

## HYBRID-HIGH RELIABILITY DC/DC CONVERTERS

### Description

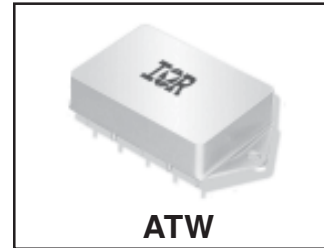
The ATW28XXD Series of DC/DC converters feature high power density and an extended temperature range for use in military and industrial applications. Designed to MIL-STD-704 input requirements, these devices operate with a nominal 28VDC inputs with  $\pm 12V$  and  $\pm 15V$  dual outputs to satisfy a wide range of requirements. The circuit design incorporates a pulse width modulated push-pull topology operating in the feed-forward mode at a nominal switching frequency of 270KHz. 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 elements in the feedback circuits.

Manufactured in a facility fully qualified to MIL-PRF-38534, these converters are fabricated utilizing DSCC qualified processes. For available screening options, refer to device screening table in the data sheet. Variations in electrical, mechanical and screening can be accommodated. Contact IR Santa Clara for special requirements.

## ATW28XXD SERIES

28V Input, Dual Output



### Features

- 18V to 40VDC Input Range (28VDC Nominal)
- $\pm 12V$  and  $\pm 15V$  Outputs Available
- Indefinite Short Circuit and Overload Protection
- 22.8W/in<sup>3</sup> Power Density
- 30W Output Power
- Fast Loop Response for Superior Transient Characteristics
- Operating Temperature Range from -55°C to +125°C Available
- Popular Industry Standard Pin-Out
- Resistance Seam Welded Case for Superior Long Term Hermeticity
- Efficiencies up to 85%
- Shutdown from External Signal
- Full Military Screening
- 200,000 hour MTBF at 85°C
- Standard Microcircuit Drawings Available

## Specifications

ATW2812D

| Absolute Maximum Ratings   |                      |
|----------------------------|----------------------|
| Input voltage              | -0.5V to +50VDC      |
| Soldering temperature      | 300°C for 10 seconds |
| Operating case temperature | -55°C to +125°C      |
| Storage case temperature   | -65°C to +135°C      |

Table I. Electrical Performance Characteristics

| Test                                                                | Symbol              | Conditions<br>-55°C ≤ T <sub>c</sub> ≤ +125°C<br>V <sub>in</sub> = 28 Vdc ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |        | Unit   |
|---------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|--------|--------|
|                                                                     |                     |                                                                                                                                 |                      |                 | Min    | Max    |        |
| Output voltage                                                      | V <sub>OUT</sub>    | I <sub>OUT</sub> = 0                                                                                                            | 1                    | All             | ±11.88 | ±12.12 | V      |
|                                                                     |                     |                                                                                                                                 | 2,3                  |                 | ±11.76 | ±12.24 |        |
| Output current <sup>1,2</sup>                                       | I <sub>OUT</sub>    | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>each output                                                                           | 1,2,3                | All             | 250    | 2250   | mA     |
| Output ripple voltage <sup>3</sup>                                  | V <sub>RIP</sub>    | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>B.W. = 20Hz to 2MHz                                                                   | 1,2,3                | All             |        | 85     | mVp-p  |
| Line regulation <sup>4</sup>                                        | VR <sub>LINE</sub>  | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                                | 1                    | All             |        | 30     | mV     |
|                                                                     |                     |                                                                                                                                 | 2,3                  |                 |        | 60     |        |
| Load regulation <sup>4</sup>                                        | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>I <sub>OUT</sub> = 0, 1250, and 2500mA                                                | 1,2,3                | All             |        | 120    | mV     |
| Cross regulation <sup>5</sup>                                       | VR <sub>CROSS</sub> | 10% to 90% load change                                                                                                          | 1,2,3                | All             |        | 3.5    | %      |
| Input current                                                       | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 8)<br>tied to input return (pin 10)                                                          | 1,2,3                | All             |        | 18     | mA     |
|                                                                     |                     | I <sub>OUT</sub> = 0, inhibit (pin 8) =<br>open                                                                                 |                      |                 |        | 50     |        |
| Input ripple current <sup>3,4</sup>                                 | I <sub>RIP</sub>    | I <sub>OUT</sub> = 2500mA<br>B.W. = 20Hz to 2MHz                                                                                | 1,2,3                | All             |        | 50     | mA p-p |
| Efficiency <sup>4</sup>                                             | E <sub>FF</sub>     | I <sub>OUT</sub> = 2500mA<br>T <sub>C</sub> = +25°C                                                                             | 1                    | All             | 80     |        | %      |
| Isolation                                                           | ISO                 | Input to output or any pin<br>to case (except pin 7) at<br>500 V dc T <sub>C</sub> = +25°C                                      | 1                    | All             | 100    |        | MΩ     |
| Capacitive load <sup>6,7</sup>                                      | C <sub>L</sub>      | No effect on dc<br>performance, T <sub>C</sub> = +25°C,<br>total for both outputs                                               | 4                    | All             |        | 200    | μF     |
| Power dissipation<br>load fault                                     | P <sub>D</sub>      | Overload, T <sub>C</sub> = +25°C <sup>8</sup>                                                                                   | 1                    | All             |        | 12     | W      |
|                                                                     |                     | Short circuit, T <sub>C</sub> = +25°C                                                                                           |                      |                 |        | 9.0    |        |
| Switching frequency <sup>4</sup>                                    | F <sub>S</sub>      | I <sub>OUT</sub> = 2500mA                                                                                                       | 4,5,6                | 01              | 250    | 300    | KHz    |
|                                                                     |                     |                                                                                                                                 |                      | 02              | 250    | 270    |        |
|                                                                     |                     |                                                                                                                                 |                      | 03              | 275    | 300    |        |
| Output response to step<br>transient load<br>changes <sup>4,9</sup> | VO <sub>TLOAD</sub> | 1250mA to/from 2500mA                                                                                                           | 4,5,6                | All             | -400   | +400   | mV pk  |
|                                                                     |                     | 0mA to/from 2500mA                                                                                                              | 4,5,6                | All             | -800   | +800   |        |
| Recovery time step<br>transient load<br>changes <sup>4,9,10</sup>   | TT <sub>LOAD</sub>  | 1250mA to/from 2500mA                                                                                                           | 4,5,6                | All             |        | 70     | μs     |
|                                                                     |                     | 0mA to/from 1250mA                                                                                                              | 4,5,6                | All             |        | 500    |        |
|                                                                     |                     | 1250mA to/from 0mA                                                                                                              | 4,5,6                | All             |        | 5.0    | ms     |

For Notes to Specifications, refer to page 3

**Table I. Electrical Performance Characteristics - continued**
**ATW2812D**

| Test                                                                   | Symbol                         | Conditions<br>-55°C ≤ T <sub>c</sub> ≤ +125°C<br>V <sub>in</sub> = 28 V <sub>dc</sub> ±5%, C <sub>L</sub> = 0<br>unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |      | Unit  |
|------------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|------|-------|
|                                                                        |                                |                                                                                                                                             |                      |                 | Min    | Max  |       |
| Output response<br>transient step line<br>changes <sup>4, 7, 11</sup>  | V <sub>O<sub>TLINE</sub></sub> | Input step from/to 18 to 40<br>V <sub>dc</sub> , I <sub>OUT</sub> = 2500mA                                                                  | 4,5,6                | All             | -800   | +800 | mV pk |
| Recovery time<br>transient step line<br>change <sup>4, 7, 10, 11</sup> | T <sub>TLINE</sub>             | Input step from/to 18 to 40<br>V <sub>dc</sub> , I <sub>OUT</sub> = 2500mA                                                                  | 4,5,6                | All             |        | 4000 | μs    |
| Turn on overshoot <sup>4</sup>                                         | V <sub>TonOS</sub>             | I <sub>OUT</sub> = 0 and 2500mA                                                                                                             | 4,5,6                | All             |        | 750  | mV pk |
| Turn on delay <sup>4, 12</sup>                                         | T <sub>onD</sub>               | I <sub>OUT</sub> = 0 and 2500mA                                                                                                             | 4,5,6                | All             |        | 14   | ms    |
| Load fault recovery <sup>7</sup>                                       | T <sub>rLF</sub>               |                                                                                                                                             | 4,5,6                | All             |        | 14   | ms    |
| Weight                                                                 |                                | Flange                                                                                                                                      |                      |                 |        | 75   | g     |

**Notes to Specifications**

- 1 Parameter guaranteed by line, load and cross regulation tests.
- 2 Up to 90% of full power is available from either output provided the total output does not exceed 30W.
- 3 Bandwidth guaranteed by design. Tested for 20KHz to 2MHz.
- 4 Load current split equally between +V<sub>OUT</sub> and -V<sub>OUT</sub>.
- 5 Three-watt load on output under test, 3.0W to 27W load change on other output.
- 6 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.
- 7 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.
- 8 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.
- 9 Load step transition time between 2.0μs and 10μs.
- 10 Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1.0% of V<sub>OUT</sub> at 50%load.
- 11 Input step transition time between 2.0μs and 10μs.
- 12 Turn-on delay time measurement is for either a step application of power at the input or the removal of ground signal from the inhibit pin (pin 8) while power is applied to the input.

## Specifications

## ATW2815D

| Absolute Maximum Ratings   |                      |
|----------------------------|----------------------|
| Input voltage              | -0.5V to +50VDC      |
| Soldering temperature      | 300°C for 10 seconds |
| Operating case temperature | -55°C to +125°C      |
| Storage case temperature   | -65°C to +135°C      |

Table II. Electrical Performance Characteristics

| Test                                                                     | Symbol              | Conditions<br>-55°C ≤ T <sub>c</sub> ≤ +125°C<br>V <sub>in</sub> = 28 Vdc ±5%, C <sub>L</sub> = 0<br>Unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |        | Unit              |
|--------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|--------|--------|-------------------|
|                                                                          |                     |                                                                                                                                 |                      |                 | Min    | Max    |                   |
| Output voltage                                                           | V <sub>OUT</sub>    | V <sub>IN</sub> = 18, 28, and 40 Vdc<br>I <sub>OUT</sub> = 0                                                                    | 1                    | All             | ±14.85 | ±15.15 | V <sub>DC</sub>   |
|                                                                          |                     |                                                                                                                                 | 2,3                  | All             | ±14.70 | ±15.30 | V <sub>DC</sub>   |
| Output current <sup>11, 13</sup>                                         | I <sub>OUT</sub>    | V <sub>IN</sub> = 18, 28, and 40 V dc                                                                                           | 1,2,3                | All             | 0.200  | 2000   | mA <sub>DC</sub>  |
| Output ripple voltage <sup>8</sup>                                       | V <sub>RIP</sub>    | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>B.W. = DC to MHz                                                                      | 1,2,3                | All             |        | 85     | mVp-p             |
| Output Power <sup>4, 11</sup>                                            | P <sub>OUT</sub>    | V <sub>IN</sub> = 18, 28, 40 Vdc                                                                                                | 1,2,3                | All             | 30     |        | W                 |
| Line regulation <sup>9, 10</sup>                                         | VR <sub>LINE</sub>  | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>I <sub>out</sub> = 0, 1000, and 2000mA                                                | 1                    | All             |        | 35     | mV                |
| Load regulation <sup>9, 10</sup>                                         | VR <sub>LOAD</sub>  | V <sub>IN</sub> = 18, 28, and 40 V dc,<br>I <sub>OUT</sub> = 0, 1000, and 2000mA                                                | 2,3                  | All             |        | 75     | mV                |
|                                                                          |                     |                                                                                                                                 | 1,2,3                | All             |        | 150    | mV                |
| Input current                                                            | I <sub>IN</sub>     | I <sub>OUT</sub> = 0, inhibit (pin 8)                                                                                           | 1,2,3                | All             |        | 12     | mA <sub>DC</sub>  |
|                                                                          |                     | I <sub>OUT</sub> = 0, inhibit (pin 8) = open                                                                                    | 1,2,3                | All             |        | 30     | mA <sub>DC</sub>  |
| Input ripple current                                                     | I <sub>RIP</sub>    | I <sub>OUT</sub> = 2000mA                                                                                                       | 1,2,3                | All             |        | 60     | mA <sub>p-p</sub> |
| Efficiency                                                               | E <sub>FF</sub>     | I <sub>OUT</sub> = 2500mA T <sub>C</sub> = 25°C                                                                                 | 1                    | All             | 80     |        | %                 |
| Isolation                                                                | ISO                 | Input to output or any pin<br>to case (except pin 8) at<br>500V dc T <sub>C</sub> = 25°C                                        | 1                    | All             | 100    |        | MΩ                |
| Capacitive load <sup>6, 12</sup>                                         | C <sub>L</sub>      | No effect on dc performance,<br>T <sub>C</sub> = 25°C                                                                           | 4                    | All             |        | 500    | μF                |
| Power dissipation<br>load fault                                          | P <sub>D</sub>      | Overload, T <sub>C</sub> = +25°C <sup>3</sup>                                                                                   | 1                    | All             |        | 9.0    | W                 |
|                                                                          |                     | Short circuit, T <sub>C</sub> = +25°C                                                                                           | 1                    | All             |        | 9.0    | W                 |
| Switching frequency                                                      | F <sub>S</sub>      | I <sub>OUT</sub> = 2000mA                                                                                                       | 1,2,3                | 01              | 237    | 263    | KHz               |
|                                                                          |                     |                                                                                                                                 | 1,2,3                | 02              | 230    | 245    | KHz               |
|                                                                          |                     |                                                                                                                                 | 1,2,3                | 03              | 250    | 265    | KHz               |
| Output response to step<br>transient<br>load changes <sup>7, 9, 10</sup> | VO <sub>TLOAD</sub> | 50% load to/from 100% load                                                                                                      | 4,5,6                | All             | -300   | +300   | mV pk             |
|                                                                          |                     | No load to 100% load                                                                                                            | 4,5,6                | All             | -800   | -800   | mV pk             |
|                                                                          |                     | 100% load to no load                                                                                                            | 4,5,6                | All             | +800   | +800   | mV pk             |
| Recovery time step<br>transient load changes <sup>1, 7</sup>             | TT <sub>LOAD</sub>  | 50% load to/from 100% load                                                                                                      | 4,5,6                | All             |        | 25     | μs                |
|                                                                          |                     | No load to 50% load                                                                                                             | 4,5,6                | All             |        | 500    | μs                |
|                                                                          |                     | 50% load to no load                                                                                                             | 4,5,6                | All             |        | 7.0    | ms                |

For Notes to Specifications, refer to page 5

Table II. Electrical Performance Characteristics - continued

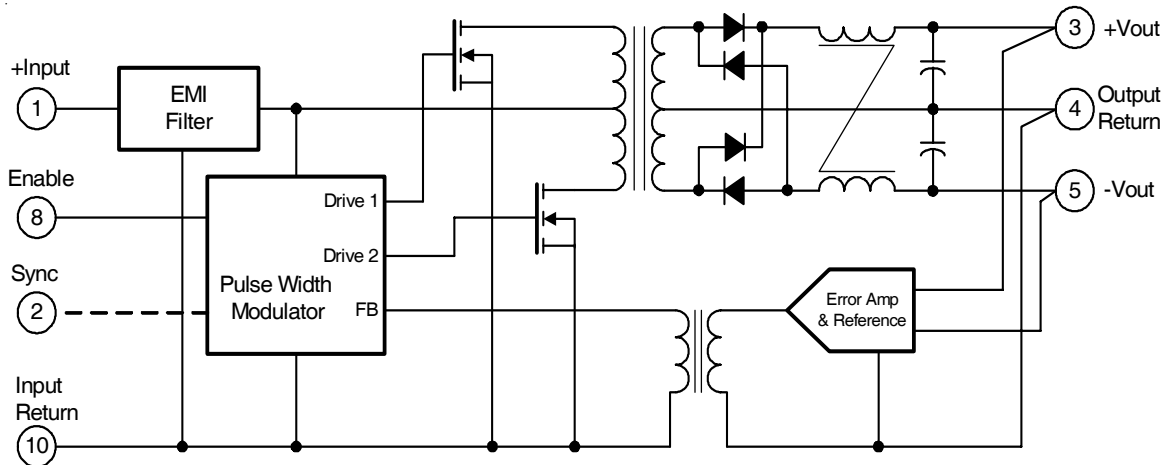
ATW2815D

| Test                                                                | Symbol              | Conditions<br>-55°C ≤ Tc ≤ +125°C<br>Vin = 28 Vdc ±5%, CL = 0<br>unless otherwise specified | Group A<br>Subgroups | Device<br>Types | Limits |      | Unit  |
|---------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------|----------------------|-----------------|--------|------|-------|
|                                                                     |                     |                                                                                             |                      |                 | Min    | Max  |       |
| Output response<br>transient step line<br>changes <sup>5, 12</sup>  | VO <sub>TLINE</sub> | Input step from/to 18 to<br>40VDC                                                           | 4,5,6                | All             |        | +180 | mV pk |
| Recovery time<br>transient step line<br>changes <sup>1, 5, 12</sup> | TT <sub>LINE</sub>  | Input step from 40 to 18 VDC                                                                | 4,5,6                | All             |        | -600 | mV pk |
|                                                                     |                     | Input step from/to 18 to 40<br>VDC                                                          | 4,5,6                | All             |        | 400  | μs    |
|                                                                     |                     | Input step from 40 to 18 VDC                                                                | 4,5,6                | All             |        | 400  | μs    |
| Turn on overshoot                                                   | V <sub>TonOS</sub>  | I <sub>OUT</sub> = 0 and 2000mA                                                             | 4,5,6                | All             |        | 750  | mV pk |
| Turn on delay <sup>2</sup>                                          | T <sub>onD</sub>    | I <sub>OUT</sub> = 0 and 2000mA                                                             | 4,5,6                | All             |        | 12   | ms    |
| Load fault recovery <sup>12</sup>                                   | Tr <sub>LF</sub>    | V <sub>IN</sub> = 18 to 40 VDC                                                              | 4,5,6                | All             |        | 12   | ms    |
| Weight                                                              |                     | Flange                                                                                      |                      |                 |        | 75   | g     |

#### Notes to Specifications

- Recovery time is measured from the initiation of the transient to where V<sub>OUT</sub> has returned to within ±1.0% of V<sub>OUT</sub> at 50% load.
- 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 8) while power is applied to the input.
- 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.
- Above +125°C case, derate output power linearly to 0 at +135°C case.
- Input step transition time between 2.0μs and 10μs.
- 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 will interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn on.
- Load step transition time between 2.0μs and 10μs.
- Bandwidth guaranteed by design. Tested for 20KHz to 2MHz.
- Load current split equally between +V<sub>OUT</sub> and -V<sub>OUT</sub>.
- When operating with unbalanced loads, at least 25% of the load must be on the positive output to maintain regulation.
- Parameter guaranteed by line and load regulation tests.
- 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.
- Up to 90% of full power is available from either output provided the total output does not exceed 30W.

### Block Diagram



### Application Information

#### Inhibit Function (Enable)

Connecting the inhibit input (Pin 8) 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 400 $\mu$ A of current. The open circuit voltage of the inhibit input is 11.5  $\pm$  1.0VDC.

#### EMI Filter

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

#### Device Synchronization

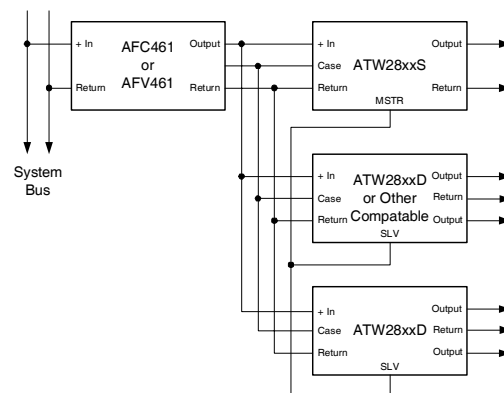
Whenever multiple DC/DC converters are utilized in a single system, significant low frequency noise may be generated due to the slight differences in the switching frequencies of the converters (beat frequency noise). Because of the low frequency nature of this noise (typically less than 10KHz), it is difficult to filter out and may interfere with proper operation of sensitive systems (communications, radar or telemetry). International Rectifier offers an option, which allows synchronization of multiple AHE/ATW type converters, thus eliminating this type of noise.

To take advantage of this capability, the system designer must assign one of the converters as the master. Then, by definition, the remaining converters become slaves and will operate at the masters' switching frequency.

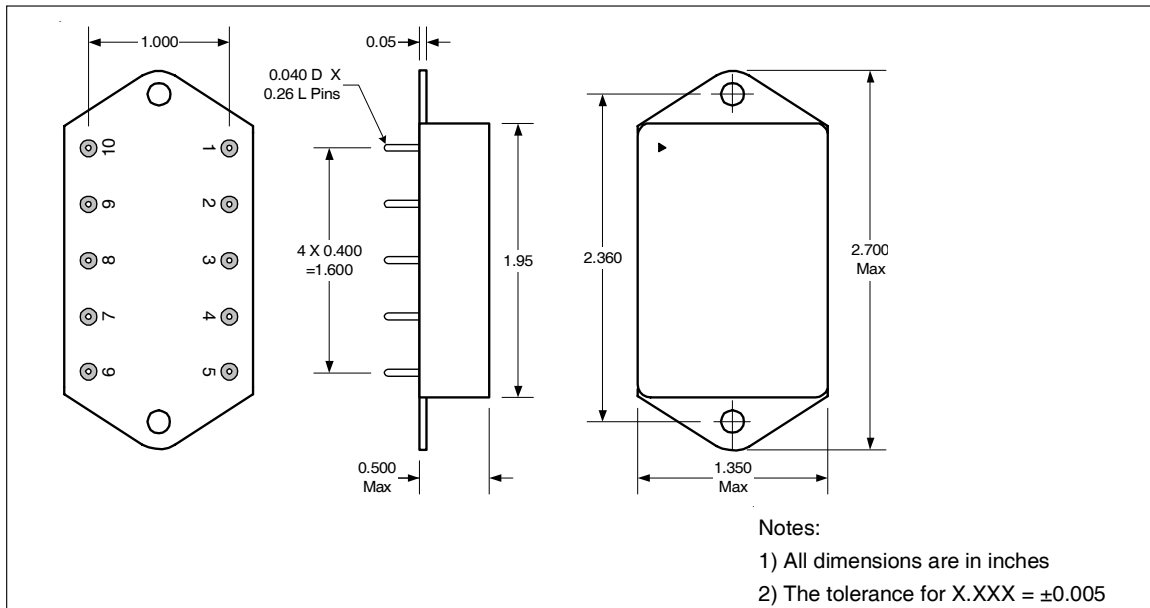
The user should be aware that the synchronization system is fail-safe; that is, the slaves will continue operating should the master frequency be interrupted for any reason. The layout must be such that the synchronization output (pin 2) of the master device is connected to the synchronization input (pin 2) of each slave device. It is advisable to keep this run short to minimize the possibility of radiating the 250KHz switching frequency.

The appropriate parts must be ordered to utilize this feature. After selecting the converters required for the system, a 'MSTR' suffix is added for the master converter part number and a 'SLV' suffix is added for slave part number. See Part Number section.

#### Typical Synchronization Connection



**Mechanical Outline**



**Pin Designation**

| Pin # | Designation                          |
|-------|--------------------------------------|
| 1     | + Input                              |
| 2     | NC Standard or<br>Sync. ( Optional ) |
| 3     | + Output                             |
| 4     | Output Return                        |
| 5     | - Output                             |
| 6     | NC                                   |
| 7     | Case Ground                          |
| 8     | Enable                               |
| 9     | NC                                   |
| 10    | Input Return                         |

**Standard Microcircuit Drawing Equivalence Table**

| Standard Microcircuit<br>Drawing Number | Vendor Cage<br>Code | IR Standard<br>Part Number |
|-----------------------------------------|---------------------|----------------------------|
| 5962-92109                              | 52467               | ATW2812D                   |
| 5962-91613                              | 52467               | ATW2815D                   |

## ATW28XXD Series

International  
**IR** Rectifier

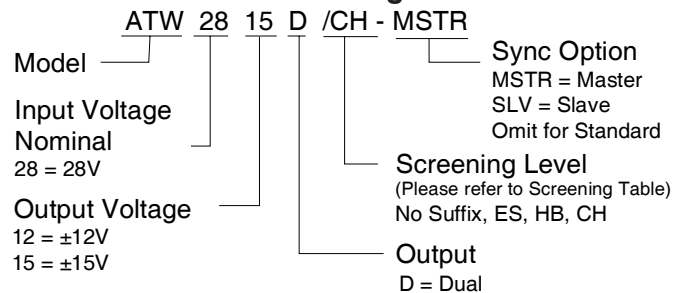
### Device Screening

| Requirement                     | MIL-STD-883 Method               | No Suffix      | ES ②              | HB                      | CH                      |
|---------------------------------|----------------------------------|----------------|-------------------|-------------------------|-------------------------|
| Temperature Range               | —                                | -20°C to +85°C | -55°C to +125°C ③ | -55°C to +125°C         | -55°C to +125°C         |
| Element Evaluation              | MIL-PRF-38534                    | N/A            | N/A               | N/A                     | Class H                 |
| Non-Destructive<br>Bond Pull    | 2023                             | N/A            | N/A               | N/A                     | N/A                     |
| Internal Visual                 | 2017                             | ①              | Yes               | Yes                     | Yes                     |
| Temperature Cycle               | 1010                             | N/A            | Cond B            | Cond C                  | Cond C                  |
| Constant Acceleration           | 2001, Y1 Axis                    | N/A            | 500 Gs            | 3000 Gs                 | 3000 Gs                 |
| PIND                            | 2020                             | N/A            | N/A               | N/A                     | N/A                     |
| Burn-In                         | 1015                             | N/A            | 48 hrs@hi temp    | 160 hrs@125°C           | 160 hrs@125°C           |
| Final Electrical<br>( Group A ) | MIL-PRF-38534<br>& Specification | 25°C           | 25°C ②            | -55°C, +25°C,<br>+125°C | -55°C, +25°C,<br>+125°C |
| PDA                             | MIL-PRF-38534                    | N/A            | N/A               | N/A                     | 10%                     |
| Seal, Fine and Gross            | 1014                             | Cond A         | Cond A, C         | Cond A, C               | Cond A, C               |
| Radiographic                    | 2012                             | N/A            | N/A               | N/A                     | N/A                     |
| External Visual                 | 2009                             | ①              | Yes               | Yes                     | Yes                     |

#### Notes:

- ① Best commercial practice
- ② Sample tests at low and high temperatures
- ③ -55°C to +105°C for AHE, ATO, ATW

### Part Numbering



International  
**IR** Rectifier

**WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, Tel: (310) 252-7105

**IR SANTA CLARA:** 2270 Martin Av., Santa Clara, California 95050, Tel: (408) 727-0500

Visit us at [www.irf.com](http://www.irf.com) for sales contact information.

Data and specifications subject to change without notice. 12/2006