Power Matters

Microsemi Standard Isolated DC/DC Portfolio & Roadmap

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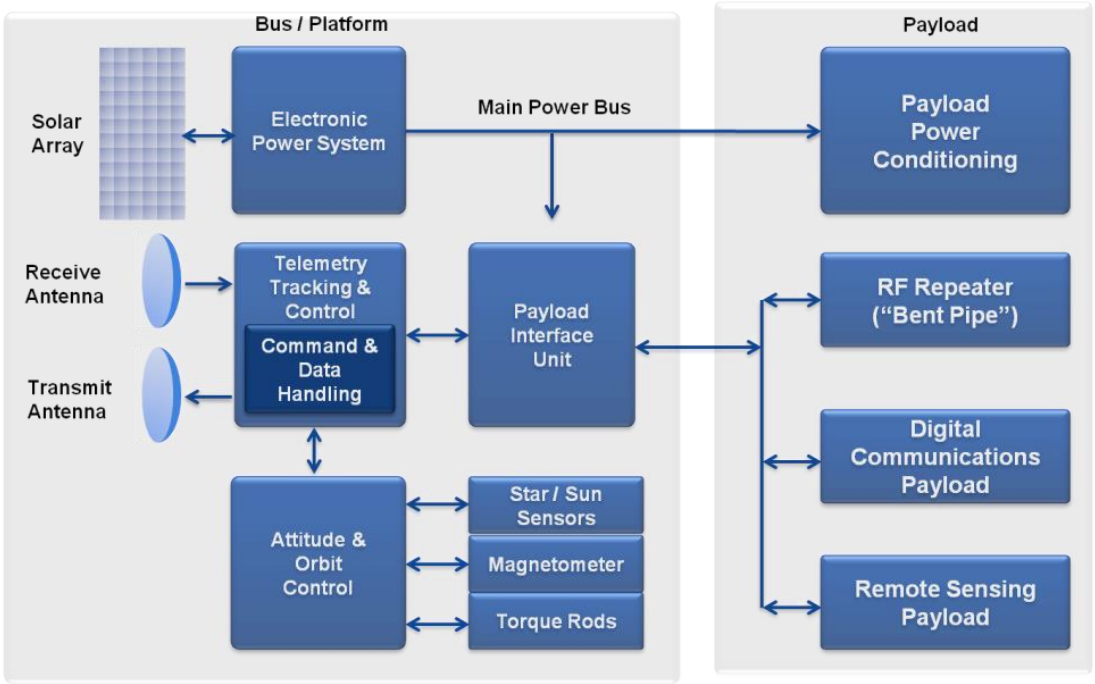
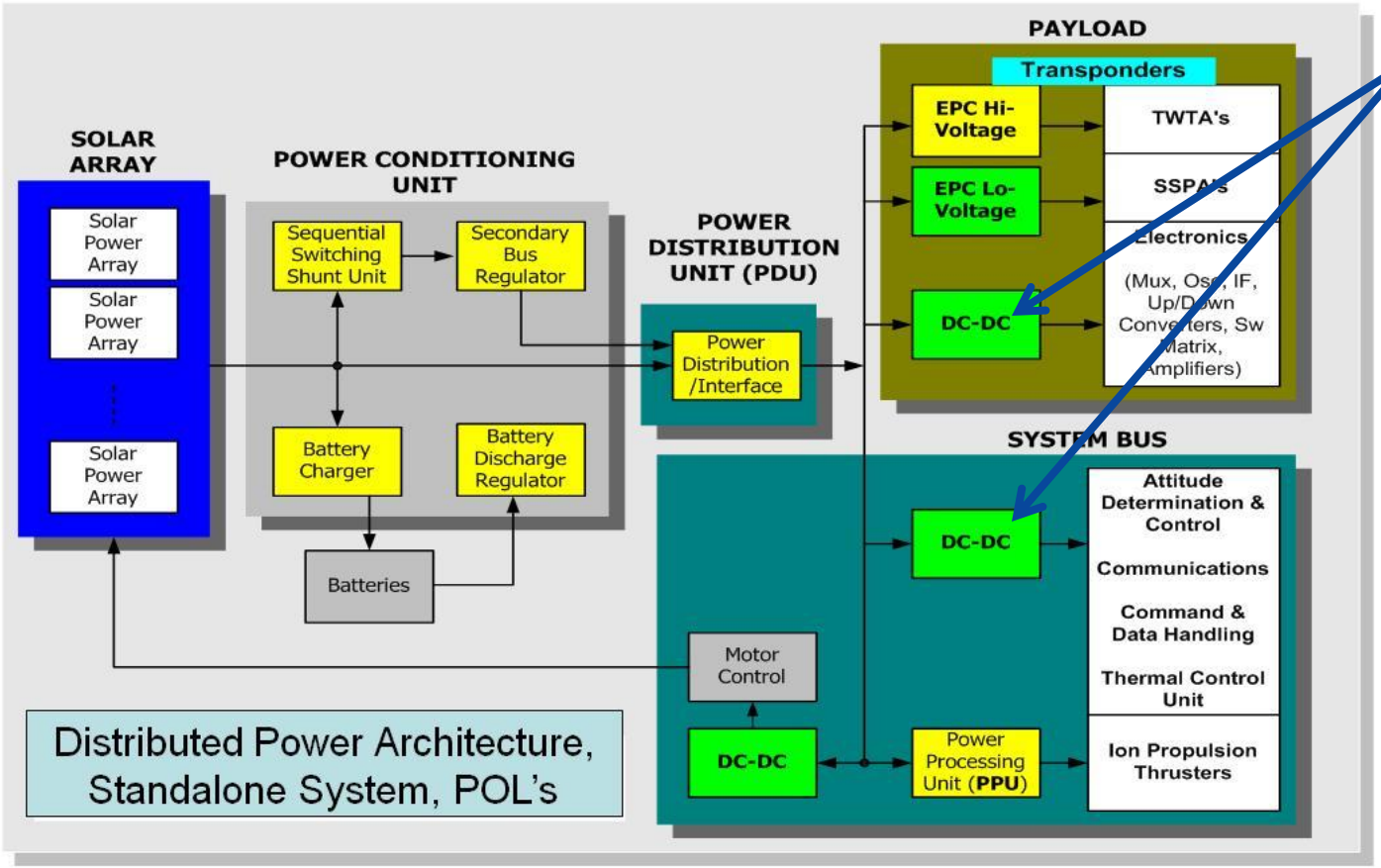
Overview

- SA50 Series DC – DC
  - Product Overview
  - Application
  - Standard Offerings
  - Radiation Performance
  - Customization Capability
  - Derating Guidelines
  - Design Reports
- Sub Bus Distribution vs POL
- SB30 Series DC – DC
  - Product Overview
  - Application



SA50 Series Applications



Applications

- Multiplexers
- IF Oscillators
- Up / Down Converters
- Matrix Amplifiers
- Altitude / general Computers
- Communications
- Command
- Thermal Control

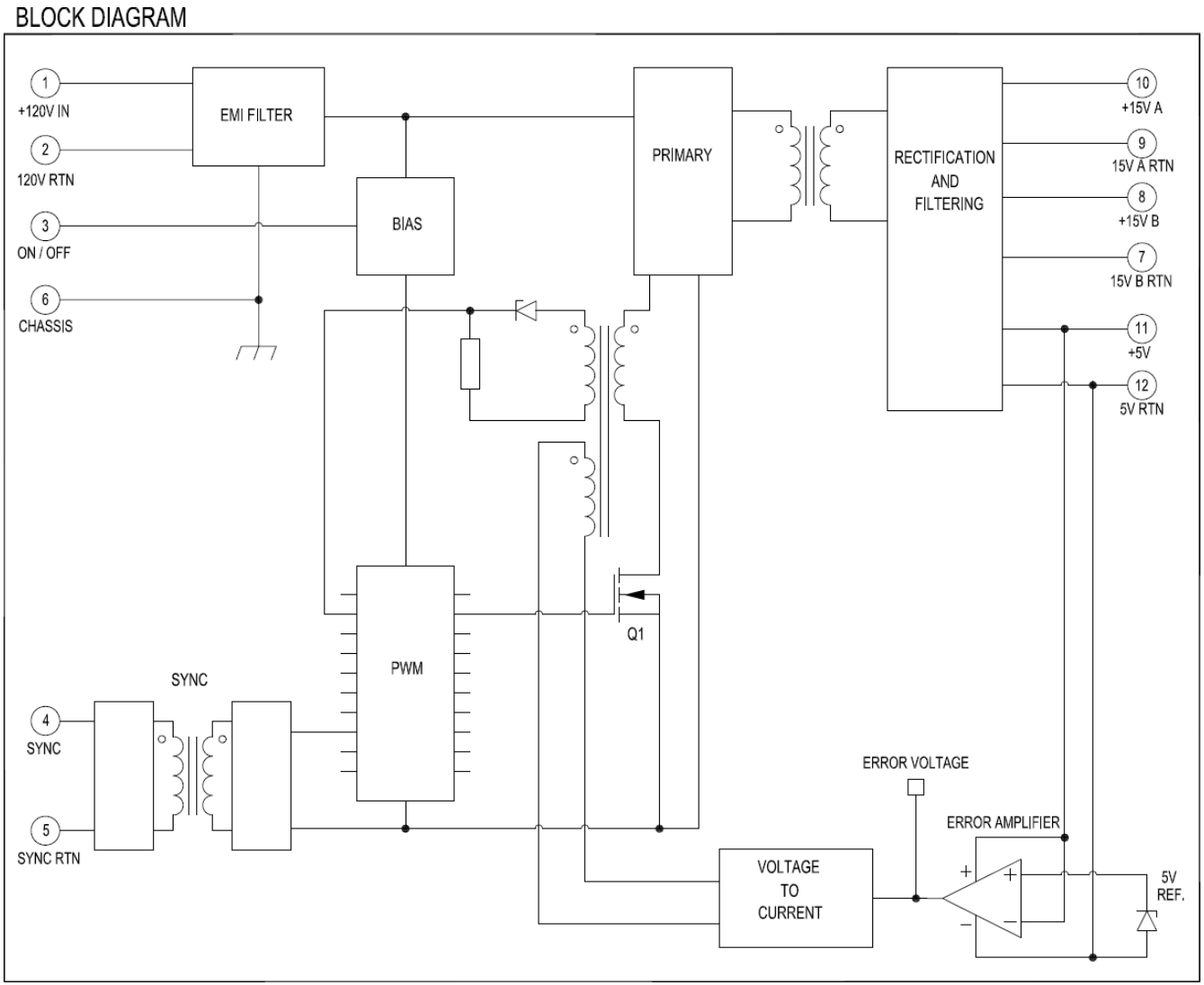
Converts Satellite Main Bus to Local Power Bus driving Analog and Digital Electronics loads

SA50 Series Isolated DC-DC Features

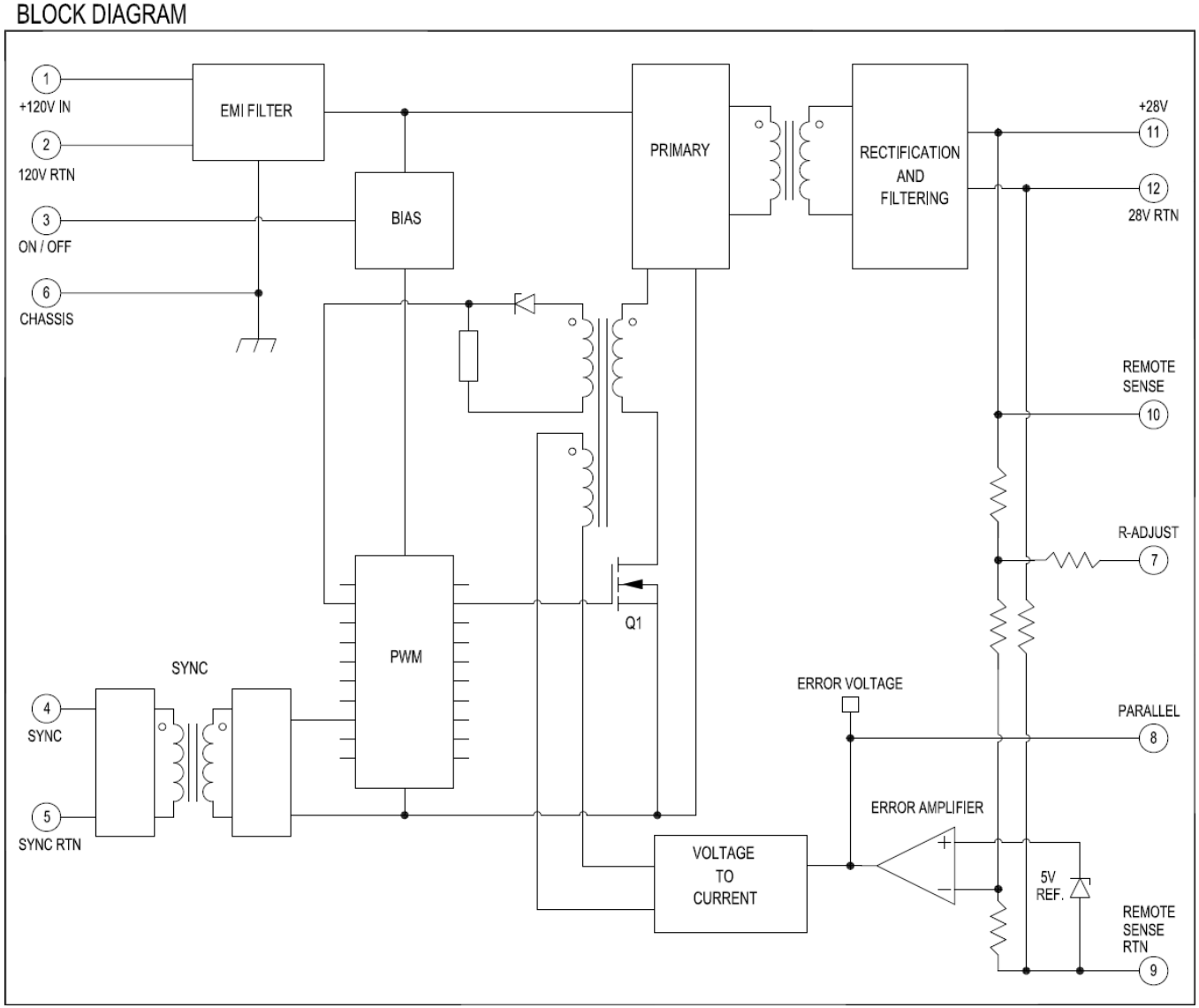
Industry Standard Package

- 28V or 120V nominal Inputs
- Internal EMI Filter (120V)
- Triple, dual and single output versions
- Isolated outputs
- 50W total combined power output
- Inhibit Feature
- Isolated Sync Input, 500kHz
- Output trim on Single & Dual Variants
- >86% efficient Full load @5 +-15V output (T Version)
- Length Width Height
  - –3.055 x 2.055” x 0.50” Envelope
- Total Dose Rating of 100KRads (min)
- Threshold (LET) with no latch-up >80MeV-cm^2/mg (H Version)

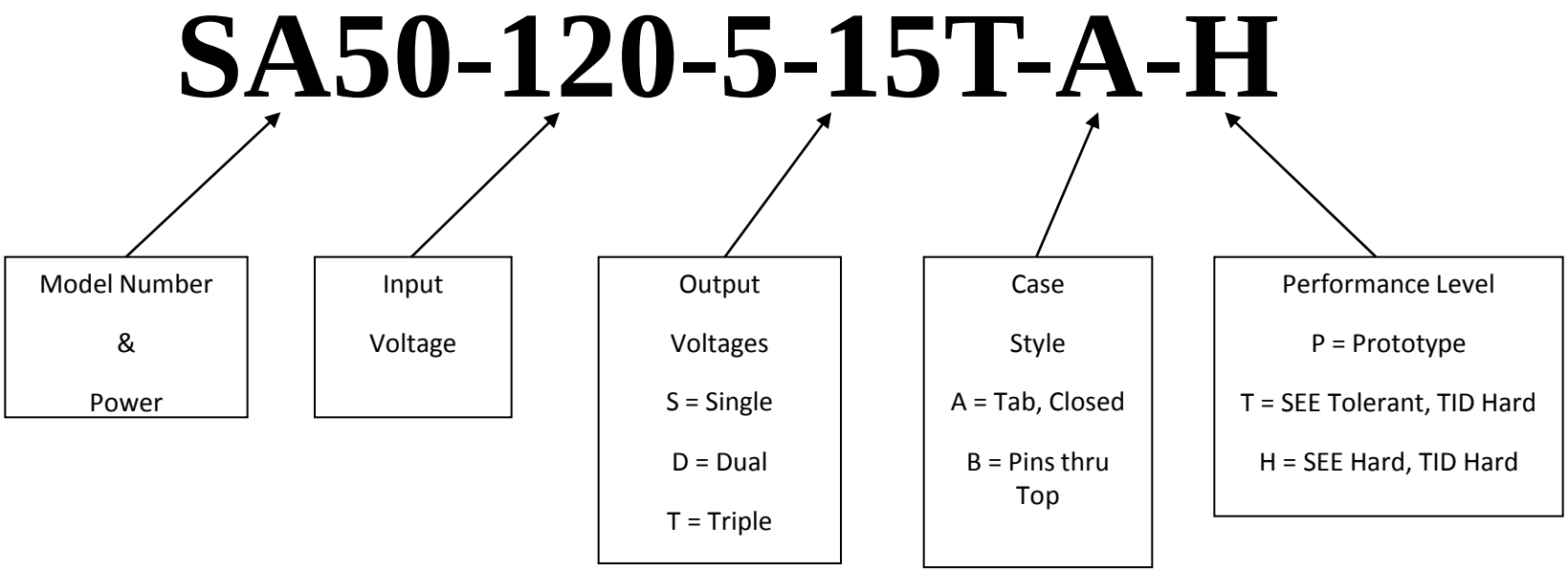
Block Diagram Triple



Block Diagram Single



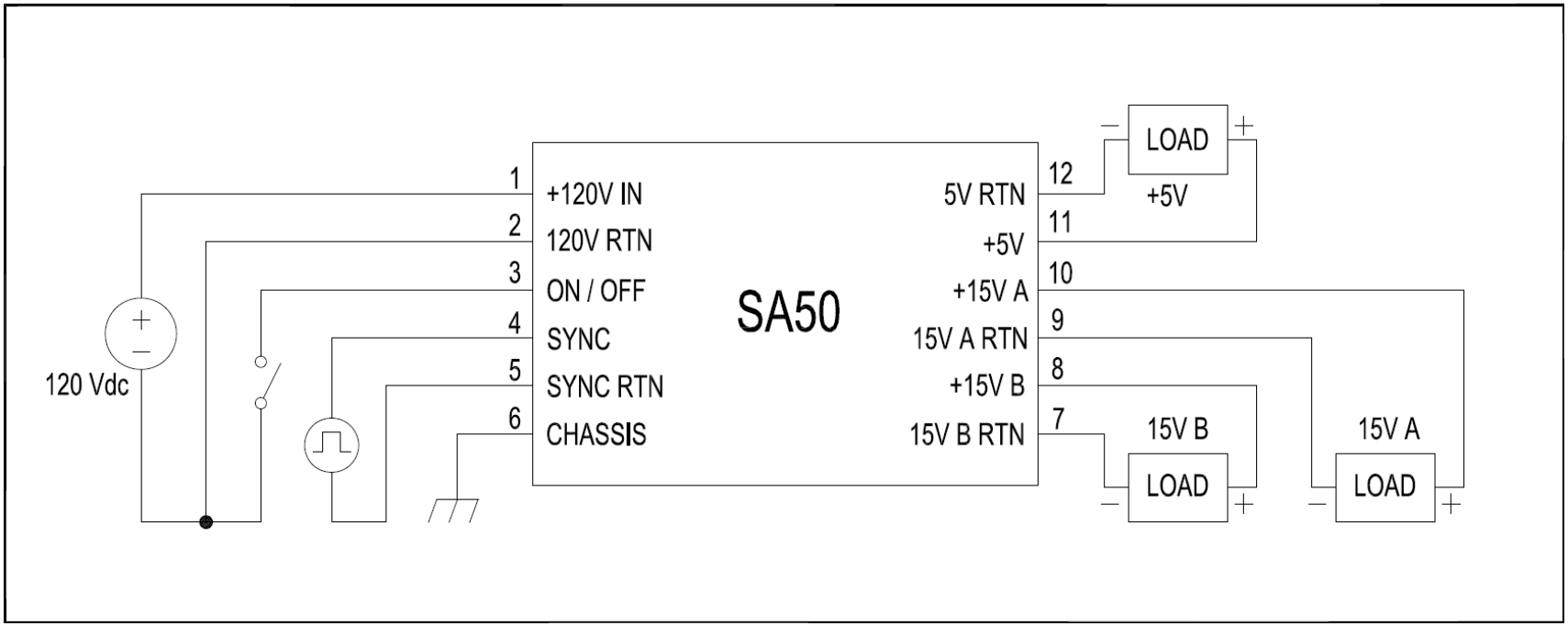
Input / Output / Versions



- Input Voltages 28V & 120V Standard, others Custom
- Single Outputs: 3.3V, 5V, 12V, 15V, 28V Standard, others Custom
- Dual Outputs: +-12V, +-15V Standard, others Custom
- Triple Outputs: 3.3V or 5V with +-12V or +-15V Standard, others Custom

SA50 Hookup

TYPICAL CONNECTION DIAGRAM



All SA50 outputs are isolated from the input and each other, allowing great flexibility in connection

Radiation Capability

Test	Conditions	Min	Typ	Unit
Total Ionizing Dose (Gamma)	MIL-STD-883, Method 1019 Operating bias applied during exposure, Full Rated Load, VIN = Nominal	100	200	kRads (Si)
Dose Rate (Gamma Dot) Temporary Saturation / Survival	MIL-STD-883, Method 1023 Operating bias applied during exposure, Full Rated Load, VIN = Nominal	1E8 / 4E10	1E11	Rads (Si) /sec
Neutron Fluence	MIL-STD-883, Method 1017	8E12	1E13	Neutrons /cm^2
Single Event Effects SEU, SEL, SEGR, SEB	Heavy ions (LET) Operating bias applied during exposure, Full Rated Load, VIN = Nominal	82		MeV•cm^2 /mg

- 28V Input versions meet radiation goals with full performance

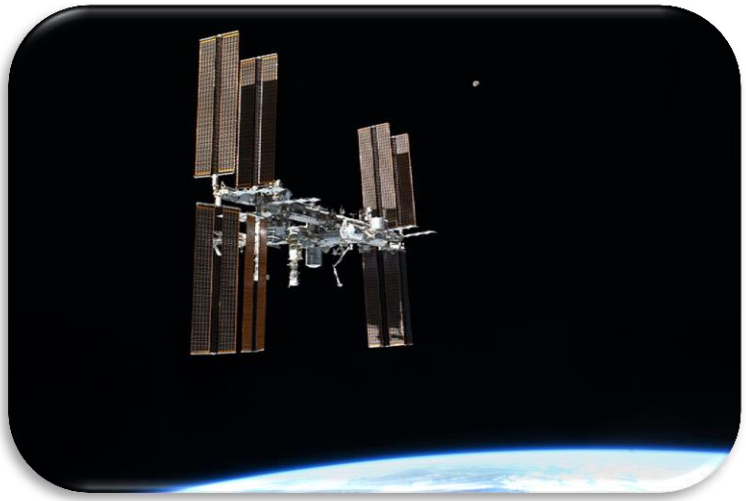
- 120V Input versions
  - Radiation Hard version has a 2% reduction in efficiency
  - Radiation Tolerant version has full electrical performance at LET 35 (^{129}Xe)

Customization Capabilities

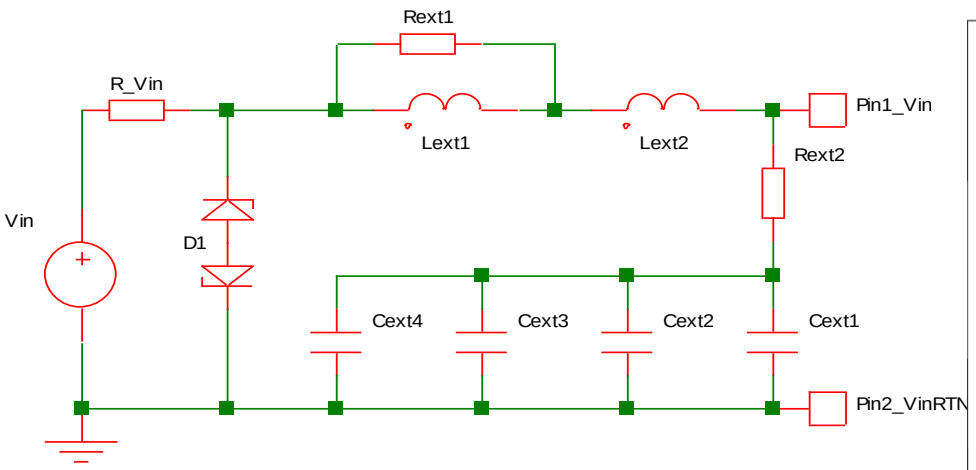
- Typical Customizations
  - Input Voltage
  - Output voltage (combinations)
  - Package / Mounting
  - Customer Marking
  - Current / Power Limit settings
  - Power Up / Power Down profiles
  - Enhanced Traceability
    - Custom material control
  - Special Process Control
    - Assembly
    - Screening

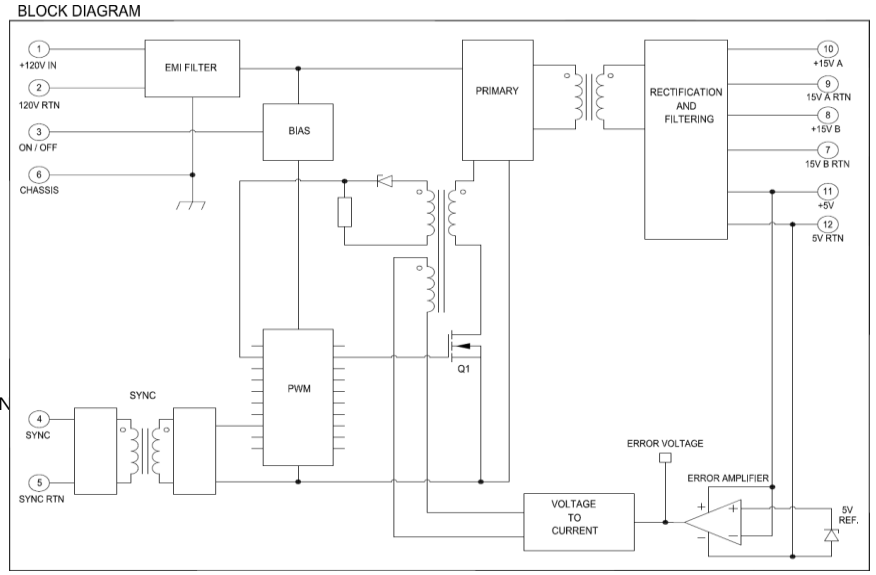
Standard Module Derivative Example

- Under Contract for ISS System Upgrade
  - Lighting to be upgraded to a high efficiency LED System
- Required Outputs
  - 3.3V @ 400mA (20% load) processor source
  - 28V@ 2A (200% load) lighting source
- Base design on SA50-120-3.3/15T-A-T
- Customizations
  - SA50-120-3.3/14T-B-TX1
  - Auxiliary outputs adjusted down to 14V
    - Connect in series to get 28V
  - Bring pins out the top of package
    - Adopted as new Standard “B” package
  - Adapt tabs to Threaded Hole
  - Load distribution facilitated by original design flexibility
- Added value scope
  - Matching network for ISS power bus compatibility
    - Impedance matching
    - Inrush control
    - CS06 transient control

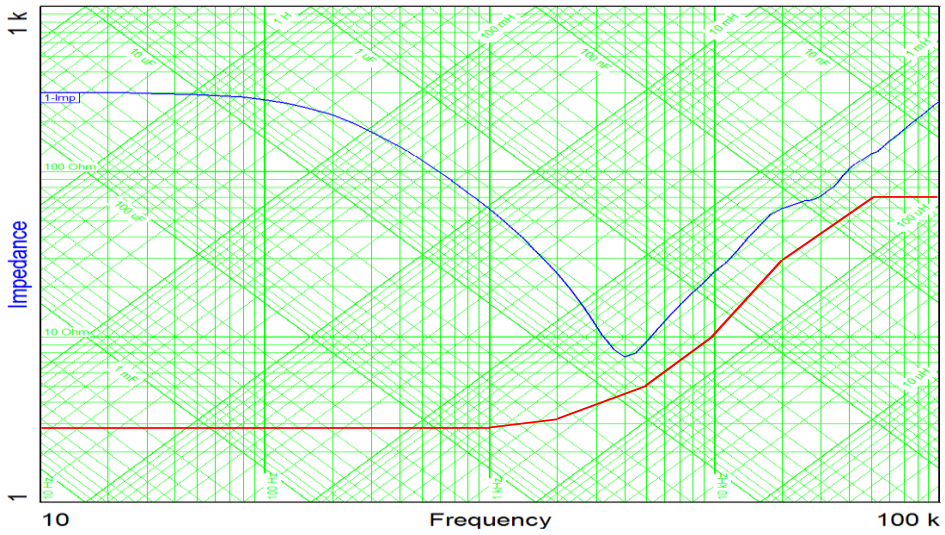


Matching SA50-120 to ISS





- Transorb for initial CS06 voltage clamping
  - LCR filter provides additional peak attenuation
- LCR provides impedance match and damping
  - Well controlled inrush
  - Damping of reflected load transients



Derating Considerations

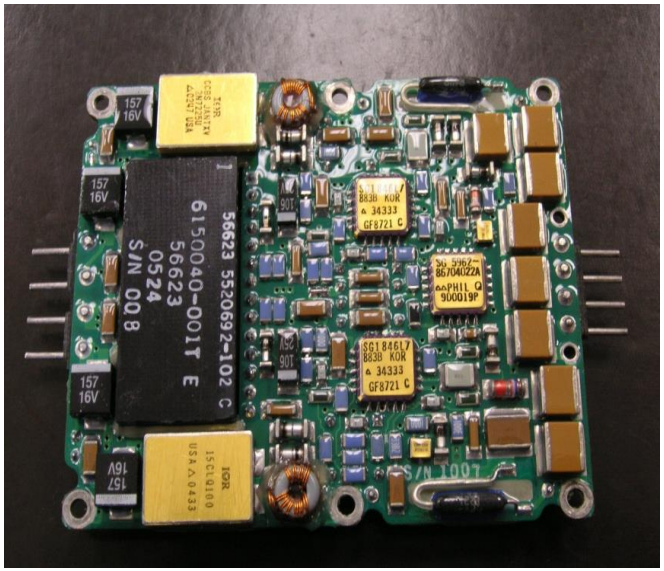
- Full power performance is specified from -55°C to +85°C for MIL-STD-975M derating criteria
  - Derate power linearly to zero from +85°C to +125°C
- For full compliance to MIL-STD-1547 either
  - Limit maximum operating temperature to +70°C
  - Limit output power to 80% of rating
- For 120V unit, operate between 86V & 100V input voltage

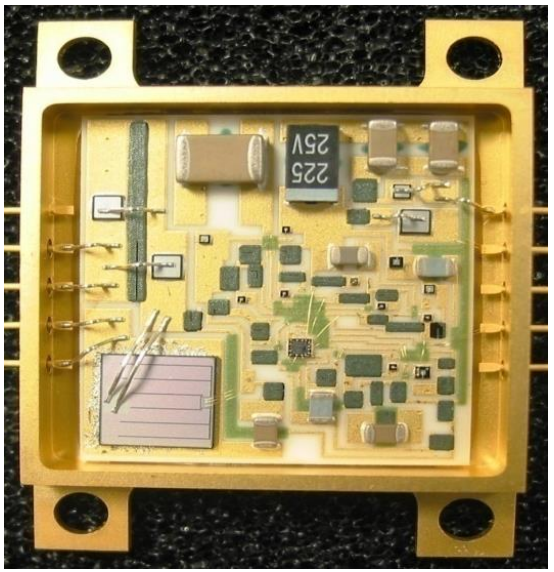
Surface Mount vs Hybrid Technology

- PMG Standard Modules are constructed with Heritage SMT processes

	SMT	HYBRID
Assembly Process	Automated	Manual
Device Attachment	Solder	Eutectic / Epoxy
Connections	Solder	Wire Bond
Components	Package pre-screened	Basic Die

SMT Process yields higher product consistency and quality



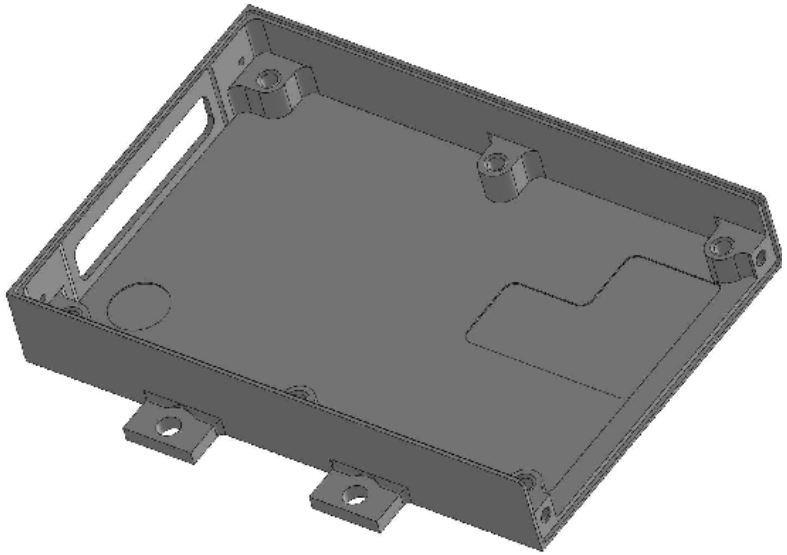


Construction Housing

- Material 6061-T651 Aluminum
  - Low weight
  - High Thermal Conductivity

Cover Groove
Optimized EMI & Environmental Performance

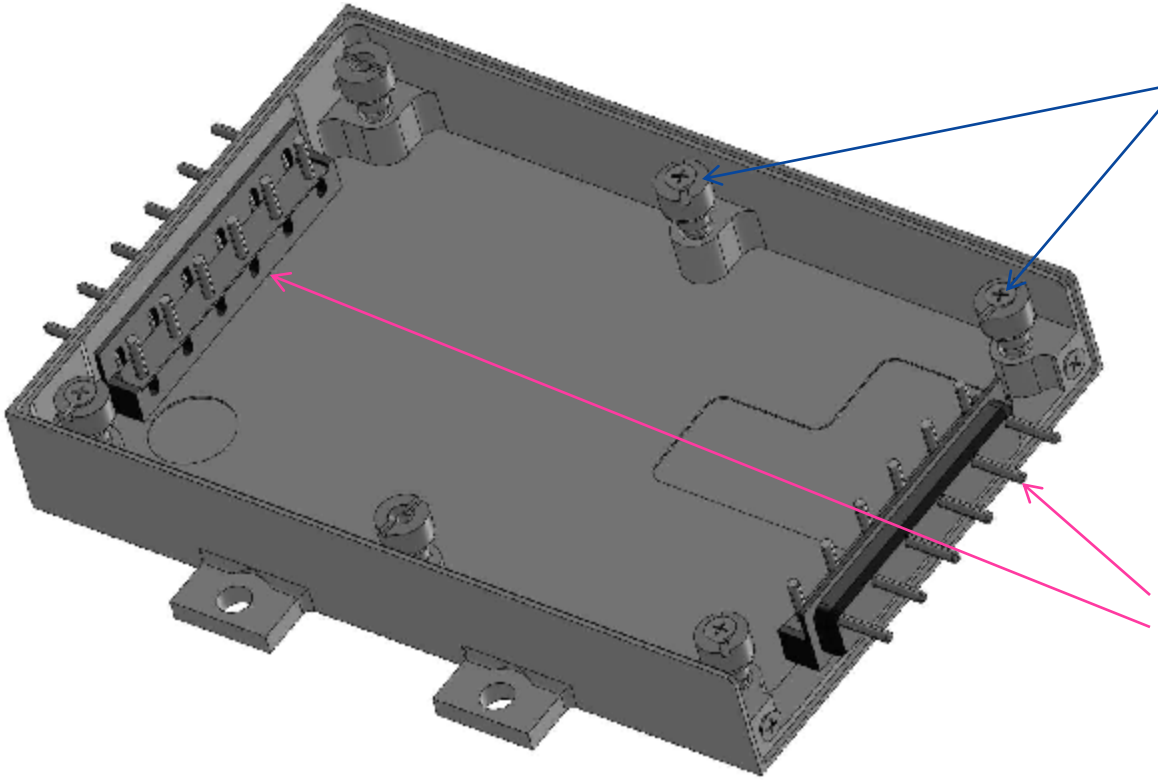
- Bosses mount PWA
  - Thermal Path to base
  - 6 for optimal performance
    - Low Vibration displacement
    - High thermal path conductivity
    - Lower solder fatigue , max life



- Industry Standard mounts
  - 4 mounts, 2 shown
  - Retains product to application heatsink

Open face concept facilitates easy assembly and max PWA area utilization

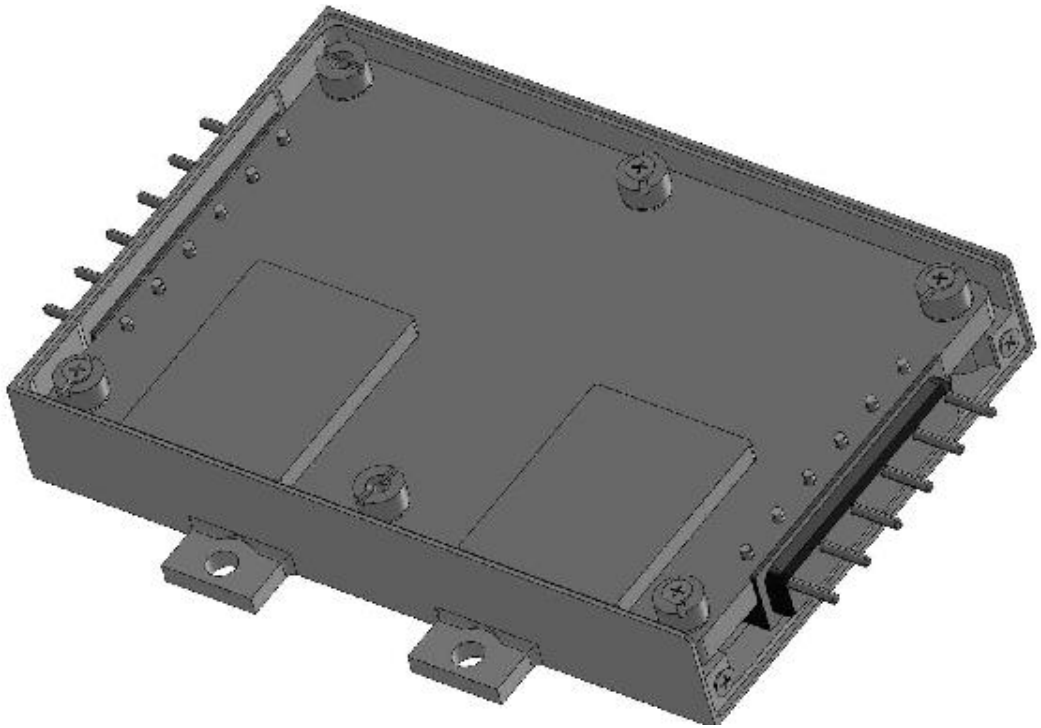
Construction PWA Mounting Scheme



- PWA Fasteners
  - Stainless Steel
    - High torque
  - Mounting pressure for thermal transfer
  - Threaded to accept lid mounting screws
  - 6 total
- Custom Connectors
  - Stress relief to PWA
  - Internal high temp solder
  - Automatic assembly alignment
  - Pre-tinned

Mounting scheme is simple, self aligning, with excellent stress relief at connectors for long life reliable operation

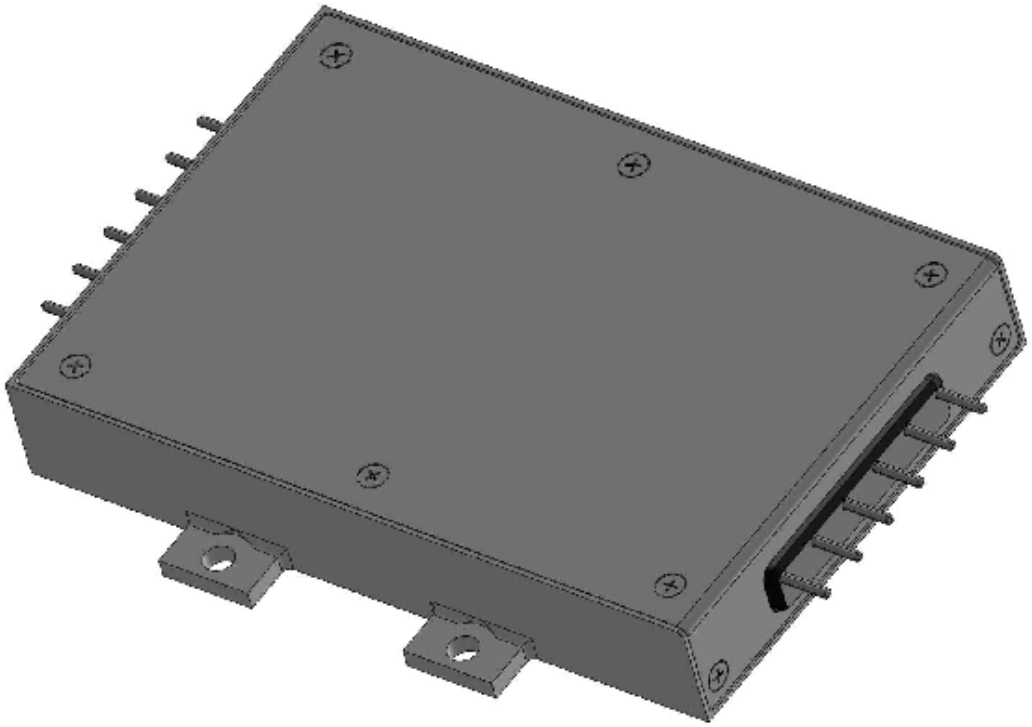
Construction PWA Assembly



Robust double sided SMT construction, manufactured using an automated assembly process. Final assembly achieved by simple, self aligning installation into housing

- Minimal Touch Labor
  - SMT for >90% Parts
  - 6 fasteners secure PWA
  - 8 screw mountings for the lid
- Planar Magnetics
  - Output Transformer
  - Output Choke
  - Stable and reliable PWB Windings
  - Simple mechanical assembly

Construction Final Assembly



Construction completed with 8 lid fasteners
Minimal touch labor during assembly
Process and performance variance minimized

Finishes
PWA:
Conformal Coat
Case:
Alodyne (Chemfilm)

ATP Screening

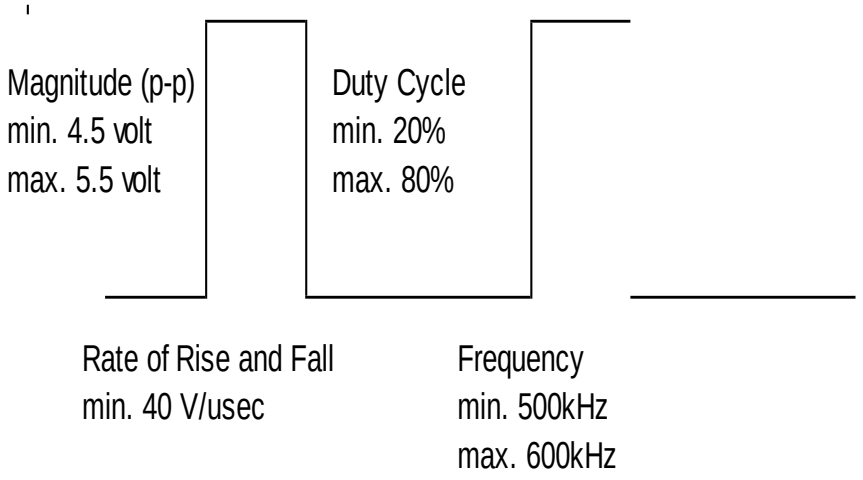
Requirement	Test Method /Condition
External Visual	Yes per O&M –dimensions and Weight
Electrical	Read & Record at +25°C
Vibration Operating	Workmanship operating Vibration (outputs monitored) MIL-STD-202, Method 214 6Grms (20Hz-2Khz) 1Minute perpendicular to the board
Post Vibration Electrical	Read & Record at +25°C
Temperature Cycle	10 cycles from base plate temperature, MIL-STD-883, M1010, Cond. A +85°C to -55°C. outputs monitored during Thermal cycles
Burn-in	160 Hrs @ 105°C, 50% of rated load
Final Electrical	-55°C +25°C +85°C
External Visual	No Damage

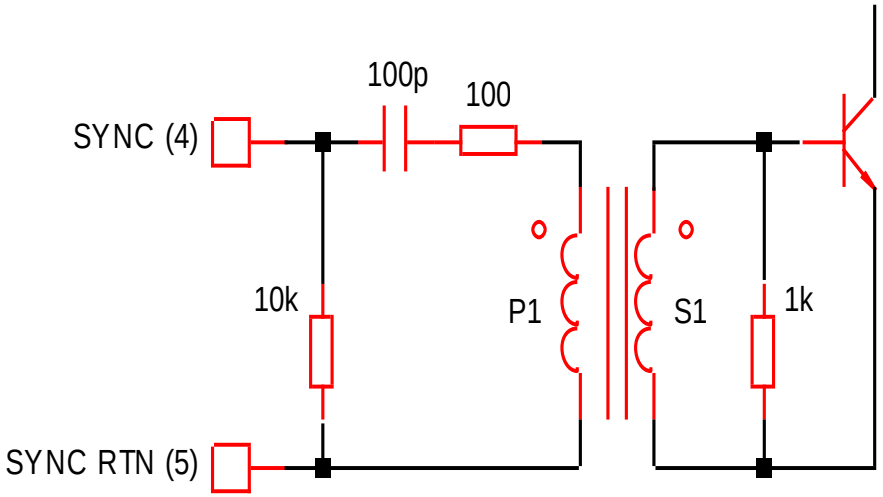
Design Reports

- 1: Mechanical Analysis
- 2: Stress Analysis
- 3: Thermal analysis
- 4: Radiation Analysis
- 5: Worse Case Analysis
- 6: Reliability Analysis
- 7: End of Life Analysis
- 8: Qualification Report
- 9: EMI test report

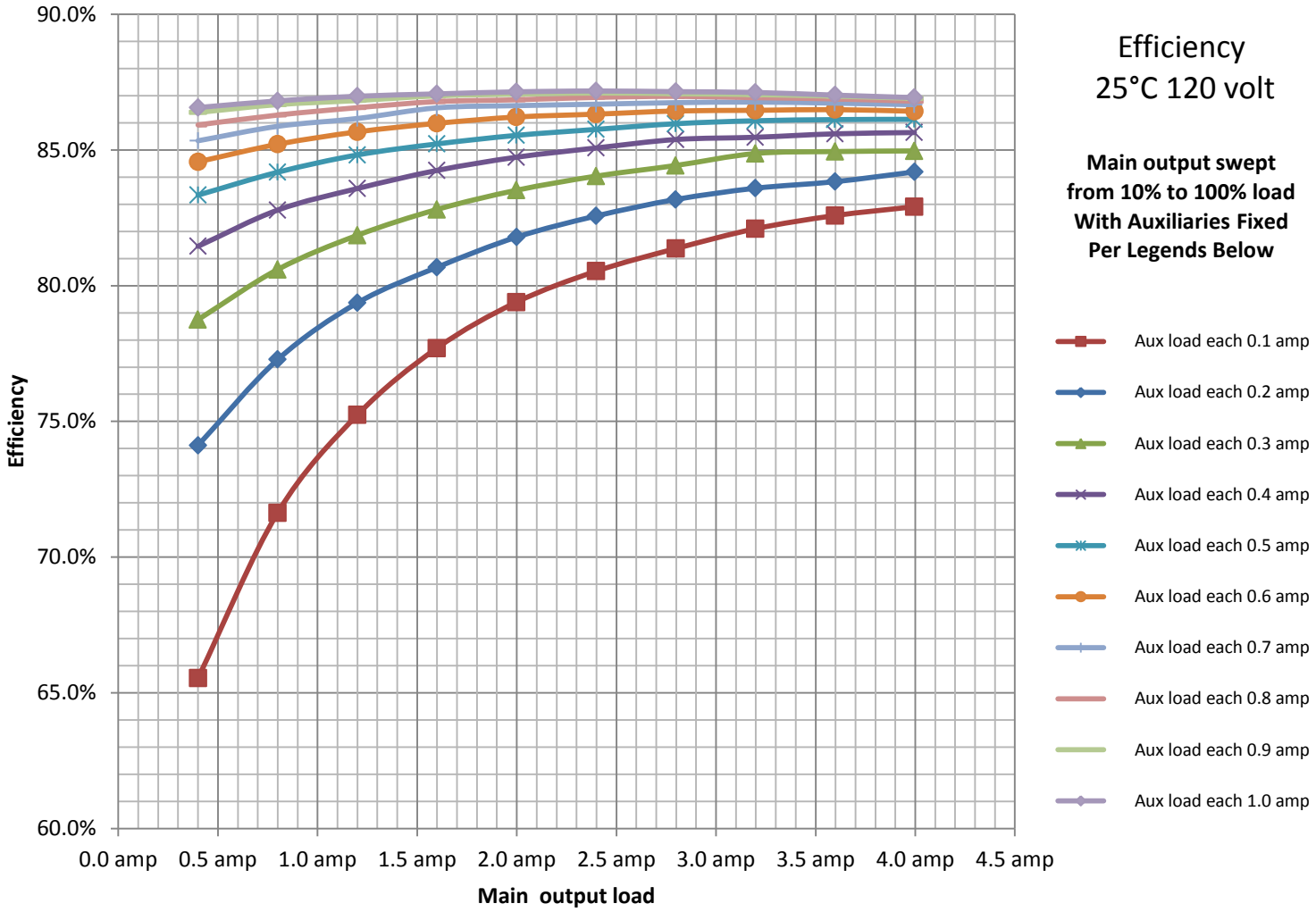
Application Notes

- Catalog application notes include
  - EMI Performance
  - Undervoltage Operation
  - Inhibit Operation
  - Current Limit Performance
  - Cross Regulation Performance
  - Output Voltage Trim
    - Single and Dual versions only
  - Synchronization
    - External drive master
    - 2x Switching frequency +
    - Fully Isolated, allows primary / secondary / arbitrary drive reference

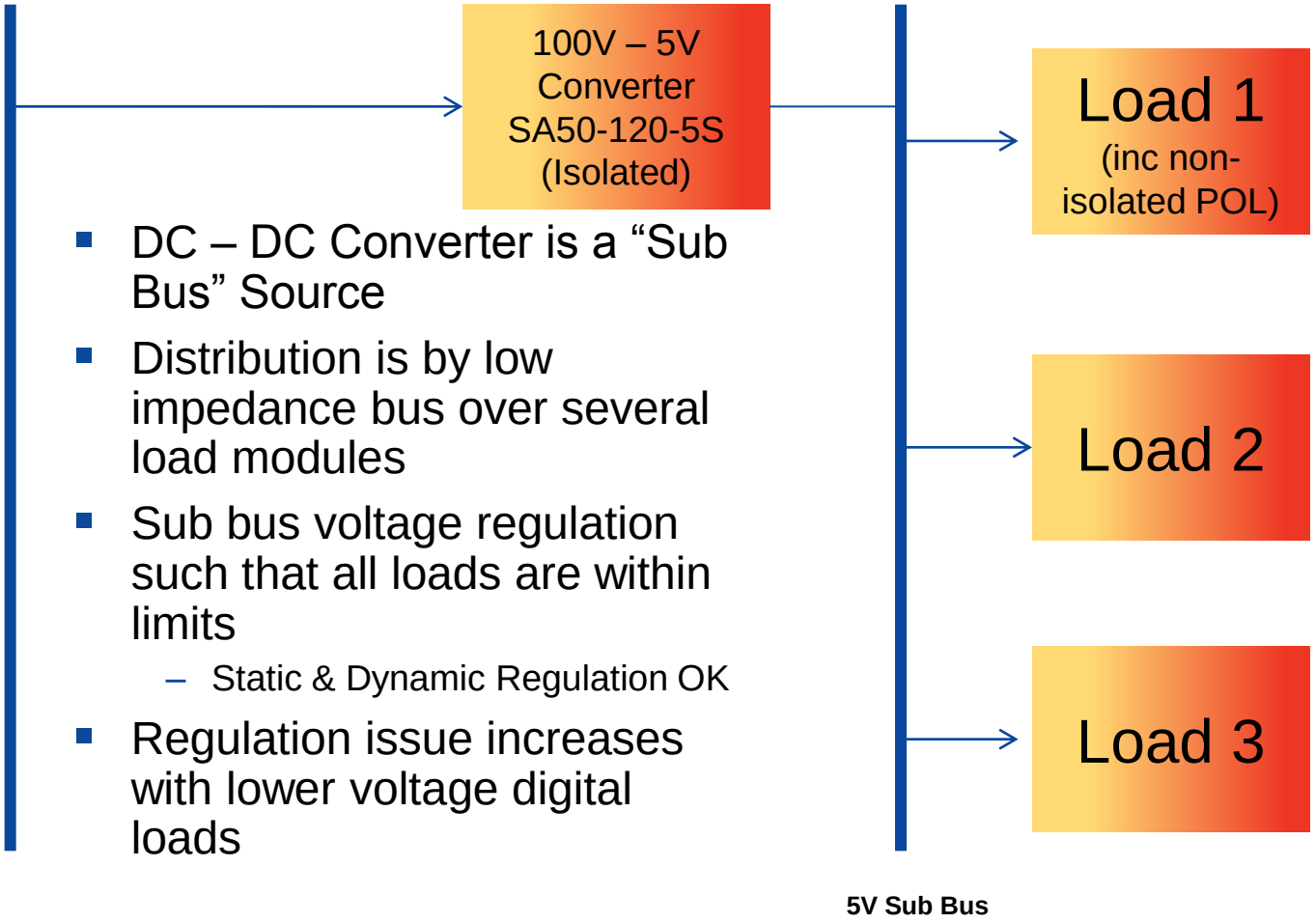




Efficiency Performance 120V Triple



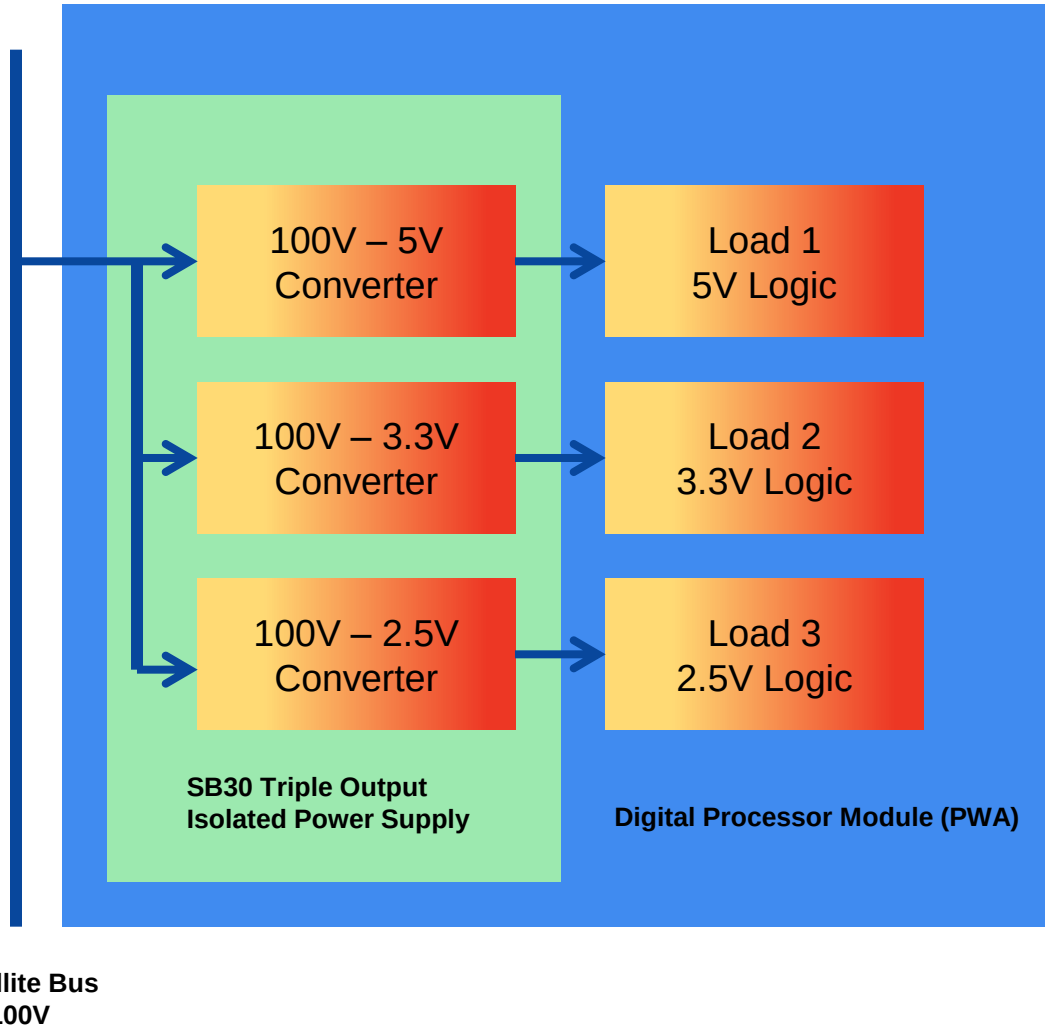
Traditional Power Distribution SA50



- DC – DC Converter is a “Sub Bus” Source
- Distribution is by low impedance bus over several load modules
- Sub bus voltage regulation such that all loads are within limits
  - Static & Dynamic Regulation OK
- Regulation issue increases with lower voltage digital loads

Isolated Point of Load Concept SB30

- Module Level POL Supply
- 3 Independently regulated output rails
- Mil Std 461 compliance at the Satellite Bus
- Input to Output Isolation
- Large step loads on one output are not seen on adjacent rails



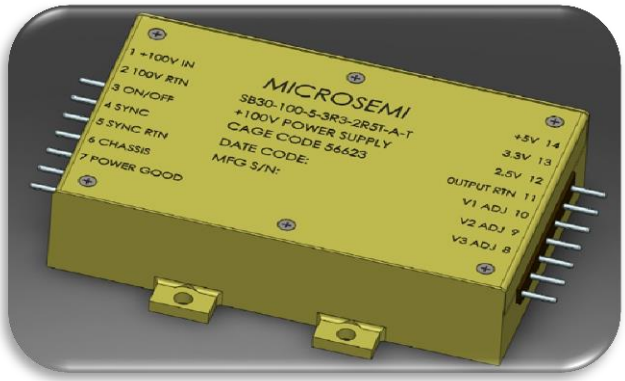
SB30 Product Series

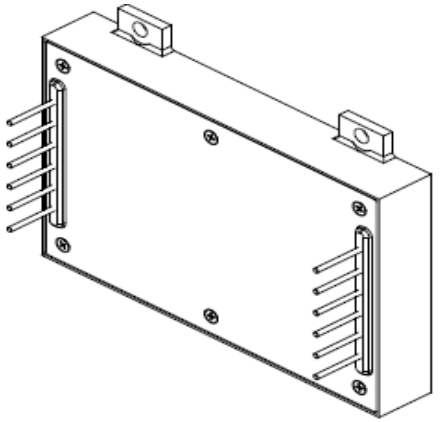
- Designed to support multiple, low voltage, digital loads
- Three independent outputs, each with it's own PWM regulator
- Load noise and transients on one rail will not induce noise on an adjacent rail
- Excellent load step response
- Power up / power down sequencing built in
- Internal and external synchronization to reduce system noise
- For a nominal NRE charge, input / output voltages can be customized

SB30 Series

SMT Construction in Industry Standard Packages

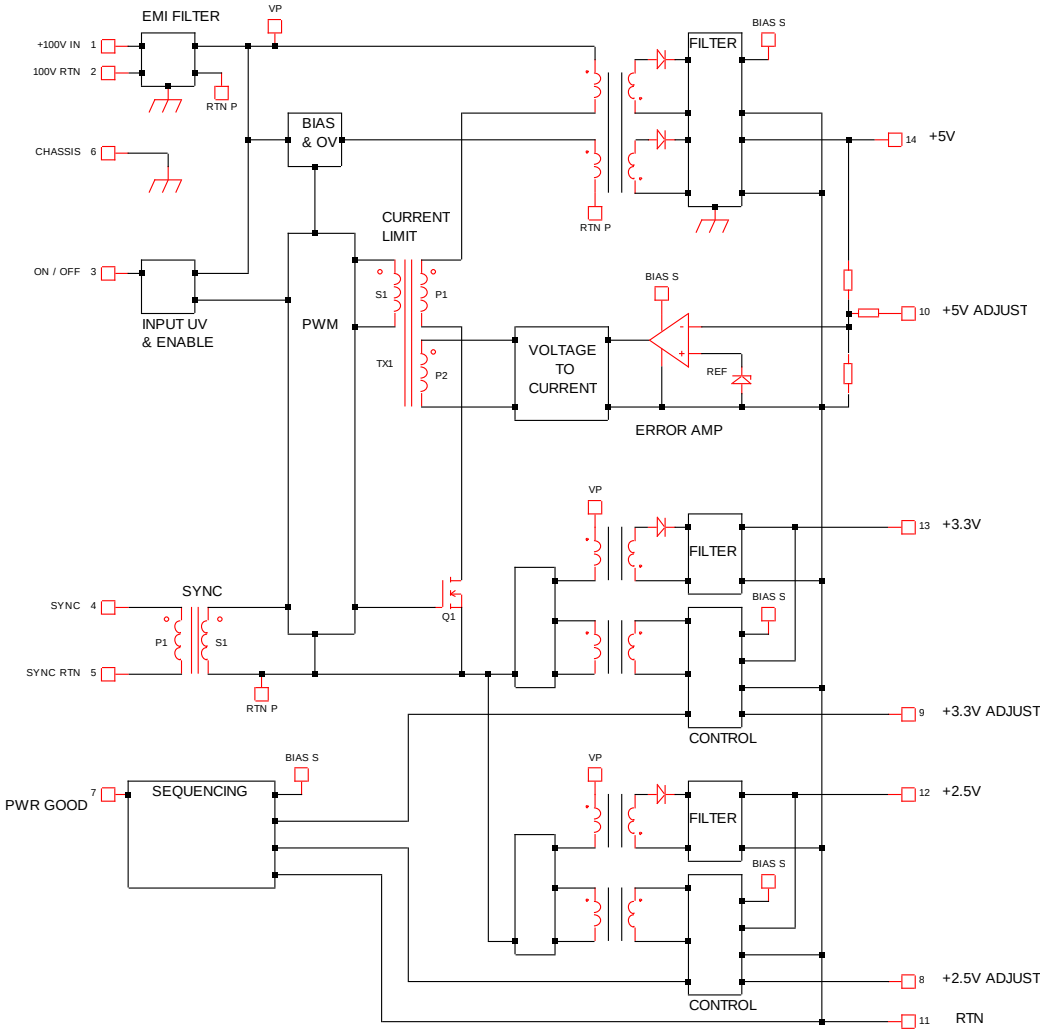
- Triple Output for Digital Loads
  +5V @ 2A; +3.3V @ 3A; +2.5V @ 3A
- Input – Output Isolation
- +28V or 100V nominal Inputs
- Internal EMI Filter (120V)
- Outputs individually regulated
  –Each with it's own PWM
- Power Good Status
- 30W total combined power output
- Inhibit Feature
- Power sequencing
- Isolated Sync Input, 500kHz
- Length Width Height
  –3.055 x 2.055" x 0.60"
- Total Dose Rating of 200KRads
- Threshold (LET) with no latch-up
  >82MeV-cm2/mg



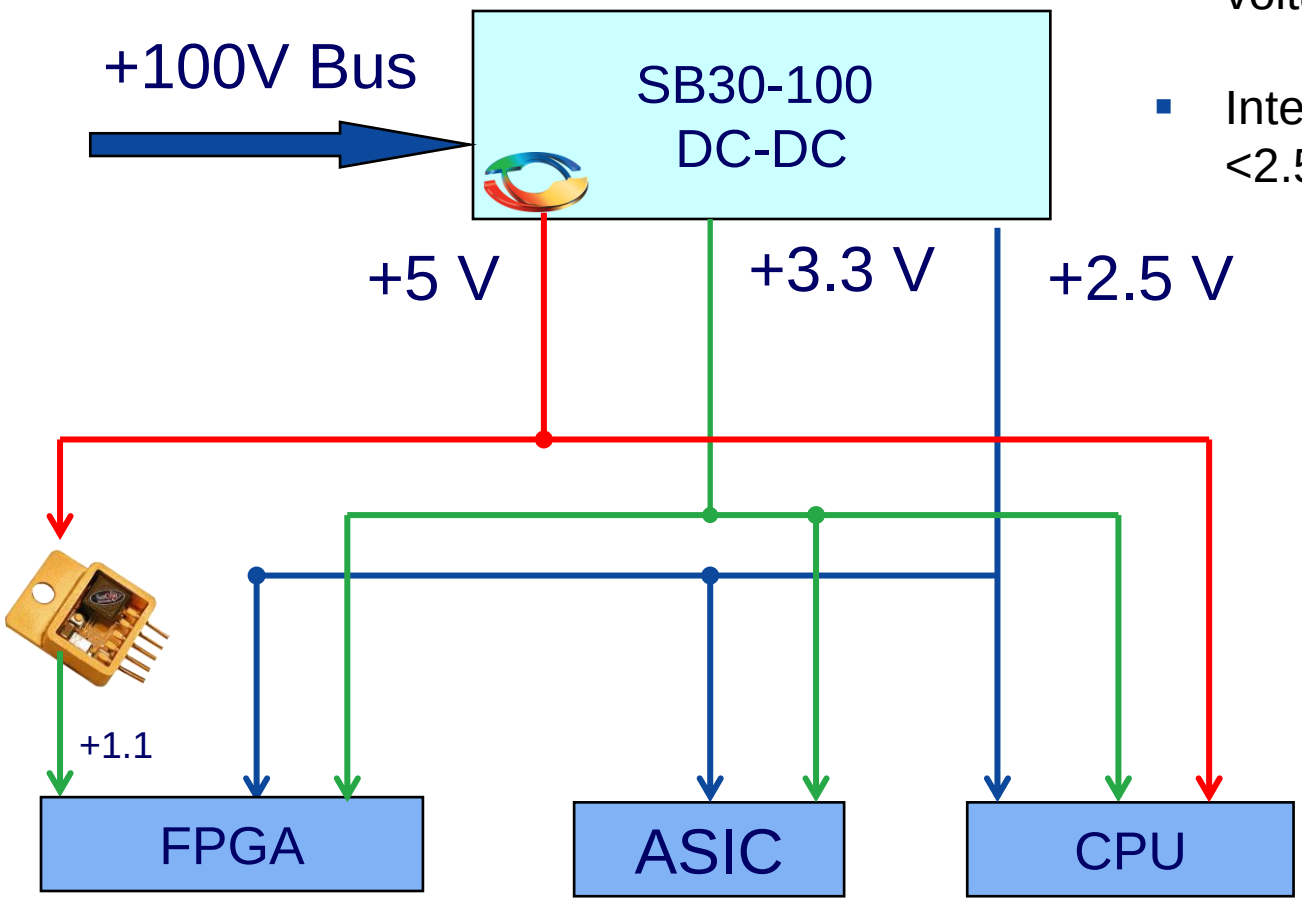


100V Prototype samples available now

SB30 Electrical Block Diagram

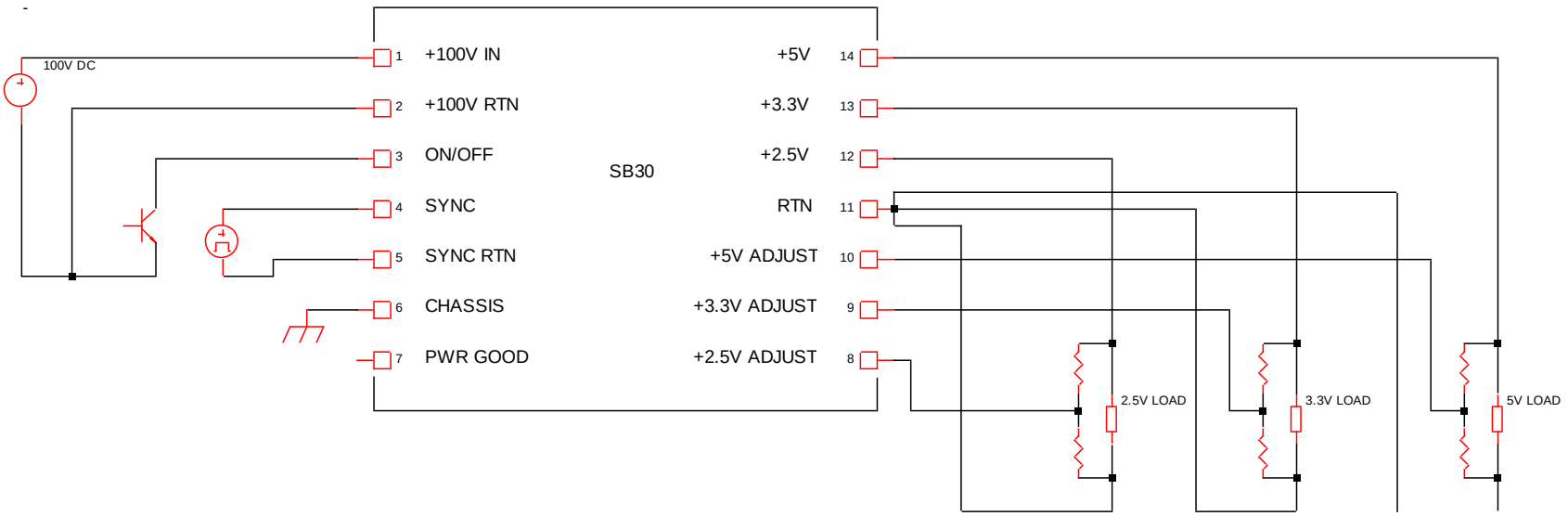


SB30 Series Typical Application



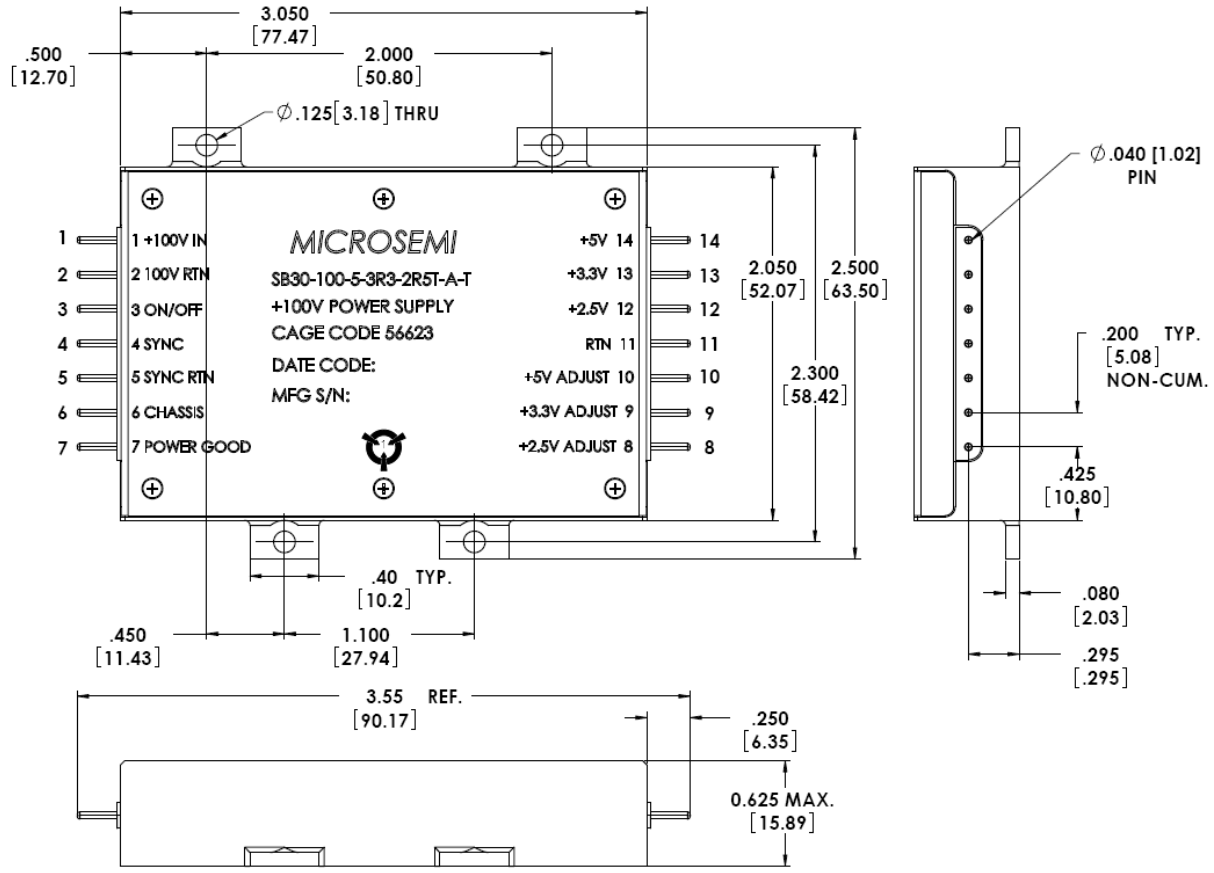
- Supports typical digital voltage requirements
- Interfaces to POL or LDO for <2.5V needs

SB30 Hookup



All SB30 Outputs are Externally Trimmable
Each output adjustable +/- 10%

Mechanical Outline A Case Style



NOTES:

1.) PINS .040" (1.02 mm) DIAMETER.
2.) PINS MATERIAL: BRASS ALLOY 360, IAW ASTM B16.
PINS FINISH: ELECTRO-SOLDER .0005 MAX. THICK. (TIN LEAD) IAW SAE-AMS-P-81728.
3.) ALL DIMENSIONS IN INCHES (mm) TOLERANCES: .XX +/-.01 in. (.X +/-.254 mm)
.XXX +/-.005 in. (.XX +/-.127 mm).
4.) WEIGHT: 125 GRAMS MAX. (.28 LB MAX.)

PIN DESIGNATIONS

PIN No.	FUNCTION	PIN No.	FUNCTION
1	+100V IN	14	+5V
2	100V RTN	13	+3.3V
3	ON/OFF	12	+2.5V
4	SYNC	11	RTN
5	SYNC RTN	10	+5V ADJUST
6	CHASSIS	9	+3.3V ADJUST
7	PWR GOOD	8	+2.5V ADJUST

Additional Multi-Output Isolated DC/DC Design Points

- Power Distribution
  - SA50 very flexible with power distribution between channels
    - Current limit determined by sum of channel currents
  - SB30 has specific channel power limits
    - Each channel has individual current limit
- Cross Regulation
  - SA50 requires a minimum of 5% loading on the main output
    - Auxiliary outputs are cross regulated
  - SB30 regulates with no load on any output
    - All outputs are independently regulated
- Sequencing
  - SA50 all outputs rise in parallel
  - SB30, 5V rail comes up first, goes off last
    - The two additional rails are predefined in sequence BUT this is customizable
- Synchronization
  - SA & SB fully synchronized externally if required

What's Next

- Demand for 100W level regulated DC – DC Converter
- Many enquiries for customizing SA & SB Series
- High efficiency 100V to Sub Bus (5v) non regulated
- Digital Bus Controlled, Configurable Power Supplies
  - Telemetry
  - Command & Control
- GaN Technology

Summary

- SA Standard family released, available in 120V & 28V versions
- SA family provides an easily customizable solution with full design and production capabilities
- SB Standard Triple, prototype samples may be ordered now
- Synergistic solutions offer benefits to architectures using Microsemi radiation hardened FPGAs and ASICs
- Designing Space Power Products with Embedded FPGA based control and telemetry

Microsemi

Thank you