

FEATURES

- Low cost integrated monolithic GaAs amplifier with step attenuator
- Attenuation Range: 0-56 dB, adjustable in 4 dB increments via a 4 wire parallel control
- Meets DOCSIS distortion requirements at +60 dBmV output signal level
- Low distortion and low noise
- Frequency range: 5-100 MHz
- 5 Volt operation
- 0 to +85 °C temperature range

APPLICATIONS

- MCNS/DOCSIS Compliant Cable Modems
- CATV Interactive Set-Top Box
- Telephony over Cable Systems
- OpenCable Set-Top Box
- Residential Gateway



PRODUCT DESCRIPTION

The ARA1400 is a GaAs IC designed to provide the reverse path amplification and output level control functions in a CATV Set-Top Box or Cable Modem. It incorporates a digitally controlled precision step attenuator that is preceded by an ultra low noise amplifier stage, and followed by an ultra-linear output driver amplifier. The device is capable of meeting the MCNS/DOCSIS requirements for

harmonic performance at a +60dBmV output level while requiring only a single polarity +5V supply. Both the input and the output are single-ended and matched to 75 Ohms, and a precision attenuator provides up to 56 dB of attenuation in 4 dB increments. The device is offered in a 28-pin SSOP package featuring a heat slug on the bottom of the package.

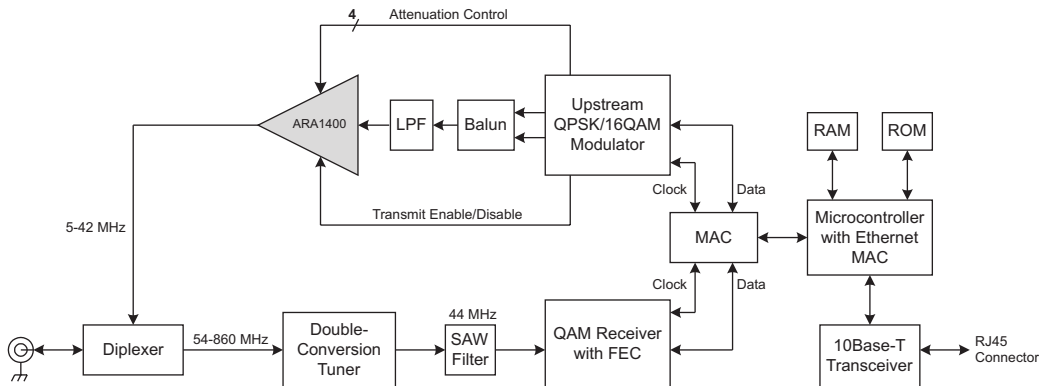


Figure 1: Cable Modem or Set Top Box Application Diagram

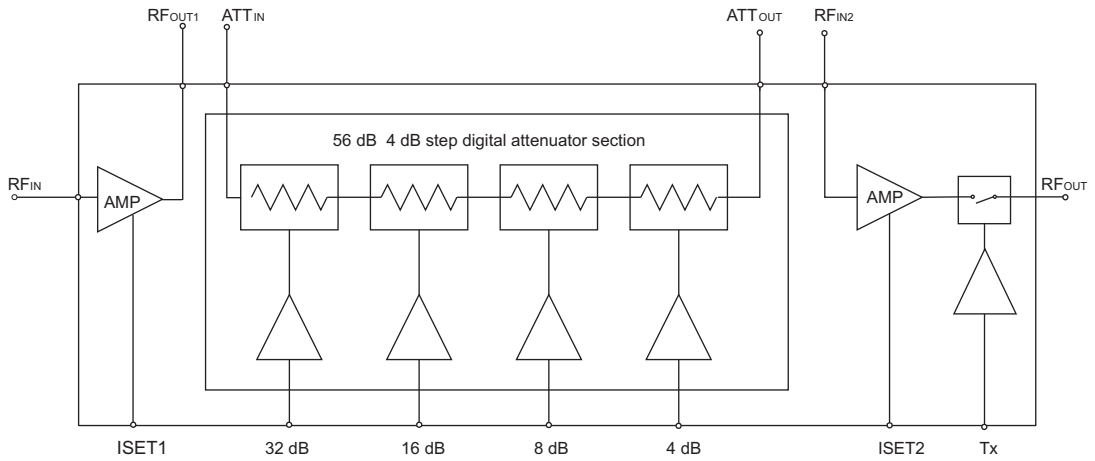


Figure 2: Functional Block Diagram

| | | | |
|----|----------|----------|----|
| 1 | GND | ATT_OUT | 28 |
| 2 | N/C | ISET2 | 27 |
| 3 | ATT_IN | RF_IN2 | 26 |
| 4 | RF_OUT1 | Tx | 25 |
| 5 | V_REF1 | ATT_ACG3 | 24 |
| 6 | ATT_ACG1 | ATT_ACG2 | 23 |
| 7 | ATT_ACG1 | ATT_ACG2 | 22 |
| 8 | ATT_ACG1 | ATT_ACG2 | 21 |
| 9 | ATT_ACG1 | ATT_ACG2 | 20 |
| 10 | RF_IN | RF_OUT | 19 |
| 11 | ISET1 | V_REF2 | 18 |
| 12 | V_ATT | V_A2 | 17 |
| 13 | 32 dB | 4 dB | 16 |
| 14 | 16 dB | 8 dB | 15 |

Figure 3: Pinout

Table 1: Pin Description

| PIN | NAME | DESCRIPTION | PIN | NAME | DESCRIPTION |
|-----|---------------------|---------------------------------------|-----|---------------------|---------------------------------------|
| 1 | GND | Ground | 15 | 8 dB | 82 dB Attenuation Control Bit |
| 2 | N/C | No Connection ⁽¹⁾ | 16 | 4 dB | 4 dB Attenuation Control Bit |
| 3 | ATT _{IN} | Attenuator Input ⁽²⁾ | 17 | V _{A2} | Amplifier A2 Supply |
| 4 | RF _{OUT1} | Amplifier A1 Output and Supply | 18 | V _{REF2} | Reference Voltage for Amplifier A2 |
| 5 | V _{REF1} | Reference Voltage for Amplifier A1 | 19 | RF _{OUT} | RF Output from Switch ⁽²⁾ |
| 6 | ATT _{ACG1} | Attenuator AC Ground 1 ⁽³⁾ | 20 | ATT _{ACG2} | Attenuator AC Ground 2 ⁽³⁾ |
| 7 | ATT _{ACG1} | Attenuator AC Ground 1 ⁽³⁾ | 21 | ATT _{ACG2} | Attenuator AC Ground 2 ⁽³⁾ |
| 8 | ATT _{ACG1} | Attenuator AC Ground 1 ⁽³⁾ | 22 | ATT _{ACG2} | Attenuator AC Ground 2 ⁽³⁾ |
| 9 | ATT _{ACG1} | Attenuator AC Ground 1 ⁽³⁾ | 23 | ATT _{ACG2} | Attenuator AC Ground 2 ⁽³⁾ |
| 10 | RF _{IN} | Amplifier A1 Input ⁽⁴⁾ | 24 | ATT _{ACG3} | Attenuator AC Ground 3 ⁽³⁾ |
| 11 | I _{SET1} | Amplifier A1 Current Adjust | 25 | Tx | Output Switch Control |
| 12 | V _{ATT} | Attenuator Supply | 26 | RF _{IN2} | Amplifier A2 Input ⁽⁴⁾ |
| 13 | 32 dB | 32 dB Attenuation Control Bit | 27 | I _{SET2} | Amplifier A2 Current Adjust |
| 14 | 16 dB | 16 dB Attenuation Control Bit | 28 | ATT _{OUT} | Attenuator Output ⁽²⁾ |

Notes:

(1) All N/C pins should be grounded.

(2) Pins should be AC-coupled. No external DC bias should be applied.

(3) Pins should be AC-grounded. No external DC bias should be applied.

(4) Pins should be AC-coupled from the RF path, and should be pulled to ground through a resistor.

ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

| PARAMETER | MIN | MAX | UNIT |
|--|------|---------------------|------|
| Analog Supply: V _{SUP} (pins 4, 12, 17) | 0 | 9 | VDC |
| Amplifier Reference Voltages (pins 5, 18) | -2.5 | $\frac{V_{SUP}}{2}$ | VDC |
| RF Power at Amplifier Inputs (pins 10, 26) | - | +60 | dBmV |
| Attenuator Controls (pins 13, 14, 15, 16) | 0 | 6 | V |
| Output Switch Control (pin 25) | 0 | 6 | V |
| Storage Temperature | -55 | +200 | °C |
| Soldering Temperature | - | 260 | °C |
| Soldering Time | - | 5 | Sec |

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.

Notes:

1. Pins 3, 19, and 28 should be AC-coupled. No external DC bias should be applied.
2. Pins 11 and 27 should be grounded or pulled to ground through a resistor. No external DC bias should be applied.
3. Pins 6, 7, 8, 9, 20, 21, 22, 23 and 24 should be AC-grounded. No external DC bias should be applied.
4. Pins 10 and 26 should be AC-coupled from the RF path, and should be pulled to ground through a resistor.

Table 3: Operating Ranges

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|----------------------|------|-----|------|
| Amplifier Supply: V _{DD} (pins 4, 17) | 4.5 | 5 | 7 | VDC |
| Attenuator Supply: V _{ATTN} (pin 12) | V _{DD} -0.5 | 5 | 7 | VDC |
| Attenuator Controls (pins 13, 14, 15, 16) | 0 | - | 5.5 | V |
| Amplifier Reference Voltages (pins 5, 18) | - | 1.75 | - | VDC |
| Output Switch Control (pin 25) | 0 | - | 5.5 | V |
| Case Temperature | 0 | 25 | 85 | °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: DC Electrical Specifications
($T_A = 25\text{ }^\circ\text{C}$; $V_{DD}, V_{ATTN} = +5.0\text{ VDC}$)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|-------------------------------|-----|------|------|------|----------|
| Amplifier A1 Current (pin 4) | - | 74 | 95 | mA | |
| Amplifier A2 Current (pin 17) | - | 108 | 130 | mA | |
| Attenuator Current (pin 12) | - | 12 | 20 | mA | |
| Total Power Consumption | - | 0.97 | 1.23 | W | |

Table 5: AC Electrical Specifications
($T_A = 25\text{ }^\circ\text{C}$; $V_{DD}, V_{ATTN} = +5.0\text{ VDC}$; $T_x = 0\text{ V}$ (switch closed), $T_x = +5\text{ V}$ (switch open))

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|--|------|--------|-------|----------------------|--|
| Gain (10 MHz) | 30 | 32 | 33 | dB | 0 dB attenuation setting |
| Gain Flatness | - | 0.75 | - | dB | 5 to 100 MHz |
| Gain Variation over Temperature | - | -0.006 | - | dB/ $^\circ\text{C}$ | |
| Attenuation Steps | | | | | |
| 4 dB | 3.6 | 3.9 | 4.2 | dB | Monotonic |
| 8 dB | 7.7 | 8.0 | 8.3 | | |
| 16 dB | 15.3 | 15.7 | 16.1 | | |
| 32 dB | 31.0 | 31.5 | 32.0 | | |
| Switch Isolation at 45 MHz | - | 35 | 30 | dB | Difference in output signal level between active and standby |
| Harmonics ($f_o = 10\text{ MHz}$) | | | | | |
| 2 f_o | - | -57 | -52 | dBc | f_o power = +60 dBmV into 75 Ohms |
| 3 f_o | - | -64 | -56 | | |
| 3 rd Order Output Intercept | 78 | - | - | dBmV | |
| 1 dB Gain Compression Point | - | 70 | - | dBmV | |
| Noise Figure | - | 1.7 | 2.5 | dB | |
| Output Noise Power | | | | | |
| Active / No Signal / Min. Atten. Set. | - | - | -37.6 | dBmV | Any 160 kHz bandwidth from 5 to 42 MHz |
| Active / No Signal / Max. Atten. Set. | - | - | -54.6 | | |
| Input Impedance | - | 75 | - | Ohms | |

Note: As measured in ANADIGICS test fixture.

continued: AC Electrical Specifications
(T_A = 25 °C; V_{DD}, V_{ATTN} = +5.0 VDC; T_x = 0 V (switch closed), T_x = +5 V (switch open))

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|--------|------------|------------|-------|------------------------------|
| Input Return Loss (75 Ohm characteristic impedance) | - | -20 | -15 | dB | |
| Output Impedance | - | -20 -12 | -15 -10 | Ohms | Switch closed Switch open |
| Output Return Loss (75 Ohm characteristic impedance) | - - | -17 -15 | -12 -10 | dB | Switch closed Switch open |
| Output Voltage Transient switch closed / switch open | - | 4 | 7 | mVp-p | |

Note: As measured in ANADIGICS test fixture.

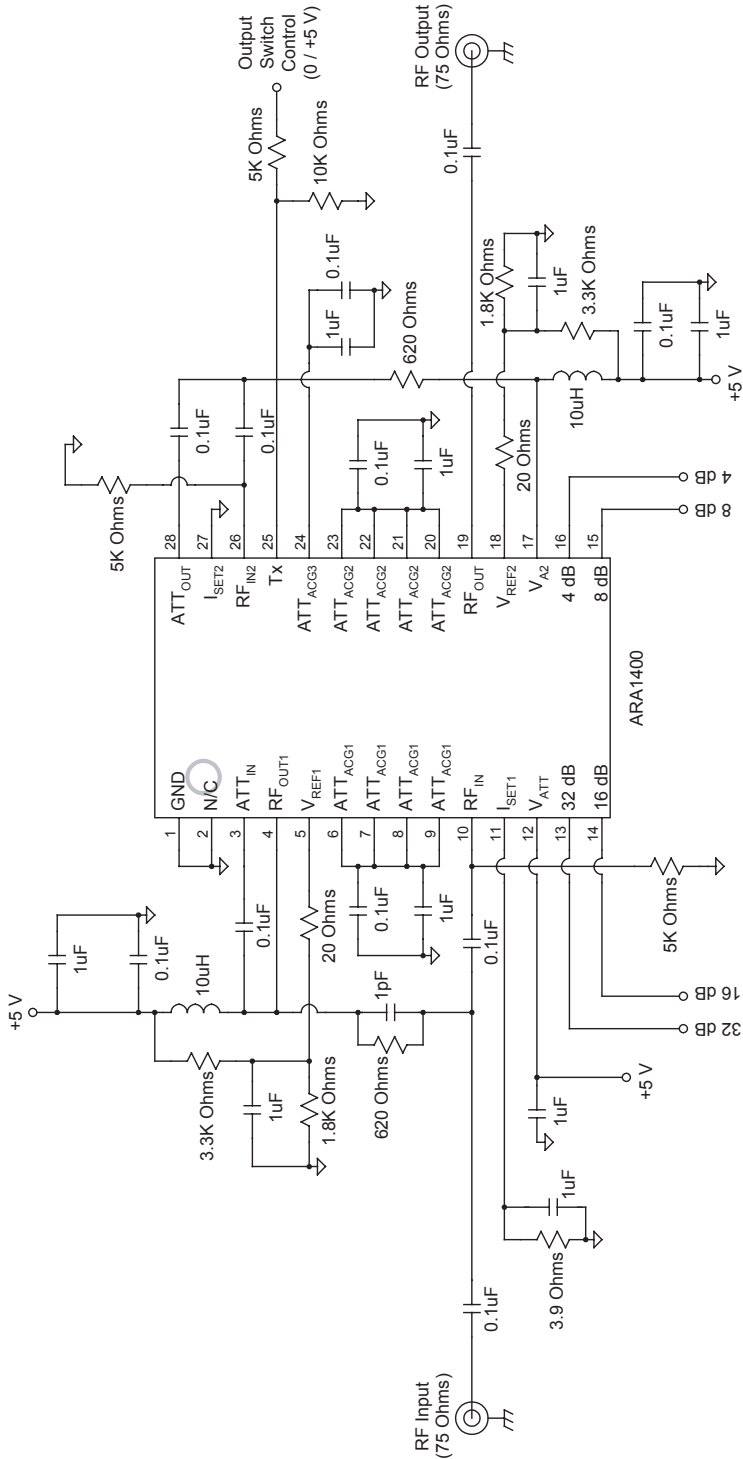
Table 6: Logic Interface Specifications
(T_A = 25 °C; V_{DD}, V_{ATTN} = +5.0 VDC)

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|--|----------|--------|------------|------|---|
| Attenuator Control Logic V _{IN,LOW} V _{IN,HIGH} | 0 2.7 | - - | 0.5 5.5 | V | Bypasses atten. stage Enables atten. stage |
| Attenuator Control Impedance | - | 5 K | - | Ohms | |
| Output Switch Control Logic V _{IN,LOW} V _{IN,HIGH} | 0 2.8 | - - | 1 5.5 | V | Switch closed Switch open |
| Output Switch Control Impedance | - | 10 K | - | Ohms | |

Table 7: Attenuator Logic

| ATTENUATION (dB) | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 |
|----------------------------|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 4 dB Logic Input (pin 16) | L | H | L | H | L | H | L | H | L | H | L | H | L | H | L | H |
| 8 dB Logic Input (pin 15) | L | L | H | H | L | L | H | H | L | L | H | H | L | L | H | H |
| 16 dB Logic Input (pin 14) | L | L | L | L | H | H | H | H | L | L | L | L | H | H | H | H |
| 32 dB Logic Input (pin 13) | L | L | L | L | L | L | L | L | H | H | H | H | H | H | H | H |

Notes: "L" = logic low, "H" = logic high



Note:
 Output Switch Closed: Output Switch Control = 0 V
 Output Switch Open: Output Switch Control = +5 V

Figure 4: Test Circuit

APPLICATION INFORMATION

Amplifier Enable / Disable

The ARA1400 includes two amplification stages that each can be shut down through external control pins V_{REF1} and V_{REF2} (pins 5 and 18, respectively). By applying a typical bias of 1.75 Volts to these pins, the amplifiers are enabled. In order to fully disable an amplifier, its control pin requires a negative bias of -1.5 to -2.0 Volts.

Output Switch Control

A switch located at the output of Amplifier A2 in the ARA1400 provides isolation without having to disable the amplifiers. The switch is controlled by the Tx logic input (pin 25).

Amplifier Bias Current

The I_{SET} pins (11 and 27) set the bias current for the amplification stages. Grounding these pins results in the maximum possible current. By placing a resistor from the pin to ground, the current can be reduced. The recommended bias conditions use the configuration shown in the test circuit schematic in Figure 4.

Thermal Layout Considerations

The device package for the ARA1400 features a heat slug on the bottom of the package body. Use of the heat slug is an integral part of the device design. Soldering it to the ground plane of the PC board will ensure the lowest possible thermal resistance for the device, and will result in the longest MTF (mean time to failure.)

A PC board layout that optimizes the benefits of the heat slug is shown in Figure 5. The via holes located under the body of the device must be plated through to a ground plane layer of metal, in order to provide sufficient thermal conductivity. The recommended solder mask outline is shown in Figure 6.

ESD Sensitivity

Electrostatic discharges can cause permanent damage to these devices. Electrostatic charges accumulate on test equipment and the human body, and can discharge without detection. Proper precautions and handling are strongly recommended. Refer to the ANADIGICS application note on ESD precautions.

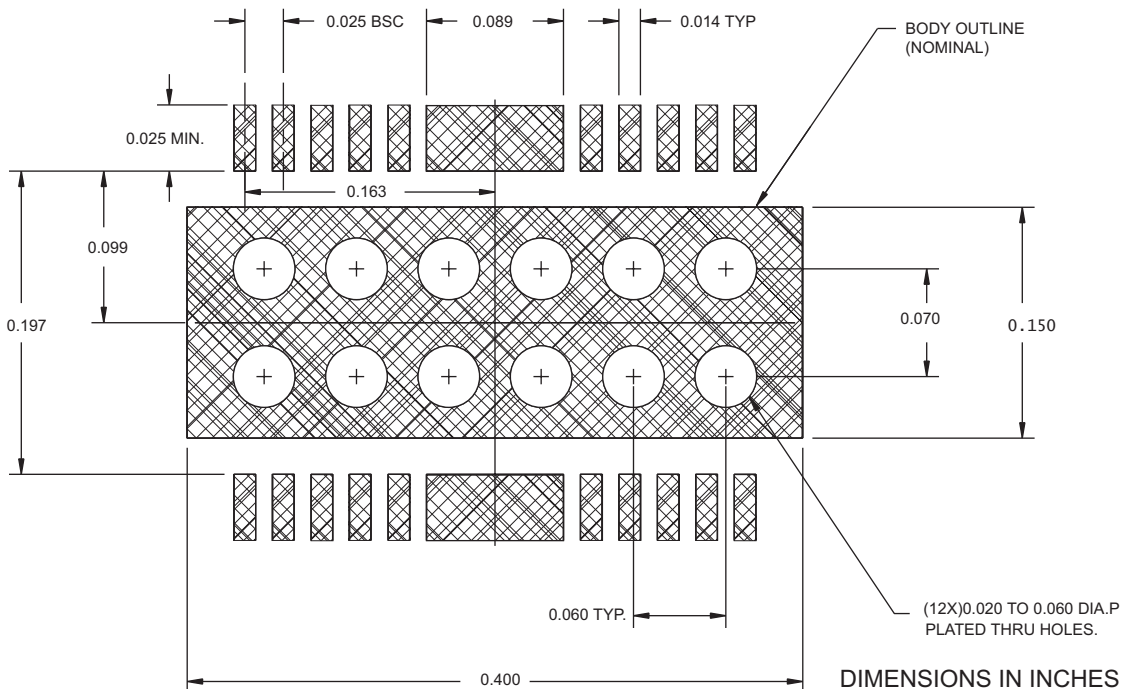
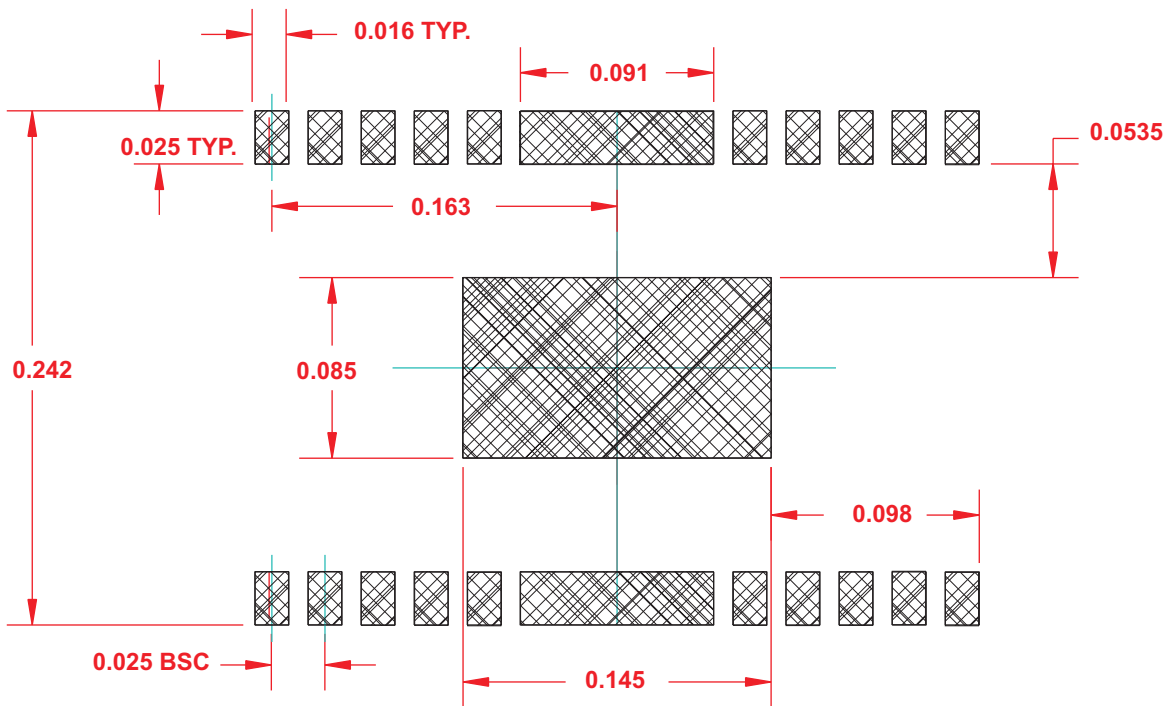


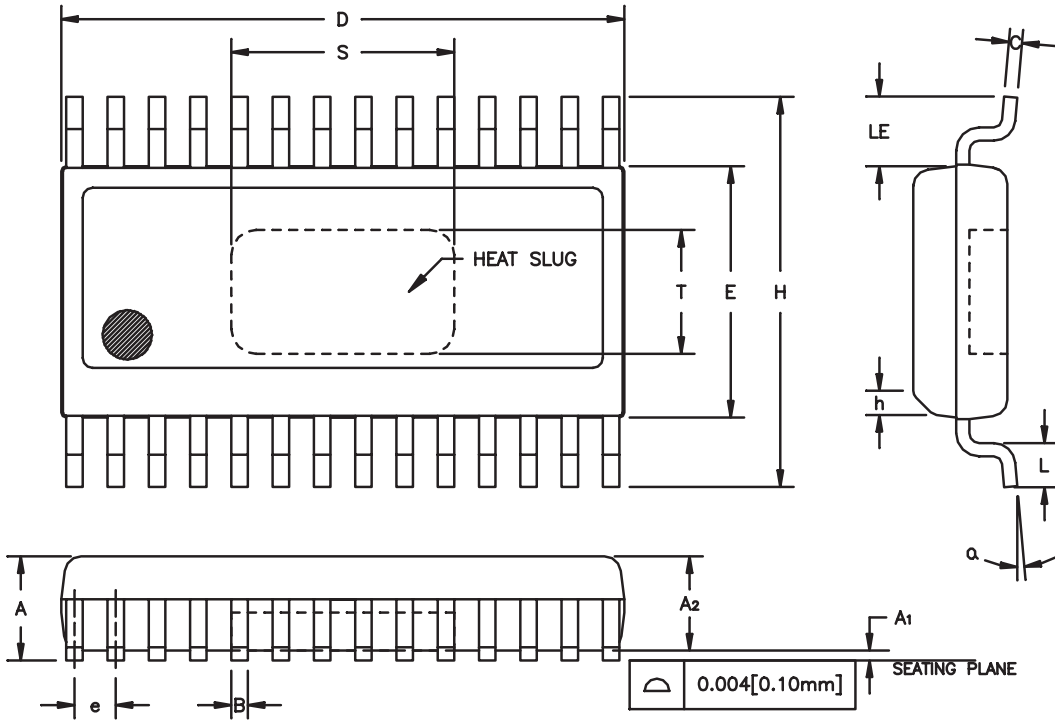
Figure 5: PC Board Layout



DIMENSIONS IN INCHES

Figure 6: Solder Mask Outline

PACKAGE OUTLINE



| SYMBOL | INCHES | | MILLIMETERS | | NOTE |
|----------------|-----------|-------|-------------|------|------|
| | MIN. | MAX. | MIN. | MAX. | |
| A | 0.058 | 0.068 | 1.47 | 1.73 | |
| A ₁ | 0.000 | 0.004 | 0.00 | 0.10 | |
| A ₂ | 0.054 | 0.060 | 1.37 | 1.52 | |
| B | 0.008 | 0.014 | 0.20 | 0.35 | 5 |
| C | 0.007 | 0.012 | 0.18 | 0.30 | 5 |
| D | 0.385 | 0.393 | 9.78 | 9.98 | 2 |
| E | 0.151 | 0.157 | 3.84 | 3.99 | 3 |
| e | 0.025 BSC | | 0.64 BSC | | 4 |
| H | 0.228 | 0.244 | 5.79 | 6.20 | |
| h | 0.015x45° | | 0.38x45° | | |
| L | 0.016 | 0.032 | 0.41 | 0.81 | |
| LE | 0.042 | — | 1.07 | — | |
| α | 0° | 8° | 0° | 8° | |
| S | 0.105 | 0.135 | 2.67 | 3.43 | 6 |
| T | 0.045 | 0.075 | 1.41 | 1.91 | 6 |

NOTES:

1. CONTROLLING DIMENSION: INCHES
2. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.006 [0.15mm] PER SIDE.
3. DIMENSION "E" DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.010 [0.25mm] PER SIDE.
4. MAXIMUM LEAD TWIST/SKEW TO BE ±0.0035 [0.089mm].
5. LEAD WIDTH "B" AND THICKNESS "C" MAX. DIMENSION IS AFTER PLATING.
6. DIMENSIONS "S" AND "T" INDICATE EXPOSED SLUG AREA.

Figure 7: S12 Package Outline - 28 Pin SSOP with Heat Slug

COMPONENT PACKAGING

Volume quantities of the ARA1400 are supplied on tape and reel. Each reel holds 3,500 pieces. Smaller quantities are available in plastic tubes of 50 pieces.

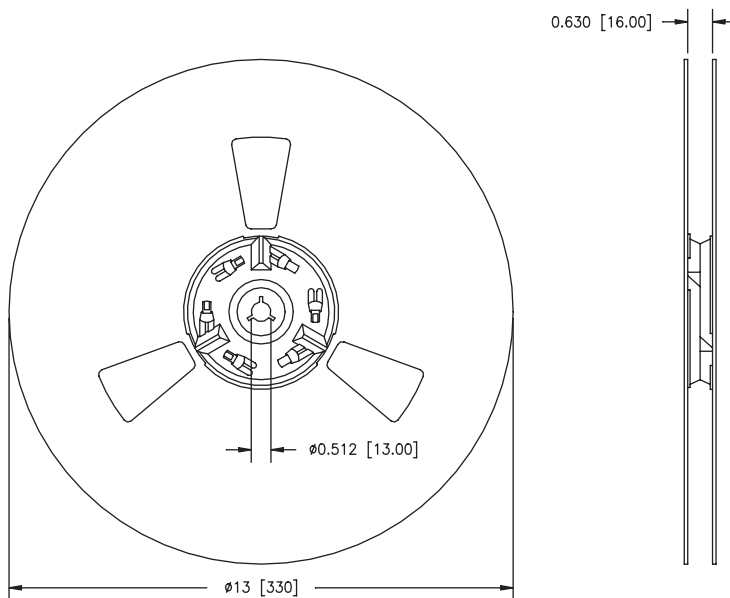


Figure 8: Reel Dimensions

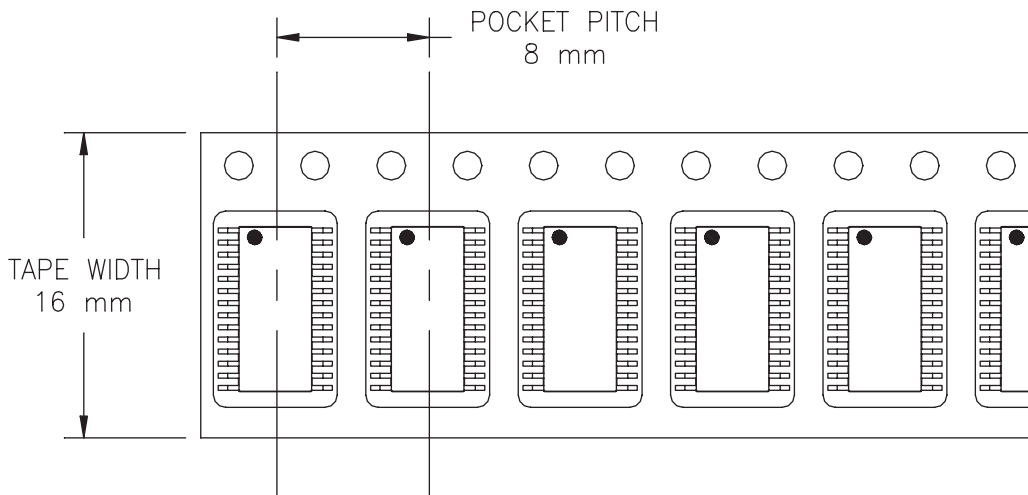


Figure 9: Tape Dimensions

ORDERING INFORMATION

| ORDER NUMBER | TEMPERATURE RANGE | PACKAGE DESCRIPTION | COMPONENT PACKAGING |
|---------------|-------------------|----------------------------|------------------------------------|
| ARA1400S12CTR | 0 to 85 °C | 28 Pin SSOP with Heat Slug | 3,500 piece tape and reel |
| ARA1400S12C | 0 to 85 °C | 28 Pin SSOP with Heat Slug | Plastic tubes (50 pieces per tube) |

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