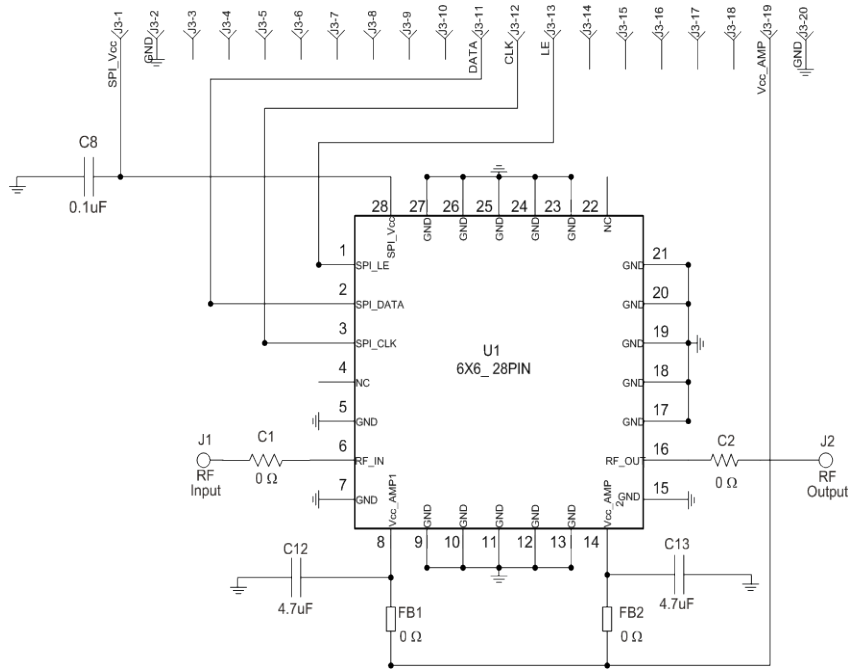
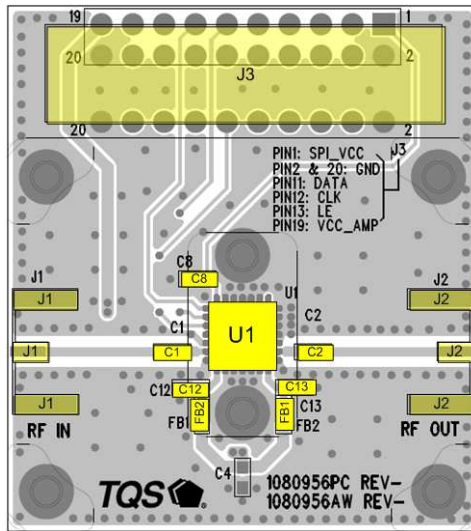
| Parameter                           | Conditions                               | Min                                     | Typ   | Max  | Units |
|-------------------------------------|--|---|-------|------|-------|
| Operational Frequency Range         |  | 1400                                    |       | 2700 | MHz   |
| Test Frequency                      |  |   | 2000  |      | MHz   |
| Gain                                |  | 27.5                                    | 31.7  | 34   | dB    |
| Gain Control Range                  | 0.5 dB Step Size                         |   | 31.5  |      | dB    |
| Attenuation Accuracy                | All States, 3 wire SPI, 6 states         | ±(0.3+5% of Attenuation setting)<br>Max |       |      | dB    |
| Control Interface                   | 3-wire serial interface                  |   | 6     |      | Bit   |
| Input Return Loss                   |  |   | 21    |      | dB    |
| Output Return Loss                  |  |   | 20    |      | dB    |
| Output P1dB                         |  |   | +24.5 |      | dBm   |
| Output IP3                          | P <sub>out</sub> =+11 dBm/tone, Δf=1 MHz | +38                                     | +43.0 |      | dBm   |
| Noise Figure                        |  |   | 1.5   |      | dB    |
| I/O Impedance                       |  |   | 50    |      | Ohm   |
| Supply Voltage                      |  |   | +5    |      | V     |
| Supply Current                      |  |   | 174   | 240  | mA    |
| Thermal Resistance, θ <sub>jc</sub> | Module (junction to case)                |   |       | 36.7 | °C/W  |

# TQM879006A

1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier



## Application Circuit (TQM879006A-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 and AMP2.

## Bill of Material - TQM879006A-PCB

| Reference Des.   | Value  | Description                     | Manuf.   | Part Number |
|------------------|--------|---------------------------------|----------|-------------|
| U1               | n/a    | 1.5-2.7 GHz 1/4 W DVGA          | TriQuint | TQM879006A  |
| C8               | 0.1 uF | Cap, Chip, 0603, 16V, X7R, 10%  | various  |             |
| C12, C13         | 4.7 uF | Cap, Chip, 0603, 6.3V, X5R, 20% | various  |             |
| C1, C2, FB1, FB2 | 0 Ω    | Res, Chip, 0603, 1/16W, 5%      | various  |             |
| C4               | DNP    |                                 |          |             |

# TQM879006A

## 1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier



### Typical Performance, Maximum Gain State

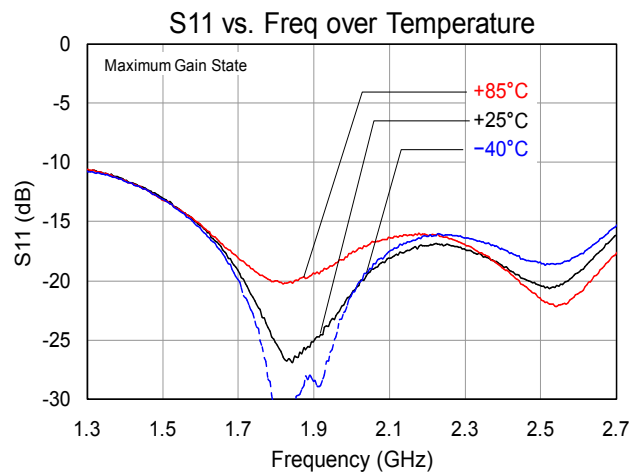
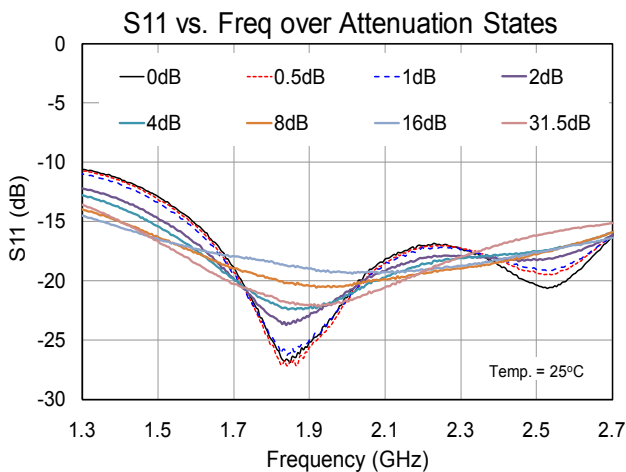
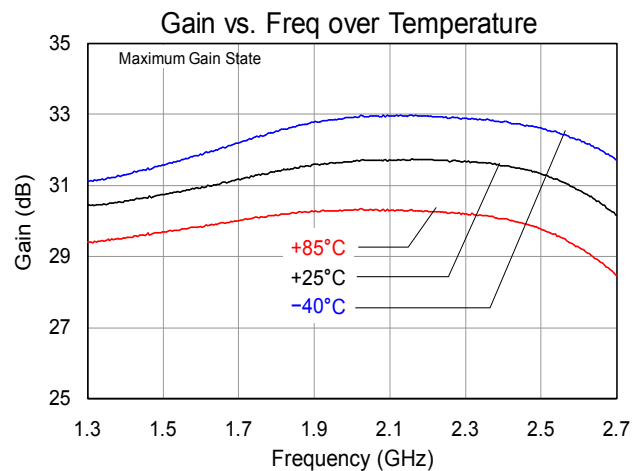
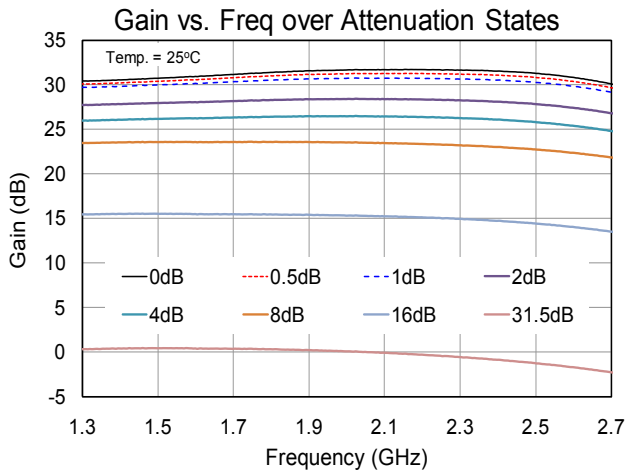
Test conditions unless otherwise noted: V<sub>cc</sub> = +5 V, I<sub>cc</sub>=174 mA (typ), Temp=25°C

| Parameter                            | Typical Value |       |       |       |       |       | Units |
|--------------------------------------|---------------|-------|-------|-------|-------|-------|-------|
| Frequency                            | 1500          | 1800  | 2000  | 2140  | 2350  | 2600  | MHz   |
| Gain                                 | 30.8          | 31.4  | 31.7  | 31.7  | 31.6  | 30.8  | dB    |
| Input Return Loss                    | 13            | 25    | 21    | 17    | 18    | 19    | dB    |
| Output Return Loss                   | 10            | 15    | 20    | 19.5  | 15    | 11    | dB    |
| Output P1dB                          | +24.1         | +24.5 | +24.5 | +24.5 | +24.4 | +24.3 | dBm   |
| Output IP3 (11 dBm/tone, Δf = 1 MHz) | +40.2         | +42.0 | +43.0 | +43.0 | +41.0 | +40.5 | dBm   |
| Noise Figure                         | 1.35          | 1.4   | 1.5   | 1.5   | 1.6   | 1.8   | dB    |

Notes:

- The evaluation board can be used with TriQuint's USB interface board. Refer to TriQuint's website for more information.

### Typical Performance Plots

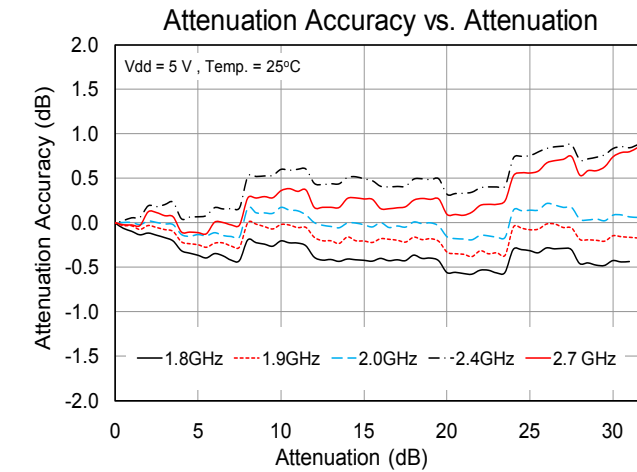
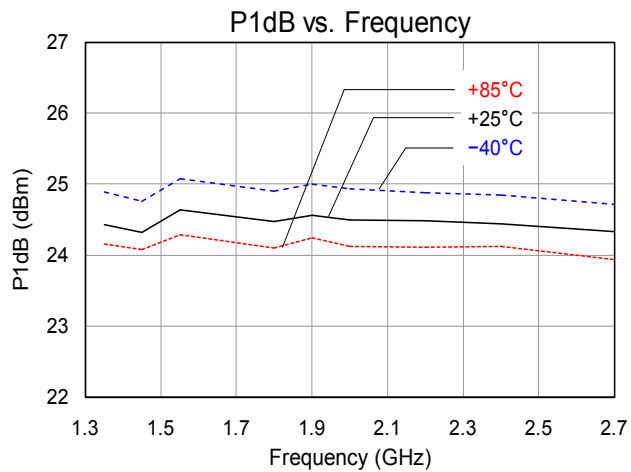
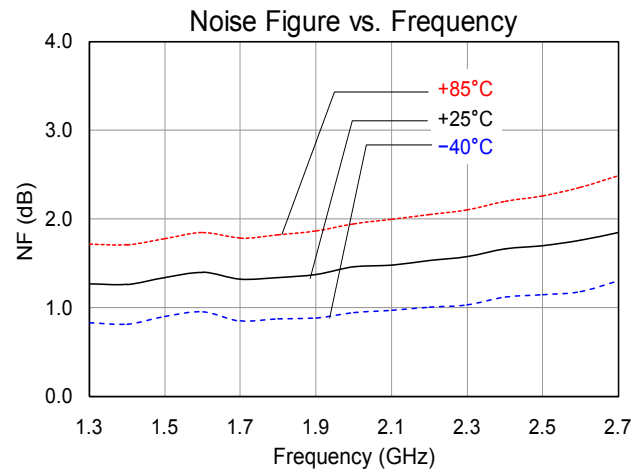
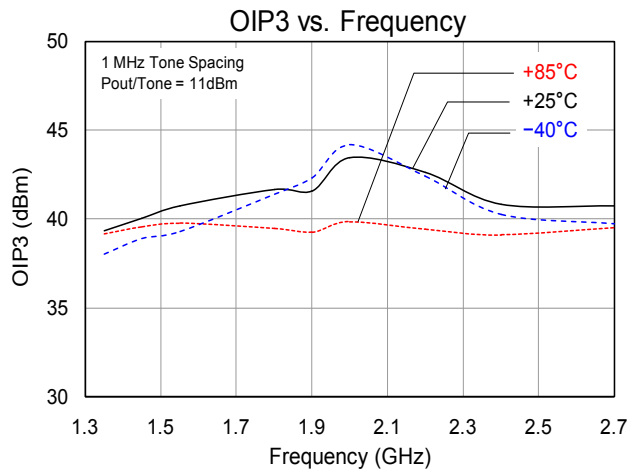
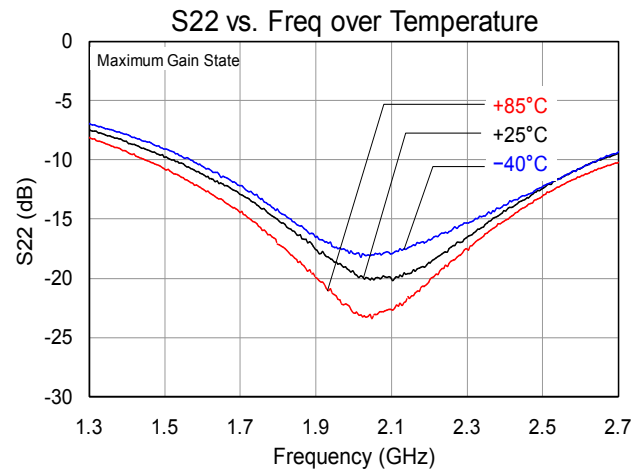
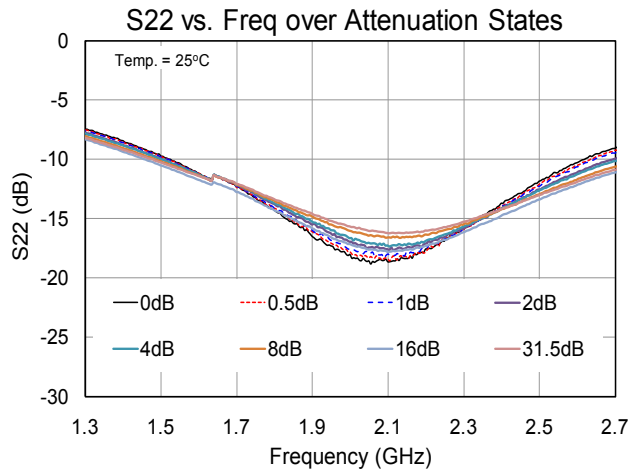


# TQM879006A

1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier



## Typical Performance Plots



### Serial Control Interface

#### Serial Control Timing Characteristics (Test conditions: $V_{CC} = +5\text{ V}$ , $T_{LEAD}=25^{\circ}\text{C}$ )

| 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: $V_{CC} = +5\text{ V}$ , $T_{LEAD}=25^{\circ}\text{C}$ )

| Parameter                        | Condition            | Min | Max      | Units         |
|----------------------------------|----------------------|-----|----------|---------------|
| Input Low Voltage, $V_{IL}$      |                      | 0   | 0.8      | V             |
| Input High Voltage, $V_{IH}$     |                      | 2.4 | $V_{CC}$ | V             |
| Input Current, $I_{IH} / I_{IL}$ | On SERIN, LE and CLK | -10 | +10      | $\mu\text{A}$ |

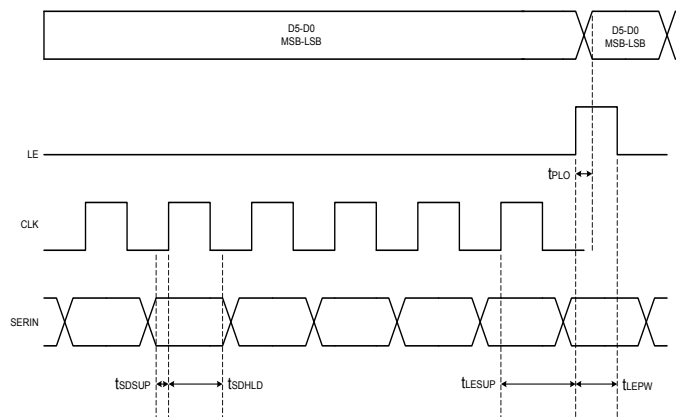
#### SERIN (MSB in First 6-Bit Word) Control Logic Truth Table

| MSB |    | 6-Bit Control Word to DSA |    |    |    | LSB | Gain Relative to Maximum Gain |
|-----|----|---------------------------|----|----|----|-----|-------------------------------|
| D5  | D4 | D3                        | D2 | D1 | D0 |     | Reference : 1L                |
| 1   | 1  | 1                         | 1  | 1  | 1  |     | 0 dB                          |
| 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 a reduction in gain of approximately the sum of the bits selected.

### Serial Control Interface Timing Diagram

CLK is disabled when LE is high



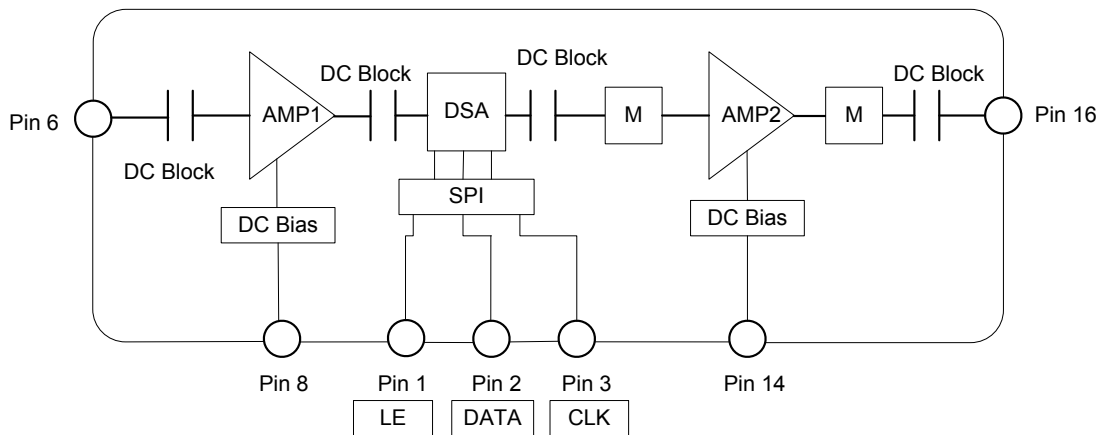
# TQM879006A

## 1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier

### Detailed Device Description

The TQM879006A 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 a low noise amplifier gain block, a digital-step attenuator (DSA), along with a high linearity 1/4W amplifier as shown in the functional diagram below. 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 1.4 - 2.7 GHz.

### Functional Schematic Diagram



Where M = Matching Network.

### Chain Analysis Table

This table provides the typical performance of individual stages in the module as well as overall module performance.

| Parameter | AMP1 | DSA  | AMP2 | Overall Module | Units |
|-----------|------|------|------|----------------|-------|
| Gain      | 19   | -1.8 | 14.5 | 31.7           | dB    |
| NF        | 1.3  | 1.8  | 4.0  | 1.5            | dB    |
| OIP3      | 36   | 55   | 43   | 43             | dBm   |
| P1dB      | 20   | 28.5 | 24.5 | 24.5           | dBm   |
| Icc       | 85   | 2.0  | 87   | 174            | mA    |

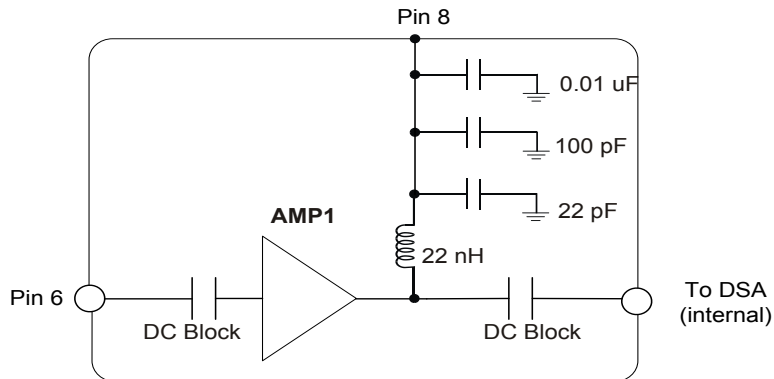
# TQM879006A

## 1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier

### Detailed Device Description

#### AMP1

AMP1 is a wide band low noise amplifier gain block in DVGA module. The amplifier provides 19 dB gain, 1.3 dB noise figure, +36 dBm OIP3 at 2.0 GHz while only drawing 85 mA current. External DC blocks and biasing is not required. AMP1 is DC blocked internally and is connected internally to three bypass capacitors (22 pF, 100 pF, 0.01 uF) followed by 22 nH inductor inside the module as shown in the figure below.

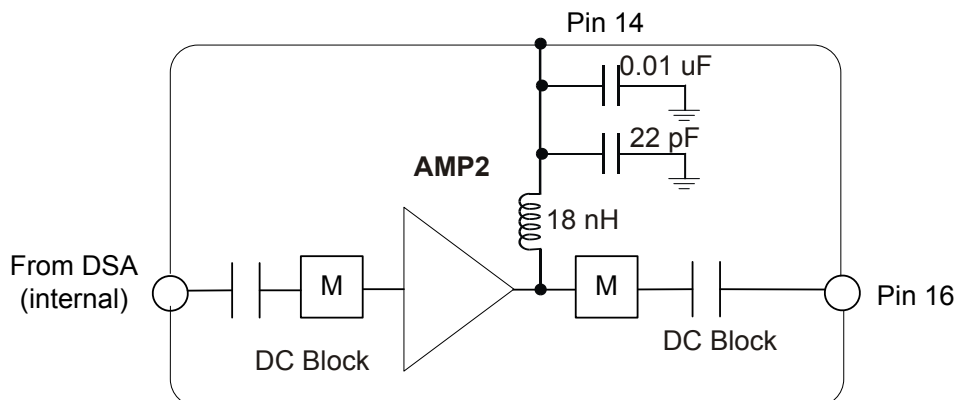


#### DSA (Digital Step Attenuator)

DVGA has a serial digital step attenuator that is controlled with 6-bit serial periphery interface (SPI™) and has 0.5 dB step size with 31.5 dB attenuation range. This 50-ohm RF DSA maintains high attenuation accuracy over frequency and temperature. “000000” represents maximum attenuation state. External bypass capacitors are needed to compensate the inductance effect associated with long transmission lines on the evaluation board.

#### AMP2

AMP2 is high linearity 1/4-W amplifier in DVGA module. The amplifier provides 14.4 dB gain, +24.5 dBm P1dB, +43 dBm OIP3 at 2.0 GHz while only drawing 87 mA current. The amplifier is optimized over 1.4 – 2.7 GHz bandwidth using internal matching components. AMP2 is DC blocked internally and is connected internally to two bypass capacitors (22 pF, 0.01 uF) followed by an 18 nH inductor inside the module as shown in the figure below. External DC blocks and biasing is not required.







# TQM879006A

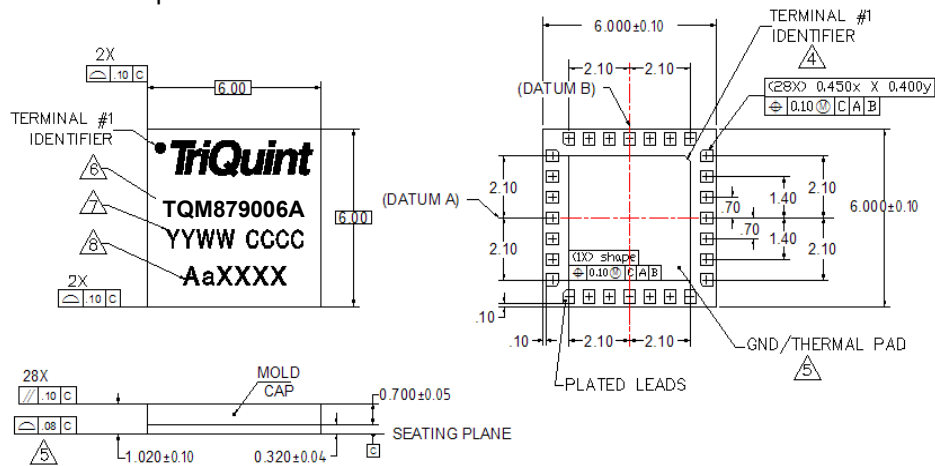
1.4-2.7GHz 1/4 W Digital Variable Gain Amplifier



## Mechanical Information

### Package Marking and Dimensions

Marking: Part number – TQM879006A  
 Lot Code – YYWW CCCC  
 Vendor Code and Triquint Lot Number - AaXXXX

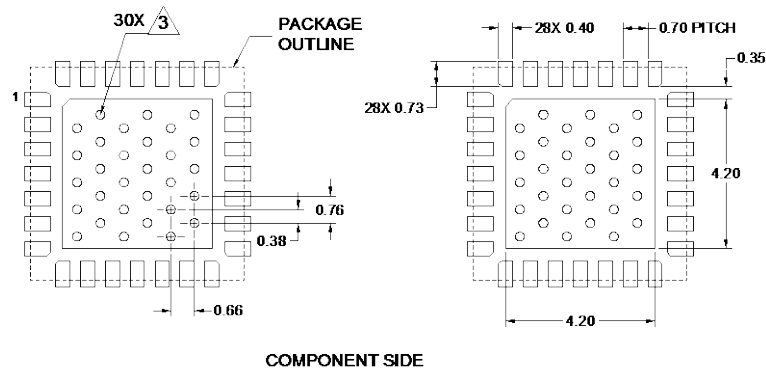


**NOTES:**

1. All dimensions are in millimeters. Angles are in degrees.
2. Except where noted, this part outline conforms to JEDEC standard MO-220, Issue E (Variation VGGC) for thermally enhanced plastic very thin fine pitch quad flat no lead package (QFN).
3. Dimension and tolerance formats conform to ASME Y14.4M-1994.
4. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION CONFORM TO JESD 95-1 SPP-012.

## 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 0.25 mm (0.10").
4. Ensure good package backside paddle solder attach for reliable operation and best electrical performance.

# TQM879006A

## 1.4-2.7GHz ¼ W Digital Variable Gain Amplifier

### Product Compliance Information

#### ESD Sensitivity Ratings



#### Caution! ESD-Sensitive Device

ESD Rating: Class 1A  
Value: Passes  $\geq 250$  V to  $< 500$  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

MSL Rating: Level 3  
Test: 260°C convection reflow  
Standard: JEDEC Standard IPC/JEDEC J-STD-020

#### Solderability

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

Contact plating: Electrolytic Plated Au over Ni

#### RoHs Compliance

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 ( $C_{15}H_{12}Br_4O_2$ ) 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: [sjapplications.engineering@tqs.com](mailto:sjapplications.engineering@tqs.com)

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