

**Test Data  
For PMP20322  
6/2/2016**



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## 1. Design Specifications

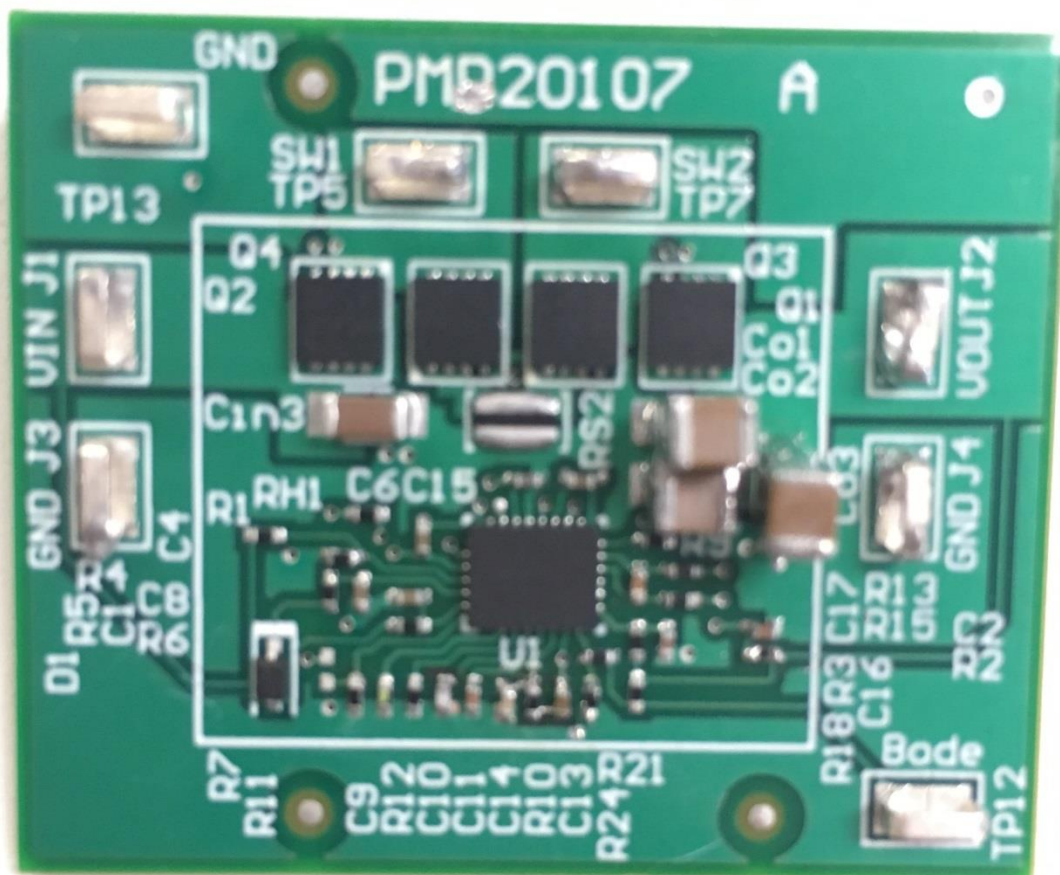
|                             |             |
|-----------------------------|-------------|
| Vin Minimum                 | 10VDC       |
| Vin Maximum                 | 14VDC       |
| Vout                        | +12VDC @ 2A |
| Nominal Switching Frequency | ≈ 300KHz    |

## 2. Circuit Description

PMP20322 is a 4-switch buck-boost controller utilizing the LM5175 for consumer applications. This design has a minimum operating input voltage of 10V and a maximum input voltage of 14V. The design is capable of sourcing 2A continuous current at 12Vout. Switching frequency is set to 300kHz. PMP20322 is assembled on PMP20107 PCB.

## 3. PMP20322 Board Photos

Board Dimensions: 40.13mm x 33.02mm



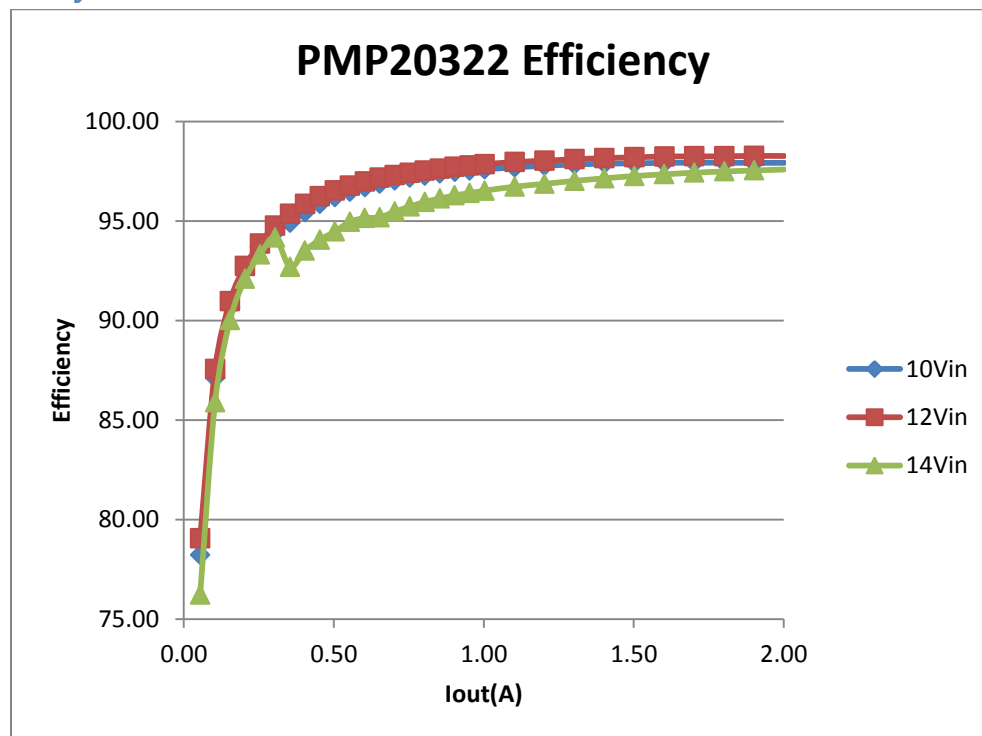
Board Photo (Top)



Board Photo (Bottom)

## 4. Efficiency

### 4.1 Efficiency Chart



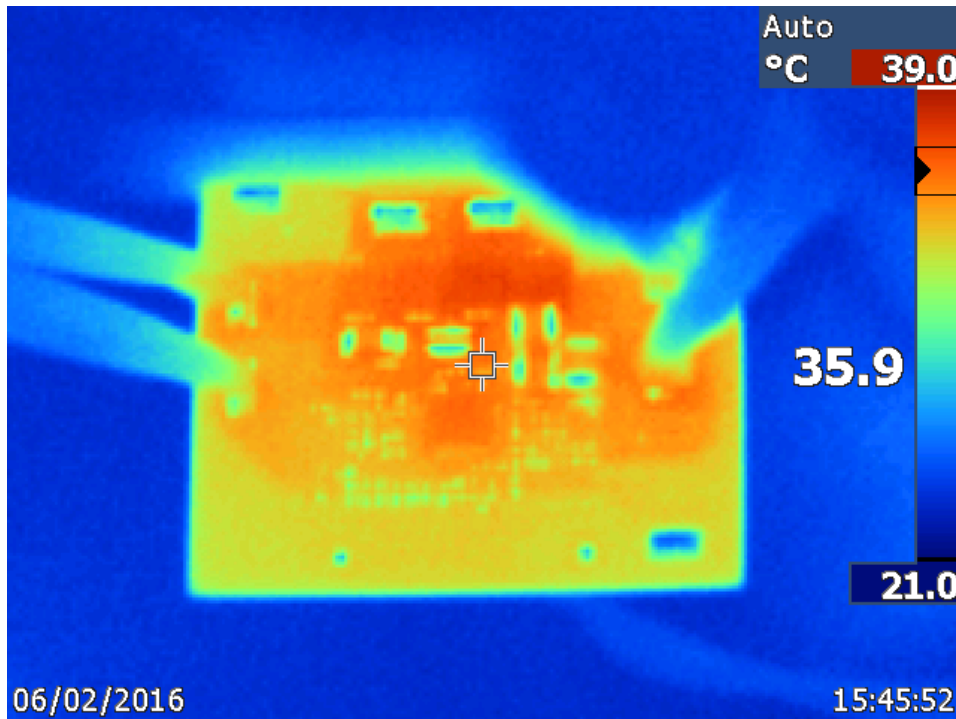
## 4.2 Efficiency Data

| Vin(V) | Iin(A) | Vout(V) | Iout(A) | Pin(W) | Pout(W) | Losses(W) | Efficiency |
|--------|--------|---------|---------|--------|---------|-----------|------------|
| 10.01  | 0.02   | 11.94   | 0.00    | 0.18   | 0.00    | 0.18      | 0.00       |
| 10.01  | 0.08   | 11.94   | 0.05    | 0.83   | 0.65    | 0.18      | 78.23      |
| 10.01  | 0.14   | 11.94   | 0.10    | 1.43   | 1.25    | 0.18      | 87.12      |
| 10.01  | 0.20   | 11.94   | 0.15    | 2.03   | 1.84    | 0.19      | 90.68      |
| 10.01  | 0.26   | 11.94   | 0.20    | 2.64   | 2.44    | 0.20      | 92.54      |
| 10.01  | 0.32   | 11.94   | 0.25    | 3.24   | 3.04    | 0.21      | 93.68      |
| 10.01  | 0.38   | 11.94   | 0.30    | 3.85   | 3.63    | 0.21      | 94.42      |
| 10.01  | 0.45   | 11.94   | 0.35    | 4.46   | 4.23    | 0.23      | 94.92      |
| 10.01  | 0.51   | 11.94   | 0.40    | 5.06   | 4.82    | 0.23      | 95.44      |
| 10.01  | 0.57   | 11.94   | 0.45    | 5.65   | 5.42    | 0.23      | 95.86      |
| 10.01  | 0.63   | 11.94   | 0.50    | 6.25   | 6.02    | 0.24      | 96.19      |
| 10.01  | 0.69   | 11.94   | 0.55    | 6.85   | 6.61    | 0.24      | 96.47      |
| 10.01  | 0.74   | 11.94   | 0.60    | 7.45   | 7.21    | 0.25      | 96.69      |
| 10.01  | 0.81   | 11.94   | 0.65    | 8.06   | 7.80    | 0.25      | 96.87      |
| 10.01  | 0.87   | 11.94   | 0.70    | 8.66   | 8.40    | 0.26      | 97.02      |
| 10.01  | 0.93   | 11.94   | 0.75    | 9.26   | 9.00    | 0.26      | 97.17      |
| 10.01  | 0.99   | 11.94   | 0.80    | 9.86   | 9.59    | 0.27      | 97.27      |
| 10.01  | 1.05   | 11.94   | 0.85    | 10.47  | 10.19   | 0.27      | 97.38      |
| 10.01  | 1.11   | 11.94   | 0.90    | 11.07  | 10.79   | 0.28      | 97.46      |
| 10.01  | 1.17   | 11.94   | 0.95    | 11.67  | 11.38   | 0.29      | 97.53      |
| 10.01  | 1.23   | 11.94   | 1.00    | 12.27  | 11.98   | 0.30      | 97.59      |
| 10.01  | 1.35   | 11.94   | 1.10    | 13.48  | 13.17   | 0.31      | 97.69      |
| 10.01  | 1.47   | 11.94   | 1.20    | 14.69  | 14.36   | 0.33      | 97.77      |
| 10.01  | 1.59   | 11.94   | 1.30    | 15.90  | 15.56   | 0.34      | 97.84      |
| 10.01  | 1.71   | 11.94   | 1.40    | 17.11  | 16.75   | 0.36      | 97.88      |
| 10.01  | 1.83   | 11.94   | 1.50    | 18.33  | 17.94   | 0.39      | 97.89      |
| 10.01  | 1.95   | 11.94   | 1.60    | 19.54  | 19.13   | 0.41      | 97.92      |
| 10.01  | 2.07   | 11.94   | 1.70    | 20.76  | 20.32   | 0.43      | 97.93      |
| 10.01  | 2.20   | 11.94   | 1.80    | 21.97  | 21.52   | 0.45      | 97.93      |
| 10.01  | 2.32   | 11.94   | 1.90    | 23.19  | 22.71   | 0.48      | 97.92      |
| 10.01  | 2.44   | 11.94   | 2.00    | 24.41  | 23.91   | 0.51      | 97.92      |
|        |        |         |         |        |         |           |            |
| 12.01  | 0.01   | 11.93   | 0.00    | 0.17   | 0.00    | 0.17      | 0.00       |
| 12.01  | 0.07   | 11.93   | 0.05    | 0.82   | 0.65    | 0.17      | 79.06      |
| 12.01  | 0.12   | 11.94   | 0.10    | 1.42   | 1.24    | 0.18      | 87.56      |
| 12.01  | 0.17   | 11.93   | 0.15    | 2.02   | 1.84    | 0.18      | 90.97      |
| 12.01  | 0.22   | 11.94   | 0.20    | 2.63   | 2.44    | 0.19      | 92.73      |
| 12.01  | 0.27   | 11.93   | 0.25    | 3.23   | 3.03    | 0.20      | 93.87      |

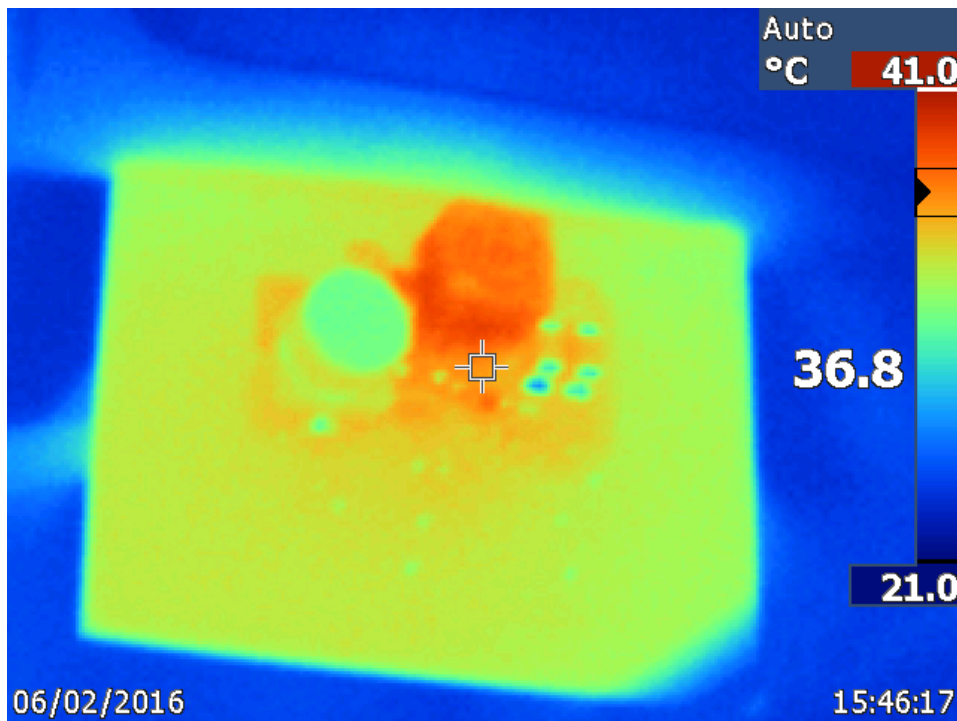
|       |      |       |      |       |       |      |       |
|-------|------|-------|------|-------|-------|------|-------|
| 12.01 | 0.32 | 11.93 | 0.30 | 3.83  | 3.63  | 0.20 | 94.76 |
| 12.01 | 0.37 | 11.93 | 0.35 | 4.43  | 4.23  | 0.21 | 95.36 |
| 12.01 | 0.42 | 11.93 | 0.40 | 5.03  | 4.82  | 0.21 | 95.86 |
| 12.01 | 0.47 | 11.93 | 0.45 | 5.63  | 5.42  | 0.21 | 96.24 |
| 12.01 | 0.52 | 11.93 | 0.50 | 6.23  | 6.01  | 0.22 | 96.52 |
| 12.01 | 0.57 | 11.93 | 0.55 | 6.83  | 6.61  | 0.22 | 96.78 |
| 12.01 | 0.62 | 11.93 | 0.60 | 7.43  | 7.20  | 0.22 | 96.99 |
| 12.01 | 0.67 | 11.93 | 0.65 | 8.03  | 7.80  | 0.23 | 97.17 |
| 12.01 | 0.72 | 11.93 | 0.70 | 8.63  | 8.40  | 0.23 | 97.30 |
| 12.01 | 0.77 | 11.93 | 0.75 | 9.23  | 8.99  | 0.24 | 97.42 |
| 12.01 | 0.82 | 11.93 | 0.80 | 9.83  | 9.59  | 0.24 | 97.53 |
| 12.01 | 0.87 | 11.93 | 0.85 | 10.43 | 10.18 | 0.25 | 97.63 |
| 12.01 | 0.92 | 11.93 | 0.90 | 11.03 | 10.78 | 0.25 | 97.72 |
| 12.01 | 0.97 | 11.93 | 0.95 | 11.63 | 11.38 | 0.26 | 97.78 |
| 12.01 | 1.02 | 11.93 | 1.00 | 12.23 | 11.97 | 0.26 | 97.85 |
| 12.01 | 1.12 | 11.93 | 1.10 | 13.44 | 13.16 | 0.27 | 97.96 |
| 12.01 | 1.22 | 11.93 | 1.20 | 14.64 | 14.35 | 0.29 | 98.03 |
| 12.01 | 1.32 | 11.93 | 1.30 | 15.85 | 15.55 | 0.30 | 98.10 |
| 12.01 | 1.42 | 11.94 | 1.40 | 17.06 | 16.74 | 0.31 | 98.16 |
| 12.01 | 1.52 | 11.94 | 1.50 | 18.26 | 17.93 | 0.33 | 98.20 |
| 12.01 | 1.62 | 11.94 | 1.60 | 19.47 | 19.12 | 0.34 | 98.24 |
| 12.01 | 1.72 | 11.94 | 1.70 | 20.68 | 20.32 | 0.36 | 98.24 |
| 12.01 | 1.82 | 11.94 | 1.80 | 21.89 | 21.51 | 0.38 | 98.25 |
| 12.01 | 1.92 | 11.94 | 1.90 | 23.10 | 22.70 | 0.40 | 98.27 |
| 12.01 | 2.03 | 11.94 | 2.00 | 24.32 | 23.89 | 0.42 | 98.26 |
|       |      |       |      |       |       |      |       |
| 14.01 | 0.01 | 11.94 | 0.00 | 0.20  | 0.00  | 0.20 | 0.00  |
| 14.01 | 0.06 | 11.94 | 0.05 | 0.85  | 0.65  | 0.20 | 76.24 |
| 14.01 | 0.10 | 11.94 | 0.10 | 1.45  | 1.24  | 0.20 | 85.89 |
| 14.01 | 0.15 | 11.94 | 0.15 | 2.04  | 1.84  | 0.20 | 90.02 |
| 14.01 | 0.19 | 11.94 | 0.20 | 2.65  | 2.44  | 0.21 | 92.09 |
| 14.01 | 0.23 | 11.94 | 0.25 | 3.25  | 3.03  | 0.22 | 93.31 |
| 14.01 | 0.28 | 11.94 | 0.30 | 3.85  | 3.63  | 0.22 | 94.18 |
| 14.02 | 0.33 | 11.93 | 0.35 | 4.56  | 4.22  | 0.33 | 92.69 |
| 13.99 | 0.37 | 11.93 | 0.40 | 5.15  | 4.82  | 0.33 | 93.51 |
| 14.00 | 0.41 | 11.93 | 0.45 | 5.76  | 5.41  | 0.34 | 94.05 |
| 14.01 | 0.45 | 11.93 | 0.50 | 6.36  | 6.01  | 0.35 | 94.47 |
| 13.99 | 0.50 | 11.93 | 0.55 | 6.95  | 6.60  | 0.35 | 94.96 |
| 14.01 | 0.54 | 11.93 | 0.60 | 7.57  | 7.20  | 0.37 | 95.14 |
| 14.01 | 0.58 | 11.93 | 0.65 | 8.19  | 7.79  | 0.39 | 95.18 |

|       |      |       |      |       |       |      |       |
|-------|------|-------|------|-------|-------|------|-------|
| 14.01 | 0.63 | 11.93 | 0.70 | 8.79  | 8.39  | 0.40 | 95.48 |
| 14.01 | 0.67 | 11.93 | 0.75 | 9.39  | 8.99  | 0.40 | 95.72 |
| 14.01 | 0.71 | 11.93 | 0.80 | 9.99  | 9.58  | 0.40 | 95.96 |
| 14.01 | 0.76 | 11.93 | 0.85 | 10.59 | 10.18 | 0.41 | 96.12 |
| 14.01 | 0.80 | 11.93 | 0.90 | 11.19 | 10.77 | 0.42 | 96.28 |
| 14.01 | 0.84 | 11.93 | 0.95 | 11.80 | 11.37 | 0.42 | 96.40 |
| 14.01 | 0.89 | 11.93 | 1.00 | 12.40 | 11.97 | 0.43 | 96.52 |
| 14.01 | 0.97 | 11.93 | 1.10 | 13.60 | 13.16 | 0.45 | 96.72 |
| 14.01 | 1.06 | 11.93 | 1.20 | 14.81 | 14.35 | 0.46 | 96.87 |
| 14.01 | 1.14 | 11.93 | 1.30 | 16.02 | 15.54 | 0.48 | 97.01 |
| 14.01 | 1.23 | 11.93 | 1.40 | 17.22 | 16.73 | 0.49 | 97.14 |
| 14.01 | 1.32 | 11.93 | 1.50 | 18.43 | 17.93 | 0.51 | 97.26 |
| 14.01 | 1.40 | 11.93 | 1.60 | 19.64 | 19.11 | 0.52 | 97.34 |
| 14.01 | 1.49 | 11.93 | 1.70 | 20.84 | 20.31 | 0.54 | 97.43 |
| 14.01 | 1.57 | 11.93 | 1.80 | 22.05 | 21.50 | 0.55 | 97.49 |
| 14.01 | 1.66 | 11.93 | 1.90 | 23.26 | 22.69 | 0.57 | 97.54 |
| 14.01 | 1.75 | 11.93 | 2.00 | 24.48 | 23.88 | 0.59 | 97.59 |

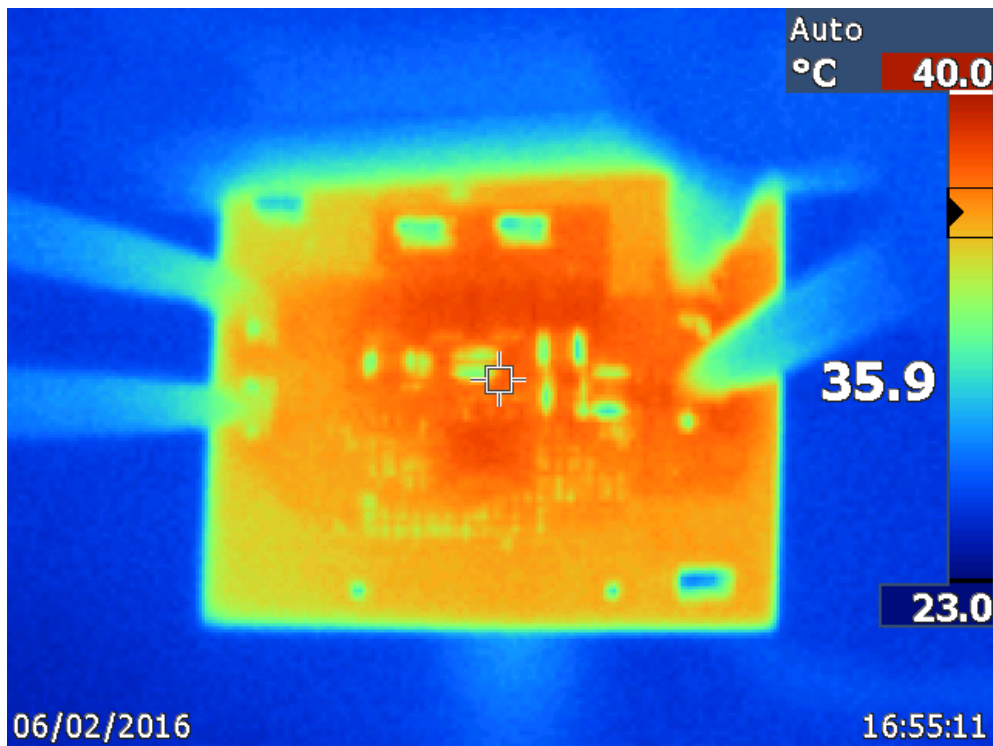
## 5 Thermal Images



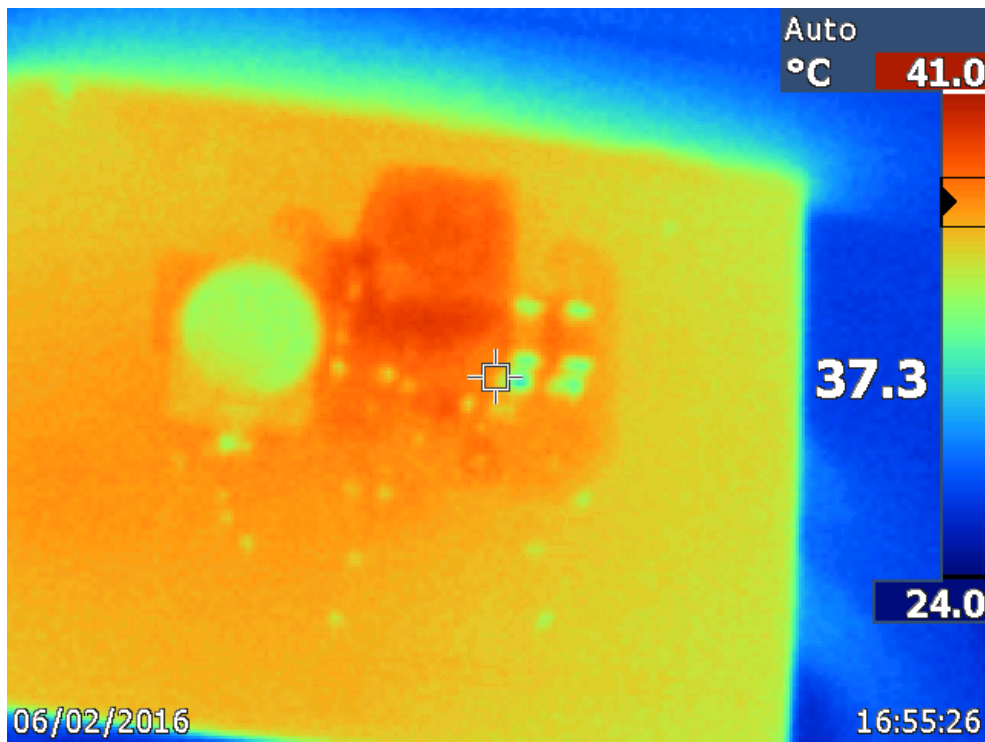
Top Thermal image was taken at 10Vin, 2A load when the board reaches equilibrium without airflow.



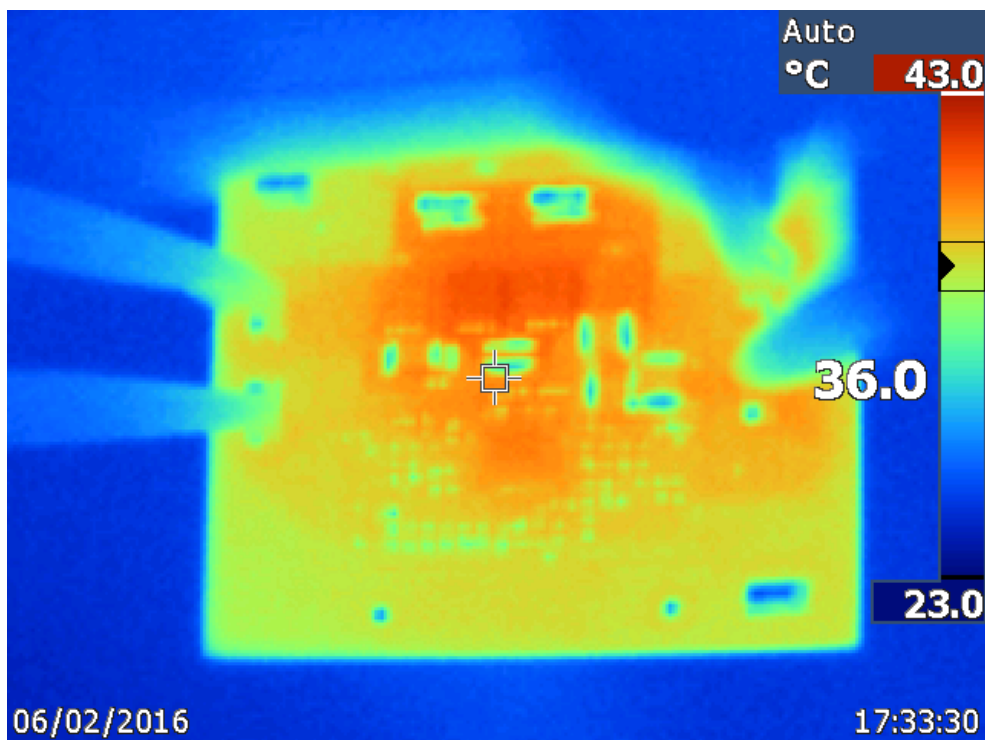
Bottom Thermal image was taken at 10Vin, 2A load when the board reaches equilibrium without airflow.



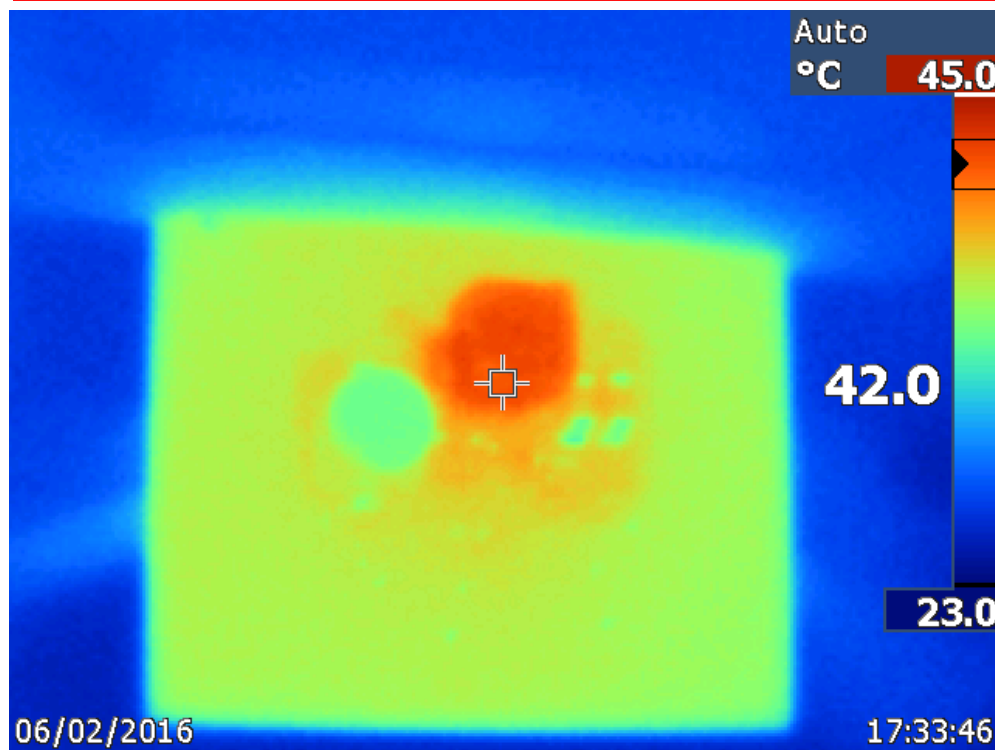
Top Thermal image was taken at 12Vin, 2A load when the board reaches equilibrium without airflow.



Bottom Thermal image was taken at 12Vin, 2A load when the board reaches equilibrium without airflow.



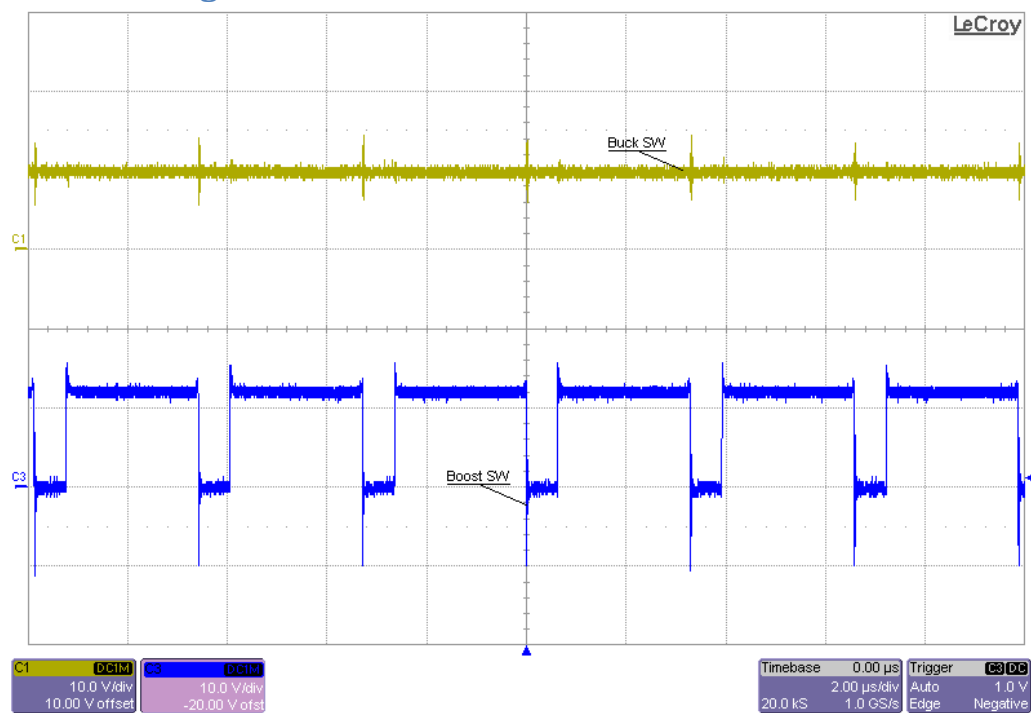
Top Thermal image was taken at 14Vin, 2A load when the board reaches equilibrium without airflow.



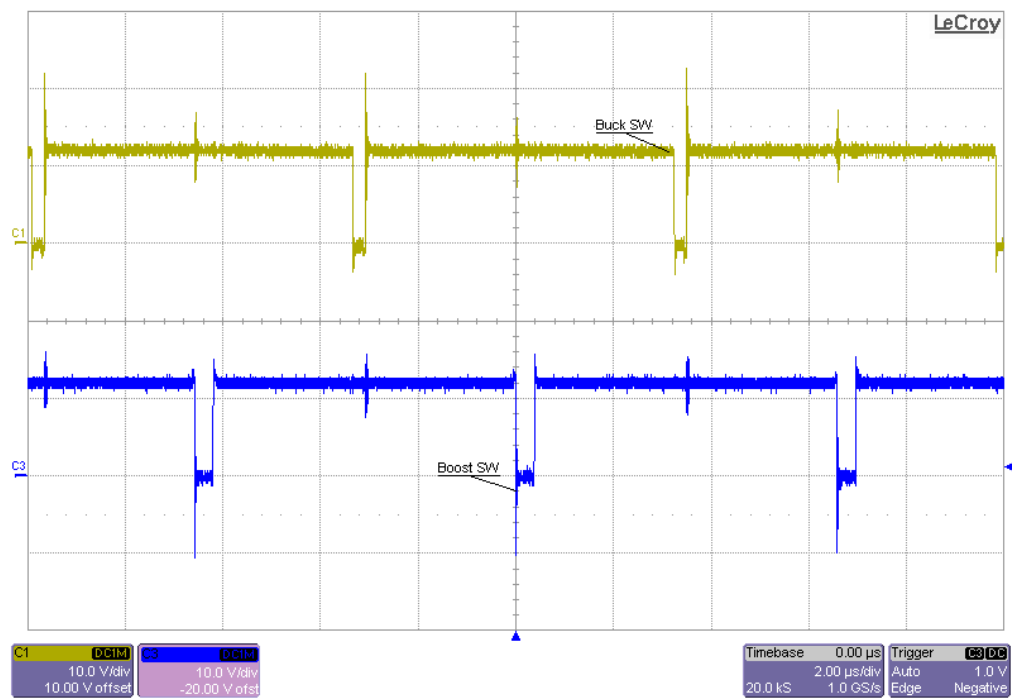
Bottom Thermal image was taken at 14Vin, 2A load when the board reaches equilibrium without airflow.

## 6 Waveform

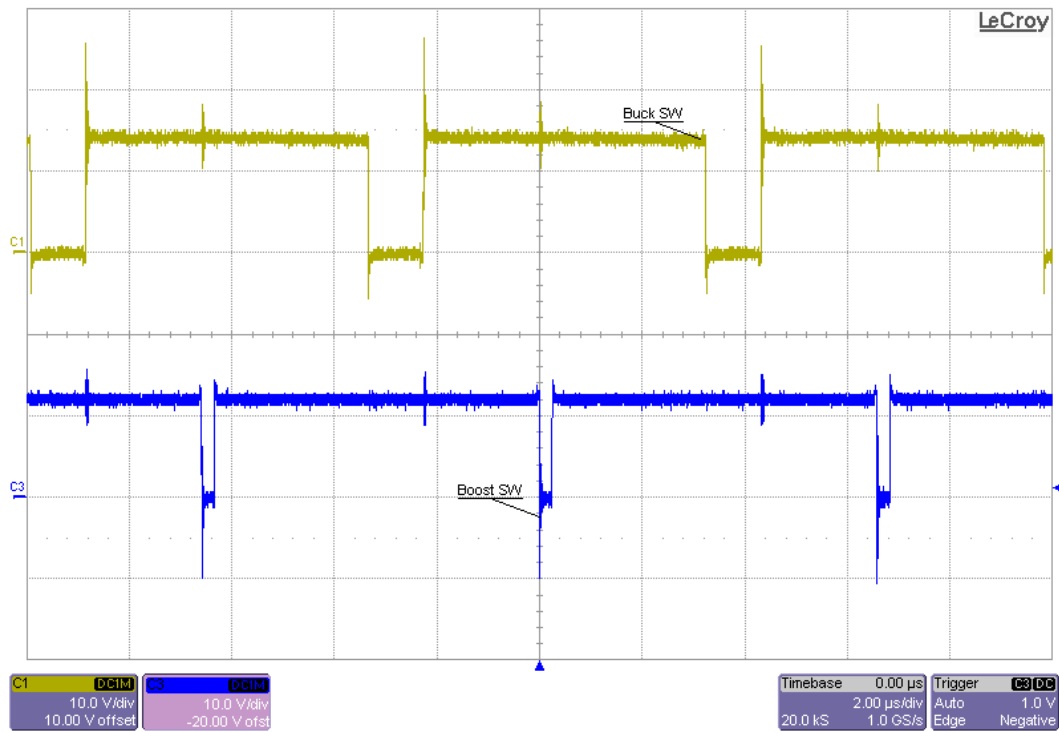
### 6.1 Switching Waveform



10Vin, 2A load. Ch1 measures buck switch, Ch3 measures boost switch.

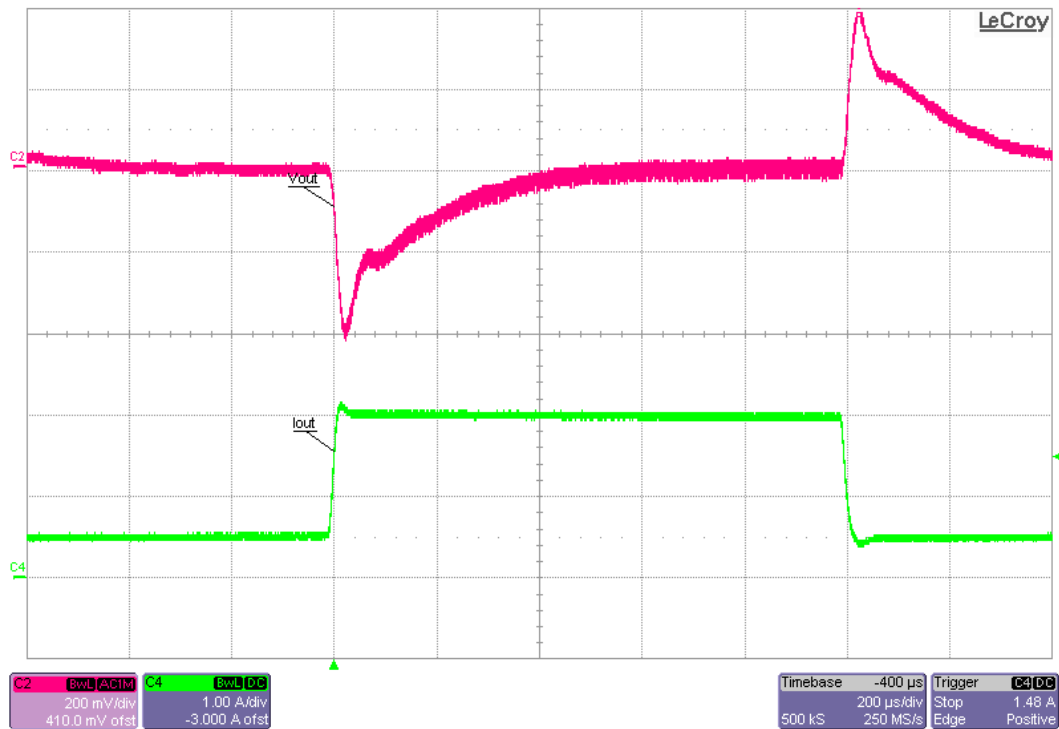


12Vin, 2A load. Ch1 measures buck switch, Ch3 measures boost switch.

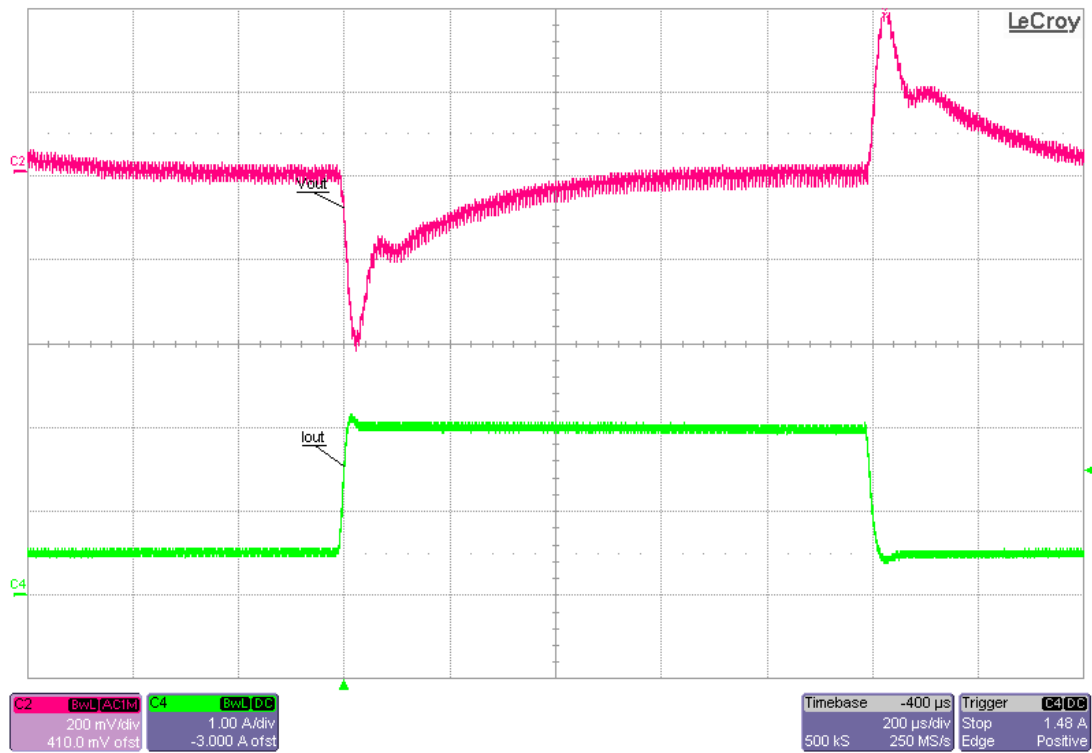


14Vin, 2A load. Ch1 measures buck switch, Ch3 measures boost switch.

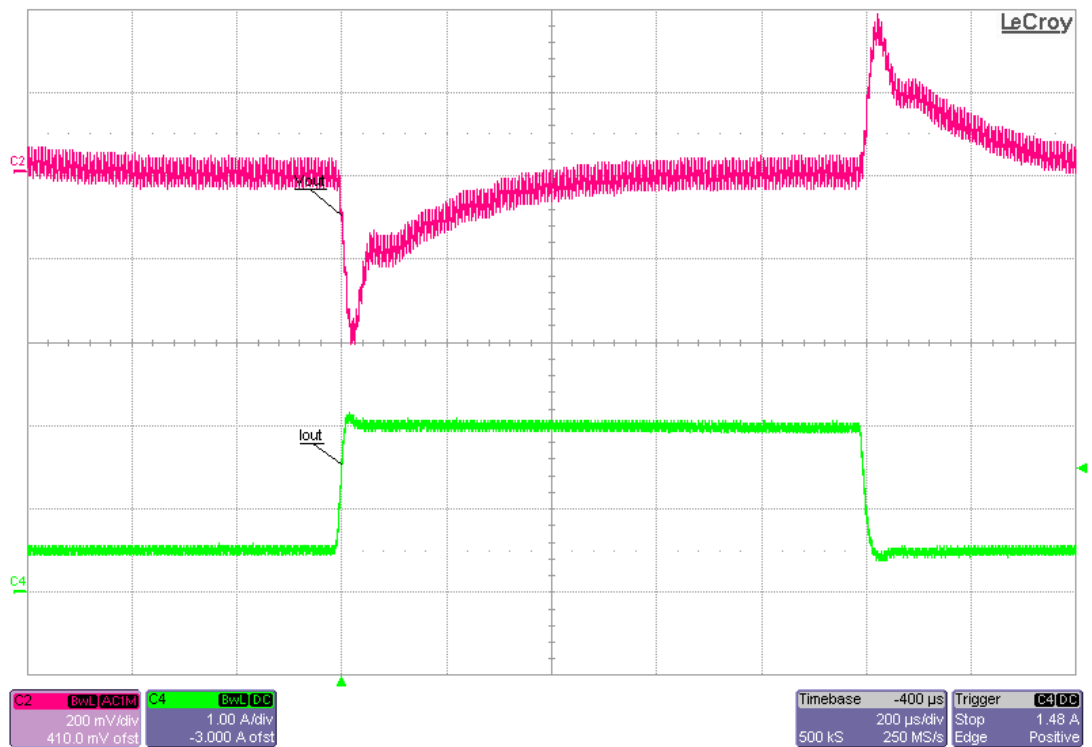
## 6.2 Load Transient



10Vin, 0.5A to 2A load transient. Ch2 measures output voltage, Ch4 measures output current.

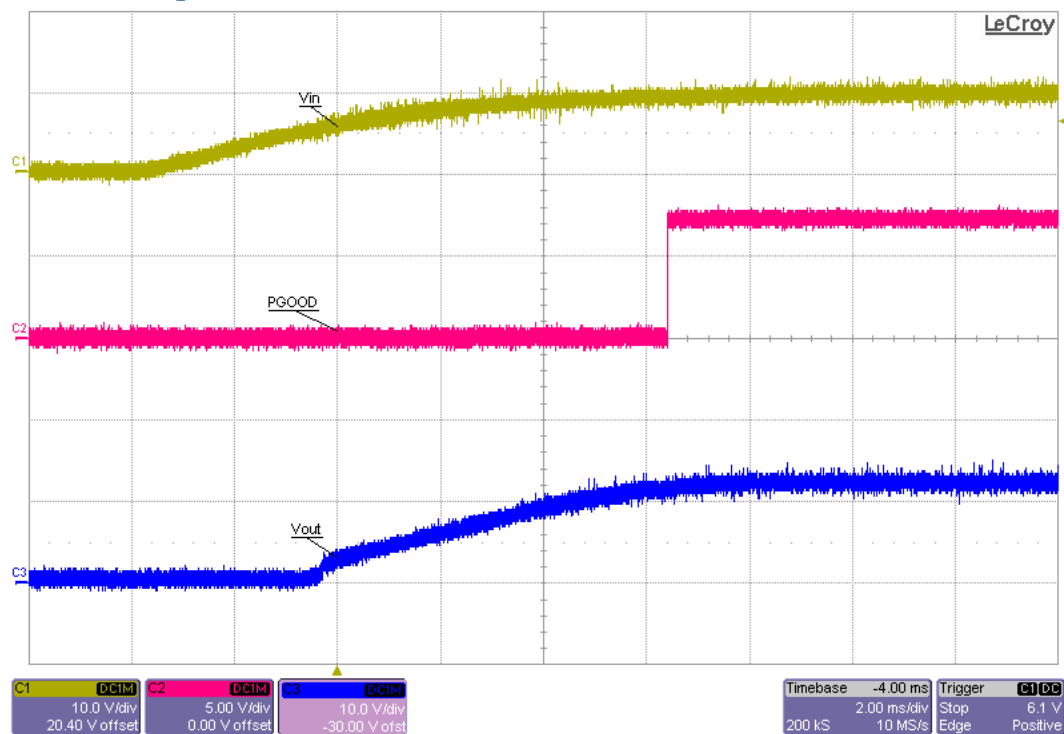


12Vin, 0.5A to 2A load transient. Ch2 measures output voltage, Ch4 measures output current.

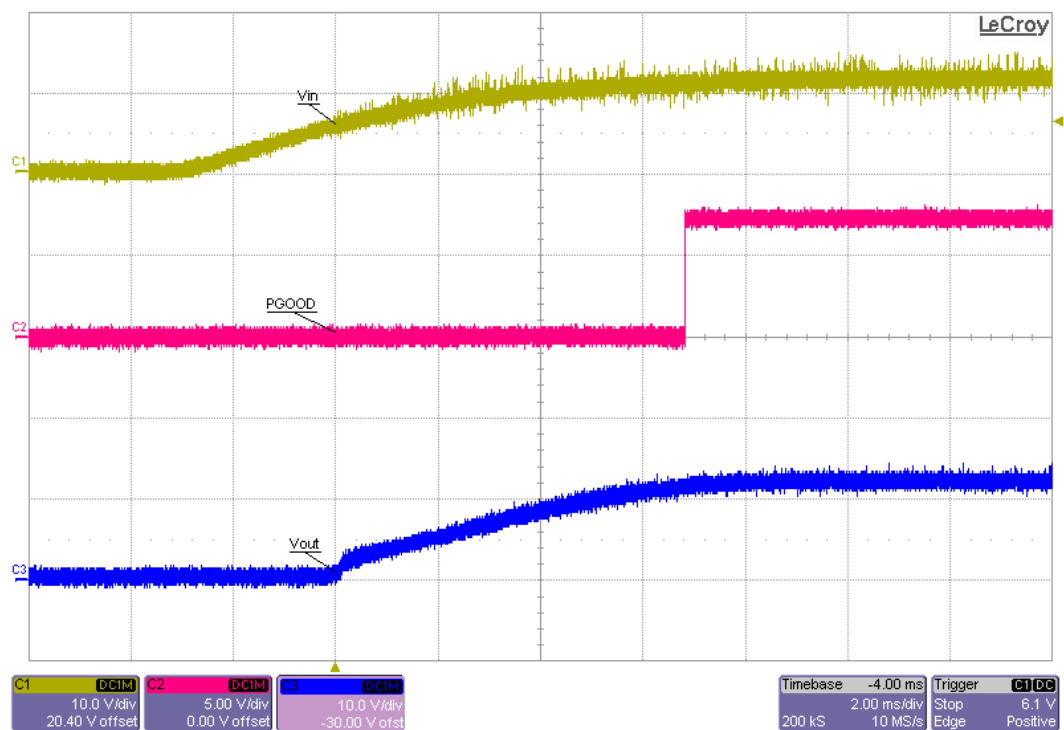


14Vin, 0.5A to 2A load transient. Ch2 measures output voltage, Ch4 measures output current.

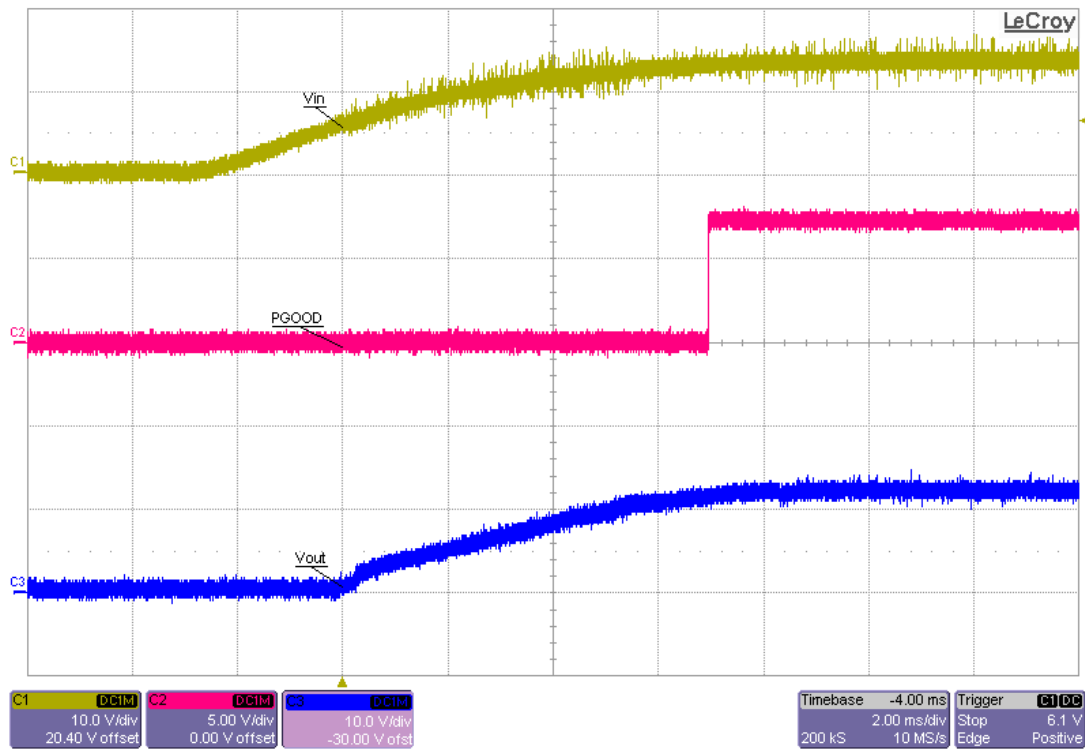
### 6.3 Start-Up



10Vin, 2A load. Ch1-Vin, Ch2-PGOOD, Ch3-Vout.

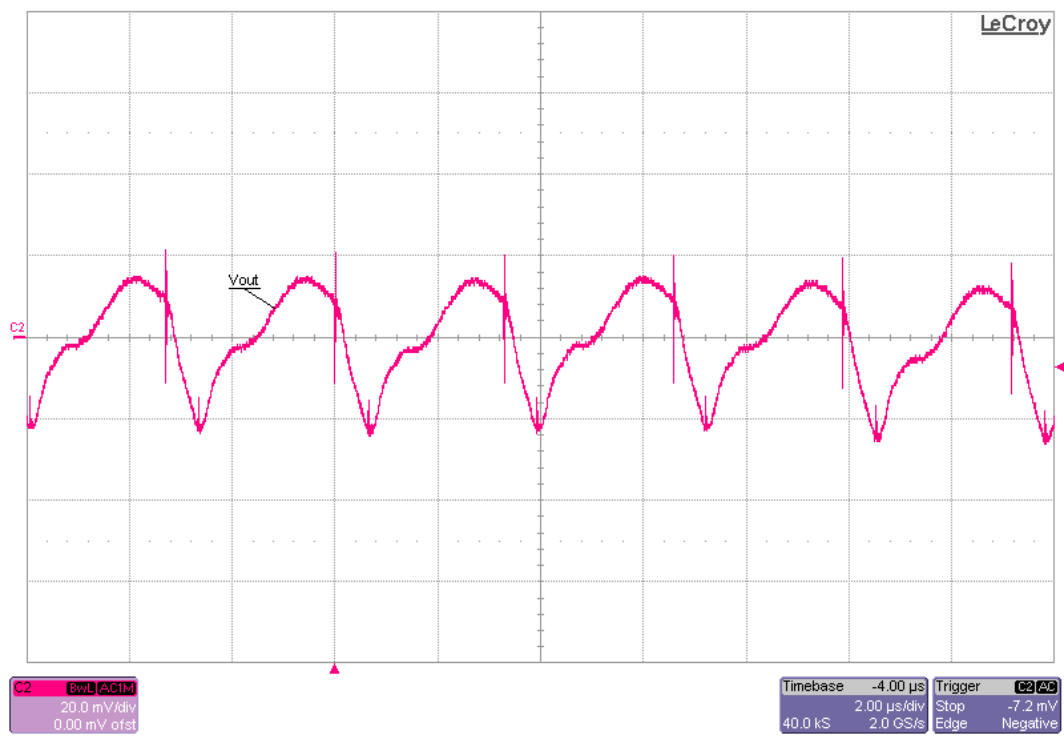


12Vin, 2A load. Ch1-Vin, Ch2-PGOOD, Ch3-Vout.

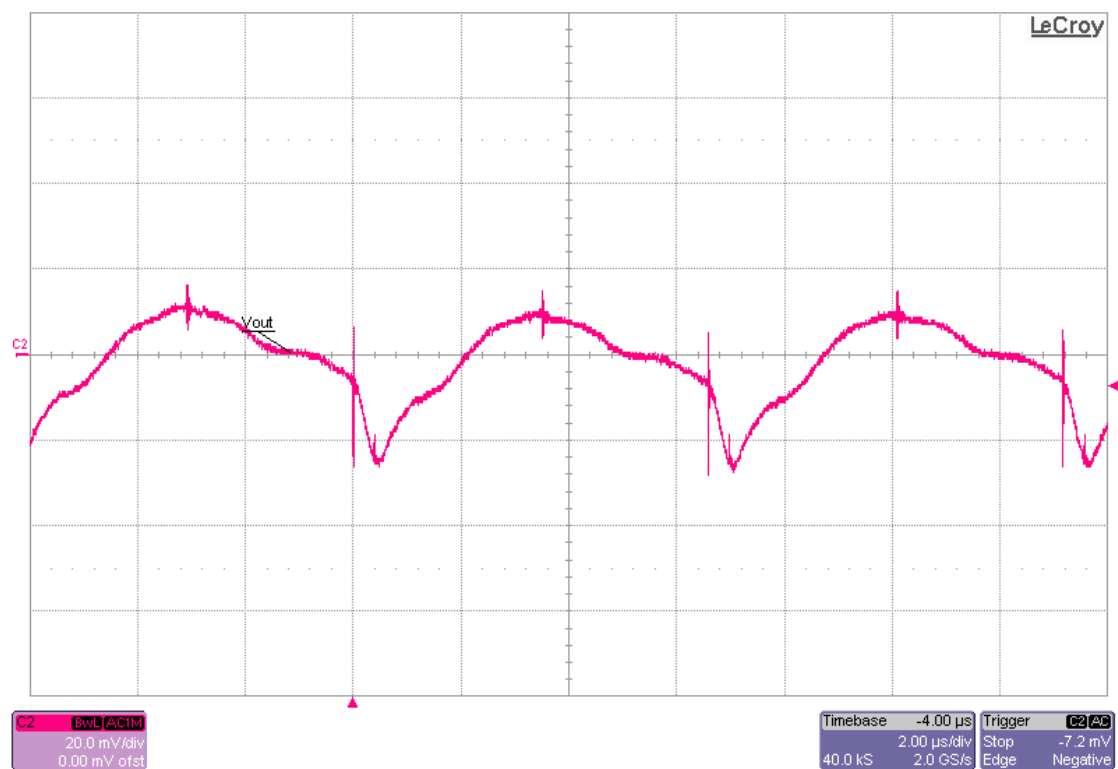


14Vin, 2A load. Ch1-Vin, Ch2-PGOOD, Ch3-Vout.

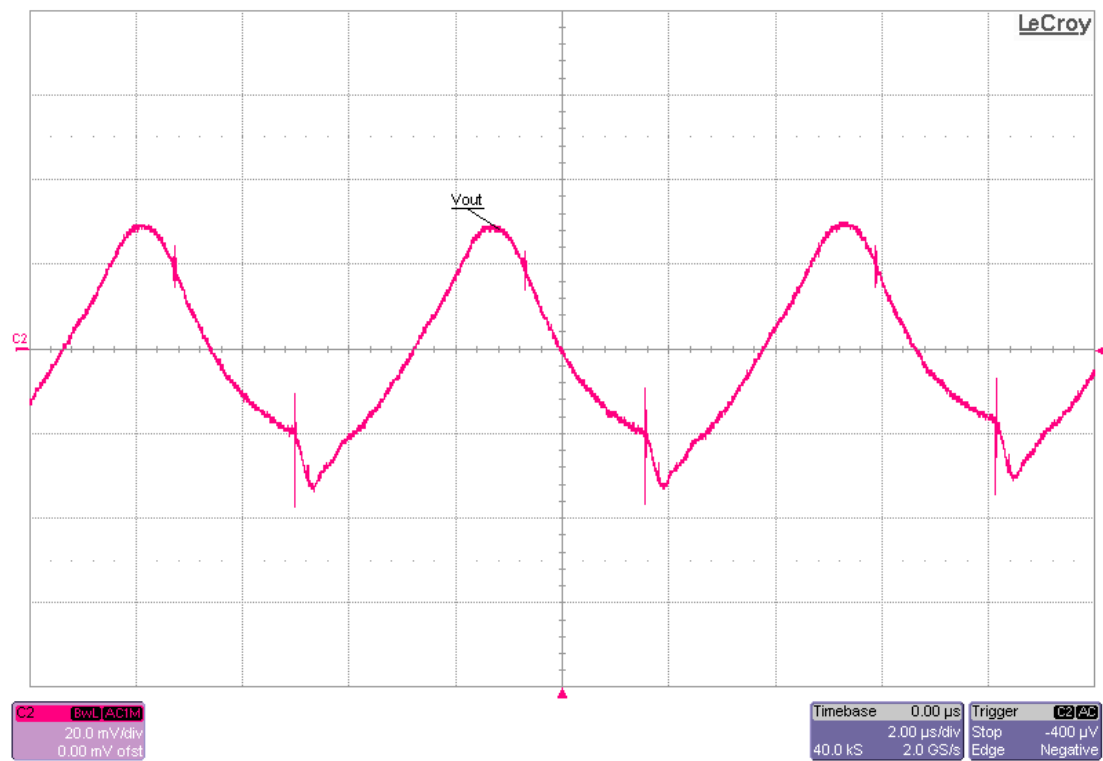
## 6.4 Output Ripple



10Vin, 2A load. Ch2-Vout.

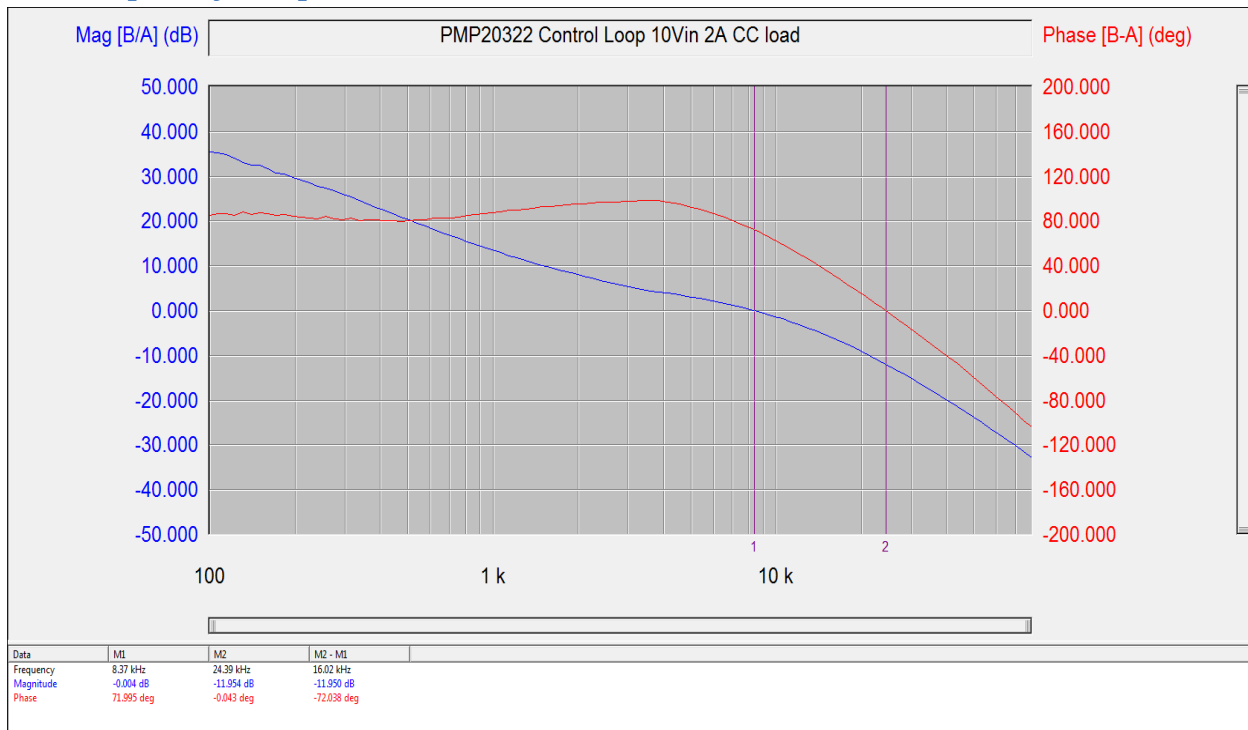


12Vin, 2A load. Ch2-Vout.

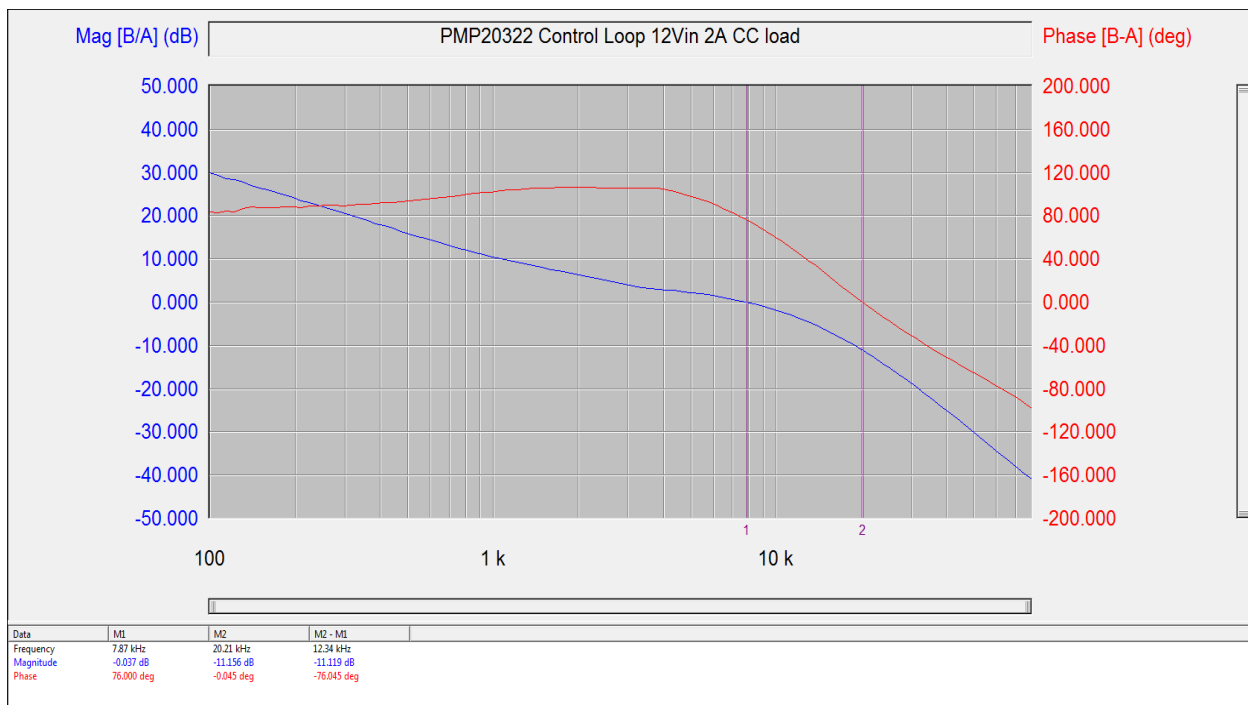


14Vin, 2A load. Ch2-Vout.

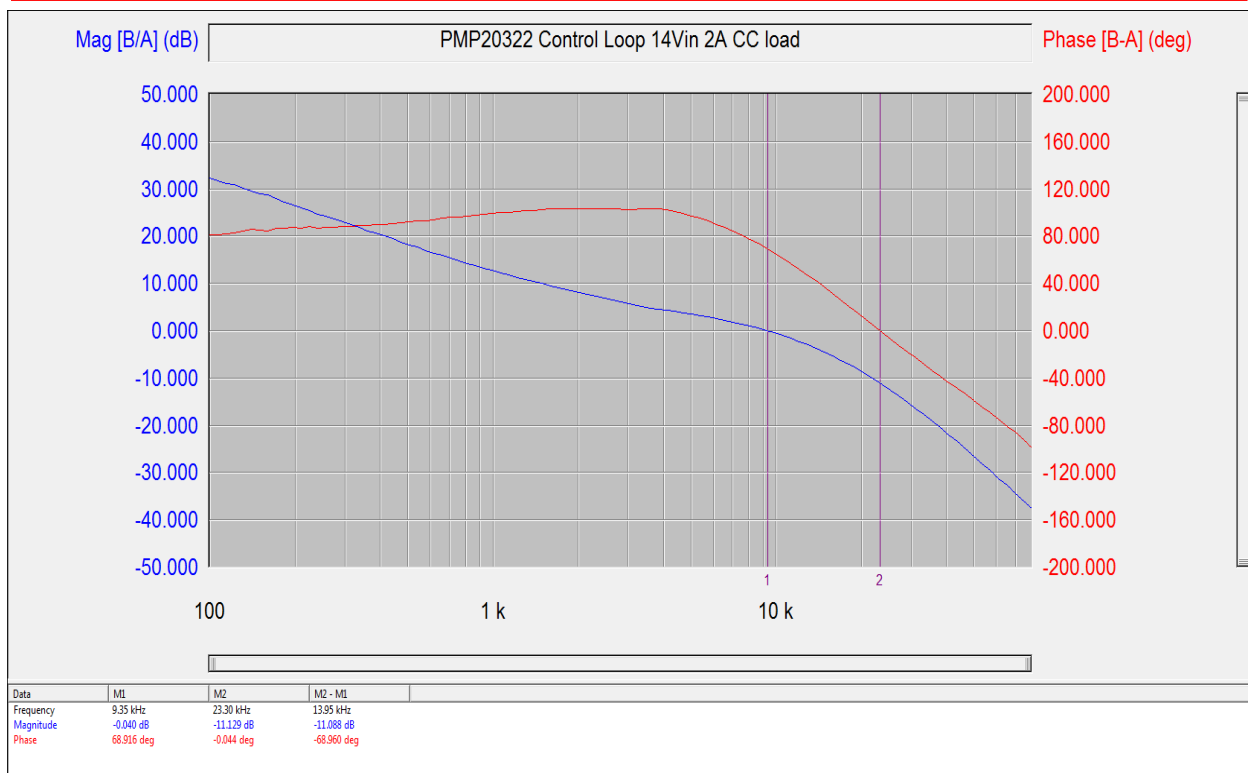
## 6.5 Frequency Response



**10Vin, 2A load. Phase margin equals 72 degrees, gain margin equals 12dB.**



**12Vin, 2A load. Phase margin equals 76 degrees, gain margin equals 11dB.**



**14Vin, 2A load. Phase margin equals 69 degrees, gain margin equals 11dB.**

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