Table of Contents: **tested with both 60A rated CSD95372B's & 45A rated CSD95373B's**

Testing note: valid for both with 60A CSD95372B's and with 45A CSD95373B's:
        For Vin at 12V and Vout below 900mV, the frequency drops with reduced Vout. At 600mV frequency is 211kHz (4 phases & 120A load). At 500mV frequency is 178kHz. Going to 400kHz setting gets 301kHz at 600mV out and 254kHz at 500mV out. However, lower frequency at these low Vouts saves 620mW at 120A load. Hence, the lower 300kHz setting will be retained. While lower frequency helps efficiency, output ripple could be worse. Hence, ripple was measured at both full load and no load where actual frequency was lowest at both 4 phase and 3 phase settings. In all cases output ripple stayed below 10mV p-p. See pages 4-5 for waveforms.

Power up instructions: valid for both with 60A CSD95372B's and with 45A CSD95373B's:
Increase Vin to at least 5V and start up GUI
Make the 7 updates as shown below with red "U" by them.
Then click on "Write to Hardware" (upper left corner of screen)
The updates should be accepted and the "U"s disappear.
Then turn on conversion by clicking the "On" button by "OPERATION" (lower right of GUI)
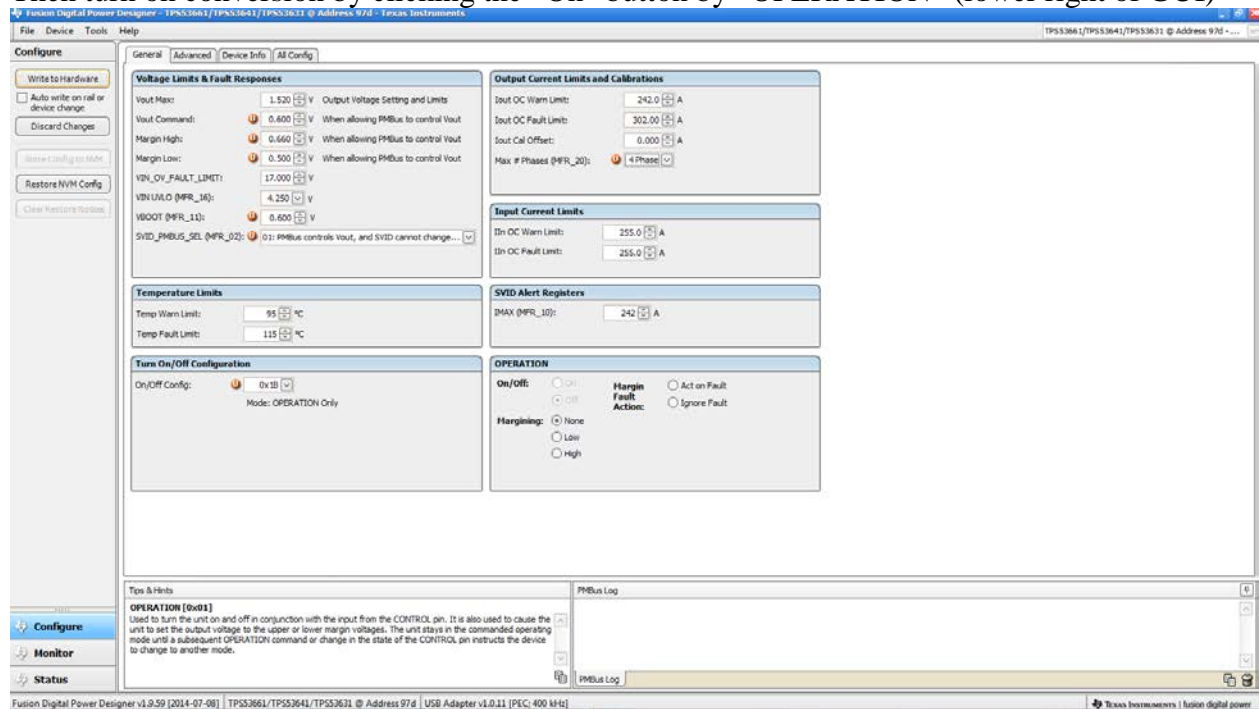
Efficiency and Losses: **with CSD95372B's**
PMP9738 model t3 set to 600mV output: 12Vin, Vout set at 600mV
Close in Vin & Vout measurements, Vout measurement at output caps and not at sense points,
with fan for ~200 LFM **with CSD95372B's**
4 Phases Enabled:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.017	7.039	0.6049	120.00	85.8	12.000	211kHz
12.036	5.741	0.6033	100.00	87.3	8.769	
12.026	4.521	0.6018	80.03	88.6	6.207	
12.052	3.344	0.6003	60.01	89.4	4.278	
12.054	2.231	0.5989	40.00	89.1	2.936	192kHz
12.039	1.143	0.5976	19.99	86.8	1.815	
12.028	0.130	0.5962	0	0.0	1.564	174kHz
12.013	7.093	0.6049	120.00	85.2	12.620	301kHz with 400kHz setting
						See testing note page 1

3 Phases Enabled:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.028	7.332	0.6044	120.03	82.3	15.643	220kHz
12.015	5.931	0.6029	100.00	84.6	10.971	213kHz
12.025	4.616	0.6015	80.00	86.7	7.387	207kHz
12.043	3.382	0.6001	59.96	88.3	4.747	200.5kHz
12.052	2.227	0.5988	39.98	89.2	2.900	194kHz
12.052	1.135	0.5975	20.00	87.4	1.729	188kHz
12.053	0.104	0.5963	0	0.0	1.254	172kHz

Q

6 phases down to 3 phases at 120A load:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.062	6.820	0.60555	120.31	88.6	9.409	6 phases 204kHz
12.058	6.890	0.60535	120.33	87.7	10.238	5 phases 206kHz
12.051	7.043	0.60505	120.34	85.8	12.063	4 phases 211kHz
12.036	7.350	0.60445	120.33	82.2	15.731	3 phases 220kHz

boot up with 3 phases with ~100usec rise and 30mV overshoot: **with CSD95372B's**

11-Aug-14
20:28:57


```
50 µs
100mV
```
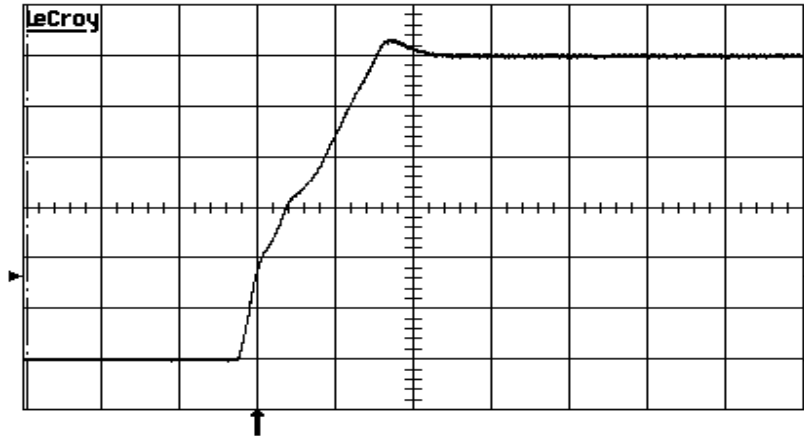
```
rise(1)         73.2904 µs
maximum(1)         631mV
Fall(1)            - - -
minimum(1)         -6mV
50 µs      BWL  Freq(1)            - - -
1  .1  V  DC
2  .5  V  DC ×10
3  .5  V  DC          ___|‾|    1  DC  166mV        200 MS/s
4  50 mV  AC                                       □   STOPPED
q
```
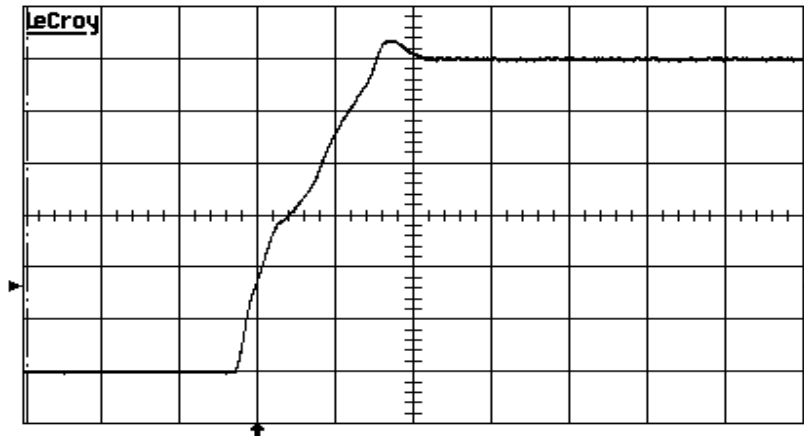
boot up with 4 phases with 634mV max, same rise time

11-Aug-14
20:32:05


```
50 µs
100mV
```

```
rise(1)         75.7440 µs
maximum(1)         634mV
Fall(1)            - - -
minimum(1)         -6mV
50 µs      BWL  Freq(1)            - - -
1  .1  V  DC
2  .5  V  DC ×10
3  .5  V  DC          ___|‾|    1  DC  166mV        200 MS/s
4  50 mV  AC                                       □   STOPPED
Q
```
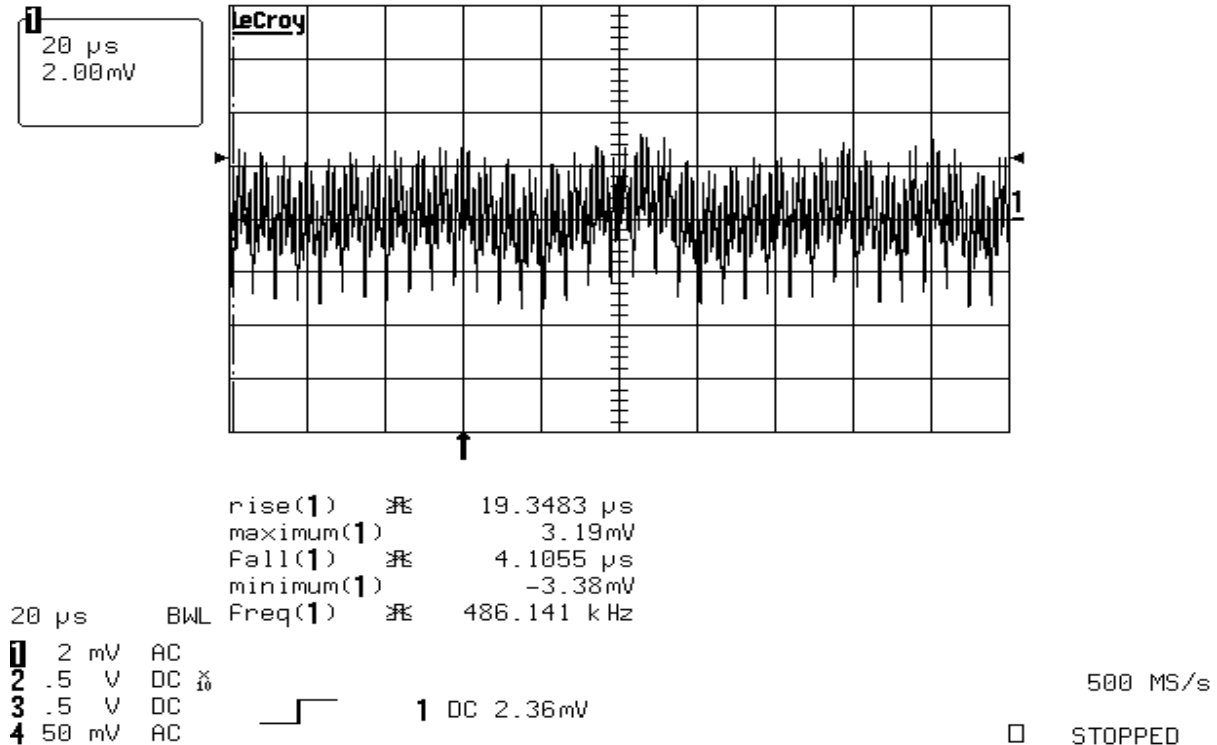
Output ripple: **with CSD95372B's**

12Vin 600mVout 120A load 4 phases with each phase at 211kHz: 6.6mV p-p (20MHz BW)
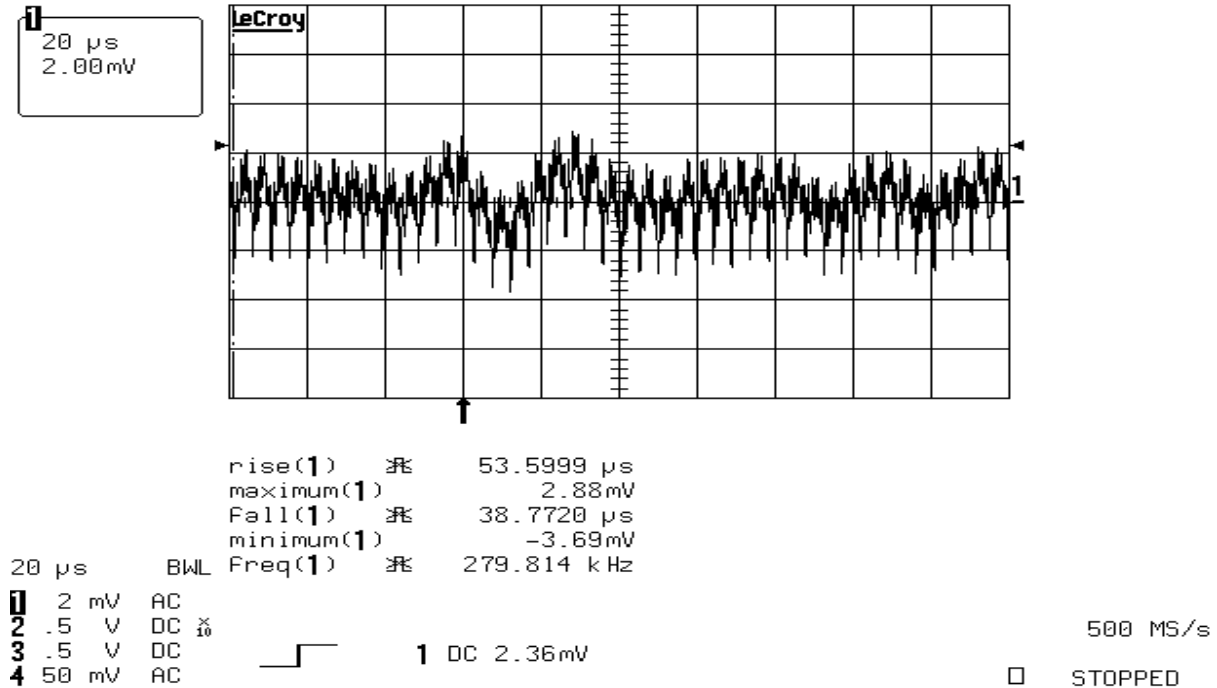
11-Aug-14
19:26:00

```
20 µs
2.00mV
```

LeCroy

```
rise(1)        兆      19.3483 µs
maximum(1)             3.19mV
Fall(1)        兆       4.1055 µs
minimum(1)            -3.38mV
20 µs    BWL  Freq(1)  兆    486.141 kHz
1   2 mV  AC
2  .5  V  DC  ×10
3  .5  V  DC         ┌─┐  1 DC 2.36mV
4 50 mV  AC         ─┘ └─
Q
```

500 MS/s

☐   STOPPED

Output ripple: 12Vin 600mVout 0A load 4 phases with each phase at 174kHz: 6.6mV p-p (20MHz BW)

11-Aug-14
19:43:54

```
20 µs
2.00mV
```

LeCroy

```
rise(1)        兆      53.5999 µs
maximum(1)             2.88mV
Fall(1)        兆      38.7720 µs
minimum(1)            -3.69mV
20 µs    BWL  Freq(1)  兆    279.814 kHz
1   2 mV  AC
2  .5  V  DC  ×10
3  .5  V  DC         ┌─┐  1 DC 2.36mV
4 50 mV  AC         ─┘ └─
Q
```
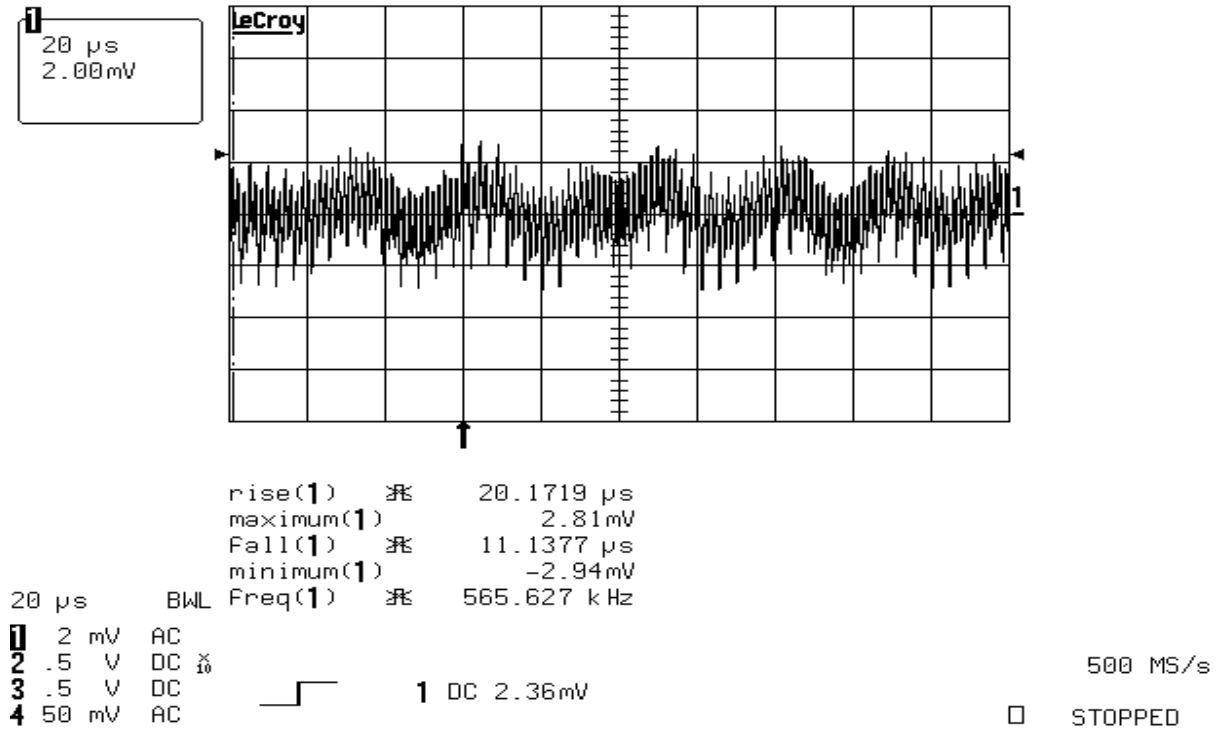
500 MS/s

☐   STOPPED

Output ripple: **with CSD95372B's**
12Vin 600mVout 120A load 3 phases with each phase at 220kHz: 5.8mV p-p (20MHz BW)
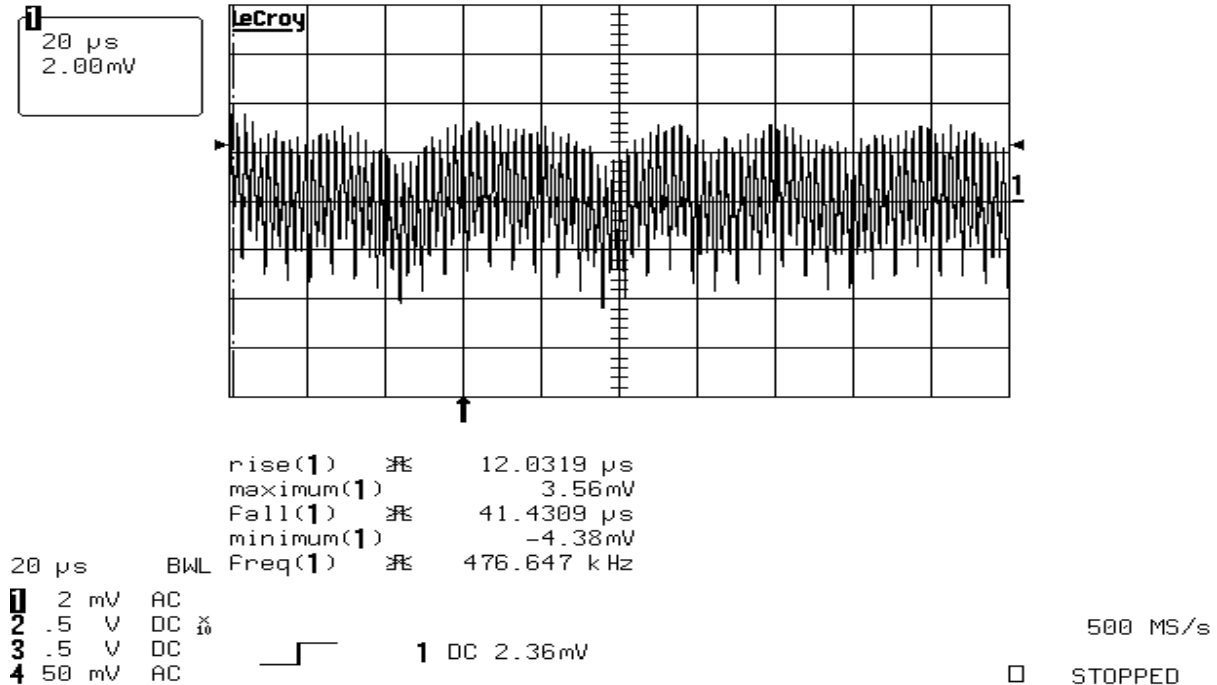
11-Aug-14
19:47:31

```
20 µs
2.00mV
```

rise(1)   20.1719 µs
maximum(1)   2.81mV
Fall(1)   11.1377 µs
minimum(1)   -2.94mV
20 µs   BWL Freq(1)   565.627 kHz
1   2 mV   AC
2 .5 V   DC ×10
3 .5 V   DC
4 50 mV   AC   1 DC 2.36mV
500 MS/s
STOPPED

Q
Output ripple: 12Vin 600mVout 0A load 3 phases with each phase at 172kHz: 7.9mV p-p (20MHz BW)

11-Aug-14
20:22:23

```
20 µs
2.00mV
```

rise(1)   12.0319 µs
maximum(1)   3.56mV
Fall(1)   41.4309 µs
minimum(1)   -4.38mV
20 µs   BWL Freq(1)   476.647 kHz
1   2 mV   AC
2 .5 V   DC ×10
3 .5 V   DC
4 50 mV   AC   1 DC 2.36mV
500 MS/s
STOPPED

Thermal Images: **with CSD95372B's / 4 phases**
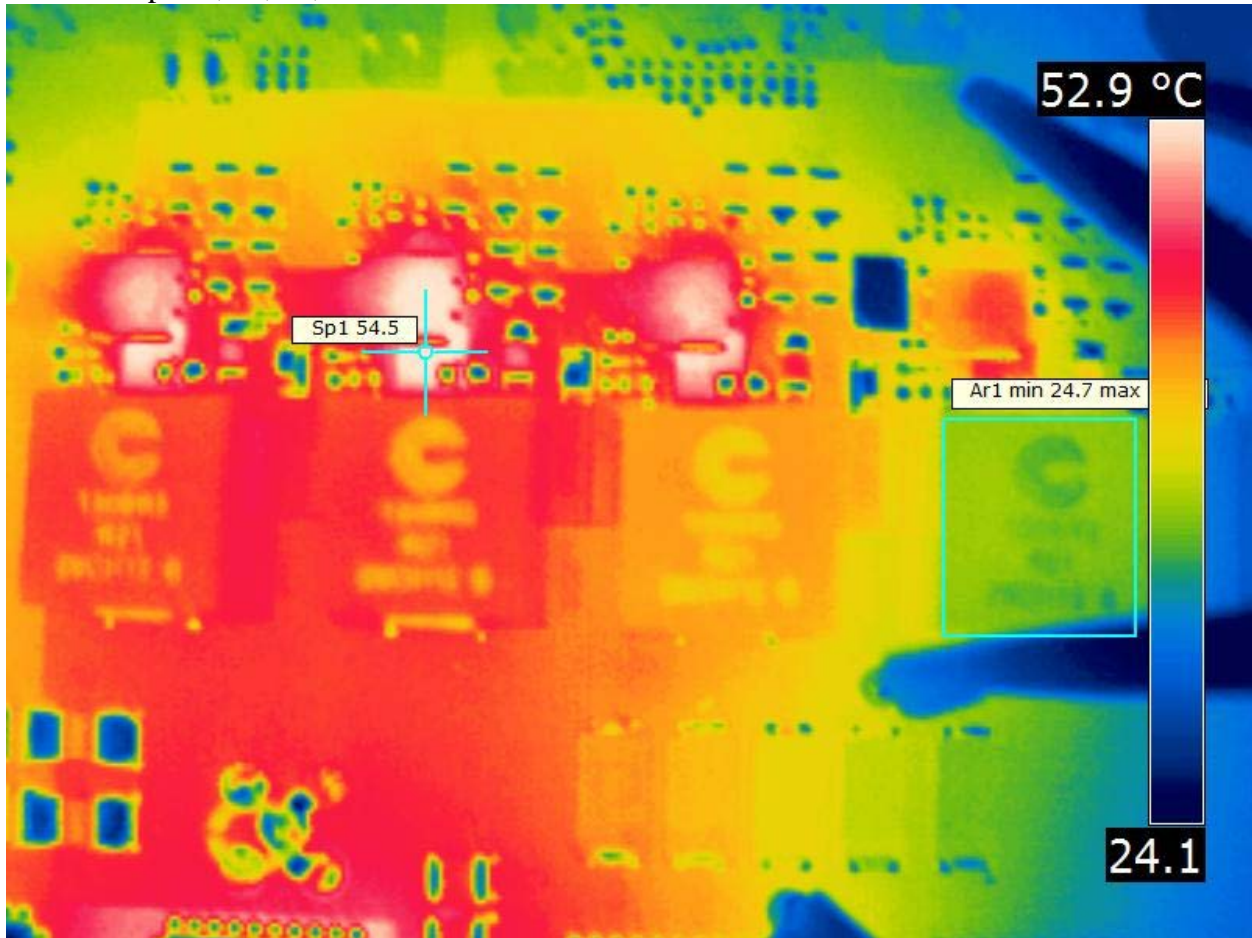EX320 Flir camera with emissivity set at 0.94
PMP10393: 12vin 600mV out at 120A 4 phases operating, each @ 210kHz; ~200 LFM airflow
from right side
 21 deg. C ambient 12W loss on board
Power stages left to right: 53.3, 54.5, 52.7, 46.2 deg. C
Adjacent copper hottest
Inductor tops 47, 47, 44, 38

Q

Thermal Images: **with CSD95372B's / 3 phases**
EX320 Flir camera with emissivity set at 0.94
PMP10393: 12Vin 600mV out at 120A 3 phases operating, each @ 220kHz;
~200 LFM airflow from right side
 21 deg. C ambient   15.6W loss on board
Power stages left to right: 68, 69, 66 deg. C
Adjacent copper hottest
Inductor tops 53, 54, 50

Q

This 15.6W compares with 18.4W for the 1.2Vout with same 120A and same 12Vin and similar
airflow of ~200LFM in the PMP10306 Test Report.

Efficiency and Losses: **with CSD95373B's**:
PMP9738 model t3 set to 600mV output: 12Vin, Vout set at 600mV
Close in Vin & Vout measurements, Vout measurement at output caps and not at sense points,
with fan for ~200 LFM   CSD95373B date code May 2014
4 Phases Enabled:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.065	7.356	0.6068	120.18	82.2	15.825	4 phases 221.6kHzxxd005rippleIR577_60deg
12.051	5.959	0.6053	99.99	84.3	11.288	215.5kHz; 40degC max
12.027	4.654	0.6039	79.98	86.3	7.674	209.5kHz
12.033	3.418	0.6026	59.98	87.9	4.985	203kHz
12.036	2.255	0.60135	40.00	88.6	3.087	197kHz
12.038	1.147	0.6001	20.01	87.0	1.800	184kHz
12.038	0.120	0.5987	0	0.0	1.445	Rippled007; 173kHz

Q

3 Phases Enabled:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.041	7.827	0.6062	120.17	77.3	21.398	235.5kHz 82 deg. IR576
12.024	6.248	0.6048	100.03	80.5	14.628	226kHz 63degCmax
12.021	4.810	0.6036	79.93	83.4	9.575	217kHz 49degCmax
12.053	3.482	0.6023	59.98	86.1	5.843	208kHz
12.035	2.269	0.6011	40.00	88.0	3.263	201kHz
12.055	1.139	0.5999	20.03	87.5	1.715	191kHz
12.02	0.099	0.5987	0	0.0	1.190	173kHz

Q
All output ripple measurements under 10mV p-p (see pages 4-5)

Below is full load vs. number of phases 6 down to 3:

Vin Volts	Iin A	Vout Volts	Iout A	% Efficiency	Losses in W	Notes
12.071	7.002	0.60725	120.18	86.3	11.542	6 phases 210kHz 45.5degCmax
12.0645	7.131	0.60715	120.18	84.8	13.065	5 phases 214kHz 51degCmax
12.065	7.356	0.6068	120.18	82.2	15.825	4 phases 221.6kHz IR577_60deg
12.041	7.827	0.6062	120.17	77.3	21.398	3 phases 235.5kHz IR576 82 deg

Q

D010 is boot up with 3 phases **with CSD95373B's** ~90usec rise and 634mV max

18-Aug-14
20:34:51
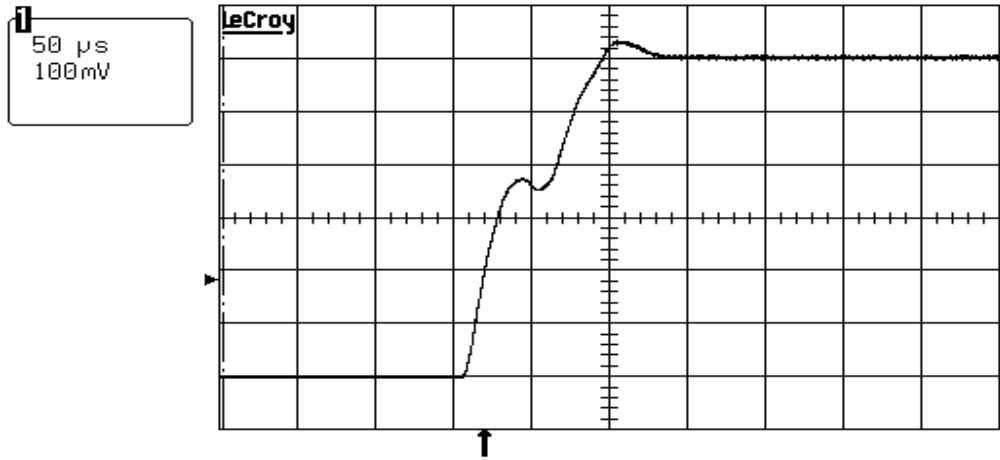
50 µs
100mV

rise(1)   71.7046 µs
maximum(1)   634mV
pkpk(1)   638mV
mean(1)   371.2mV
50 µs   BWL Freq(1)   - - -

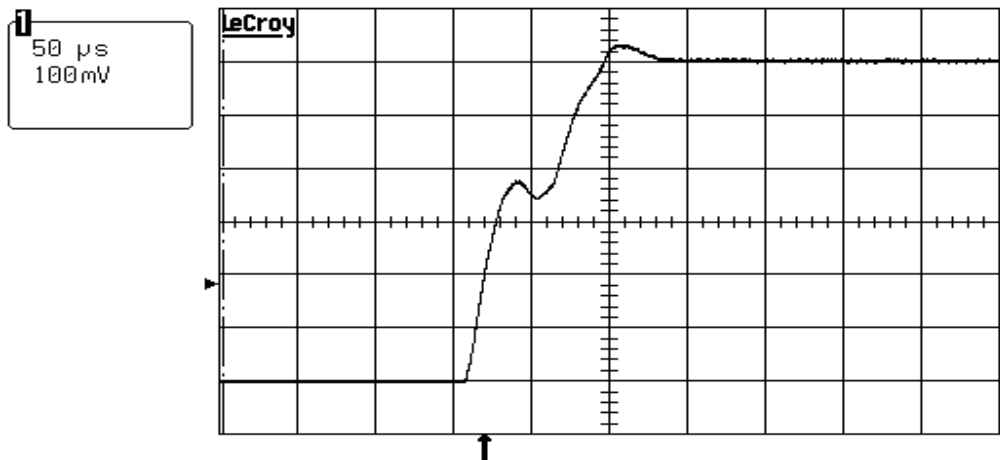1 .1 V DC
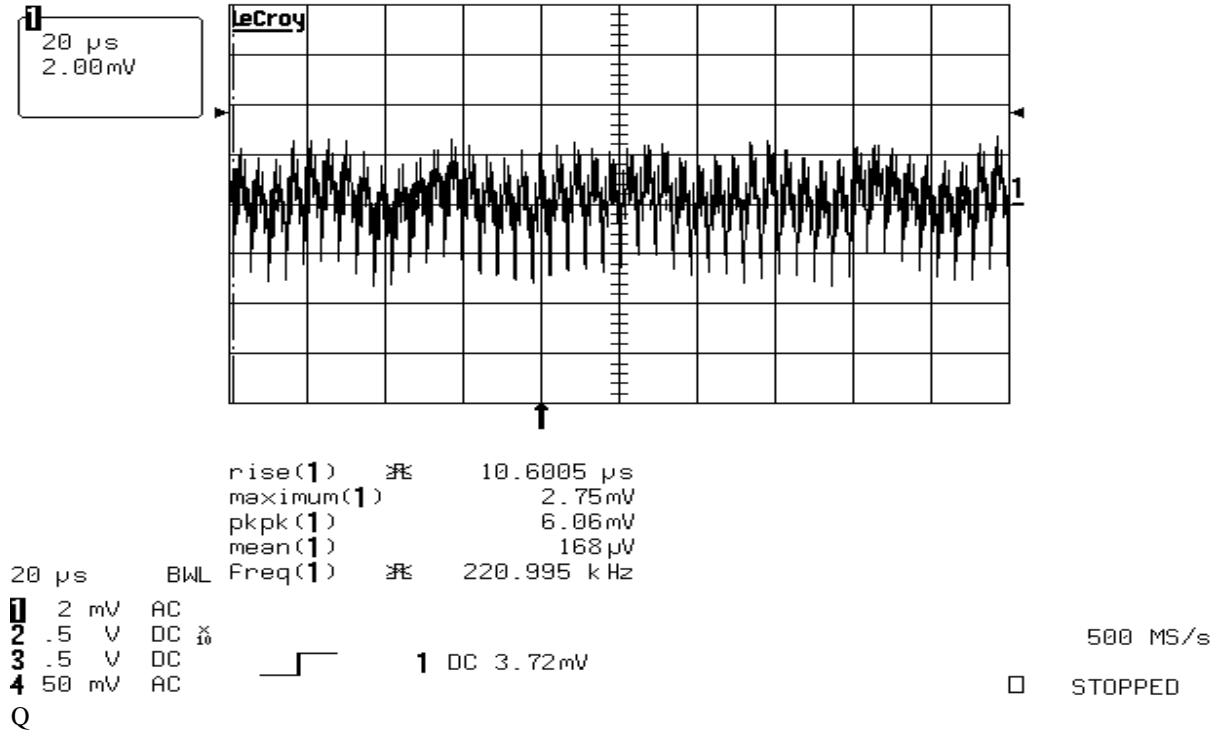2 .5 V DC
3 .5 V DC
4 50 mV AC

1 DC 186mV

200 MS/s

STOPPED

q
D008/9 is boot up with 4 phases with 631mV max, same rise time

18-Aug-14
20:32:19

50 µs
100mV

rise(1)   72.2746 µs
maximum(1)   631mV
pkpk(1)   634mV
mean(1)   370.8mV
50 µs   BWL Freq(1)   - - -

1 .1 V DC
2 .5 V DC
3 .5 V DC
4 50 mV AC

1 DC 186mV

200 MS/s

STOPPED

Q

Output ripple: 4 phases with CSD95373B's

with each phase at 222kHz: 12Vin 600mVout 120A load **6.1mV p-p** (20MHz BW)

18-Aug-14
18:20:02

```
20 µs
2.00mV
```

LeCroy

```
rise(1)        10.6005 µs
maximum(1)        2.75mV
pkpk(1)           6.06mV
mean(1)            168 µV
```
20 µs   BWL Freq(1)   220.995 kHz

```
1   2 mV   AC
2  .5  V   DC ×10
3  .5  V   DC
4  50 mV   AC
```
Q

                                       1 DC 3.72mV

500 MS/s

☐ STOPPED

Output ripple: 12Vin 600mVout 0A load 4 phases with each phase at 173kHz: **6.5mV p-p** (20MHz BW)

18-Aug-14
19:35:58

```
20 µs
2.00mV
```

LeCroy

```
rise(1)         3.4568 µs
maximum(1)        3.06mV
pkpk(1)           6.50mV
mean(1)            146 µV
```
20 µs   BWL Freq(1)   368.695 kHz

```
1   2 mV   AC
2  .5  V   DC ×10
3  .5  V   DC
4  50 mV   AC
```
Q

                                       1 DC 3.72mV

500 MS/s

☐ STOPPED
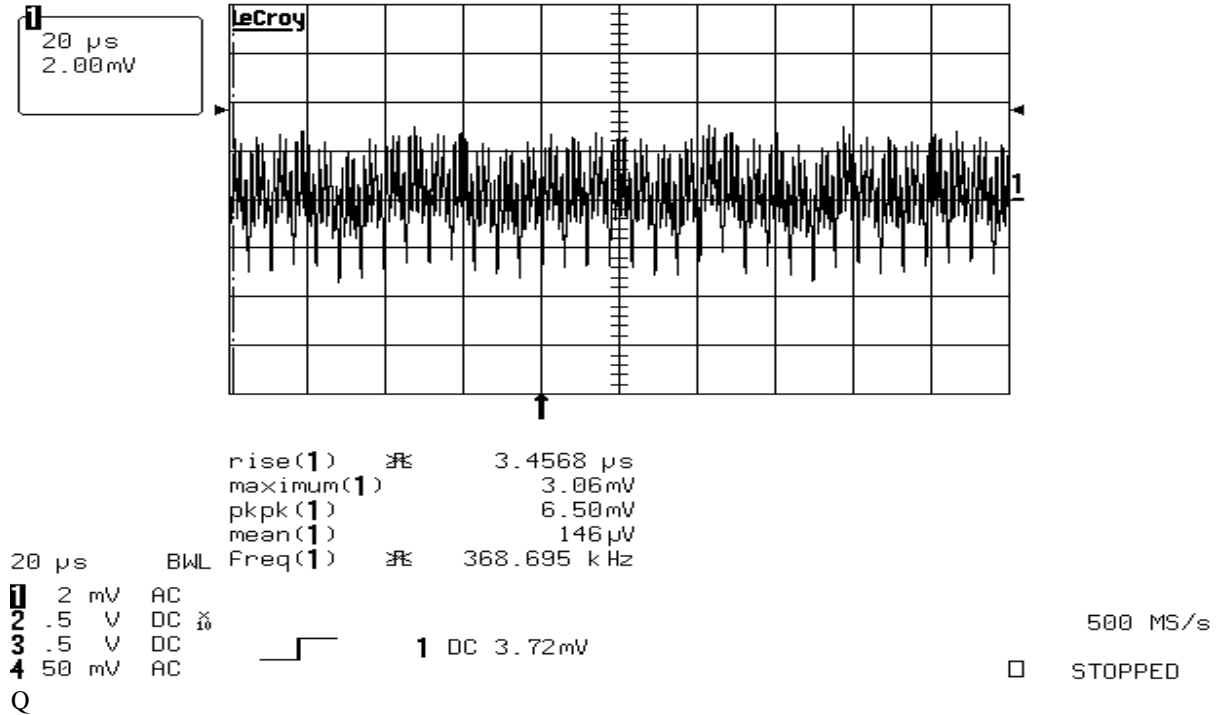
Output ripple: 3 phases with CSD95373B's

with each phase at 235.5kHz: 12Vin 600mVout 120A load **5.4mV p-p** (20MHz BW)

```
18-Aug-14
18:07:48
```



```
          rise(1)    ⫪      16.8214 µs
          maximum(1)          2.63mV
          pkpk(1)             5.44mV
          mean(1)              64µV
20 µs      BWL Freq(1)   ⫪   671.264 kHz
```

```
1   2 mV   AC
2   .5  V   DC ×10
3   .5  V   DC            1 DC 3.72mV
4  50 mV   AC
Q
```

500 MS/s

☐   STOPPED
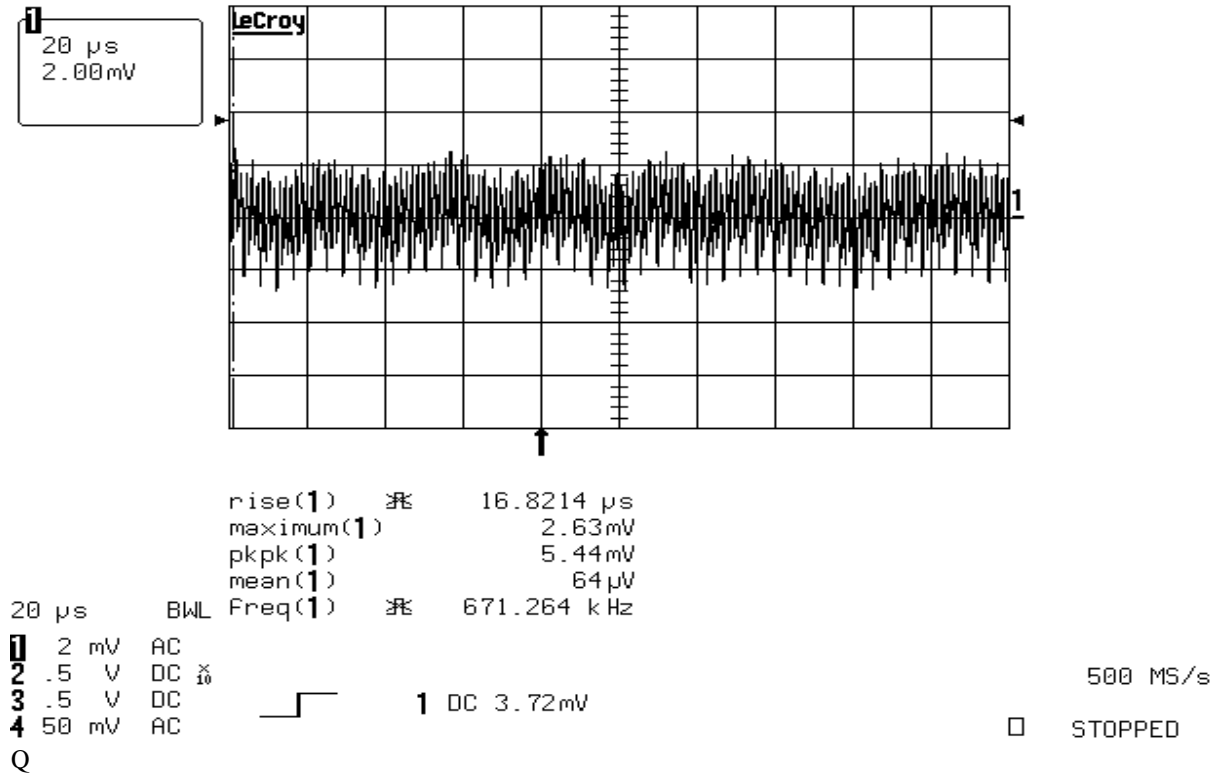
Output ripple: 12Vin 600mVout 0A load 3 phases with each phase at 173kHz: **6.8mV p-p** (20MHz BW)

```
18-Aug-14
19:30:10
```



```
          rise(1)    ⫪      670.3 ns
          maximum(1)          3.06mV
          pkpk(1)             6.81mV
          mean(1)             -44µV
20 µs      BWL Freq(1)   ⫪   476.111 kHz
```

```
1   2 mV   AC
2   .5  V   DC ×10
3   .5  V   DC            1 DC 3.72mV
4  50 mV   AC
```

500 MS/s

☐   STOPPED
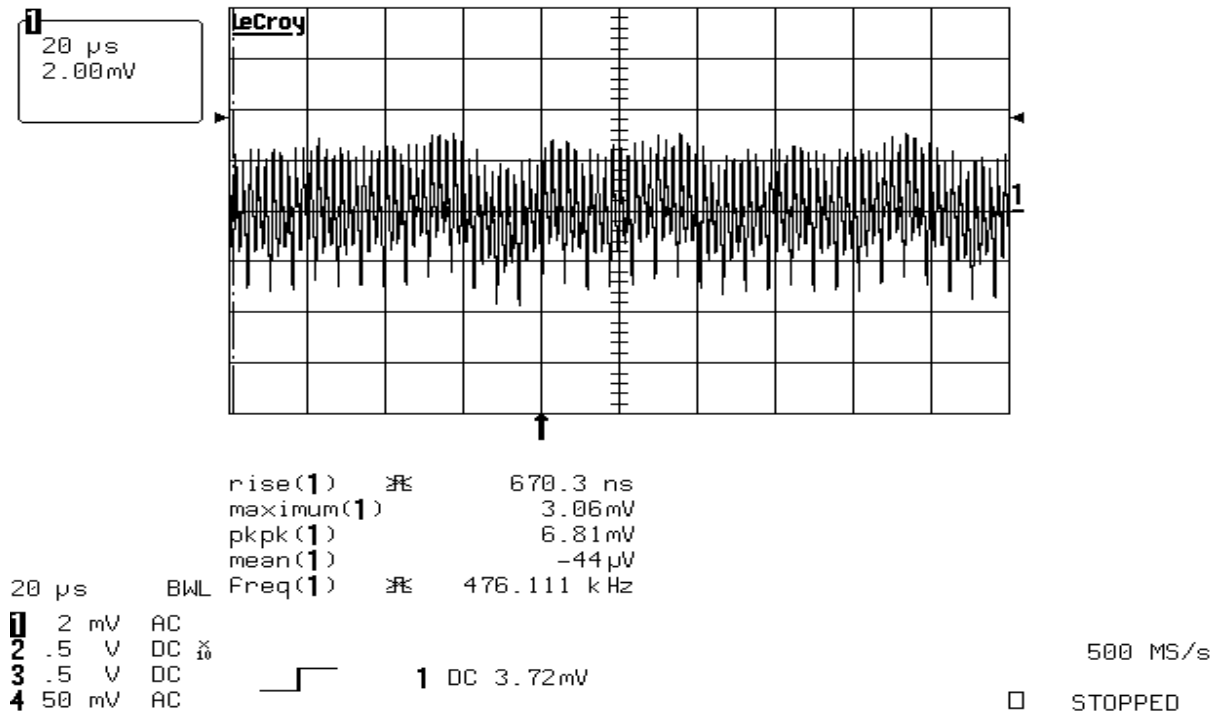
Thermal Image: 4 Phases 120A load off 600mV, 12Vin with CSD95373B's

EX320 Flir camera with emissivity set at 0.94
PMP10393: CSD95373B 222kHz
12Vin 600mV out at 120A 4 phases
~200 LFM airflow from right side: 15.8W on board ~22 deg. C ambient
Power stages left to right: 60, 60, 57, 53 deg. C
Inductor tops left to right: 44, 44, 40, 36
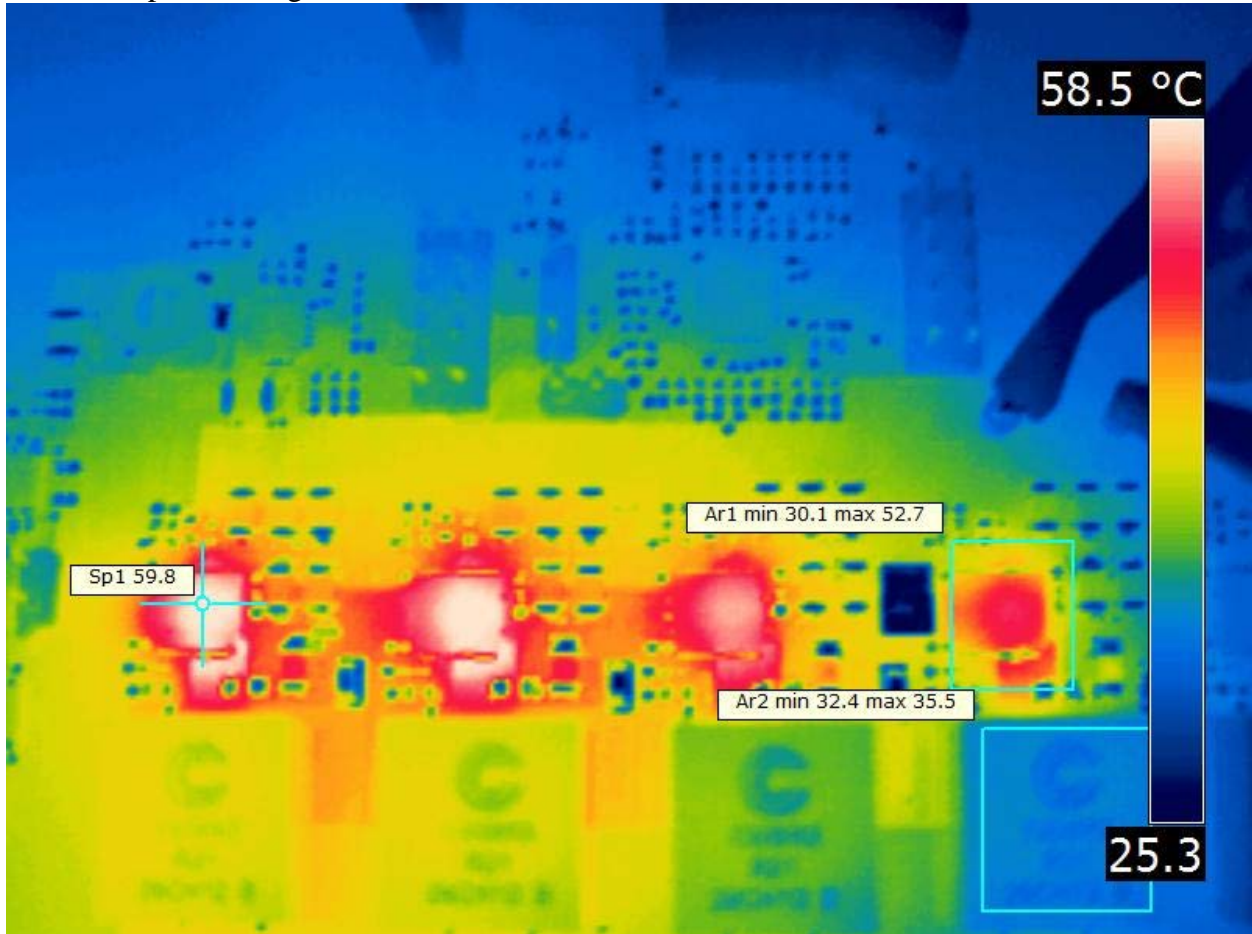
Q

Thermal Image: 3 Phases 120A load off 600mV, 12Vin with CSD95373B's

EX320 Flir camera with emissivity set at 0.94
PMP10393: CSD95373B 235.5kHz
12Vin 600mV out at 120A 3 phases
~200 LFM airflow from right side: 21.4W on board ~22 deg. C ambient
Power stages left to right: 82, 82, 75 deg. C
Inductor tops left to right: 53, 52, 45
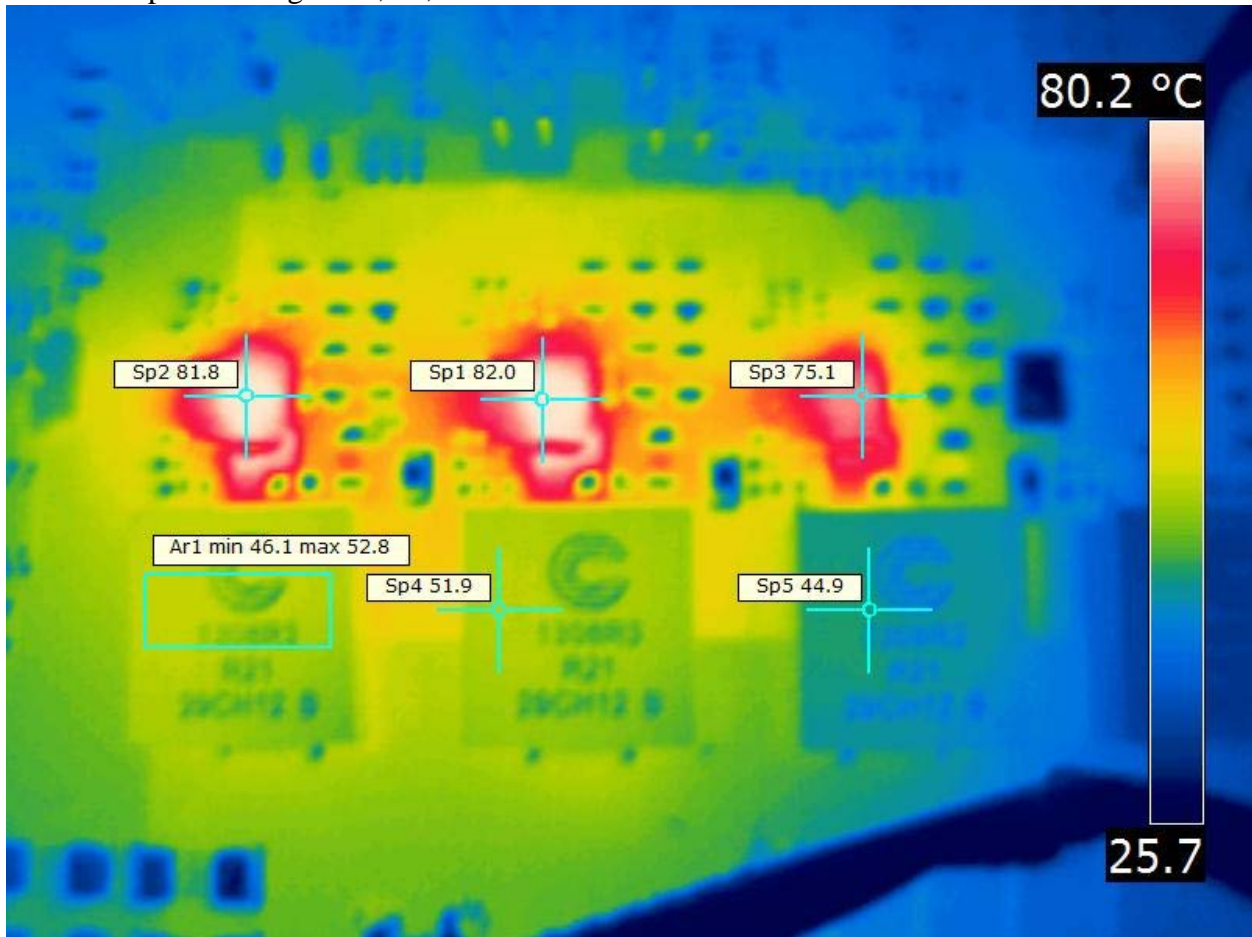
Q

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