



fTOF POWER BOARD

POWERING RDO BOARD & ASIC SERVICE HYBRIDS

Presented by Tim Camarda, Brookhaven National Lab

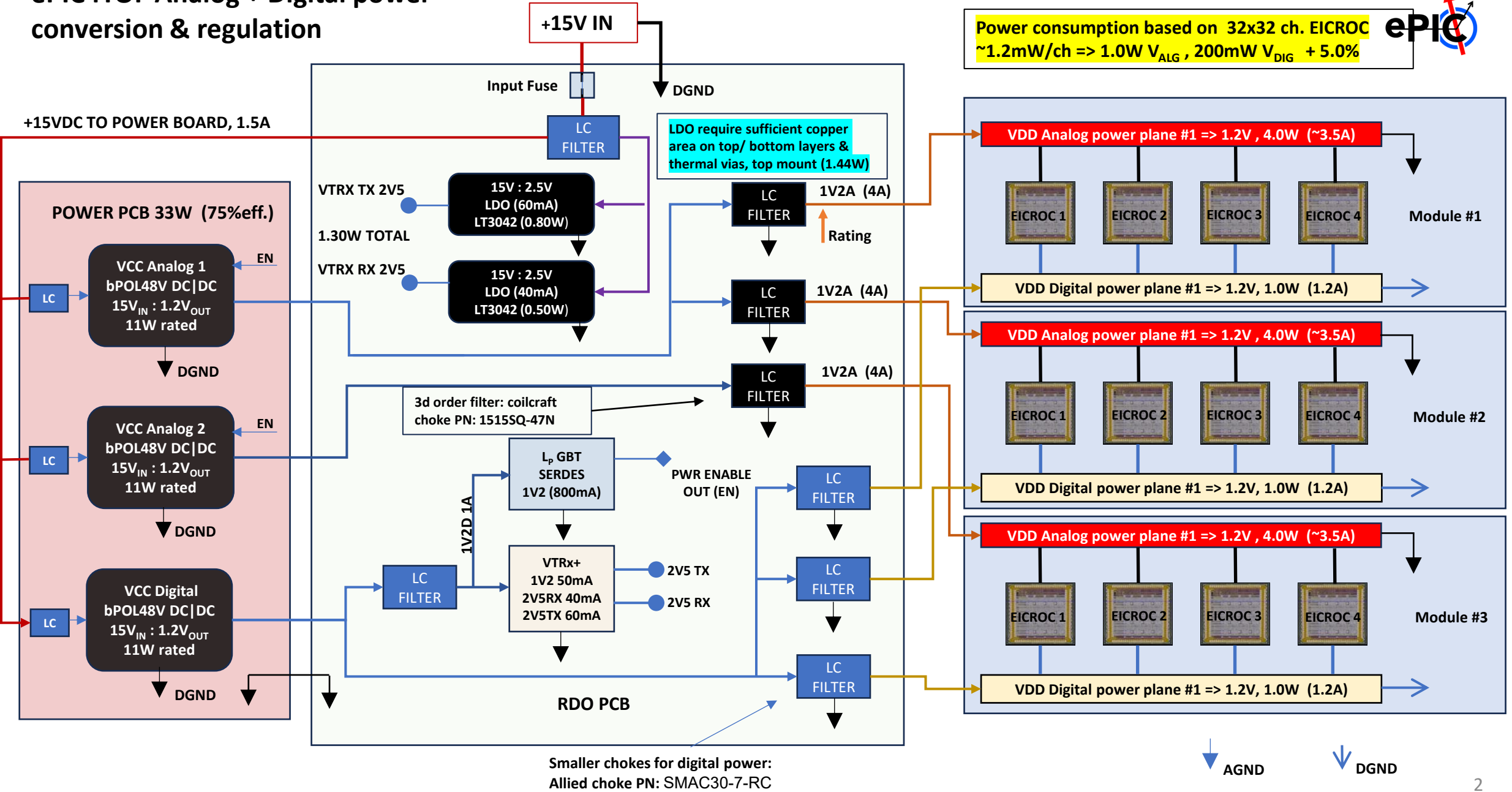
With contributions from Mikhail Matveev, Rice U.

Updated, February 2025, REV1c

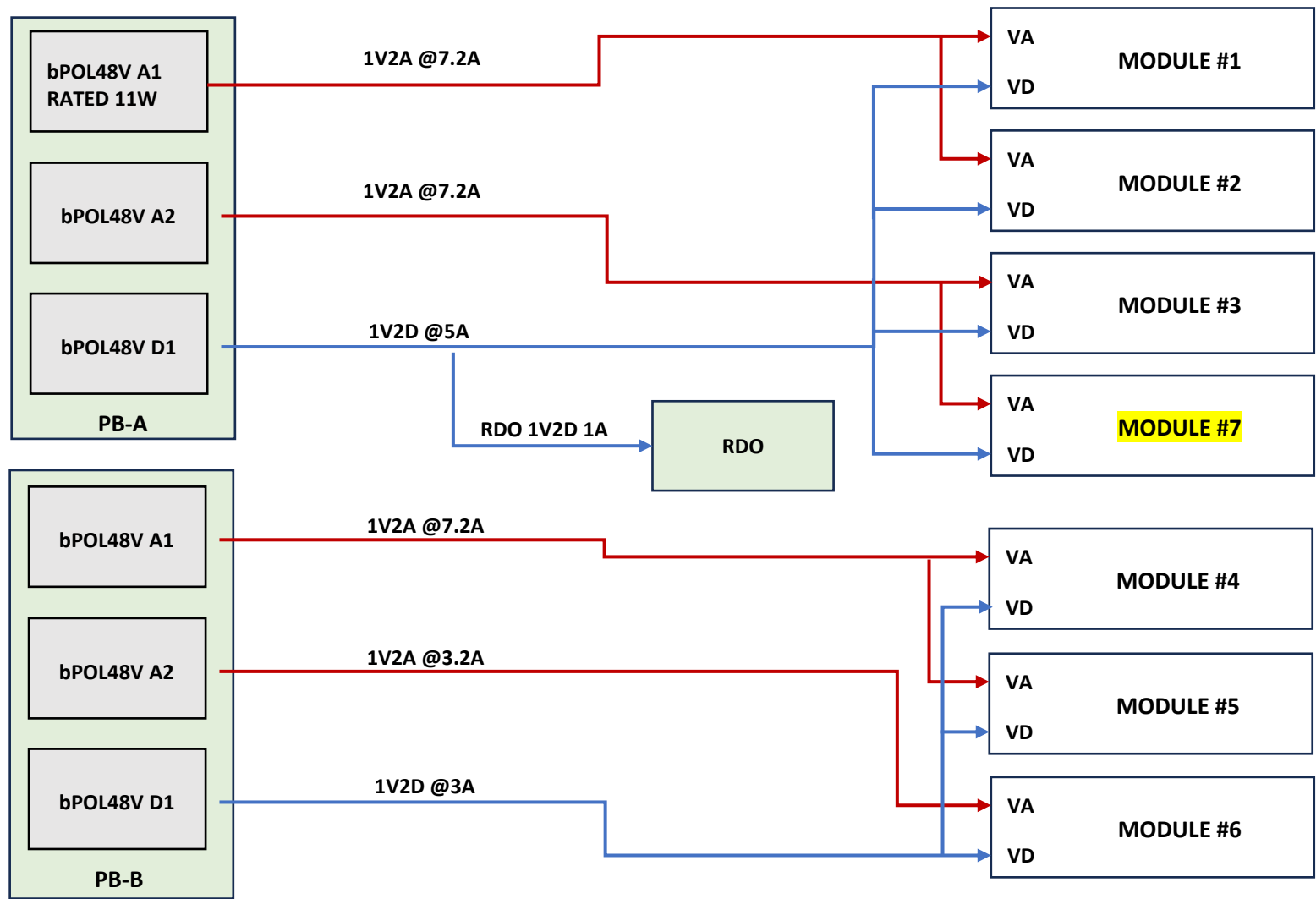


ePIC fTOF Analog + Digital power conversion & regulation

Power consumption based on 32x32 ch. EICROC
~1.2mW/ch => 1.0W V_{ALG} , 200mW V_{DIG} + 5.0%



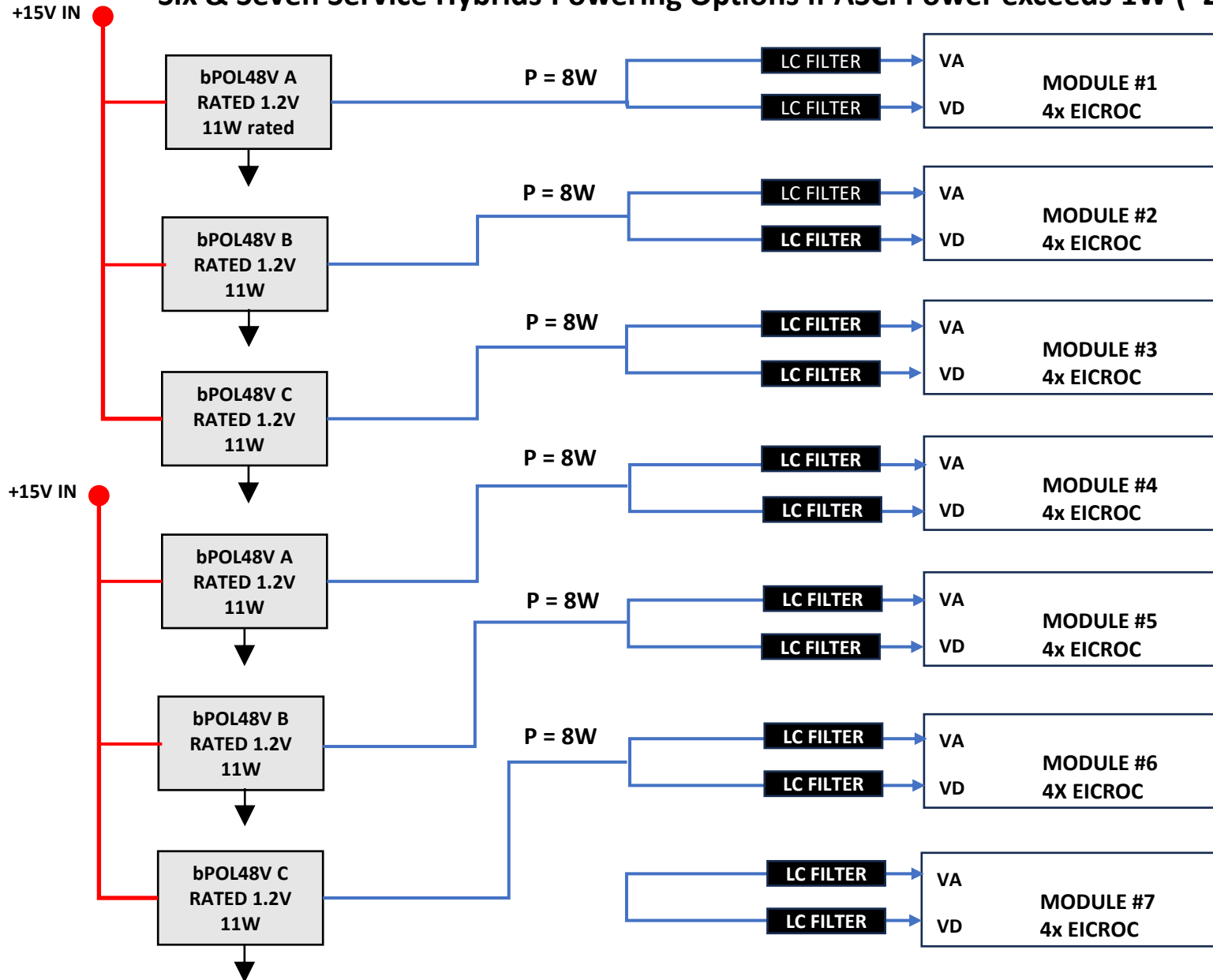
Powering for the 6X and 7x service hybrids
Scenario where ASIC power is 1.2W



NOTE: each bPOL48V power regulator:
specified for 8A continuous load

For 6x module configuration: MODULE #7 is removed

Six & Seven Service Hybrids Powering Options if ASCI Power exceeds 1W ($\sim 2W$ / ASIC Total $V_{ALG} + V_{DIG}$)



Scenario where each EICROC is 1.5mW/ channel or 1.5W/ ASIC

Each module is $\sim 8.0W$ with 75% power efficiency

RDO power $\sim 1.6W$

So, one bPOL48V will have: 10.7W

$\Rightarrow 6.4W$ ALG, 1.6W DIG

For 7X modules we have 44.8W ALG, 11.2W DIG

ADD 1.6W for RDO DIG

Then we have 12.8W DIG

Need additional power for #7 service hybrid.
Possibly we need a power board with 4x bPOL48V

Increase power board size from 103mm x 22mm to 140mm x 22mm with 3x Samtec power connectors.

DRAFT

LT3042 junction temperature from table #4
(calculated from data sheet) for 60mA load (VTRX TX)

Iout	Vin	Vout	IGND	Power Diss.	°C/W	TJMAX
0.06	15.00	2.50	6.00E-03	0.84	33	112.72

MSOP junction temperature with 1000mm² top copper plane: TABLE 4 =>
4 layers, 2oz copper (60mA)

Iout	Vin	Vout	IGND	Power Diss.	°C/W	TJMAX
0.10	15.00	2.50	6.00E-03	1.34	33	129.22

MSOP junction temperature with 1000mm² top copper plane: TABLE 4 =>
4 layers, 2oz copper (100mA)

For continuous normal load conditions, do not exceed the maximum junction temperature, (125°C for E-, I-grades and 150°C for H-, MP-grades).

Thermal resistance table from manufacturers data sheet
2oz copper on top plane and no thermal vias
4 layer PCB

Table 4. Measured Thermal Resistance for MSOP Package

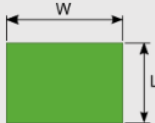
COPPER AREA		BOARD AREA	THERMAL RESISTANCE
TOP SIDE*	BOTTOM SIDE		
2500mm ²	2500mm ²	2500mm ²	33°C/W
1000mm ²	2500mm ²	2500mm ²	33°C/W
225mm ²	2500mm ²	2500mm ²	34°C/W
100mm ²	2500mm ²	2500mm ²	35°C/W

*Device is mounted on topside

Tables 3 and 4 list thermal resistance as a function of copper area on a fixed board size. All measurements were taken in still air on a 4 layer FR-4 board with 1 oz solid internal planes and 2oz top/bottom planes with a total board thickness of 1.6mm. The four layers were electrically isolated with no thermal vias present. PCB layers, copper weight,

LT3042 W/ 15Vin : 1.2Vout @60mA load
 Junction temperature @ 0.84W **30°C ambient**

PCB Dimensions



L: mm

W: mm

PCB Layers

Number of Layers:

Material	Thickness [mm]	% Coverage	Device
Copper	0.07	25	L1
FR-4/Pre-preg	0.15	-	
Copper	0.035	80	L2
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L3
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L4
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L5
FR-4/Pre-preg	0.15	-	
Copper	0.07	80	L6

106 °C

Junction Temperature

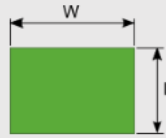
91 °C/W

Junction to Ambient Thermal Resistance

Dissipation from PCB surface : 0.835 W

Dissipation from device top : 0.00472 W

PCB Dimensions



L: mm

W: mm

PCB Layers

Number of Layers:

Material	Thickness [mm]	% Coverage	Device
Copper	0.07	25	L1
FR-4/Pre-preg	0.15	-	
Copper	0.035	80	L2
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L3
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L4
FR-4/Pre-preg	0.16	-	
Copper	0.035	80	L5
FR-4/Pre-preg	0.15	-	
Copper	0.07	80	L6

73.4 °C

Junction Temperature

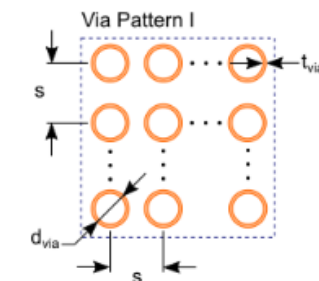
51.7 °C/W

Junction to Ambient Thermal Resistance

Dissipation from PCB surface : 0.837 W

Dissipation from device top : 0.00253 W

Same PCB but with thermal vias



6Layer 1mm thick PCB with 1000mm² top copper plane, no thermal vias

1oz copper

84mW power dissipation (as per data sheet with 60mA load)

LT3042 W/ 15Vin : 1.2Vout @100mA load (VTRX 1V2TX + 1V2RX) 30°C ambient

PCB Dimensions



L: mm

W: mm

PCB Layers

Number of Layers:

Material	Thickness [mm]	% Coverage 	Device
Copper	0.07	25	U1
FR-4/Pre-preg	0.15	-	L1
Copper	0.035	80	L2
FR-4/Pre-preg	0.16	-	L3
Copper	0.035	80	L4
FR-4/Pre-preg	0.16	-	L5
Copper	0.035	80	L6
FR-4/Pre-preg	0.15	-	L7
Copper	0.07	80	L8

103 °C

Junction Temperature

50.8 °C/W

Junction to Ambient
Thermal Resistance

Dissipation from PCB surface : 1.44 W

Dissipation from device top : 0.0047 W

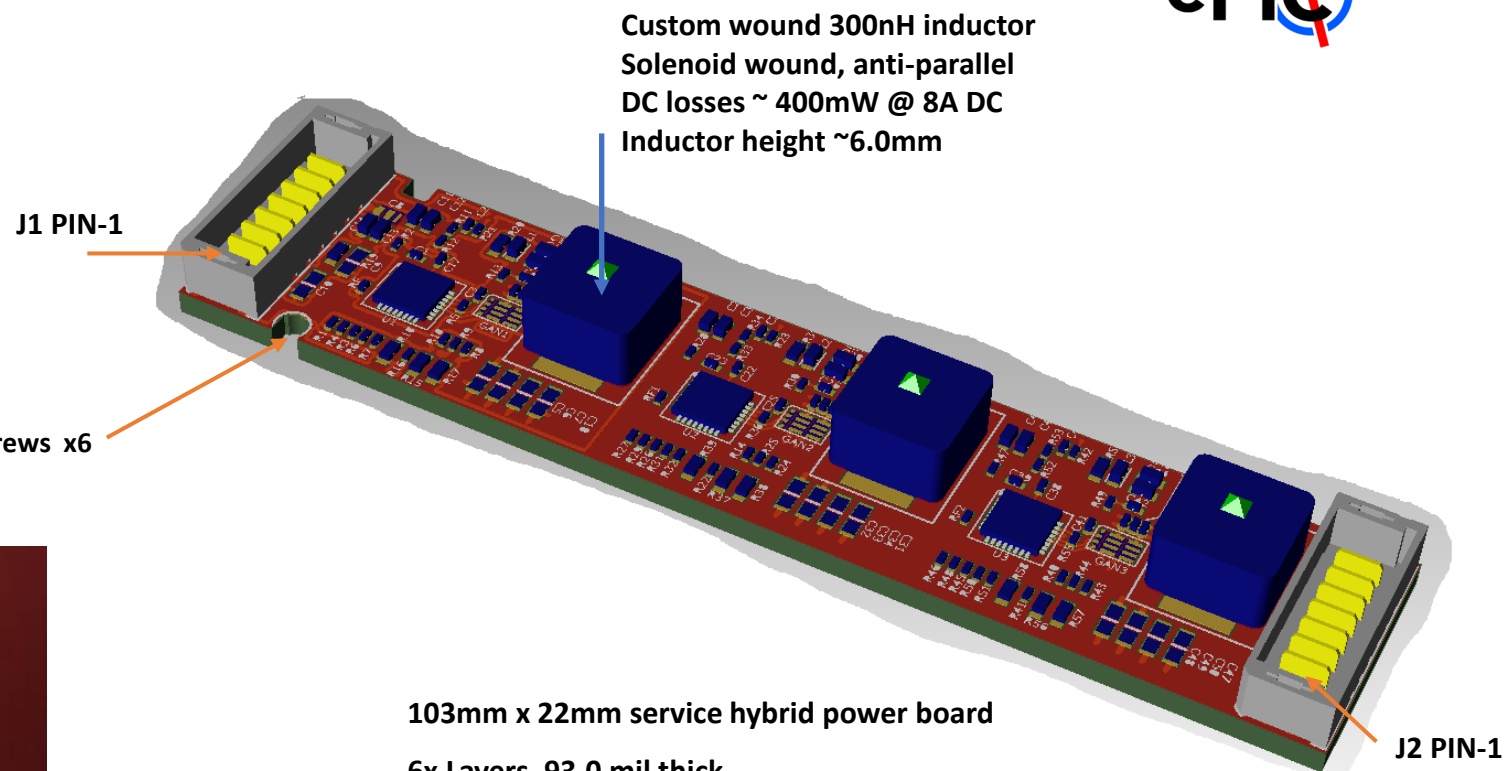
Power Board Footprint

Connector Samtec: UMPT-07-01.5-G-V-S-W-TR

RDO side => UMPS-07-05.5-G-V-S-W-TR

[Samtec power report](#)

Reference page 7 for 30°C rise and 4 pins carrying power.

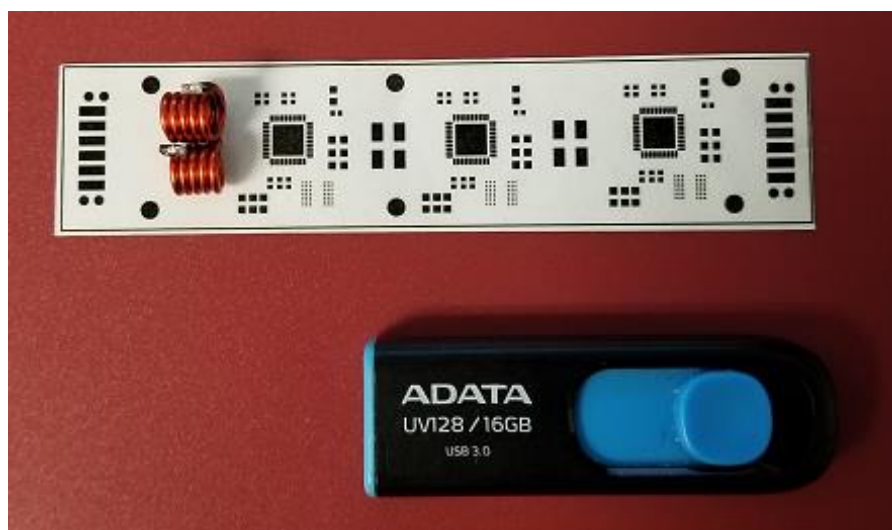


103mm x 22mm service hybrid power board

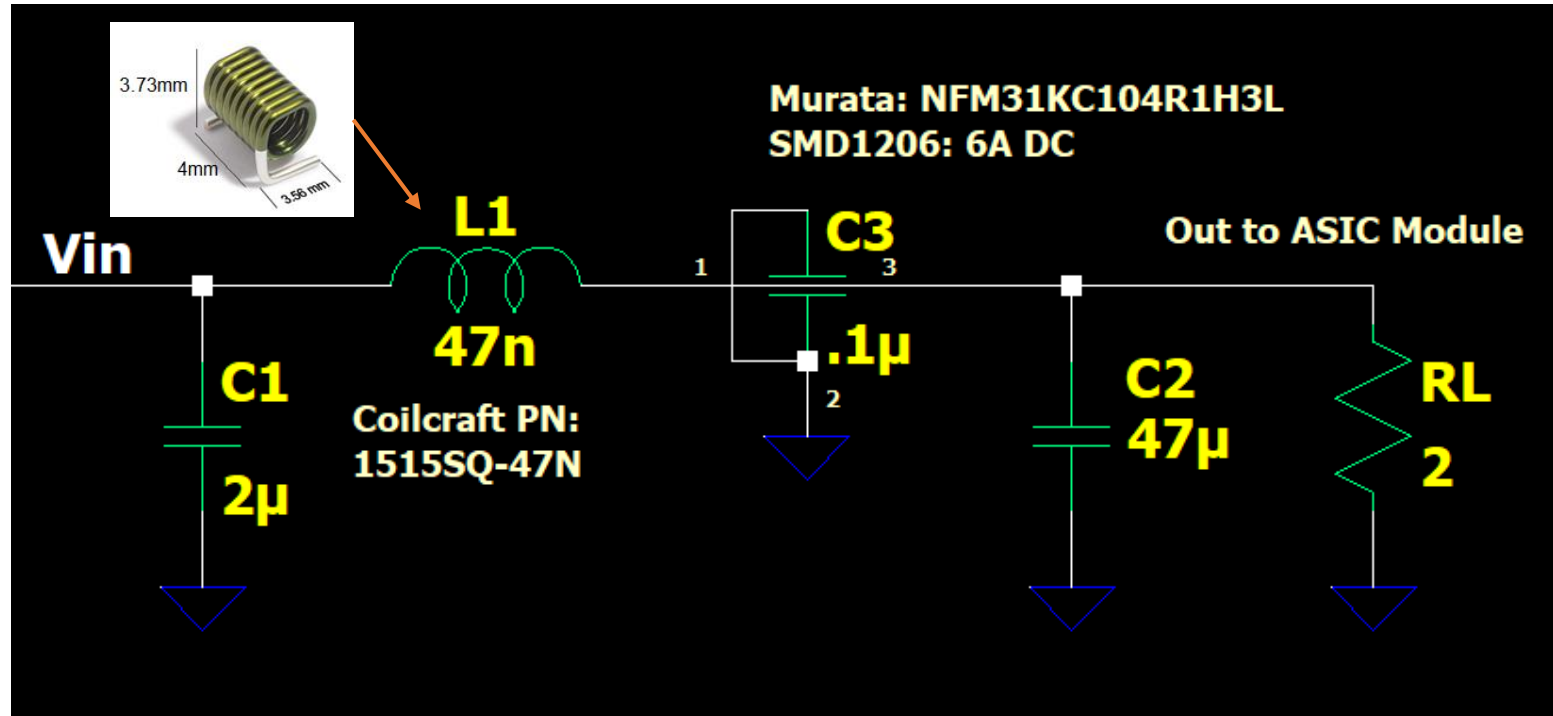
6x Layers, 93.0 mil thick

Single side components

Bottom copper to cooling plate



LC filter for input power to ASIC modules



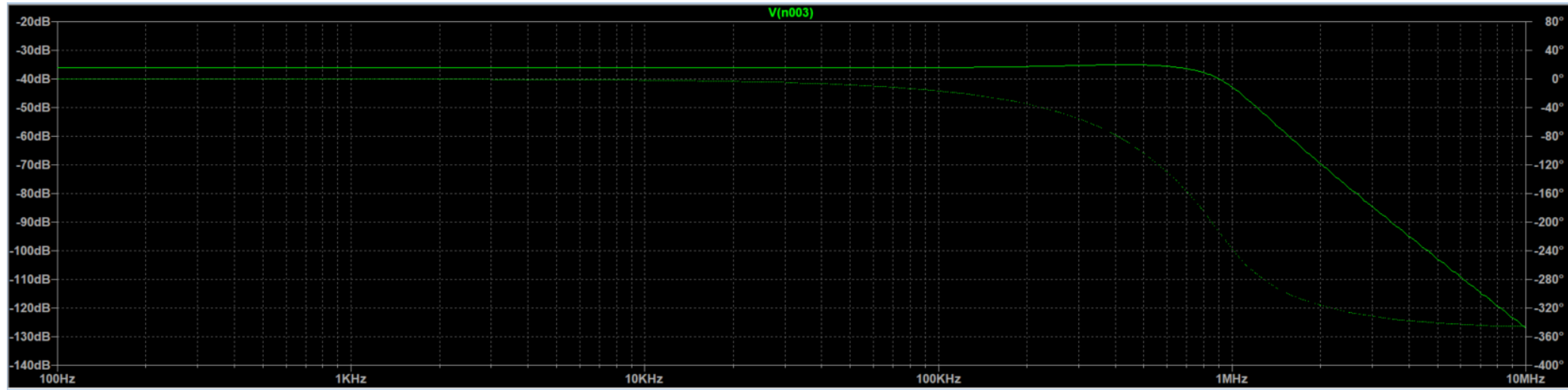
C1 and C2: Ceramic

C3: feedthrough PN:NFM31KC104R1H3L

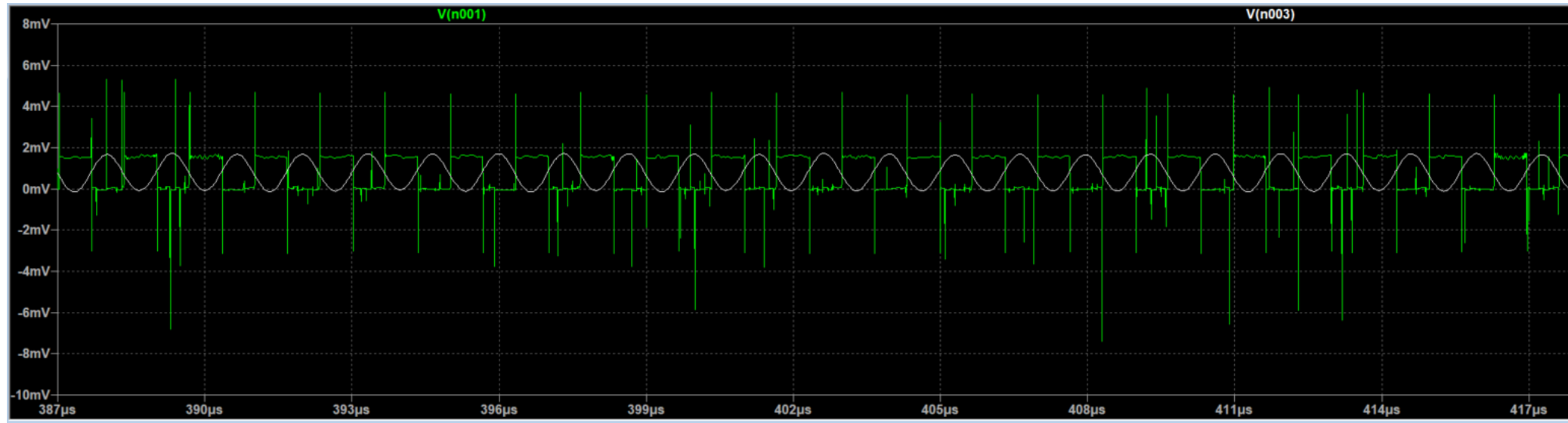
NOTE: choke for digital power rail use: Coilcraft 1515SQ-47N-J-E-C

choke for analog power rail use: Coilcraft 1111SQ-47N-J-E-C

LC filter simulation report



Bode plot for third order butterworth LC filter, ~800kHz cut off frequency



Frequency domain for third order butterworth LC filter, ~800kHz cut off frequency (green trace is switching noise, white trace is Vout)