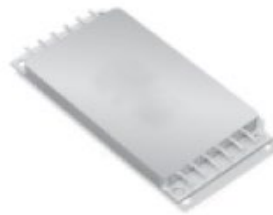


AFL28XXS Series

28V Input, Single Output

Part Numbers: AFL2805S, AFL2807S, AFL2808S, AFL2809S, AFL2812S, AFL2815S, AFL2828S



Advanced Product Brief

The AFL Series of DC/DC converters feature high power density with no derating over the full military temperature range. This series is offered as part of a complete family of converters providing single and dual output voltages and operating from nominal +28V or +270V inputs with output power ranging from 80W to 120W. For applications requiring higher output power, individual converters can be operated in parallel. The internal current sharing circuits assure equal current distribution among the paralleled converters. This series incorporates our proprietary magnetic pulse feedback technology providing optimum dynamic line and load regulation response. This feedback system samples the output voltage at the pulse width modulator fixed clock frequency, nominally 550KHz. Multiple converters can be synchronized to a system clock in the 500KHz to 700KHz range or to the synchronization output of one converter. Undervoltage lockout, primary and secondary referenced inhibit, soft-start and load fault protection are provided on all models.

These converters are hermetically packaged in two enclosure variations, utilizing copper core pins to minimize resistive DC losses. Three lead styles are available, each fabricated with our rugged ceramic lead-to-package seal assuring long term hermeticity in the most-harsh environments.

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.

Features

- 16V to 40V Input Range
- 5, 7, 8, 9, 12, 15 and 28V Outputs Available
- High Power Density - up to 84W/in³
- Up to 120W Output Power
- Parallel Operation with Power Sharing
- Low Profile (0.380") Seam Welded Package
- Ceramic Feed-Thru Copper Core Pins
- High Efficiency - to 85%
- Full Military Temperature Range
- Continuous Short Circuit and Overload Protection
- Primary and Secondary Referenced Inhibit Functions
- Line Rejection > 40dB - DC to 50KHz
- External Synchronization Port
- Fault Tolerant Design
- Dual Output Versions Available
- Standard Microcircuit Drawing Available

Revision History

| Revision | Description | Release Date |
|----------|-------------------------------|--------------|
| 1.0 | AFL28XXS Microcross Datasheet | 11/21/2024 |
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1.0 Specifications

| Table 1. 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 2. Static Characteristics | | | | | | |
|--|-------------------|---------------------------------------|-------|-------|-------|------|
| -55°C < T _{CASE} ≤ +125°C, 16V ≤ V _{IN} ≤ 40V Unless Otherwise Specified | | | | | | |
| Parameter | Group A Subgroups | Test Conditions | Min | Nom | Max | Unit |
| Input Voltage | | Note 6 | 16 | 28 | 40 | V |
| Output Voltage | | V _{IN} = 28V, 100% Load | | | | |
| AFL2805S | 1 | | 4.95 | 5.00 | 5.05 | |
| AFL2807S | 1 | | 6.93 | 7.00 | 7.07 | |
| AFL2808S | 1 | | 7.92 | 8.00 | 8.08 | |
| AFL2809S | 1 | | 8.91 | 9.00 | 9.09 | |
| AFL2812S | 1 | | 11.88 | 12.00 | 12.12 | |
| AFL2815S | 1 | | 14.85 | 15.00 | 15.15 | |
| AFL2828S | 1 | | 27.72 | 28.00 | 28.28 | V |
| AFL2805S | 2,3 | | 4.90 | | 5.10 | |
| AFL2807S | 2,3 | | 6.86 | | 7.17 | |
| AFL2808S | 2,3 | | 7.84 | | 8.16 | |
| AFL2809S | 2,3 | | 8.82 | | 9.18 | |
| AFL2812S | 2,3 | | 11.76 | | 12.24 | |
| AFL2815S | 2,3 | | 14.70 | | 15.30 | |
| AFL2828S | 2,3 | | 27.44 | | 28.56 | |
| Output Current | | V _{IN} = 16, 28, 40V. Note 6 | | | | |
| AFL2805S | | | | | 16 | |
| AFL2807S | | | | | 11.4 | A |
| AFL2808S | | | | | 10 | |

Table 2. Static Characteristics Cont.

-55°C < T_{CASE} ≤ +125°C, 16V ≤ V_{IN} ≤ 40V Unless Otherwise Specified

| Parameter | Group A Subgroups | Test Conditions | Min | Nom | Max | Unit |
|---|-------------------|--|-------------------------------|------|--------|------|
| Output Current | | V _{IN} = 16, 28, 40V. Note 6 | | | | |
| AFL2809S | | | | | 10 | A |
| AFL2812S | | | | | 9.0 | |
| AFL2815S | | | | | 8.0 | |
| AFL2828S | | | | | 4.0 | |
| Output Power | | Note 6 | | | | |
| AFL2805S | | | | | 80 | W |
| AFL2807S | | | | | 80 | |
| AFL2808S | | | | | 80 | |
| AFL2809S | | | | | 90 | |
| AFL2812S | | | | | 108 | |
| AFL2815S | | | | | 120 | |
| AFL2828S | | | | | 112 | |
| Maximum Capacitive Load | | Note 1 | 10,000 | | | μF |
| Output Voltage Temperature Coefficient | | V _{IN} = 28V, 100% Load. Notes 1,6 | -0.015 | | +0.015 | %/°C |
| Output Voltage Regulation | | | | | | |
| AFL2828S | Line | 1,2,3 | No Load, 50% Load, 100% Load | -70 | +70 | mV |
| All Others | Line | 1,2,3 | V _{IN} = 16, 28, 40V | -20 | +20 | mV |
| | Load | 1,2,3 | | -1.0 | +1.0 | % |
| Output Ripple Voltage | | V _{IN} = 16, 28, 40V, 100% Load BW = 10MHz | | | | |
| AFL2805S | | 1,2,3 | | | 30 | mVpp |
| AFL2807S | | 1,2,3 | | | 40 | |
| AFL2808S | | 1,2,3 | | | 40 | |
| AFL2809S | | 1,2,3 | | | 40 | |
| AFL2812S | | 1,2,3 | | | 45 | |
| AFL2815S | | 1,2,3 | | | 50 | |

Table 2. Static Characteristics Cont.

-55°C < T_{CASE} ≤ +125°C, 16V ≤ V_{IN} ≤ 40V Unless Otherwise Specified

| Parameter | Group A Subgroups | Test Conditions | Min | Nom | Max | Unit |
|--|-------------------|--|-----|-----|-----|------|
| Output Ripple Voltage AFL2828S | 1,2,3 | V _{IN} = 16, 28, 40V, 100% Load BW = 10MHz | | | 100 | mVpp |
| Input Current No Load | 1 | V _{IN} = 28V I _{OUT} = 0 | | | 80 | mA |
| Inhibit 1 | 2,3 | | | 100 | | |
| Inhibit 2 | 1,2,3 | Pin 4 Shortened to Pin 2 | | 5.0 | | |
| | 1,2,3 | Pin 12 Shortened to Pin 8 | | 50 | | |
| Input Ripple Current AFL2805S | 1,2,3 | V _{IN} = 28V, 100% Load BW = 10MHz | | | 60 | mApp |
| AFL2807S | 1,2,3 | | | 60 | | |
| AFL2808S | 1,2,3 | | | 60 | | |
| AFL2809S | 1,2,3 | | | 60 | | |
| AFL2812S | 1,2,3 | | | 60 | | |
| AFL2815S | 1,2,3 | | | 60 | | |
| AFL2828S | 1,2,3 | | | 60 | | |
| Current Limit Point Expressed as Percentage of Full Rated Load | 1 | V _{OUT} = 90% V _{NOM} , V _{IN} = 28V. Note 5 | 115 | | 125 | % |
| | 2 | | 105 | | 115 | |
| | 3 | | 125 | | 140 | |
| Load Fault Power Dissipation Overload or Short Circuit | 1,2,3 | V _{IN} = 28V | | | 33 | W |
| Efficiency AFL2805S | 1,2,3 | V _{IN} = 120V, 100% Load | 78 | 81 | | % |
| AFL2807S | 1,2,3 | | 79 | 82 | | |
| AFL2808S | 1,2,3 | | 79 | 82 | | |

Table 2. Static Characteristics Cont.

-55°C < T_{CASE} ≤ +125°C, 16V ≤ V_{IN} ≤ 40V Unless Otherwise Specified

| Parameter | Group A Subgroups | Test Conditions | Min | Nom | Max | Unit |
|--|-------------------|---|------|-----|-----|------|
| Efficiency | | V _{IN} = 28V, 100% Load | | | | |
| AFL2809S | 1,2,3 | | 80 | 83 | | % |
| AFL2812S | 1,2,3 | | 80 | 84 | | |
| AFL2815S | 1,2,3 | | 81 | 85 | | |
| AFL2828S | 1,2,3 | | 81 | 84 | | |
| Enable Inputs (Inhibit Function) | | | | | | |
| Converter Off | 1,2,3 | Logical Low on Pin 4 or Pin 12 | -0.5 | | 0.8 | V |
| Sink Current | | Note 1 | | | 100 | μA |
| Converter On | 1,2,3 | Logical High on Pin 4 & 12. Note 9 | 2.0 | | 50 | V |
| Sink Current | | Note 1 | | | 100 | μA |
| Switching Frequency | 1,2,3 | | 500 | 550 | 600 | KHz |
| Synchronization Input | | | | | | |
| Frequency Range | 1,2,3 | | 500 | | 700 | KHz |
| Pulse Amplitude, Hi | 1,2,3 | | 2.0 | | 10 | V |
| Pulse Amplitude, Lo | 1,2,3 | | -0.5 | | 0.8 | V |
| Pulse Rise Time | | Note 1 | | | 100 | ns |
| Pulse Duty Cycle | | Note 1 | 20 | | 80 | % |
| Isolation | 1 | Input Output or Any Pin to Case (except Pin 3). Test @ 500VDC | 100 | | | MΩ |
| Device Weight | | Slight Variations with Case Style | | 85 | | g |
| MTBF | | MIL-HDBK-217F, AIF at T _C = 40°C | 300 | | | KHrs |

Table 3. Dynamic Characteristics

-55°C < T_{CASE} ≤ +125°C, V_{IN} = 28V Unless Otherwise Specified

| Parameter | | Group A Subgroups | Test Conditions | | Min | Nom | Max | Unit |
|--------------------------------|-----------|-------------------|-----------------|------------|-------|-----|------|------|
| Load Transient Response | | | Notes 2,8 | | | | | |
| AFL2805S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -450 | | 450 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -450 | | 450 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2807S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -500 | | 500 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -500 | | 500 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2808S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -500 | | 500 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -500 | | 500 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2809S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -600 | | 600 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -600 | | 600 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2812S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -750 | | 750 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -750 | | 750 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2815S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -750 | | 750 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |
| | Amplitude | 4,5,6 | Load Step | 10% ↔ 50% | -750 | | 750 | mV |
| | Recovery | 4,5,6 | | | | | 400 | μs |
| AFL2828S | Amplitude | 4,5,6 | Load Step | 50% ↔ 100% | -1200 | | 1200 | mV |
| | Recovery | 4,5,6 | | | | | 200 | μs |

Table 3. Dynamic Characteristics Cont.

-55°C < T_{CASE} ≤ +125°C, V_{IN} = 28V Unless Otherwise Specified

| Parameter | Group A Subgroups | Test Conditions | Min | Nom | Max | Unit |
|--------------------------------|-------------------|--|-------|-----|------|------|
| Load Transient Response | | Notes 2,8 | | | | |
| AFL2828S Amplitude | 4,5,6 | Load Step 10% ↔ 50% | -1200 | | 1200 | mV |
| Recovery | 4,5,6 | | | | 400 | μs |
| Line Transient Response | | Notes 1,2,3 | | | | |
| Amplitude | | V _{IN} Step = 16 ↔ 40V | -500 | | 500 | mV |
| Recovery | | | | | 500 | μs |
| Turn-On Characteristics | | V _{IN} = 16, 28, 40V. Note 4 | | | | |
| Overshoot | 4,5,6 | Enable 1,2 on. (Pins 4, 12 high or open) | | | 250 | mV |
| Delay | 4,5,6 | | 0 | 4.0 | 10 | ms |
| Load Fault Recovery | | Same as Turn-On Characteristics | | | | |
| Line Rejection | | MIL-STD-461, CS101, 30Hz to 50KHz – Note 1 | 40 | 50 | | dB |

Notes to Specifications:

- Parameters not 100% tested but are guaranteed to the limits specified in the table.
- Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within ±1.0% of V_{OUT} at 50% load.
- Line transient transition time ≥ 100μs.
- Turn-on delay is measured with an input voltage rise time of between 100V and 500V per millisecond.
- Current limit point is that condition of excess load causing output voltage to drop to 90% of nominal.
- Parameter verified as part of another test.
- All electrical tests are performed with the remote sense leads connected to the output leads at the load.
- Load transient transition time ≥ 10μs.
- Enable inputs internally pulled high. Nominal open circuit voltage ≈ 4.0VDC.

2.0 Block Diagram

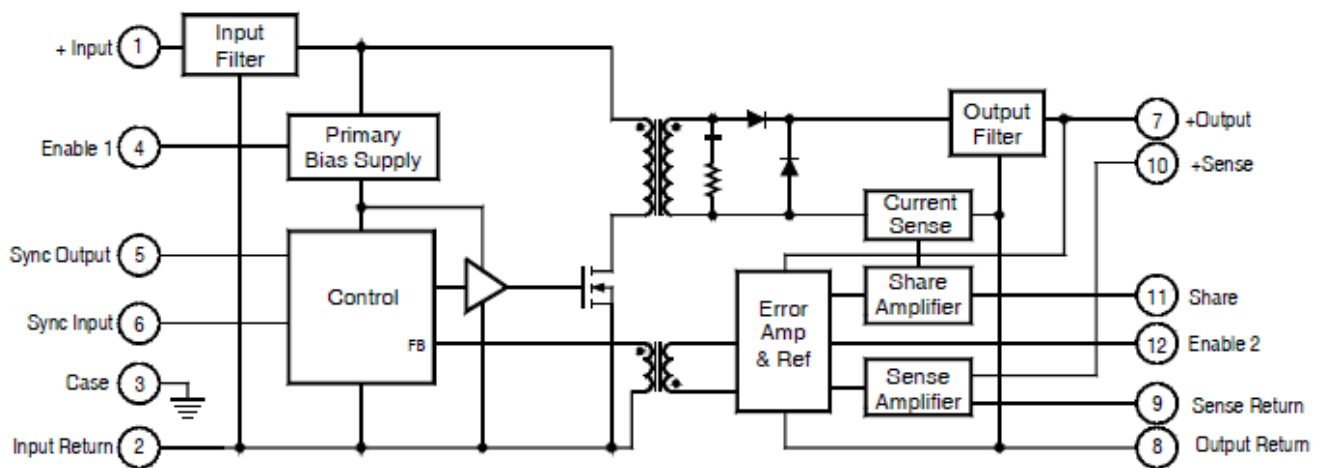


Figure 1. AFL Single Output

3.0 Circuit Operation and Application Information

The AFL series of converters employ a forward switched mode converter topology. (refer to Figure 1) Operation of the device is initiated when a DC voltage whose magnitude is within the specified input limits is applied between pins 1 and 2. If pin 4 is enabled (at a logical 1 or open) the primary bias supply will begin generating a regulated housekeeping voltage bringing the circuitry on the primary side of the converter to life. A power MOSFET is used to chop the DC input voltage into a high frequency square wave, applying this chopped voltage to the power transformer at the nominal converter switching frequency. Maintaining a DC voltage within the specified operating range at the input assures continuous generation of the primary bias voltage.

The switched voltage impressed on the secondary output transformer winding is rectified and filtered to generate the converter DC output voltage. An error amplifier on the secondary side compares the output voltage to a precision reference and generates an error signal proportional to the difference. This error signal is magnetically coupled through the feedback transformer into the controller section of the converter varying the pulse width of the square wave signal driving the MOSFET, narrowing the width if the output voltage is too high and widening it if it is too low, thereby regulating the output voltage.

4.0 Remote Sensing

Connection of the + and - sense leads at a remotely located load permits compensation for excessive resistance between the converter output and the load when their physical separation could cause undesirable voltage drop. This connection allows regulation to the placard voltage at the point of application. When the remote sensing feature is not used, the sense should be connected to their respective output terminals at the converter. Figure 3. illustrates a typical remotely sensed application.

5.0 Inhibit Converter Output (Enable)

As an alternative to application and removal of the DC voltage to the input, the user can control the converter output by providing TTL compatible, positive logic signals to either of two enable pins (pin 4 or 12). The distinction between these two signal ports is that enable 1 (pin 4) is referenced to the input return (pin 2) while enable 2 (pin 12) is referenced to the output return (pin 8). Thus, the user has access to an inhibit function on either side of the isolation barrier. Each port is internally pulled “high” so that when not used, an open connection on both enable pins permits normal converter operation. When their use is desired, a logical “low” on either port will shut the converter down.

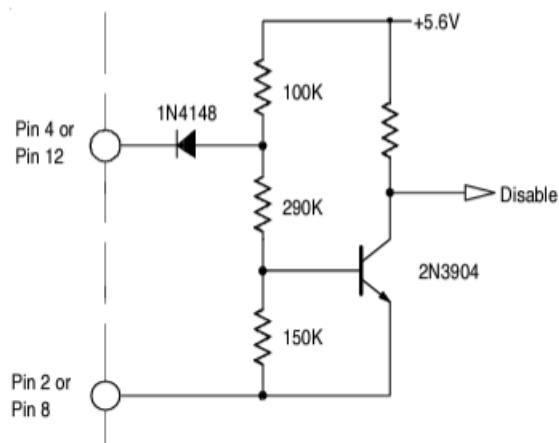


Figure 2. Enable Input Equivalent Circuit

Internally, these ports differ slightly in their function. In use, a low on Enable 1 completely shuts down all circuits in the converter while a low on Enable 2 shuts down the secondary side while altering the controller duty cycle to near zero. Externally, the use of either port is transparent to the user save for minor differences in idle current. (See specification table).

6.0 Synchronization of Multiple Converters

When operating multiple converters, system requirements often dictate operation of the converters at a common frequency. To accommodate this requirement, the AFL series converters provide both a synchronization input and output.

The sync input port permits synchronization of an AFL converter to any compatible external frequency source operating between 500KHz and 700KHz. This input signal should be referenced to the input return and have a 10% to 90% duty cycle. Compatibility requires transition times less than 100ns, maximum low level of +0.8V and a minimum high level of +2.0V. The sync output of another converter which has been designated as the master oscillator provides a convenient frequency source for this mode of operation. When external synchronization is not required, the sync in pin should be left unconnected thereby permitting the converter to operate at its' own internally set frequency.

The sync output signal is a continuous pulse train set at $550 \pm 50\text{KHz}$, with a duty cycle of $15 \pm 5.0\%$. This signal is referenced to the input return and has been tailored to be compatible with the AFL sync input port. Transition times are less than 100ns and the low-level output impedance is less than 50Ω. This signal is active when the DC input voltage is within the specified operating range and the converter is not inhibited. This output has adequate drive reserve to synchronize at least five additional converters. A typical synchronization connection option is illustrated in Figure 3.

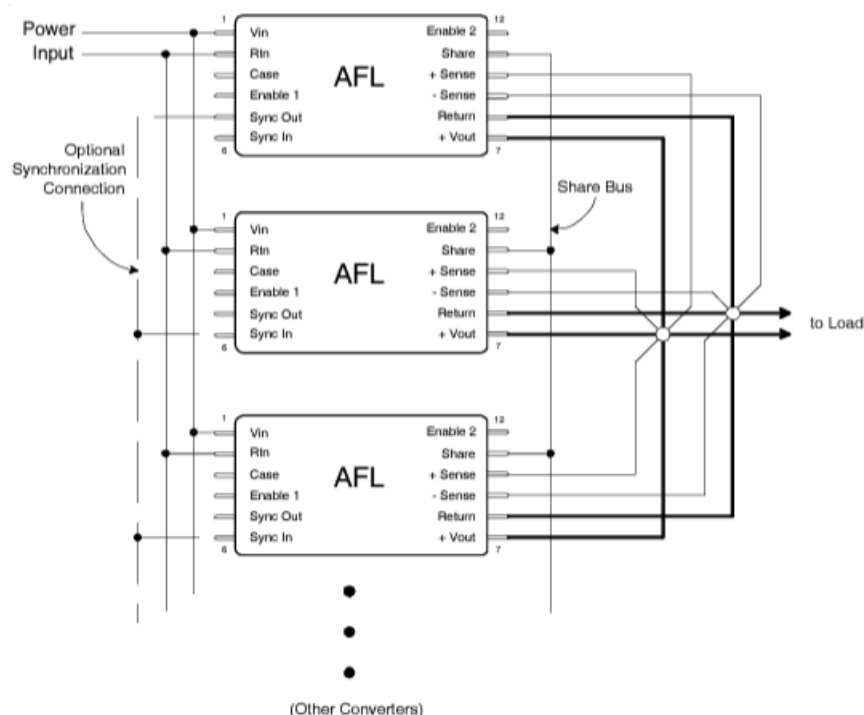


Figure 3. Preferred Connection for Parallel Operation

7.0 Parallel Operation-Current and Stress Sharing

Figure 3. illustrates the preferred connection scheme for operation of a set of AFL converters with outputs operating in parallel. Use of this connection permits equal current sharing among the members of a set whose load current exceeds the capacity of an individual AFL. An important feature of the AFL series operating in the parallel mode is that in addition to sharing the current, the stress induced by temperature will also be shared. Thus, if one member of a paralleled set is operating at a higher case temperature, the current it provides to the load will be reduced as compensation for the temperature induced stress on that device.

When operating in the shared mode, it is important that symmetry of connection be maintained as an assurance of optimum load sharing performance. Thus, converter outputs should be connected to the load with equal lengths of wire of the same gauge and should be connected to a common physical point, preferably at the load along with the converter output and return leads. All converters in a paralleled set must have their share pins connected together. This arrangement is diagrammatically illustrated in Figure 3. showing the output and return pins connected at a star point which is located close as possible to the load.

As a consequence of the topology utilized in the current sharing circuit, the share pin may be used for other functions. In applications requiring only a single converter, the voltage appearing on the share pin may be used as a “total current monitor”. The share pin open circuit voltage is nominally +1.00V at no load and increases linearly with increasing total output current to +2.20V at full load. Note that the current we refer to here is the total output current, that is, the sum of the positive and negative output currents.

8.0 Thermal Considerations

Because of the incorporation of many innovative technological concepts, the AFL series of converters is capable of providing very high output power from a package of very small volume. These magnitudes of power density can only be obtained by combining high circuit efficiency with effective methods of heat removal from the die junctions. This requirement has been effectively addressed inside the device; but when operating at maximum loads, a significant amount of heat will be generated and this heat must be conducted away from the case. To maintain the case temperature at or below the specified maximum of 125°C, this heat must be transferred by conduction to an appropriate heat dissipater held in intimate contact with the converter base-plate.

Because effectiveness of this heat transfer is dependent on the intimacy of the baseplate/heatsink interface, it is strongly recommended that a high thermal conductivity heat transference medium is inserted between the baseplate and heatsink. The material most frequently utilized at the factory during all testing and burn-in processes is sold under the trade name of Sil-Pad[®] 400¹. This particular product is an insulator but electrically conductive versions are also available. Use of these materials assures maximum surface contact with the heat dissipator thereby compensating for minor variations of either surface. While other available types of heat conductive materials and compounds may provide similar performance, these alternatives are often less convenient and are frequently messy to use.

¹Sil-Pad is a registered Trade Mark of Bergquist, Minneapolis, MN.

A conservative aid to estimating the total heat sink surface area ($A_{HEAT\ SINK}$) required to set the maximum case temperature rise (ΔT) above ambient temperature is given by the following expression:

$$A_{HEATSINK} \approx \left\{ \frac{\Delta T}{80P^{0.85}} \right\}^{-1.43} - 3.0$$

Where

ΔT = Case temperature rise above ambient

P = Device dissipation in Watts = $P_{OUT} \left\{ \frac{1}{Eff} - 1 \right\}$

As an example, it is desired to maintain the case temperature of an AFL2815S at $\leq +85^{\circ}\text{C}$ while operating in an open area whose ambient temperature is held at a constant $+25^{\circ}\text{C}$; then

$$\Delta T = 85 - 25 = 60^{\circ}\text{C}$$

From the Specification Table, the worst-case full load efficiency for this device is 83%; therefore the power dissipation at full load is given by

$$P = 120 \cdot \left\{ \frac{1}{.83} - 1 \right\} = 120 \cdot (0.205) = 24.6W$$

And the required heat sink area is

$$A_{HEATSINK} = \left\{ \frac{60}{80 \cdot 24.6^{0.85}} \right\}^{-1.43} - 3.0 = 71in^2$$

Thus, a total heat sink surface area (including fins, if any) of 71in² in this example, would limit case rise to 60°C above ambient. A flat aluminum plate, 0.25" thick and of approximate dimension 4" by 9" (36in² per side) would suffice for this application in a still air environment. Note that to meet the criteria in this example, both sides of the plate require unrestricted exposure to the ambient air.

9.0 Input Filter

The AFL28XXS series converters incorporate a two stage LC input filter whose elements dominate the input load impedance characteristic during the turn-on. The input circuit is as shown in Figure 4.

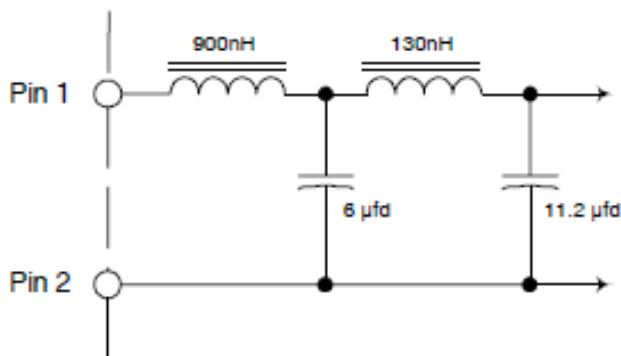


Figure 4. Input Filter Circuit

10.0 Undervoltage Lockout

A minimum voltage is required at the input of the converter to initiate operation. This voltage is set to 14V ± 0.5V. To preclude the possibility of noise or other variations at the input falsely initiating and halting converter operation, a hysteresis of approximately 1.0V is incorporated in this circuit. Thus, if the input voltage droops to 13V ± 0.5V, the converter will shut down and remain inoperative until the input voltage returns to ≈ 14V.

11.0 Output Voltage Adjust

In addition to permitting close voltage regulation of remotely located loads, it is possible to utilize the converter sense pins to incrementally increase the output voltage over a limited range. The adjustments made possible by this method are intended as a means to “trim” the output to a voltage setting for some particular application, but are not intended to create an adjustable output converter. These output voltage setting

variations are obtained by connecting an appropriate resistor value between the +sense and -sense pins while connecting the -sense pin to the output return pin as shown in Figure 5. below. The range of adjustment and corresponding range of resistance values can be determined by use of the following equation.

$$R_{adj} = 100 \cdot \left\{ \frac{V_{NOM}}{V_{OUT} - V_{NOM} - .025} \right\}$$

Where

V_{NOM} = device nominal output voltage, and

V_{OUT} = desired output voltage

Finding a resistor value for a particular output voltage, is simply a matter of substituting the desired output voltage and the nominal device voltage into the equation and solving for the corresponding resistor value.

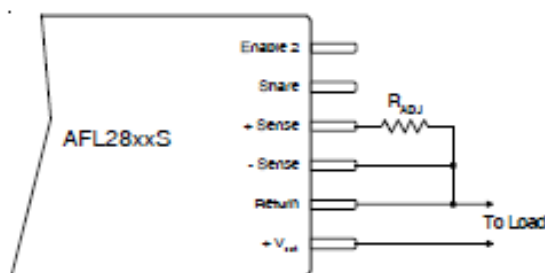


Figure 5. Connection for V_{OUT} Adjustment

Note: R_{adj} must be set $\geq 500\Omega$

Attempts to adjust the output voltage to a value greater than 120% of nominal should be avoided because of the potential of exceeding internal component stress ratings and subsequent operation to failure. Under no circumstance should the external setting resistor be made less than 500 Ω . By remaining within this specified range of values, completely safe operation fully within normal component derating limits is assured.

Examination of the equation relating output voltage and resistor value reveals a special benefit of the circuit topology utilized for remote sensing of output voltage in the AFL28XXS series of converters. It is apparent that as the resistance increases, the output voltage approaches the nominal set value of the device. In fact, the calculated limiting value of output voltage as the adjusting resistor becomes very large is $\approx 25\text{mV}$ above nominal device voltage.

The consequence is that if the +sense connection is unintentionally broken, an AFL28XXS has a fail-safe output voltage of $V_{OUT} + 25\text{mV}$, where the 25mV is independent of the nominal output voltage. It can be further demonstrated that in the event of both the + and - sense connections being broken; the output will be limited to $V_{OUT} + 440\text{mV}$. This 440mV is also essentially constant independent of the of the nominal output voltage.

12.0 General Application Information

The AFL28XXS series of converters are capable of providing large transient currents to user loads on demand. Because the nominal input voltage range in this series is relatively low, the resulting input current demands will be correspondingly large. It is important therefore, that the line impedance be kept very low to prevent steady state and transient input currents from degrading the supply voltage between the voltage source and the converter input. In applications requiring high static currents and large transients, it is recommended that the input leads be made of adequate size to minimize resistive losses, and that a good quality capacitor of approximately 100 μ fd be connected directly across the input terminals to assure an adequately low impedance at the input terminals. Table 4. relates nominal resistance values and selected wire sizes.

| Table 4. Nominal Resistance of Cu Wire | |
|--|--------------------|
| Wire Size, AWG | Resistance Per ft. |
| 24 Ga | 25.7 m Ω |
| 22 Ga | 16.2 m Ω |
| 20 Ga | 10.1 m Ω |
| 18 Ga | 6.4 m Ω |
| 16 Ga | 4.0 m Ω |
| 14 Ga | 2.5 m Ω |
| 12 Ga | 1.6 m Ω |

As an example of the effects of parasitic resistance, consider an AFL2815S operating at full power of 120W. From the specification sheet, this device has a minimum efficiency of 83% which represents an input power of more than 145W. If we consider the case where line voltage is at its' minimum of 16V, the steady state input current necessary for this example will be slightly greater than 9 amperes. If this device were connected to a voltage source with 10 feet of 20-gauge wire, the round trip (input and return) would result in 0.2 Ω of resistance and 1.8V of drop from the source to the converter. To assure 16V at the input, a source closer to 18V would be required. In applications using the paralleling option, this drop will be multiplied by the number of paralleled devices. By choosing 14- or 16-gauge wire in this example, the parasitic resistance and resulting voltage drop will be reduced to 25% or 31% of that with 20-gauge wire.

Another potential problem resulting from parasitically induced voltage drop on the input lines is with regard to the operation of the enable 1 port. The minimum and maximum operating levels required to operate this port are specified with respect to the input common return line at the converter. If a logic signal is generated with respect to a 'common' that is distant from the converter, the effects of the voltage drop over the return line must be considered when establishing the worst case TTL switching levels. These drops will effectively impart a shift to the logic levels. In Figure 6, it can be seen that referred to system ground, the voltage on the input return pin is given by

$$e_{Rtn} = I_{Rtn} \cdot R_p$$

Therefore, the logic signal level generated in the system must be capable of a TTL logic high plus sufficient additional amplitude to overcome e_{Rtn} . When the converter is inhibited, I_{Rtn} diminishes to near zero and e_{Rtn} will then be at system ground.

Incorporation of a 100 μ F capacitor at the input terminals is recommended as compensation for the dynamic effects of the parasitic resistance of the input cable reacting with the complex impedance of the converter input, and to provide an energy reservoir for transient input current requirements.

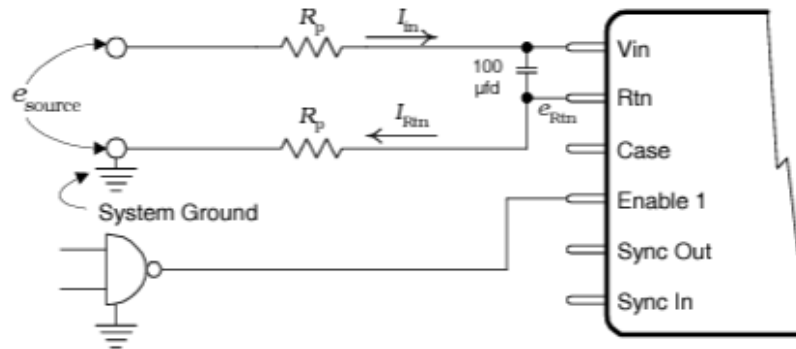


Figure 6. Problems of Parasitic Resistance in Input Leads

13.0 Mechanical Outlines

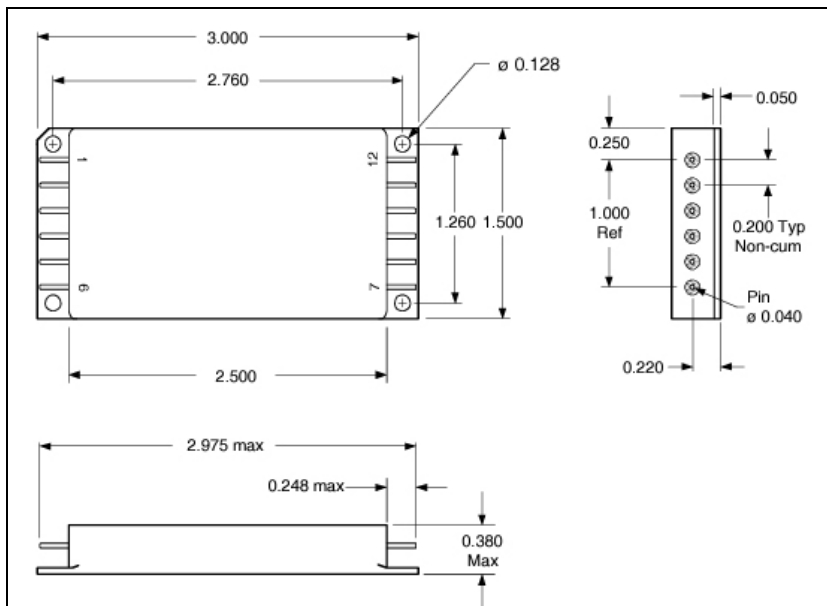


Figure 7. Case X

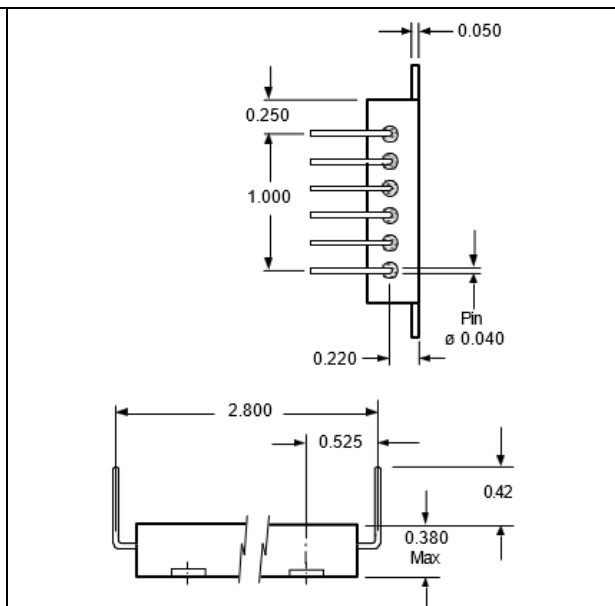


Figure 8. Case W

Pin Variation of Case Y

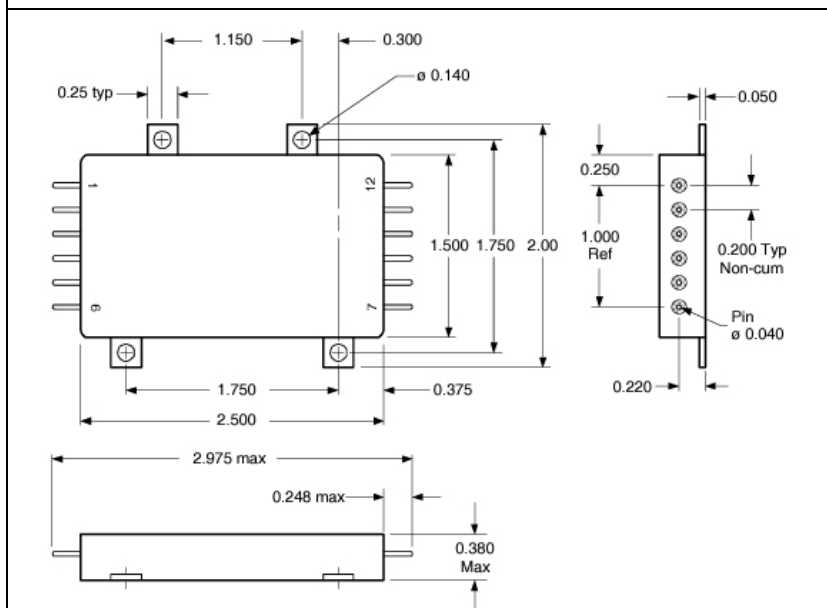


Figure 9. Case Y

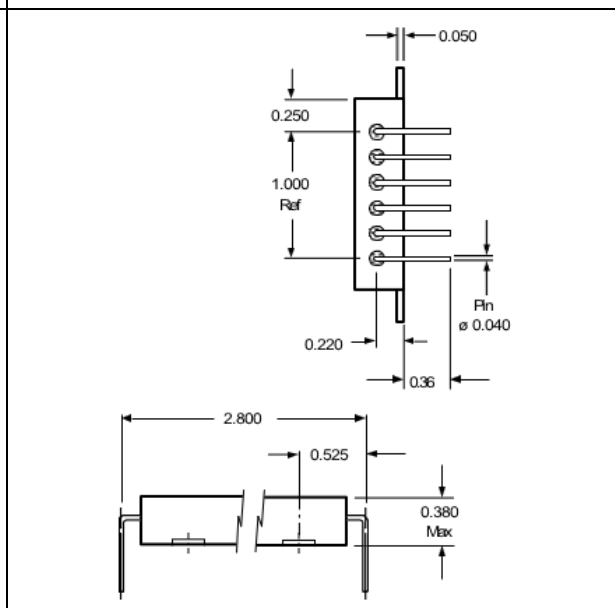


Figure 10. Case Z

Pin Variation of Case Y

Tolerances, unless otherwise specified: .XX = ±0.10

.XXX = ±0.005

BERYLLIA WARNING: These converters are hermetically sealed; however, they contain BeO substrates and should not be ground or subjected to any other operations including exposure to acids, which may produce Beryllium dust or fumes containing Beryllium

14.0 Pin Designation

| Table 5. Pin Designation | | | |
|--------------------------|--------------|-------|---------------|
| Pin # | Designation | Pin # | Designation |
| 1 | + Input | 7 | + Output |
| 2 | Input Return | 8 | Output Return |
| 3 | Case Ground | 9 | Sense Return |
| 4 | Enable 1 | 10 | + Sense |
| 5 | Sync Output | 11 | Share |
| 6 | Sync Input | 12 | Enable 2 |

15.0 Standard Microcircuit Drawing Equivalence

| Table 6. SMD Equivalence | |
|--------------------------|-------------|
| SMD Number | Part Number |
| 5962-94721 | AFL2805S |
| 5962-96659 | AFL2808S |
| 5962-94772 | AFL2812S |
| 5962-94723 | AFL2815S |
| 5962-96899 | AFL2828S |

16.0 Device Screening

| Table 7. Device Screening | | | | | |
|----------------------------|-------------------------------|----------------|--------------------------|----------------------|----------------------|
| Requirement | MIL-STD-883 Method | No Suffix | ES – Note 2 | HB | CH |
| Temperature Range | – | -20°C to +85°C | -55°C to +125°C – Note 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 Bond Pull | 2023 | N/A | N/A | N/A | N/A |
| Internal Visual | 2017 | Note 1 | Yes | Yes | Yes |
| Temperature Cycle | 1010 | N/A | Cond B | Cond C | Cond C |
| Constant Acceleration | 2001, Y1 Axis | N/A | 500Gs | 3000Gs | 3000Gs |
| PIND | 2020 | N/A | N/A | N/A | N/A |
| Burn-In | 1015 | N/A | 48hrs at Hi Temp | 160hrs at 125°C | 160hrs at 125°C |
| Final Electrical (Group A) | MIL-PRF-38534 & Specification | 25°C | 25°C – Note 2 | -55°C, +25°C, +125°C | -55°C, +25°C, +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 | Note 1 | Yes | Yes | Yes |

Notes:

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

17.0 Part Ordering

