

# International **IR** Rectifier

PD - 94549A

## HYBRID-HIGH RELIABILITY DC/DC CONVERTERS

## ATR28XXS SERIES

28V Input, Single Output

### Description

The ATR28XXS Series of DC/DC converters feature high power density and an extended temperature range for use in military and industrial applications. Designed to MIL-STD-704D input requirements, these devices have nominal 28VDC inputs with 3.3V, 5V, 12V and 15V single outputs to satisfy a wide range of requirements. The circuit design incorporates a pulse width modulated single forward topology operating in the feed-forward mode at a nominal switching frequency of 550KHz. Input to output isolation is achieved through the use of transformers in the forward and feedback circuits.

The advanced feedback design provides fast loop response for superior line and load transient characteristics and offers greater reliability and radiation tolerance than devices incorporating optical feedback circuits.

Three standard temperature grades are offered with screening options. Refer to Part Number section. These devices can be provided in a standard plug-in package for PC mounting or in a flanged package for more severe environments.

These converters are manufactured in a facility certified to MIL-PRF-38534. All processes used to manufacture these converters have been qualified to enable Advanced Analog to deliver compliant devices.

Four screening grades are available to satisfy a wide range of requirements. The CH grade converters are fully compliant to MIL-PRF-38534 for class H. The HB grade converters are processed to full class H screening but do not have class H element evaluation as required by MIL-PRF-38534. Both grades are fully tested to confirm operation over the full military temperature range without derating of output power. The ES version is a full temperature device without the full class H or element evaluation. The non-suffix device is a low cost limited temperature range option. Variations in electrical, mechanical and screening can be accommodated.



### Features

- 16 to 40 VDC Input Range (28 VDC Nominal)
- 3.3V, 5V, 12V and 15V Outputs Available
- Indefinite Short Circuit and Overload Protection
- Up to 35 W/in<sup>3</sup> Power Density
- 30 Watt Output Power Models
- Fast Loop Response for Superior Transient Characteristics
- Operating Temperature Range from -55°C to +125°C
- Popular Industry Standard Pin-Out
- Resistance Seam Welded Case for Superior Long Term Hermeticity
- Ceramic Feed-thru Pins
- External Synchronization
- Efficiencies up to 84%
- Shutdown from External Signal
- Military Screening

Extensive computer simulation using complex modeling enables rapid design modification to be provided. Contact IR Santa Clara with specific requirements.

## Specifications

## ATR2803R3S

| ABSOLUTE MAXIMUM RATINGS |                           |  |
|--------------------------|---------------------------|--|
| Input Voltage            | -0.5V to 50V              |  |
| Soldering Temperature    | 300°C for 10 seconds      |  |
| Case Temperature         | Operating -55°C to +125°C |  |
| Storage                  | -65°C to +135°C           |  |

Table I. Electrical performance Characteristics

| Test                                                             | Symbol              | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |      | Units  |
|------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|------|--------|
|                                                                  |                     |                                                                                                                    |                      |                 | Min    | Max  |        |
| Output voltage                                                   | V <sub>OUT</sub>    | I <sub>OUT</sub> = 0                                                                                               | 1                    | 01              | 3.25   | 3.35 | V      |
|                                                                  |                     |                                                                                                                    | 2,3                  |                 | 3.20   | 3.40 |        |
| Output current <sup>1</sup>                                      | I <sub>OUT</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC                                                                               | 1,2,3                | 01              |        | 7500 | mA     |
| Output ripple voltage <sup>2</sup>                               | V <sub>RIP</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC<br>B.W. = 20Hz to 2 MHz                                                       | 1,2,3                | 01              |        | 60   | mV p-p |
| Line regulation <sup>3</sup>                                     | VR <sub>LINE</sub>  | V <sub>IN</sub> = 16, 28, and 40 VDC<br>I <sub>OUT</sub> = 0, 3000, and 6000mA                                     | 1                    | 01              |        | ±20  | mV     |
|                                                                  |                     |                                                                                                                    | 2,3                  |                 |        | ±30  |        |
| Load regulation <sup>3</sup>                                     | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 16,28, and 40 VDC<br>I <sub>OUT</sub> = 0, 3000, and 6000mA                                      | 1,2,3                | 01              |        | ±50  | mV     |
| Input current                                                    | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 2)<br>Tied to input return (pin 10)                                             | 1,2,3                | 01              |        | 18   | mA     |
|                                                                  |                     | I <sub>OUT</sub> = 0, inhibit (pin 2) = open                                                                       |                      |                 |        | 50   |        |
| Input ripple current <sup>2</sup>                                | I <sub>RIP</sub>    | I <sub>OUT</sub> = 6000mA<br>B.W. = 20Hz to 2 MHz                                                                  | 1,2,3                | 01              |        | 50   | mA p-p |
| Efficiency                                                       | E <sub>FF</sub>     | I <sub>OUT</sub> = 6000mA                                                                                          | 1                    | 01              | 74     |      | %      |
|                                                                  |                     |                                                                                                                    | 2,3                  |                 | 70     |      |        |
| Isolation                                                        | ISO                 | Input to output or any pin<br>to case (except pin 8) at<br>500 VDC, TC = +25°C                                     | 1                    | 01              | 100    |      | MΩ     |
| Capacitive load <sup>4,5</sup>                                   | C <sub>L</sub>      | No effect on dc performance<br>TC = +25°C                                                                          | 4                    | 01              |        | 500  | μF     |
| Power dissipation<br>load fault                                  | P <sub>D</sub>      | Overload, TC = +25°C <sup>6</sup>                                                                                  | 1                    | 01              |        | 12   | W      |
|                                                                  |                     | Short Circuit                                                                                                      | 1,2,3                |                 |        | 9    |        |
| Switching frequency                                              | F <sub>S</sub>      | I <sub>OUT</sub> = 7500mA                                                                                          | 4,5,6                | 01              | 500    | 600  | KHz    |
| Sync frequency range                                             | F <sub>SYNC</sub>   | I <sub>OUT</sub> = 7500mA                                                                                          | 4,5,6                | 01              | 500    | 700  | KHz    |
| Output response to step<br>transient load changes <sup>7</sup>   | VO <sub>TLOAD</sub> | Load step 50% to/from 100%                                                                                         | 4,5,6                | 01              | -500   | +500 | mV pk  |
|                                                                  |                     | Load step 50% to/from 100%                                                                                         | 4,5,6                |                 | -500   | +500 |        |
| Recovery time step<br>transient load changes <sup>7,8</sup>      | TT <sub>LOAD</sub>  | Load step 50% to/from 100%                                                                                         | 4                    | 01              |        | 100  | μs     |
|                                                                  |                     |                                                                                                                    | 5,6                  |                 |        | 200  |        |
|                                                                  |                     | Load step 50% to/from 100%                                                                                         | 4                    |                 |        | 100  |        |
|                                                                  |                     |                                                                                                                    | 5,6                  |                 |        | 200  |        |
| Output response to transient<br>step line changes <sup>5,9</sup> | VO <sub>TLINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 7500mA                                                         | 4,5,6                | 01              |        | ±500 | mV pk  |

**Table I. Electrical performance Characteristics - continued**

**ATR2803R3S**

|                                                              | Symbol             | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |     | Units |
|--------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|-----|-------|
|                                                              |                    |                                                                                                                    |                      |                 | Min    | Max |       |
| Recovery time transient step line changes <sup>5, 8, 9</sup> | TT <sub>LINE</sub> | Input step 16V to/from 40VDC, I <sub>OUT</sub> = 7500mA                                                            | 4,5,6                | 01              |        | 10  | ms    |
| Turn on overshoot                                            | VT <sub>ONOS</sub> | I <sub>OUT</sub> = 10% to 100% of Load                                                                             | 4,5,6                | 01              |        | 350 | mV pk |
| Turn on delay <sup>10</sup>                                  | T <sub>OND</sub>   | I <sub>OUT</sub> = 0 and 7500mA                                                                                    | 4,5,6                | 01              |        | 25  | ms    |
| Load fault recovery <sup>5, 10</sup>                         | Tr <sub>LF</sub>   |                                                                                                                    | 4,5,6                | 01              |        | 25  | ms    |

**Notes to Specifications**

- Parameter guaranteed by line and load regulation tests.
- Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
- Output voltage measured at load with remote sense leads connected across load.
- Capacitive load may be any value from 0 to the maximum limit without compromising dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn on.
- Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in table I.
- An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
- Load step transition time between 2 and 10 microseconds.
- Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1 percent of V<sub>OUT</sub> at 50 percent load.
- Input step transition time between 2 and 10 microseconds.
- Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

## ATR28XXS Series

International  
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**ATR2805S**

### Specifications

| ABSOLUTE MAXIMUM RATINGS |                           |
|--------------------------|---------------------------|
| Input Voltage            | -0.5V to 50V              |
| Soldering Temperature    | 300°C for 10 seconds      |
| Case Temperature         | Operating -55°C to +125°C |
|                          | Storage -65°C to +135°C   |

**Table II. Electrical performance Characteristics**

| Test                                                             | Symbol              | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits       |                          | Units  |
|------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------------|--------------------------|--------|
|                                                                  |                     |                                                                                                                    |                      |                 | Min          | Max                      |        |
| Output voltage                                                   | V <sub>OUT</sub>    | I <sub>OUT</sub> = 0                                                                                               | 1<br>2,3             | 01              | 4.95<br>4.90 | 5.05<br>5.10             | V      |
| Output current <sup>1</sup>                                      | I <sub>OUT</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC                                                                               | 1,2,3                | 01              |              | 6000                     | mA     |
| Output ripple voltage <sup>2</sup>                               | V <sub>RIP</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC<br>B.W. = 20Hz to 2 MHz                                                       | 1,2,3                | 01              |              | 60                       | mV p-p |
| Line regulation <sup>3</sup>                                     | VR <sub>LINE</sub>  | V <sub>IN</sub> = 16, 28, and 40 VDC<br>I <sub>OUT</sub> = 0, 3000, and 6000mA                                     | 1<br>2,3             | 01              |              | ±20<br>±30               | mV     |
| Load regulation <sup>3</sup>                                     | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 16,28, and 40 VDC<br>I <sub>OUT</sub> = 0, 3000, and 6000mA                                      | 1,2,3                | 01              |              | ±50                      | mV     |
| Input current                                                    | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 2)<br>Tied to input return (pin 10)                                             | 1,2,3                | 01              |              | 18                       | mA     |
| Input ripple current <sup>2</sup>                                | I <sub>RIP</sub>    | I <sub>OUT</sub> = 0, inhibit (pin 2) = open<br>I <sub>OUT</sub> = 6000mA<br>B.W. = 20Hz to 2 MHz                  | 1,2,3                | 01              |              | 50                       | mA p-p |
| Efficiency                                                       | E <sub>FF</sub>     | I <sub>OUT</sub> = 6000mA                                                                                          | 1<br>2,3             | 01              | 76<br>72     |                          | %      |
| Isolation                                                        | ISO                 | Input to output or any pin<br>to case (except pin 8) at<br>500 VDC, TC = +25°C                                     | 1                    | 01              | 100          |                          | MΩ     |
| Capacitive load <sup>4,5</sup>                                   | C <sub>L</sub>      | No effect on dc performance<br>TC = +25°C                                                                          | 4                    | 01              |              | 500                      | μF     |
| Power dissipation<br>load fault                                  | P <sub>D</sub>      | Overload, TC = +25°C <sup>6</sup>                                                                                  | 1                    | 01              |              | 12                       | W      |
|                                                                  |                     | Short Circuit                                                                                                      | 1,2,3                |                 |              | 9                        |        |
| Switching frequency                                              | F <sub>S</sub>      | I <sub>OUT</sub> = 6000mA                                                                                          | 4,5,6                | 01              | 500          | 600                      | KHz    |
| Sync frequency range                                             | F <sub>SYNC</sub>   | I <sub>OUT</sub> = 6000mA                                                                                          | 4,5,6                | 01              | 500          | 700                      | KHz    |
| Output response to step<br>transient load changes <sup>7</sup>   | VO <sub>TLOAD</sub> | 3000mA to/from 6000mA<br>500mA to/from 3000mA                                                                      | 4,5,6                | 01              | -500<br>-500 | +500<br>+500             | mV pk  |
| Recovery time step<br>transient load changes <sup>7,8</sup>      | TT <sub>LOAD</sub>  | 3000mA to/from 6000mA<br>500mA to/from 3000mA                                                                      | 4<br>5,6<br>4<br>5,6 | 01              |              | 100<br>200<br>100<br>200 | μs     |
|                                                                  |                     |                                                                                                                    |                      |                 |              |                          |        |
|                                                                  |                     |                                                                                                                    |                      |                 |              |                          |        |
|                                                                  |                     |                                                                                                                    |                      |                 |              |                          |        |
| Output response to transient<br>step line changes <sup>5,9</sup> | VO <sub>TLINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 6000mA                                                         | 4,5,6                | 01              |              | ±500                     | mV pk  |

For Notes to Specifications, refer to page 5

Table II. Electrical performance Characteristics - continued

ATR2805S

| Test                                                            | Symbol                        | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |     | Units |
|-----------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|-----|-------|
|                                                                 |                               |                                                                                                                    |                      |                 | Min    | Max |       |
| Recovery time transient step<br>line changes <sup>5, 8, 9</sup> | TT <sub>LINE</sub>            | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 6000mA                                                         | 4,5,6                | 01              |        | 10  | ms    |
| Turn on overshoot                                               | V <sub>Ton<sub>OS</sub></sub> | I <sub>OUT</sub> = 0 and 6000mA                                                                                    | 4,5,6                | 01              |        | 500 | mV pk |
| Turn on delay <sup>10</sup>                                     | Ton <sub>D</sub>              | I <sub>OUT</sub> = 0 and 6000mA                                                                                    | 4,5,6                | 01              |        | 25  | ms    |
| Load fault recovery <sup>5, 10</sup>                            | Tr <sub>LF</sub>              |                                                                                                                    | 4,5,6                | 01              |        | 25  | ms    |

Notes to Specifications

- 1 Parameter guaranteed by line and load regulation tests.
- 2 Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
- 3 Output voltage measured at load with remote sense leads connected across load.
- 4 Capacitive load may be any value from 0 to the maximum limit without compromising dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn on.
- 5 Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in table II.
- 6 An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
- 7 Load step transition time between 2 and 10 microseconds.
- 8 Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1 percent of V<sub>OUT</sub> at 50 percent load.
- 9 Input step transition time between 2 and 10 microseconds.
- 10 Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

## ATR28XXS Series

International  
IOR Rectifier  
ATR2812S

### Specifications

| ABSOLUTE MAXIMUM RATINGS |                           |
|--------------------------|---------------------------|
| Input Voltage            | -0.5V to 50V              |
| Soldering Temperature    | 300°C for 10 seconds      |
| Case Temperature         | Operating -55°C to +125°C |
|                          | Storage -65°C to +135°C   |

**Table III. Electrical performance Characteristics**

| Test                                                                | Symbol              | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified     | Group A<br>Subgroups | Device<br>Types | Limits         |                          | Units |
|---------------------------------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|----------------|--------------------------|-------|
|                                                                     |                     |                                                                                                                        |                      |                 | Min            | Max                      |       |
| Output voltage                                                      | V <sub>OUT</sub>    | I <sub>OUT</sub> = 0                                                                                                   | 1<br>2,3             | 01              | 11.88<br>11.70 | 12.12<br>12.30           | V     |
| Output current <sup>1</sup>                                         | I <sub>OUT</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC                                                                                   | 1,2,3                | 01              |                | 2500                     | mA    |
| Output ripple voltage <sup>2</sup>                                  | V <sub>RIP</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC<br>B.W. = 20Hz to 2 MHz                                                           | 1,2,3                | 01              |                | 60                       | mVp-p |
| Line regulation <sup>3</sup>                                        | VR <sub>LINE</sub>  | V <sub>IN</sub> = 16, 28, and 40 VDC<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                         | 1<br>2,3             | 01              |                | ±30<br>±60               | mV    |
| Load regulation <sup>3</sup>                                        | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 16,28, and 40 VDC<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                          | 1<br>2,3             | 01              |                | ±60<br>±120              | mV    |
| Input current                                                       | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 2)<br>Tied to input return (pin 10)<br>I <sub>OUT</sub> = 0, inhibit (pin 2) = open | 1,2,3<br>1<br>2,3    | 01              |                | 18<br>50<br>75           | mA    |
| Input ripple current <sup>2</sup>                                   | I <sub>RIP</sub>    | I <sub>OUT</sub> = 2500mA<br>B.W. = 20Hz to 2 MHz                                                                      | 1,2,3                | 01              |                | 50                       | mAp-p |
| Efficiency                                                          | E <sub>FF</sub>     | I <sub>OUT</sub> = 2500mA                                                                                              | 1<br>2,3             | 01              | 80<br>75       |                          | %     |
| Isolation                                                           | I <sub>SO</sub>     | Input to output or any pin<br>To case (except pin 8) at<br>500 VDC, TC = +25°C                                         | 1                    | 01              | 100            |                          | MΩ    |
| Capacitive load <sup>4,5</sup>                                      | C <sub>L</sub>      | No effect on dc performance<br>TC = +25°C                                                                              | 4                    | 01              |                | 500                      | μF    |
| Power dissipation<br>load fault                                     | P <sub>D</sub>      | Overload, TC = +25°C <sup>6</sup><br>Short Circuit                                                                     | 1<br>1,2,3           | 01              |                | 12<br>9                  | W     |
| Switching frequency                                                 | F <sub>S</sub>      | I <sub>OUT</sub> = 2500mA                                                                                              | 4,5,6                | 01              | 500            | 600                      | KHz   |
| Sync frequency range                                                | F <sub>SYNC</sub>   | I <sub>OUT</sub> = 2500mA                                                                                              | 4,5,6                | 01              | 500            | 700                      | KHz   |
| Output response to step<br>transient load changes <sup>7</sup>      | VO <sub>TLOAD</sub> | 1250mA to/from 2500mA<br>200mA to/from 1250mA                                                                          | 4,5,6<br>4,5,6       | 01              | -800<br>-1000  | +800<br>+1000            | mV pk |
| Recovery time step<br>transient load changes <sup>7,8</sup>         | TT <sub>LOAD</sub>  | 1250mA to/from 2500mA<br>200mA to/from 1250mA                                                                          | 4<br>5,6<br>4<br>5,6 | 01              |                | 100<br>200<br>100<br>200 | μs    |
| Output response to<br>transient step line<br>changes <sup>5,9</sup> | VO <sub>TLINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 2500mA                                                             | 4,5,6                | 01              |                | ±1200                    | mV pk |

For Notes to Specifications, refer to page 7

**Table III. Electrical performance Characteristics - continued**

**ATR2812S**

| Test                                                            | Symbol             | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |     | Units |
|-----------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|-----|-------|
|                                                                 |                    |                                                                                                                    |                      |                 | Min    | Max |       |
| Recovery time transient<br>step line changes <sup>5, 8, 9</sup> | TT <sub>LINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 2500mA                                                         | 4,5,6                | 01              |        | 10  | ms    |
| Turn on overshoot                                               | VTon <sub>QS</sub> | I <sub>OUT</sub> = 0 and 2500mA                                                                                    | 4,5,6                | 01              |        | 800 | mV pk |
| Turn on delay <sup>10</sup>                                     | Ton <sub>D</sub>   | I <sub>OUT</sub> = 0 and 2500mA                                                                                    | 4,5,6                | 01              |        | 25  | ms    |
| Load fault recovery <sup>5, 10</sup>                            | Tr <sub>LF</sub>   |                                                                                                                    | 4,5,6                | 01              |        | 25  | ms    |

**Notes to Specifications**

- 1 Parameter guaranteed by line and load regulation tests.
- 2 Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
- 3 Output voltage measured at load with remote sense leads connected across load.
- 4 Capacitive load may be any value from 0 to the maximum limit without compromising dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn on.
- 5 Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in table III.
- 6 An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
- 7 Load step transition time between 2 and 10 microseconds.
- 8 Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1 percent of V<sub>OUT</sub> at 50 percent load.
- 9 Input step transition time between 2 and 10 microseconds.
- 10 Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

## ATR28XXS Series

International  
IOR Rectifier

## Specifications

ATR2815S

| ABSOLUTE MAXIMUM RATINGS |                           |
|--------------------------|---------------------------|
| Input Voltage            | -0.5V to 50V              |
| Soldering Temperature    | 300°C for 10 seconds      |
| Case Temperature         | Operating -55°C to +125°C |
|                          | Storage -65°C to +135°C   |

**Table IV. Electrical performance Characteristics**

| Test                                                                 | Symbol              | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified        | Group A<br>Subgroups | Device<br>Types | Limits         |                          | Units             |
|----------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|----------------|--------------------------|-------------------|
|                                                                      |                     |                                                                                                                           |                      |                 | Min            | Max                      |                   |
| Output voltage                                                       | V <sub>OUT</sub>    | I <sub>OUT</sub> = 0                                                                                                      | 1<br>2,3             | 01              | 14.85<br>14.60 | 15.15<br>15.40           | V                 |
| Output current <sup>1</sup>                                          | I <sub>OUT</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC<br>each output.                                                                      | 1,2,3                | 01              |                | 2000                     | mA                |
| Output ripple voltage <sup>3</sup>                                   | V <sub>RIP</sub>    | V <sub>IN</sub> = 16, 28, and 40 VDC<br>B.W. = 20Hz to 2 MHz                                                              | 1,2,3                | 01              |                | ±75                      | mVp-p             |
| Line regulation <sup>3</sup>                                         | VR <sub>LINE</sub>  | V <sub>IN</sub> = 16, 28, and 40 VDC<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                            | 1<br>2,3             | 01              |                | ±35<br>±75               | mV                |
| Load regulation <sup>3</sup>                                         | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 16,28, and 40 VDC<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                             | 1<br>2,3             | 01              |                | ±75<br>±150              | mV                |
| Input current                                                        | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 2)<br>Tied to input return (pin 10)<br>I <sub>OUT</sub> = 0,<br>Inhibit (pin 2) = open | 1,2,3<br>1<br>2,3    | 01              |                | 18<br>75<br>100          | mA                |
| Input ripple current <sup>2</sup>                                    | I <sub>RIP</sub>    | I <sub>OUT</sub> = 2500mA<br>B.W. = 20Hz to 2 MHz                                                                         | 1,2,3                | 01              |                | 50                       | mA <sub>p-p</sub> |
| Efficiency <sup>4</sup>                                              | E <sub>FF</sub>     | I <sub>OUT</sub> = 2500mA                                                                                                 | 1<br>2,3             | 01              | 79<br>75       |                          | %                 |
| Isolation                                                            | ISO                 | Input to output or any pin<br>to case (except pin 7) at<br>500 VDC, TC = +25°C                                            | 1                    | 01              | 100            |                          | MΩ                |
| Capacitive load <sup>4, 5</sup>                                      | C <sub>L</sub>      | No effect on dc performance,<br>TC = +25°C. Total for both<br>outputs                                                     | 4                    | 01              |                | 500                      | μF                |
| Power dissipation<br>load fault                                      | P <sub>D</sub>      | Overload, TC = +25°C <sup>6</sup><br>Short Circuit                                                                        | 1<br>1,2,3           | 01              |                | 12<br>9                  | W                 |
| Switching frequency <sup>4</sup>                                     | F <sub>S</sub>      | I <sub>OUT</sub> = 2500mA                                                                                                 | 4,5,6                | 01              | 500            | 600                      | KHz               |
| Sync frequency range                                                 | F <sub>SYNC</sub>   | I <sub>OUT</sub> = 2500mA                                                                                                 | 4,5,6                | 01              | 500            | 700                      | KHz               |
| Output response to step<br>transient load changes <sup>7</sup>       | VO <sub>TLOAD</sub> | 1000mA to/from 2000mA<br>167mA to/from 1000mA                                                                             | 4,5,6<br>4,5,6       | 01              | -1000<br>-1000 | +1000<br>+1000           | mVp-k             |
| Recovery time step<br>transient load changes <sup>7, 8</sup>         | TT <sub>LOAD</sub>  | 1000mA to/from 2000mA<br>167mA to/from 1000mA                                                                             | 4<br>5,6<br>4<br>5,6 | 01              |                | 100<br>200<br>100<br>200 | μs                |
| Output response to<br>transient step line<br>changes <sup>5, 9</sup> | VO <sub>TLINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 2000mA                                                                | 4,5,6                | 01              |                | ±1500                    | mVpk              |

For Notes to Specifications, refer to page 9

**Table IV. Electrical performance Characteristics - continued**

**ATR2815S**

| Test                                                            | Symbol             | Conditions<br>-55°C ≤ TC ≤ +125°C<br>V <sub>IN</sub> = 28VDC ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |      | Units |
|-----------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|------|-------|
|                                                                 |                    |                                                                                                                    |                      |                 | Min    | Max  |       |
| Recovery time transient<br>step line changes <sup>5, 8, 9</sup> | TT <sub>LINE</sub> | Input step 16V to/from<br>40VDC, I <sub>OUT</sub> = 2500mA                                                         | 4,5,6                | 01              |        | 10   | ms    |
| Turn on overshoot                                               | VTon <sub>OS</sub> | I <sub>OUT</sub> = 0 and 2000mA                                                                                    | 4,5,6                | 01              |        | 1000 | mVpk  |
| Turn on delay <sup>10</sup>                                     | Ton <sub>D</sub>   | I <sub>OUT</sub> = 0 and 2000mA                                                                                    | 4,5,6                | 01              |        | 25   | ms    |
| Load fault recovery <sup>5, 10</sup>                            | Tr <sub>LF</sub>   |                                                                                                                    | 4,5,6                | 01              |        | 25   | ms    |

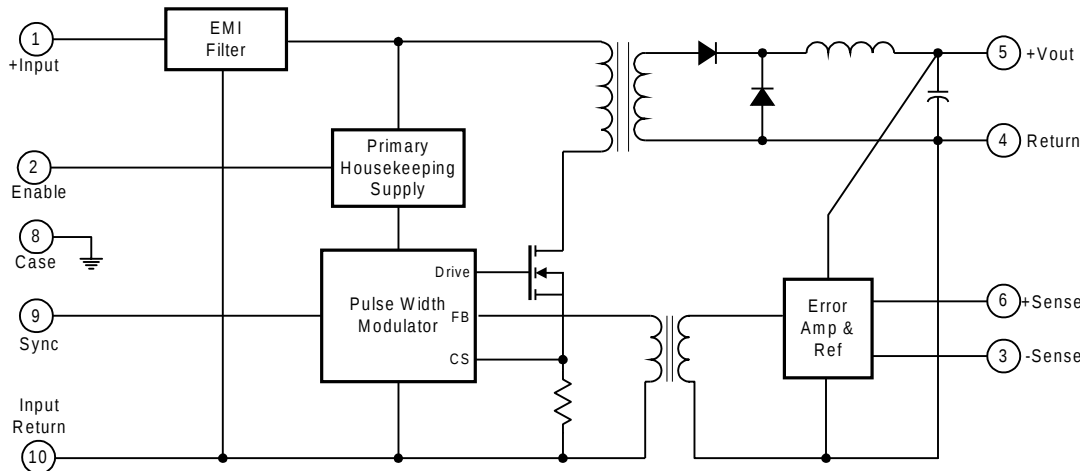
**Notes to Specifications**

- 1 Parameter guaranteed by line and load regulation tests.
- 2 Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
- 3 Output voltage measured at load with remote sense leads connected across load.
- 4 Capacitive load may be any value from 0 to the maximum limit without compromising dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn on.
- 5 Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in table IV.
- 6 An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is condition of maximum power dissipation.
- 7 Load step transition time between 2 and 10 microseconds.
- 8 Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1 percent of V<sub>OUT</sub> at 50 percent I load.
- 9 Input step transition time between 2 and 10 microseconds.
- 10 Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin2) while power is applied to the input.

## ATR28XXS Series

### ATR28XXS Block Diagram

International  
**IR** Rectifier



## Application Information

### Inhibit Function

Connecting the inhibit input (Pin 2) to input common (Pin 10) will cause the converter to shut down. It is recommended that the inhibit pin be driven by an open collector device capable of sinking at least 400μA of current. The open circuit voltage of the inhibit input is 11.5 ±1 VDC.

### EMI Filter

An Optional EMI filter (AFC461) is available that will reduce the input ripple current to levels below the limits imposed by MIL-STD-461B CEO3.

### Output Voltage Adjustment

The output voltage of the ATR2805S converter can be adjusted upward by connecting an appropriate resistor value between the Positive Output (Pin 5) and the Positive Sense (Pin 6) as shown in Table 1 below.

| Resistance Pin 5 to 6 (Ω) | Output Voltage Increase (V) |
|---------------------------|-----------------------------|
| 109                       | 0.1                         |
| 240                       | 0.2                         |
| 400                       | 0.3                         |
| 600                       | 0.4                         |
| 857                       | 0.5                         |
| 1200                      | 0.6                         |

Table1 Output adjustment resistor values for ATR2805S

### Device Synchronization

Whenever multiple DC/DC converters are utilized in a single system, significant low frequency noise may be generated due to slight difference in the switching frequencies of the converters. Because of the low frequency nature of this noise (typically less than 10KHz), it is difficult to filter out and may interfere with proper operation of sensitive systems. Advanced Analog permits synchronization of multiple ATR28XX converters to match switching frequency of the converter to the frequency of the system clock, thus eliminating this type of noise.

## Thermal Management

Assuming that there is no forced air flow, the package temperature rise above ambient ( $\Delta T$ ) may be calculated using the following expression:

$$\Delta T = 80 A^{-0.7} P_d^{0.85} (^{\circ}\text{C})$$

where A = the effective surface area in square inches (Including heat sink if used),  $P_d$  = power dissipation in watts.

The total surface area of the ATR package is 7.34 square inches. If a worst case full load efficiency of 76% is assumed, then the case temperature rise of an ATR2805S can be calculated as follows:

$$P = P_{out} \left[ \frac{1}{\text{Eff}} - 1 \right] = 30 \left[ \frac{1}{0.76} - 1 \right] = 9.5W$$

$$\Delta T = 80 (7.34)^{-0.7} (9.5)^{0.85} = 134^{\circ}\text{C}$$

Hence, if  $T_{\text{AMBIENT}} = +25^{\circ}\text{C}$ , the DC/DC converter case temperature will be approximately 159°C if no heat sink or air flow is provided.

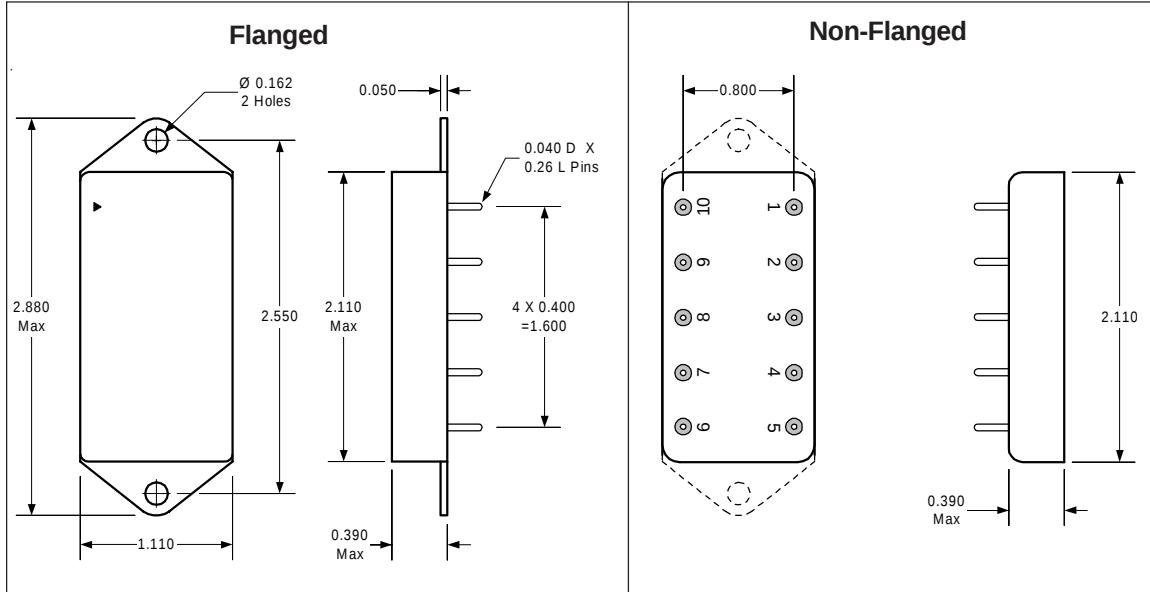
To calculate the heat sink area required to maintain a specific case temperature rise, the above equation may be manipulated as follows:

$$A_{\text{HEATSINK}} = \left[ \frac{\Delta T}{80 P_d^{0.85}} \right]^{-1.43} - A_{\text{PKG}}$$

As an example, if a maximum case temperature rise of 50°C above ambient is required, then the required effective heat sink area is:

$$A_{\text{HEATSINK}} = \left[ \frac{50}{80 (9.5)^{0.85}} \right]^{-1.43} - 7.34 = 22.9 \text{ in}^2$$

**ATR28XXS Case Outlines**

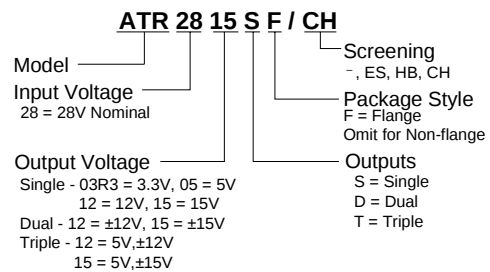


**Pin Designation**

| Pin No. | Designation     |
|---------|-----------------|
| 1       | Positive Input  |
| 2       | Enable Input    |
| 3       | Return Sense*   |
| 4       | Output Return   |
| 5       | Positive Output |
| 6       | Positive Sense* |
| 7       | N/C             |
| 8       | Case Ground     |
| 9       | Sync.           |
| 10      | Input Common    |

\* If neither remote sense nor voltage trim is used, connect Pin 3 to 4 and 5 to 6 or output voltage will increase by 1.2V.

**Part Numbering**



## ATR28XXS Series

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### Available Screening Levels and Process Variations for ATR28XXS Series

| Requirement                | MIL-STD-883 Method | No Suffix    | ES Suffix       | HB Suffix        | CH Suffix        |
|----------------------------|--------------------|--------------|-----------------|------------------|------------------|
| Temperature Range          |                    | -20 to +85°C | -55°C to +125°C | -55°C to +125°C  | -55°C to +125°C  |
| Element Evaluation         |                    |              |                 |                  | MIL-PRF-38534    |
| Internal Visual            | 2017               | *            | Yes             | Yes              | Yes              |
| Temperature Cycle          | 1010               |              | Cond B          | Cond C           | Cond C           |
| Constant Acceleration      | 2001               |              | 500g            | Cond A           | Cond A           |
| Burn-in                    | 1015               | 48hrs @ 85°C | 48hrs @ 125°C   | 160hrs @ 125°C   | 160hrs @ 125°C   |
| Final Electrical (Group A) | MIL-PRF-38534      | 25°C         | 25°C            | -55, +25, +125°C | -55, +25, +125°C |
| Seal, Fine & Gross         | 1014               | *            | Cond A, C       | Cond A, C        | Cond A, C        |
| External Visual            | 2009               | *            | Yes             | Yes              | Yes              |

\* Per Commercial Standards

### Available Standard Military Drawing (SMD) Cross Reference

| Standard Military drawing PIN | Vendor CAGE Code | Vendor Similar PIN |
|-------------------------------|------------------|--------------------|
| 5962-9462401                  | 52467            | ATR2805S/CH        |
| 5962-9462501                  | 52467            | ATR2812S/CH        |
| 5962-9462601                  | 52467            | ATR2815S/CH        |

International  
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*Data and specifications subject to change without notice. 04/2004*