# Initial Design

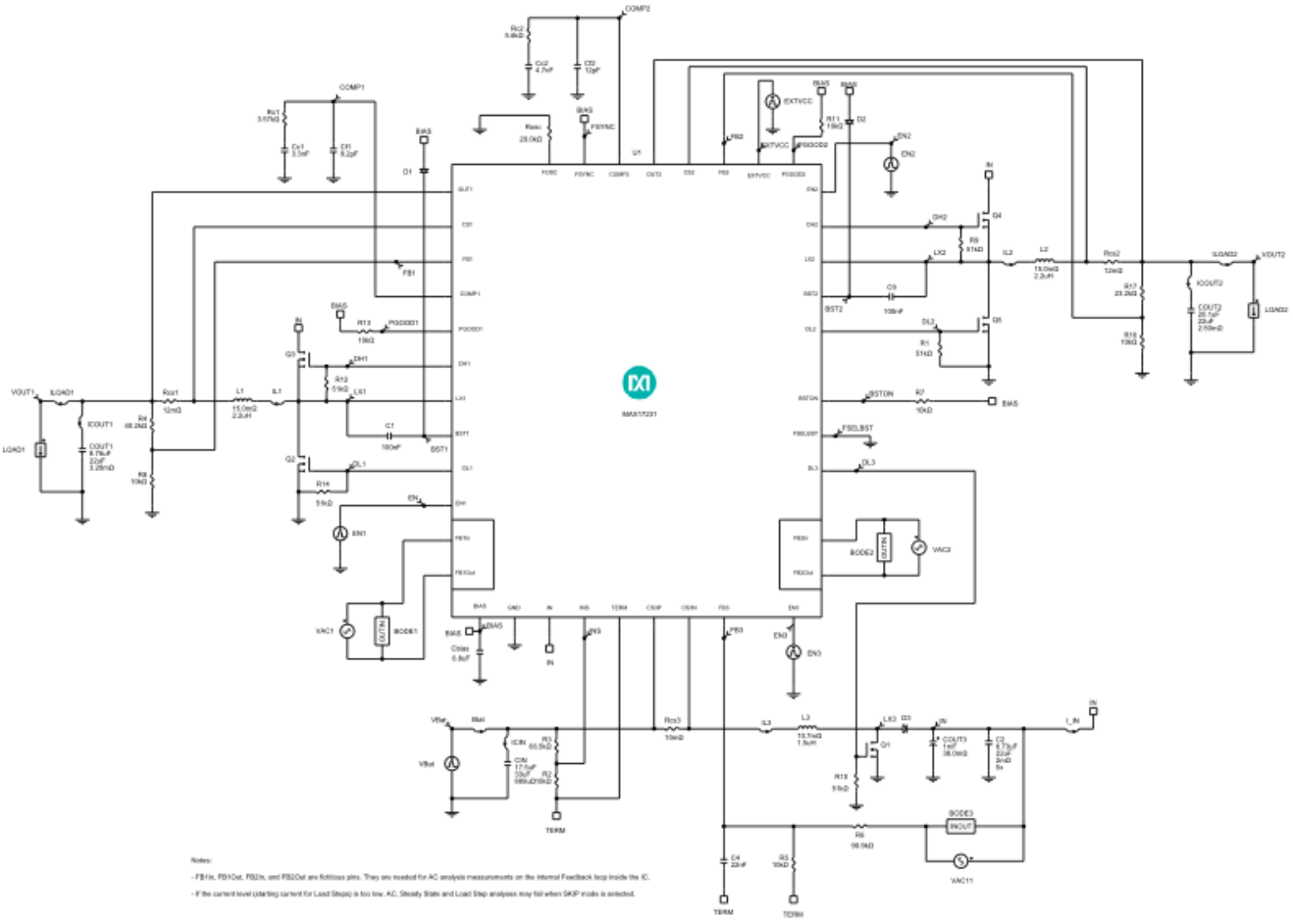
1.0

## Design Requirements

| Parameter | Value |
|---|---|
| Output Configuration | Adjustable Output Voltage |
| Minimum Input Voltage | 7.5V |
| Maximum Input Voltage | 14V |
| Nominal Input Voltage | 12V |
| Input Voltage Ripple | 0.5% |
| Output 1 Voltage | 5V |
| Output 1 Current | 3 |
| Output 2 Voltage | 3.3 |
| Output 2 Current | 3 |
| Output 1 Voltage Rippple | 1% |
| Load 1 Start Current | 1.5A |
| Load 1 Step Current | 3A |
| Load 1 Step Edge Rate | 1A/us |
| Output 1 Voltage Load Step Over/Undershoot | 5% |
| Output 2 Voltage Rippple | 1% |
| Load 2 Start Current | 1.5A |
| Load 2 Step Current | 3A |
| Load 2 Step Edge Rate | 1A/us |
| Output 2 Voltage Load Step Over/Undershoot | 5% |
| Performance Priority | Balance Efficiency and Size |
| BOM Priority | Cost |
| Input Voltage Sense | Enable |
| Preboost FSW reduced by 5 times | Disable |

| Parameter | Value |
|---|---|
| Preboost Turn ON Threshold | 8.8V |
| Preboost Output Voltage | 12V |
| Preboost Inductor Current ration (LIR) | 0.3 |
| Preboost Peak Current Limit | 11.93A |
| Mode | PWM |
| Switching Frequency Output 1 | 1600000Hz |
| Switching Frequency Output 2 | Equal to Switching Frequency of Output 1 |
| Ambient Temperature | 25°C |
| Inductor 1 Current Ratio | 0.3 |
| Inductor 2 Current Ratio | 0.3 |
| Peak Current Limit Output 1 | 5.175A |
| Peak Current Limit Output 2 | 5.175A |

## Schematic



## BOM

| Ref | Qty | Part Number | Manufacturer | Description |
|---|---|---|---|---|
| U1 | 1 | MAX17231 | Maxim Integrated | 2V - 36V, Synchronous Dual Buck Controller with Integrated Boost and 20µA Quiescent Current |
| C1 | 1 | 06035C104KAT2A | AVX | Cap Ceramic 0.1uF 50V X7R 10% Pad SMD 0603 125°C T/R |
| C2 | 5 | GRM32ER71E226ME15 | Murata | Cap Ceramic 22uF 25V 1210 125C |
| C4 | 1 | 06035C223JAT2A | AVX | Cap Ceramic 0.022uF 50V X7R 5% Pad SMD 0603 125°C T/R |
| C9 | 1 | 06035C104KAT2A | AVX | Cap Ceramic 0.1uF 50V X7R 10% Pad SMD 0603 125°C T/R |
| CIN | 1 | C4532X5R1C336M250KA | TDK | Cap Ceramic 33uF 16V 1812 85C |
| COUT1 | 1 | GRM21BR61A226ME51L | Murata | Cap Ceramic 22uF 10V X5R 20% SMD 0805 85C Embossed T/R |
| COUT2 | 1 | GRM32DR61C226KE18L | Murata | Cap Ceramic 22uF 16V X5R 10% SMD 1210 85C Embossed T/R |

| | | | | |
|---|---|---|---|---|
| COUT3 | 1 | EEUTP1E102 | Panasonic | Cap Aluminum Lytic 1000uF 25V 20% (12.5 X 20mm) Radial 5mm 0.038 Ohm 1490mA 2000h 135C Bulk |
| Cbias | 1 | C2012X5R1E685K125AC | TDK | Cap Ceramic 6.8uF 25V X5R 10% Pad SMD 0805 85°C T/R |
| Cc1 | 1 | 04025C332JAT2A | AVX | Cap Ceramic 0.0033uF 50V X7R 5% Pad SMD 0402 125°C T/R |
| Cc2 | 1 | C0402C472J4RACTU | KEMET Corporation | Cap Ceramic 0.0047uF 16V X7R 5% Pad SMD 0402 125°C T/R |
| Cf1 | 1 | C0603C829J5GACTU | KEMET Corporation | Cap Ceramic 8.2pF 50V C0G 5% Pad SMD 0603 125°C T/R |
| Cf2 | 1 | C0603C120J5RACTU | KEMET Corporation | Cap Ceramic 12pF 50V X7R 5% Pad SMD 0603 125°C T/R |
| D1 | 1 | MBR0520L | ON Semiconductor | Diode Schottky 20V 0.5A 2-Pin SOD-123 T/R |
| D2 | 1 | MBR0520L | ON Semiconductor | Diode Schottky 20V 0.5A 2-Pin SOD-123 T/R |
| D3 | 1 | V15P45S-M3/86A | Vishay | Diode Schottky 45V 15A 3-Pin(2+Tab) SMPC T/R |
| L1 | 1 | VLP8040T-2R2N | TDK | Inductor Power Shielded Wirewound 2.2uH 30% 100KHz Ferrite 6.2A 15mOhm DCR Embossed Carrier T/R |
| L2 | 1 | VLP8040T-2R2N | TDK | Inductor Power Shielded Wirewound 2.2uH 30% 100KHz Ferrite 6.2A 15mOhm DCR Embossed Carrier T/R |
| L3 | 1 | SPM6530T-1R5M100 | TDK | Inductor Power Shielded Wirewound 1.5uH 20% 100KHz Metal 11A 10.67mOhm DCR T/R |
| Q1 | 1 | FDMS0310AS | Fairchild Semiconductor | Trans MOSFET N-CH 30VDS 5.2mOhm@4.5V 5mOhm@6V 13nC 5.8nC 1.72nF 0.655nF 150°C 22A 41W 3°C/W 1.1mm 32.5mm^2 PQFN 5x6 8L (Power 56) |
| Q2 | 1 | FDMS0310AS | Fairchild Semiconductor | Trans MOSFET N-CH 30VDS 5.2mOhm@4.5V 5mOhm@6V 13nC 5.8nC 1.72nF 0.655nF 150°C 22A 41W 3°C/W 1.1mm 32.5mm^2 PQFN 5x6 8L (Power 56) |
| Q3 | 1 | FDMS0310AS | Fairchild Semiconductor | Trans MOSFET N-CH 30VDS 5.2mOhm@4.5V 5mOhm@6V 13nC 5.8nC 1.72nF 0.655nF 150°C 22A 41W 3°C/W 1.1mm 32.5mm^2 PQFN 5x6 8L (Power 56) |
| Q4 | 1 | BSC120N03MS G | Infineon Technologies | Trans MOSFET N-CH 30VDS 14mOhm@4.5V 13mOhm@6V 7.2nC 3.7nC 1.1nF 0.39nF 150°C 36A 28W 4.5°C/W 1.1mm 34mm^2 PG-TDSON-8 |
| Q5 | 1 | FDMS0310AS | Fairchild Semiconductor | Trans MOSFET N-CH 30VDS 5.2mOhm@4.5V 5mOhm@6V 13nC 5.8nC 1.72nF 0.655nF 150°C 22A 41W 3°C/W 1.1mm 32.5mm^2 PQFN 5x6 8L (Power 56) |
| R1 | 1 | ERJ2GEJ513X | Panasonic | Res Thick Film 0402 51K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD |

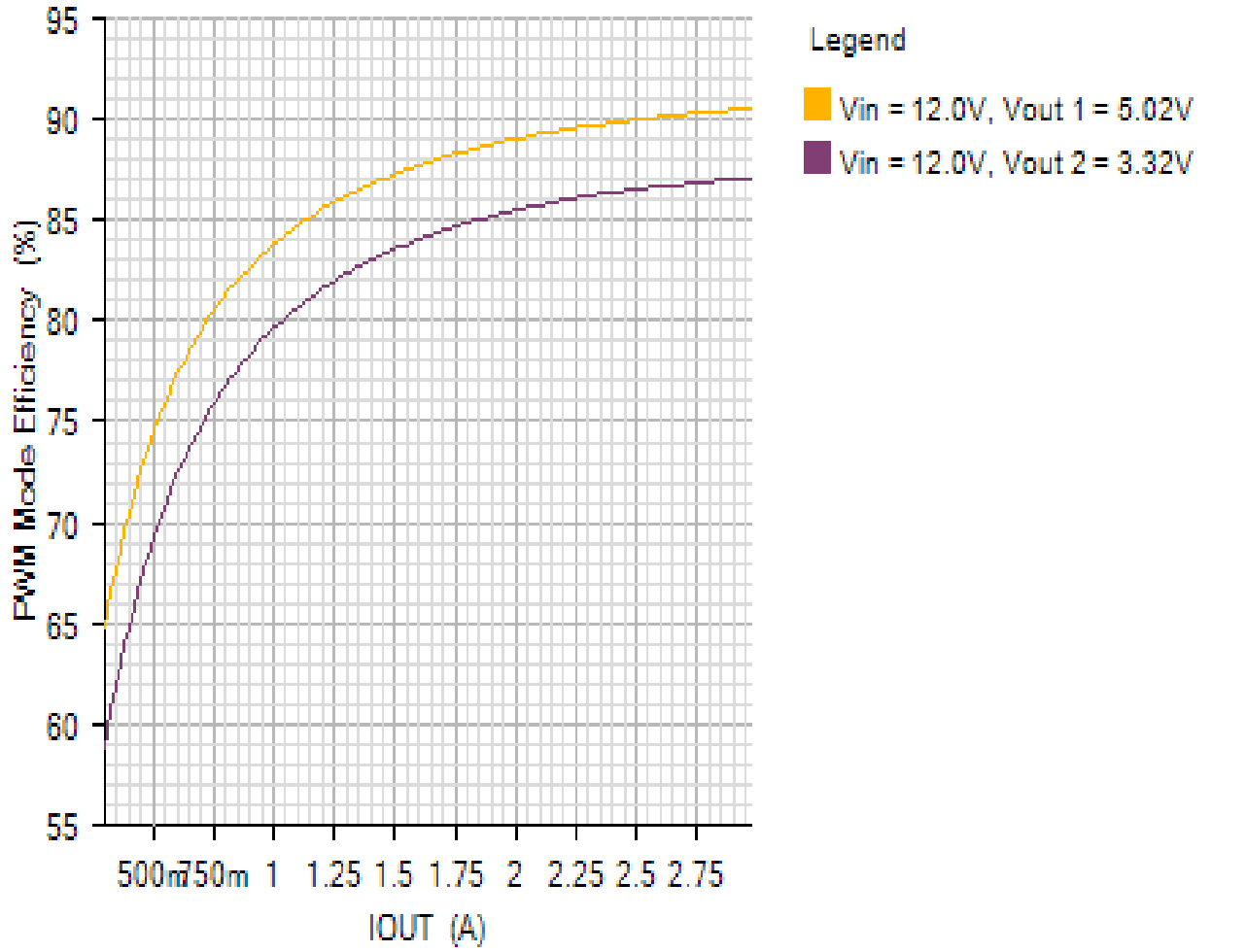
| | | | | |
|---|---|---|---|---|
| | | | | Automotive T/R |
| R2 | 1 | ERJ2RKF1002X | Panasonic | Res Thick Film 0402 10K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R3 | 1 | ERJ3EKF6652V | Panasonic | Res Thick Film 0603 66.5K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R4 | 1 | ERJ3EKF4022V | Panasonic | Res Thick Film 0603 40.2K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R5 | 1 | ERJ3EKF1002V | Panasonic | Res Thick Film 0603 10K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R6 | 1 | ERJ3EKF9092V | Panasonic | Res Thick Film 0603 90.9K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R7 | 1 | ERJ3GEYJ103V | Panasonic | Res Thick Film 0603 10K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R8 | 1 | ERJ3EKF1002V | Panasonic | Res Thick Film 0603 10K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R9 | 1 | ERJ2GEJ513X | Panasonic | Res Thick Film 0402 51K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R10 | 1 | ERJ2GEJ513X | Panasonic | Res Thick Film 0402 51K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R11 | 1 | ERJ3GEYJ103V | Panasonic | Res Thick Film 0603 10K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R12 | 1 | ERJ2GEJ513X | Panasonic | Res Thick Film 0402 51K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R13 | 1 | ERJ3GEYJ103V | Panasonic | Res Thick Film 0603 10K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R14 | 1 | ERJ2GEJ513X | Panasonic | Res Thick Film 0402 51K Ohm 5% 0.1W(1/10W) ±200ppm/°C Pad SMD Automotive T/R |
| R16 | 1 | ERJ3EKF1002V | Panasonic | Res Thick Film 0603 10K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| R17 | 1 | ERJ3EKF2322V | Panasonic | Res Thick Film 0603 23.2K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| Rc1 | 1 | ERJ2RKF3571X | Panasonic | Res Thick Film 0402 3.57K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| Rc2 | 1 | ERJ2RKF5601X | Panasonic | Res Thick Film 0402 5.6K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |
| Rcs1 | 1 | NCSS12AFR012TRF | NIC Components | Res Metal Strip 1206 0.012 Ohm 1% 0.25W(1/4W) ±75ppm/°C Pad SMD T/R |

| | | | | |
|---|---|---|---|---|
| Rcs2 | 1 | NCSS12AFR012TRF | NIC Components | Res Metal Strip 1206 0.012 Ohm 1% 0.25W(1/4W) ±75ppm/°C Pad SMD T/R |
| Rcs3 | 1 | ERJ6BWFR010V | Panasonic | Res Thick Film 0805 0.01 Ohm 1% 0.5W(1/2W) ±300ppm/°C Pad SMD Automotive T/R |
| Rosc | 1 | ERJ3EKF2002V | Panasonic | Res Thick Film 0603 20K Ohm 1% 0.1W(1/10W) ±100ppm/°C Pad SMD Automotive T/R |

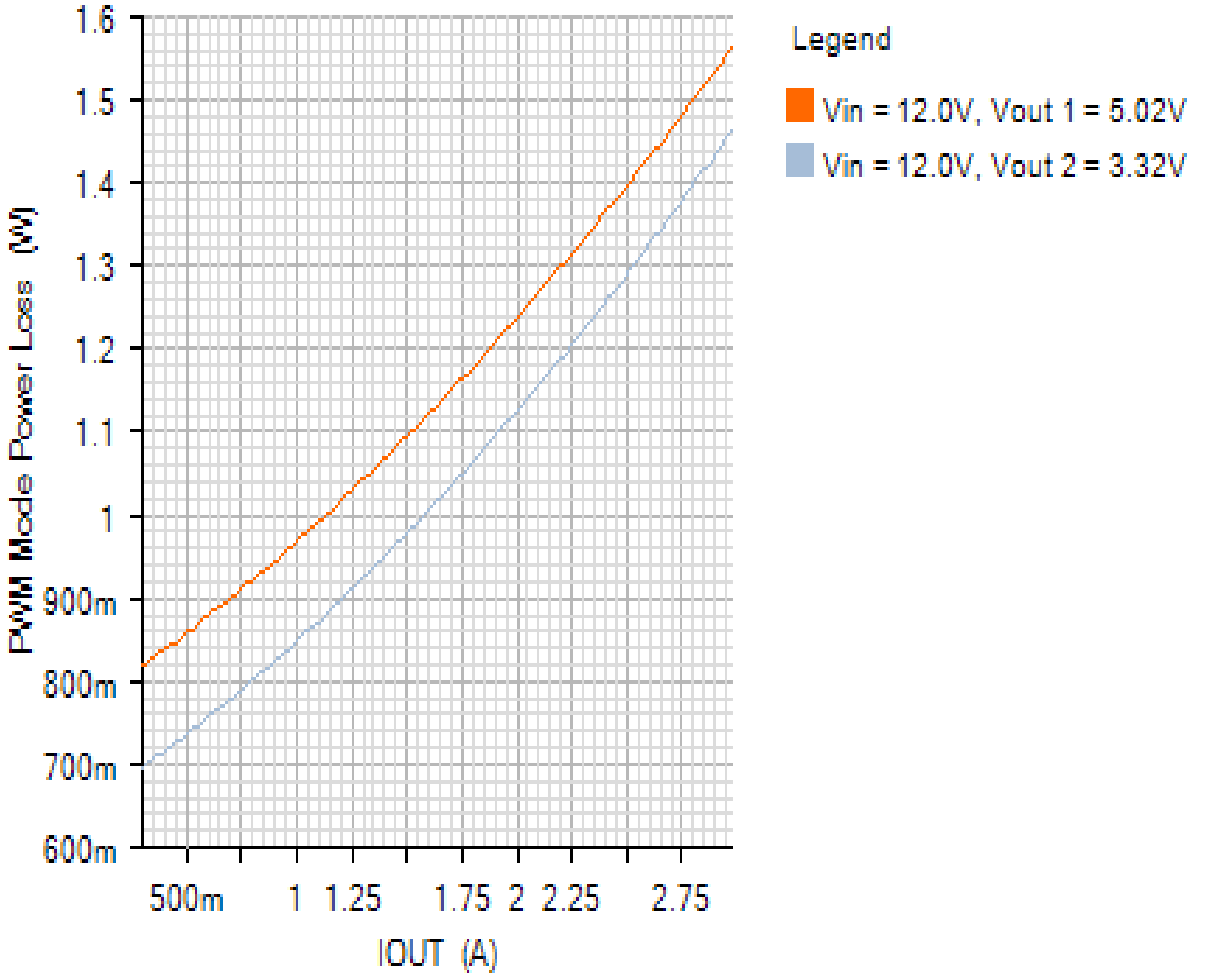
## Simulation Results

### Efficiency - Thu Nov 15 2018 14:55:37

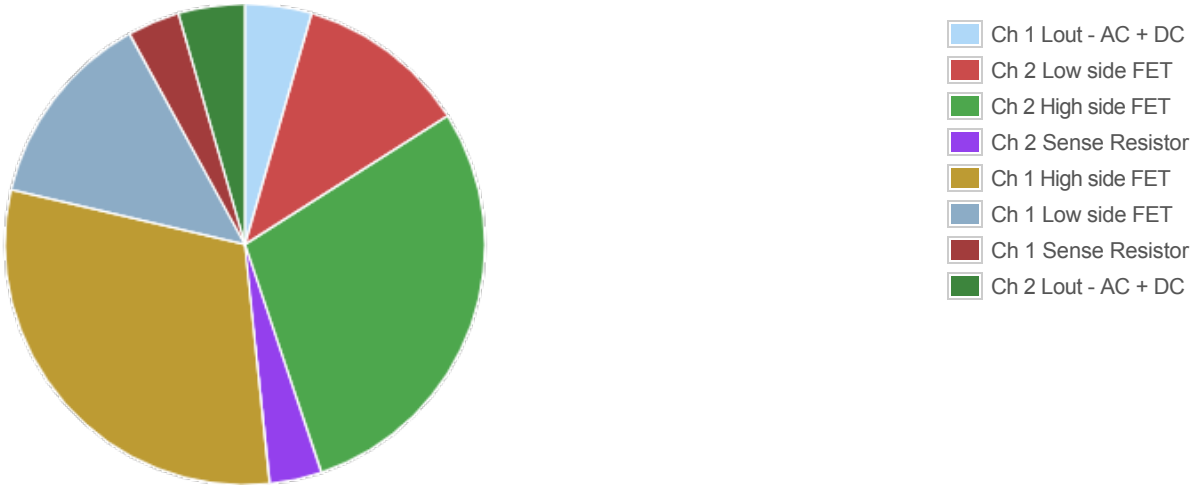
EFFICIENCY_PLOT Default



POWER_LOSS_PLOT Default




Losses

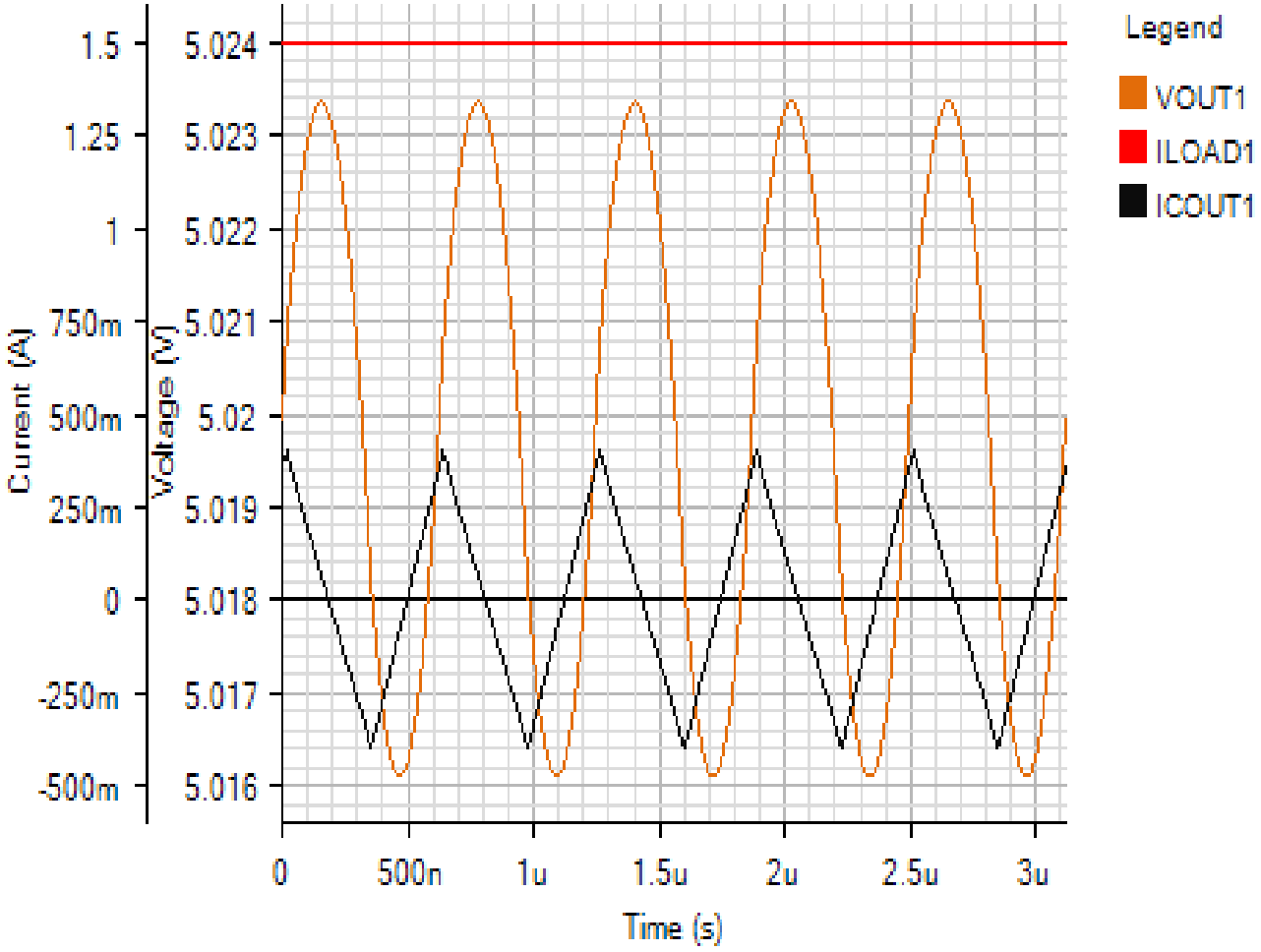



| Component | Loss (W) | % of total |
|---|---|---|

| Component | Loss (W) | % of total |
|---|---|---|
| Ch 1 Lout - AC + DC | 0.135788 | 4.5 |
| Ch 2 Low side FET | 0.349142 | 11.5 |
| Ch 2 High side FET | 0.872905 | 28.8 |
| Ch 2 Sense Resistor | 0.106519 | 3.5 |
| Ch 1 High side FET | 0.917381 | 30.3 |
| Ch 1 Low side FET | 0.403716 | 13.3 |
| Ch 1 Sense Resistor | 0.106734 | 3.5 |
| Ch 2 Lout - AC + DC | 0.13551 | 4.5 |
| Total | 3.027695 | 100 |

**Steady State - Thu Nov 15 2018 14:55:37**

OUTPUT1 Default



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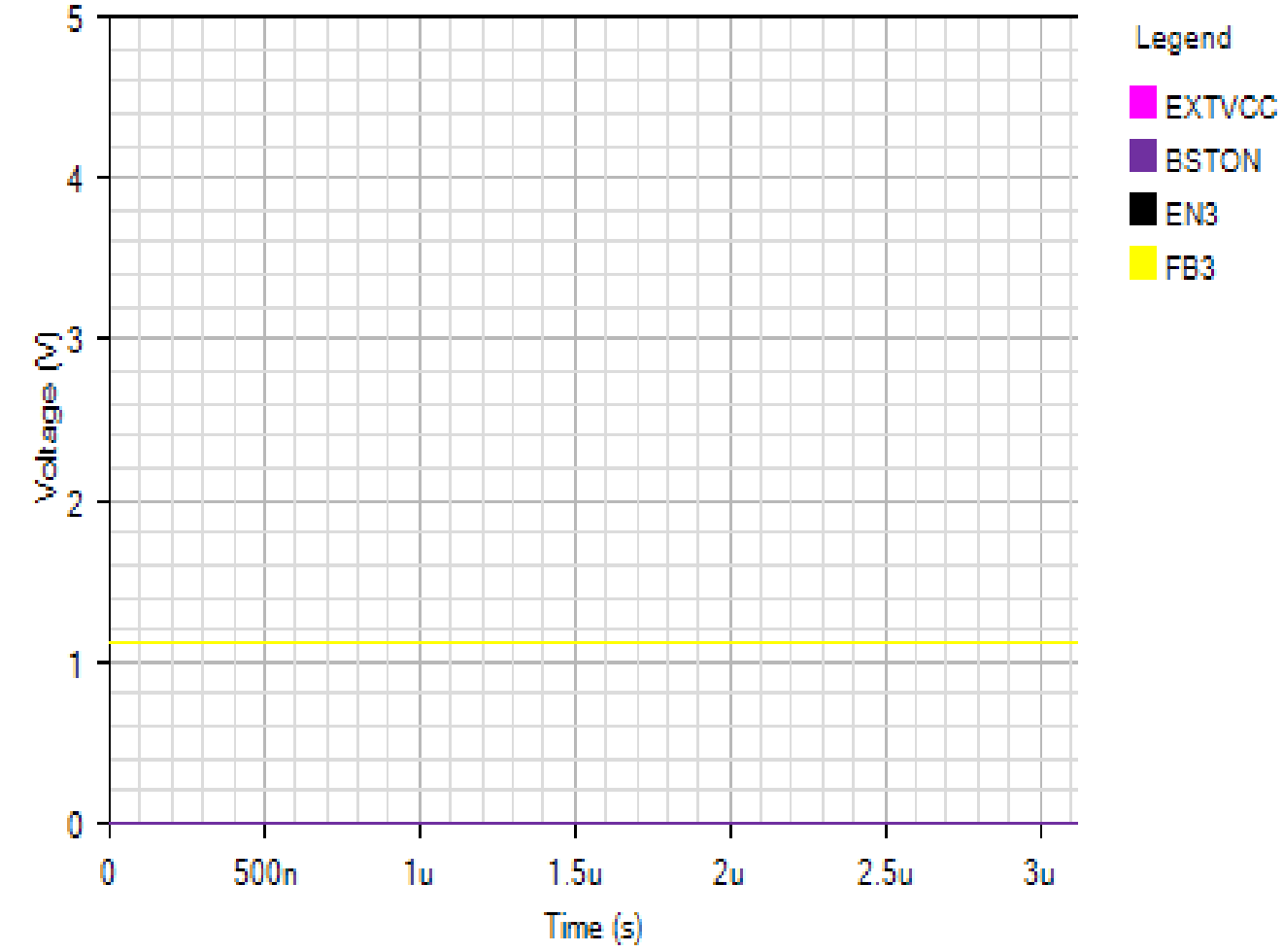

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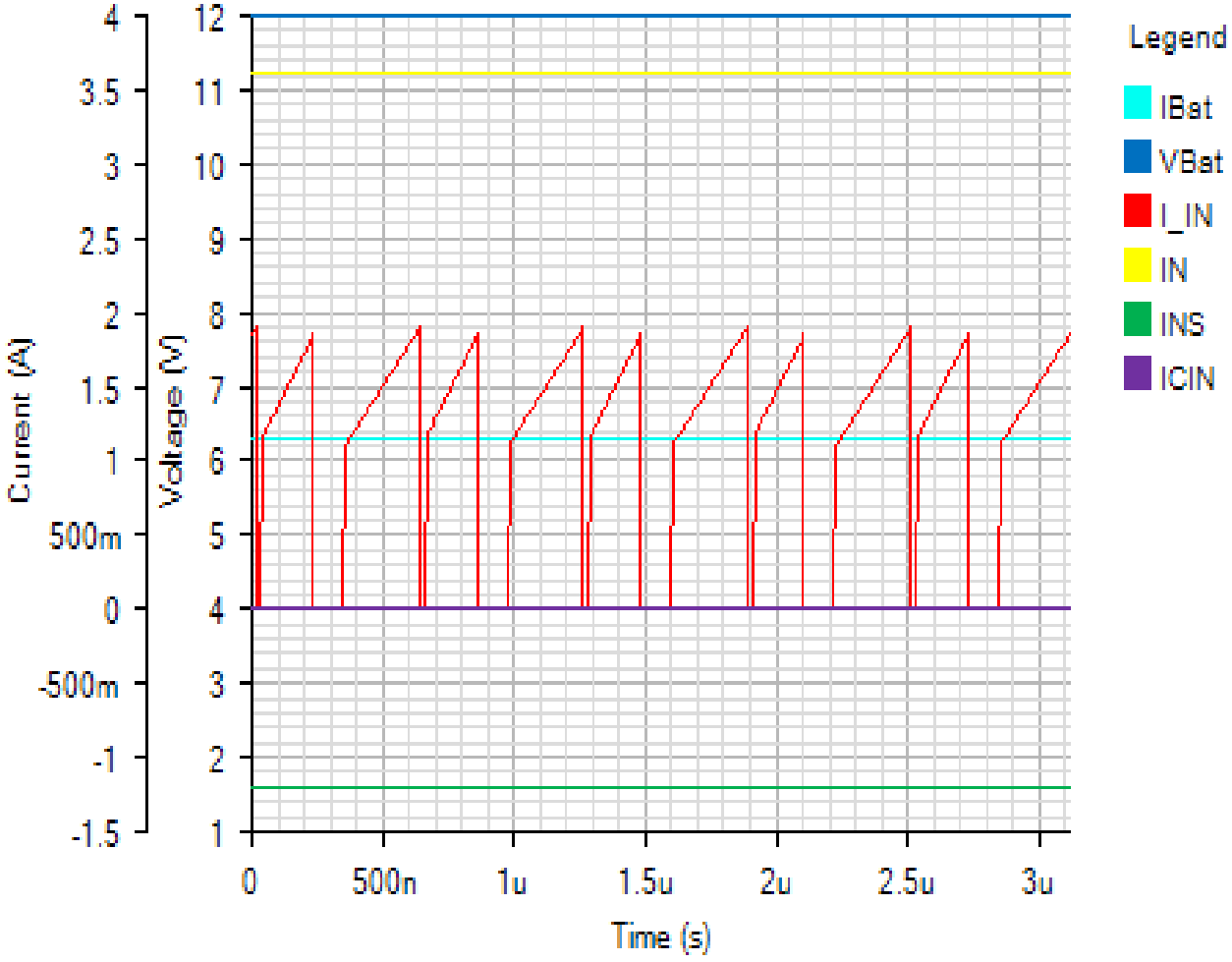

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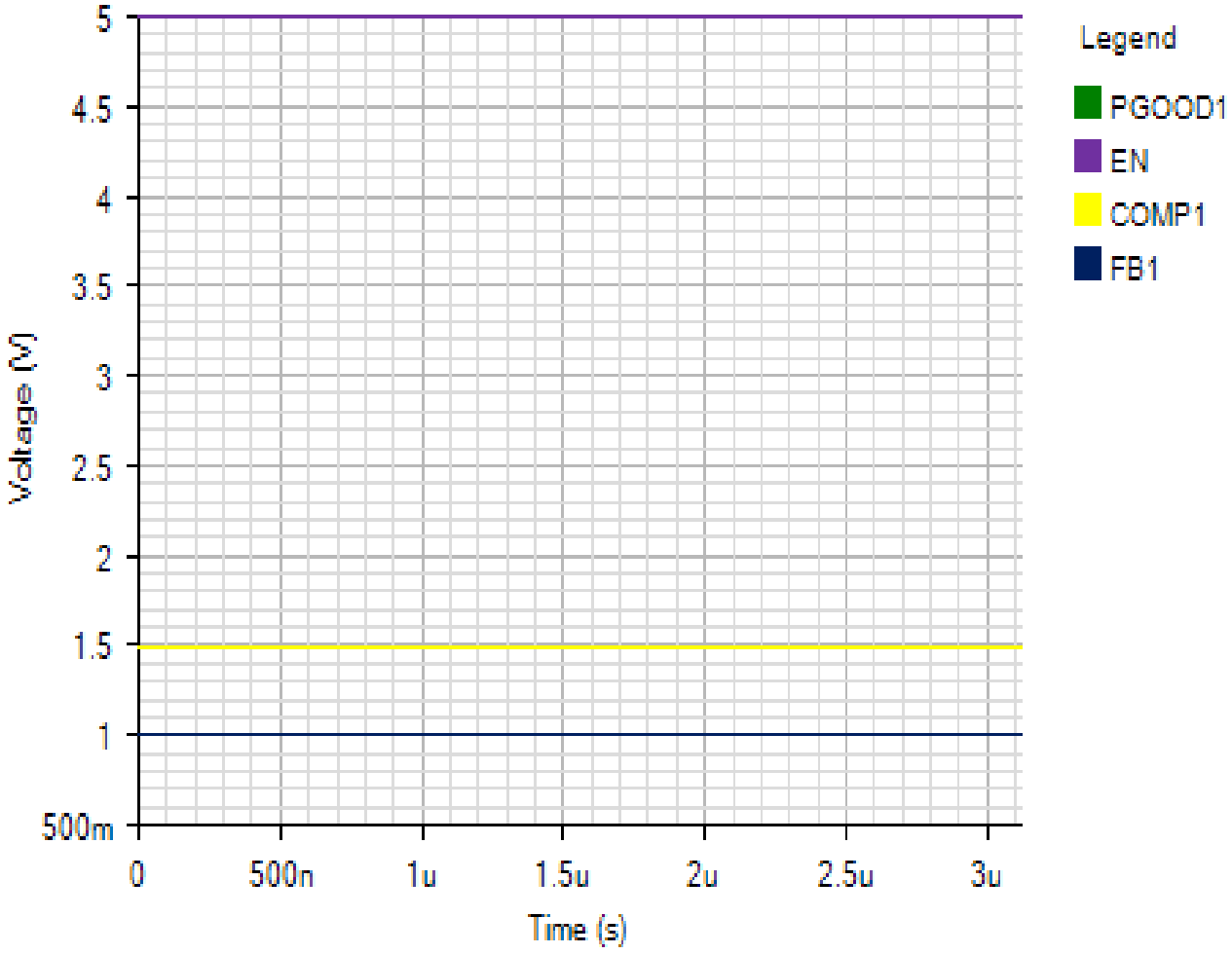

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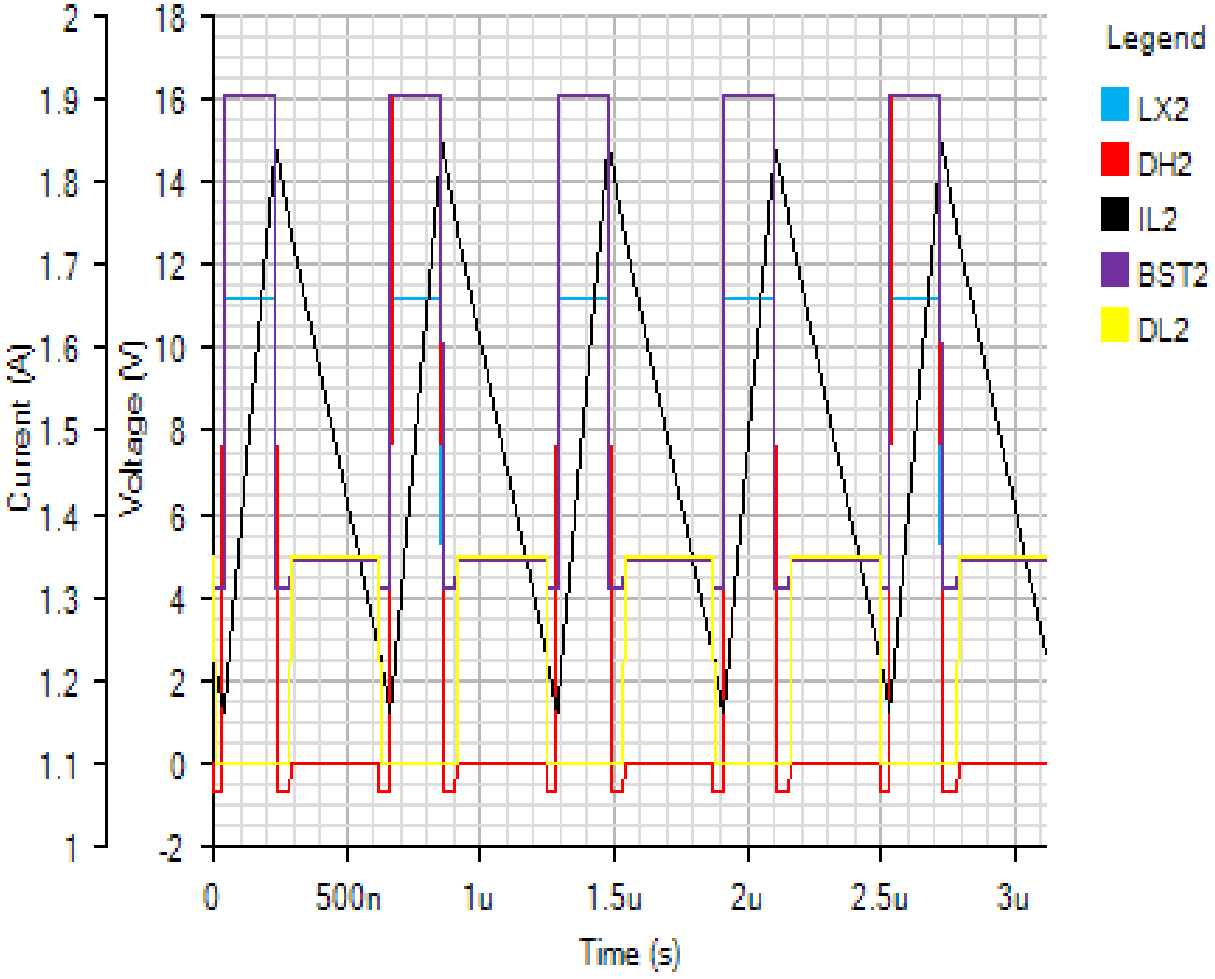

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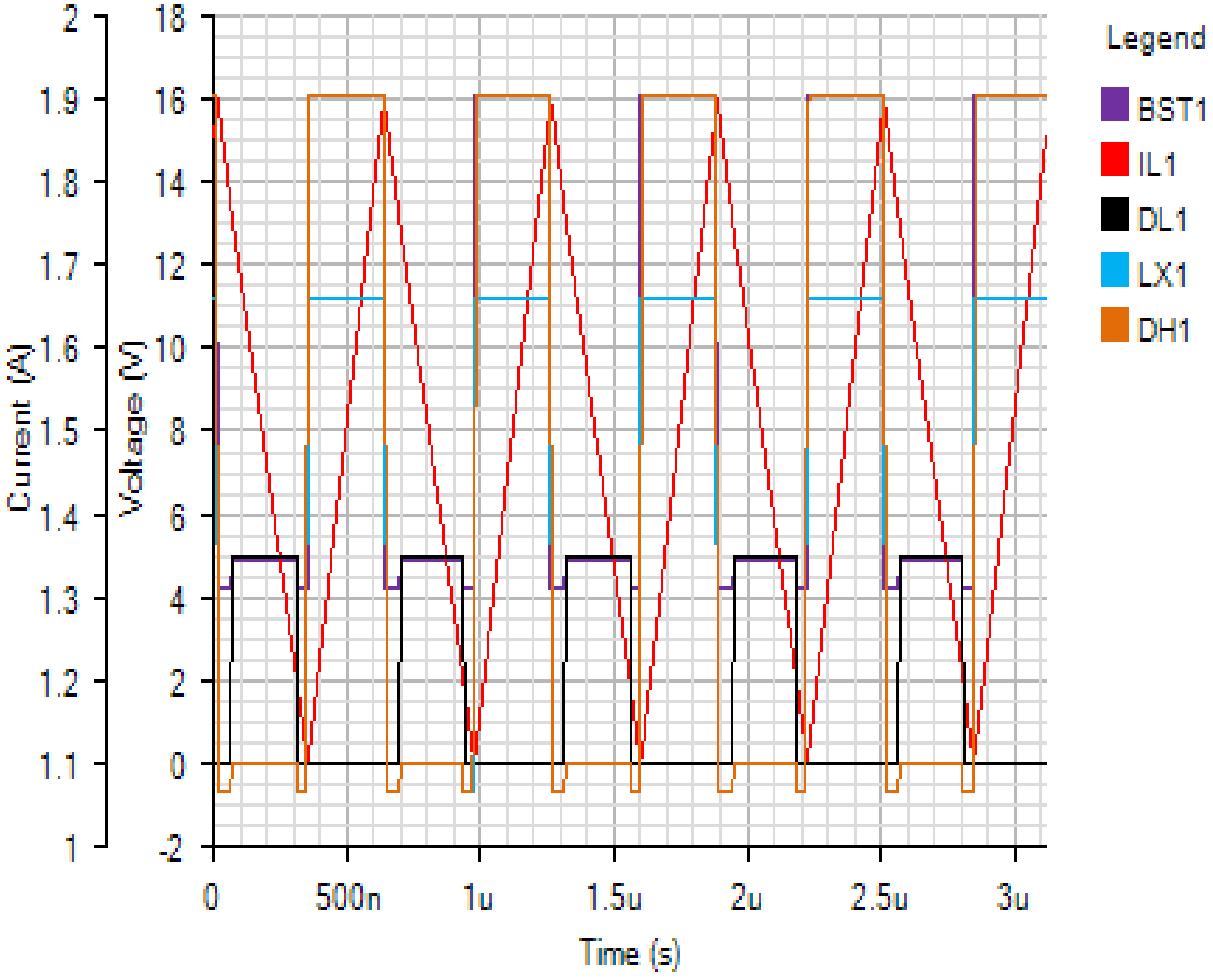

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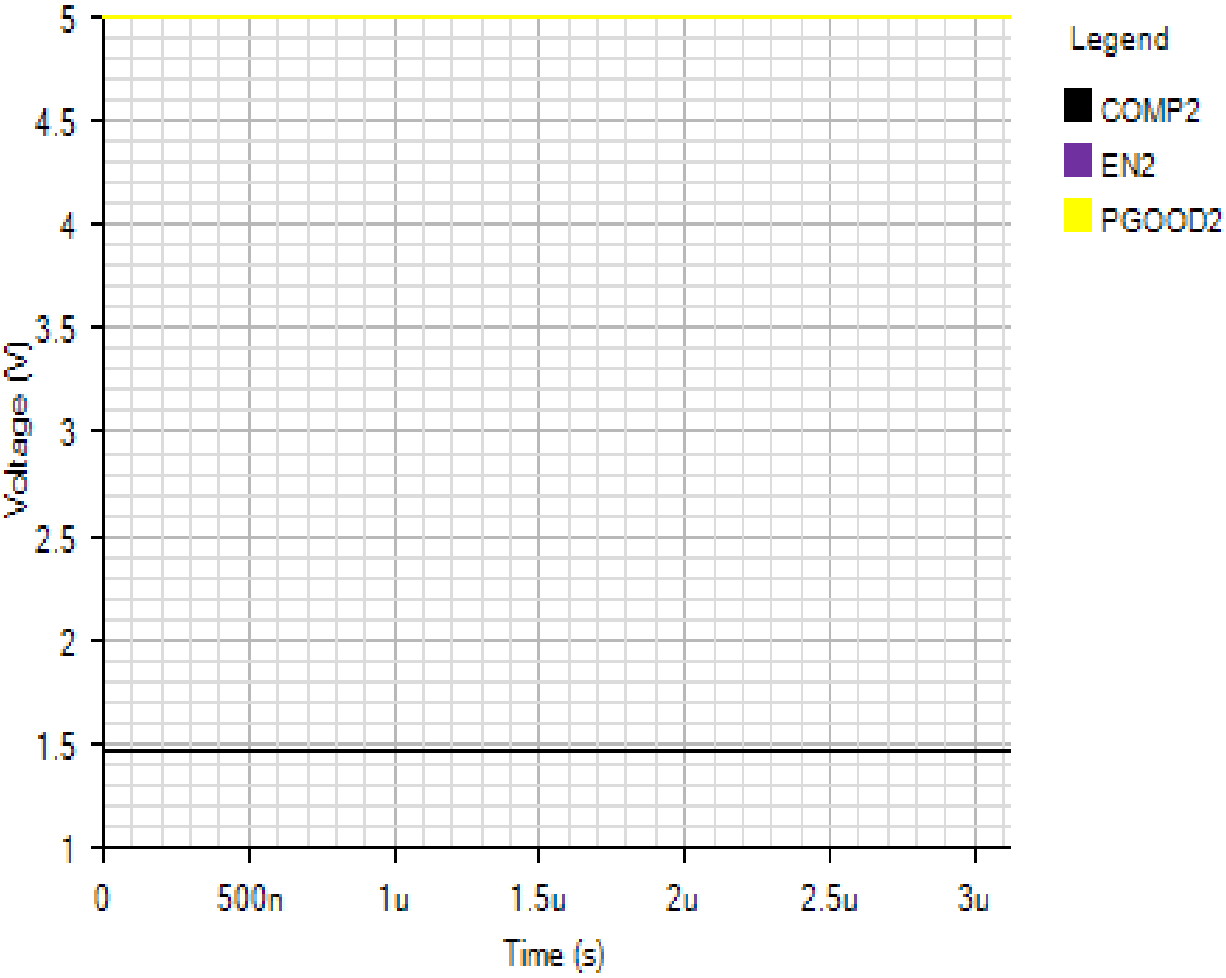

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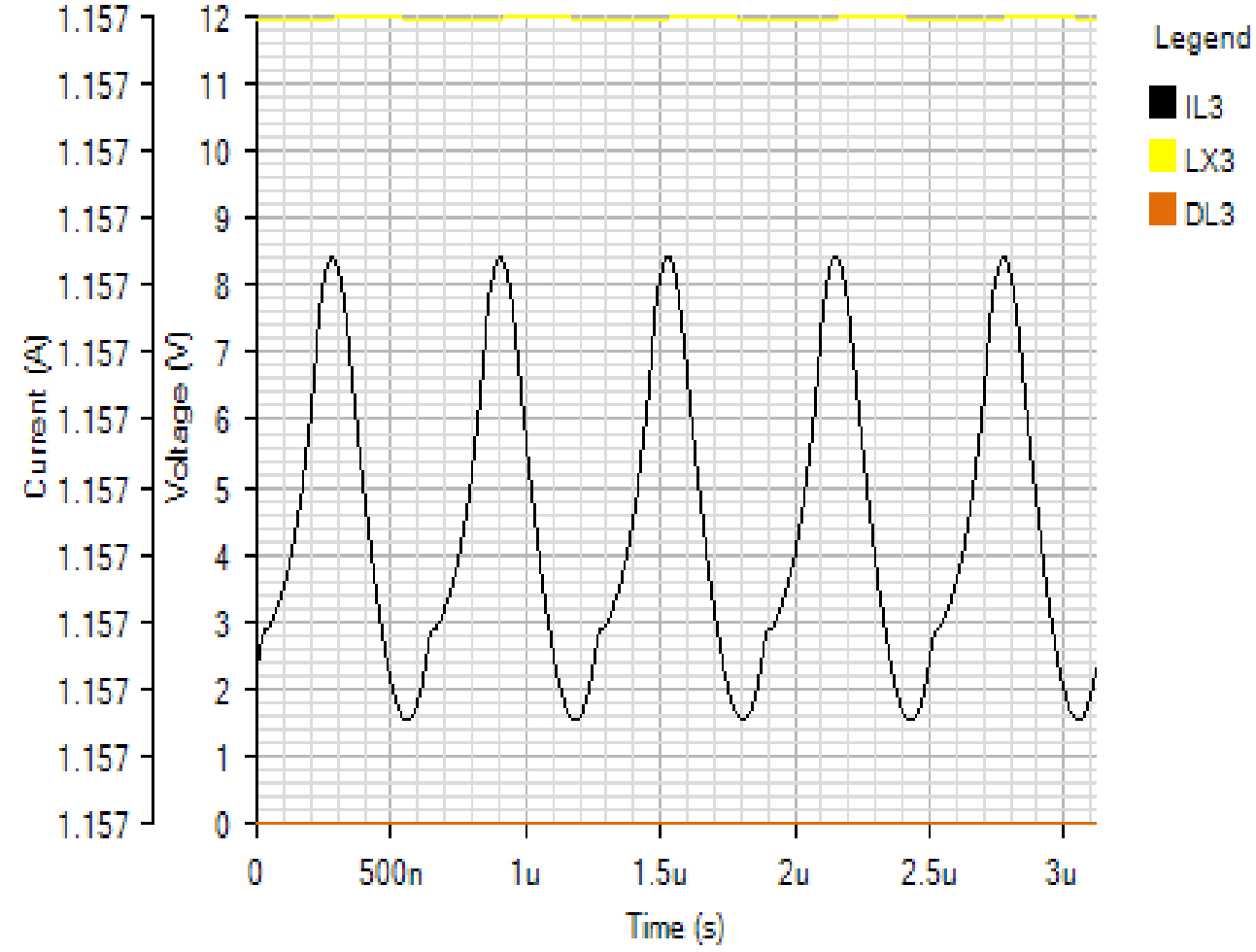

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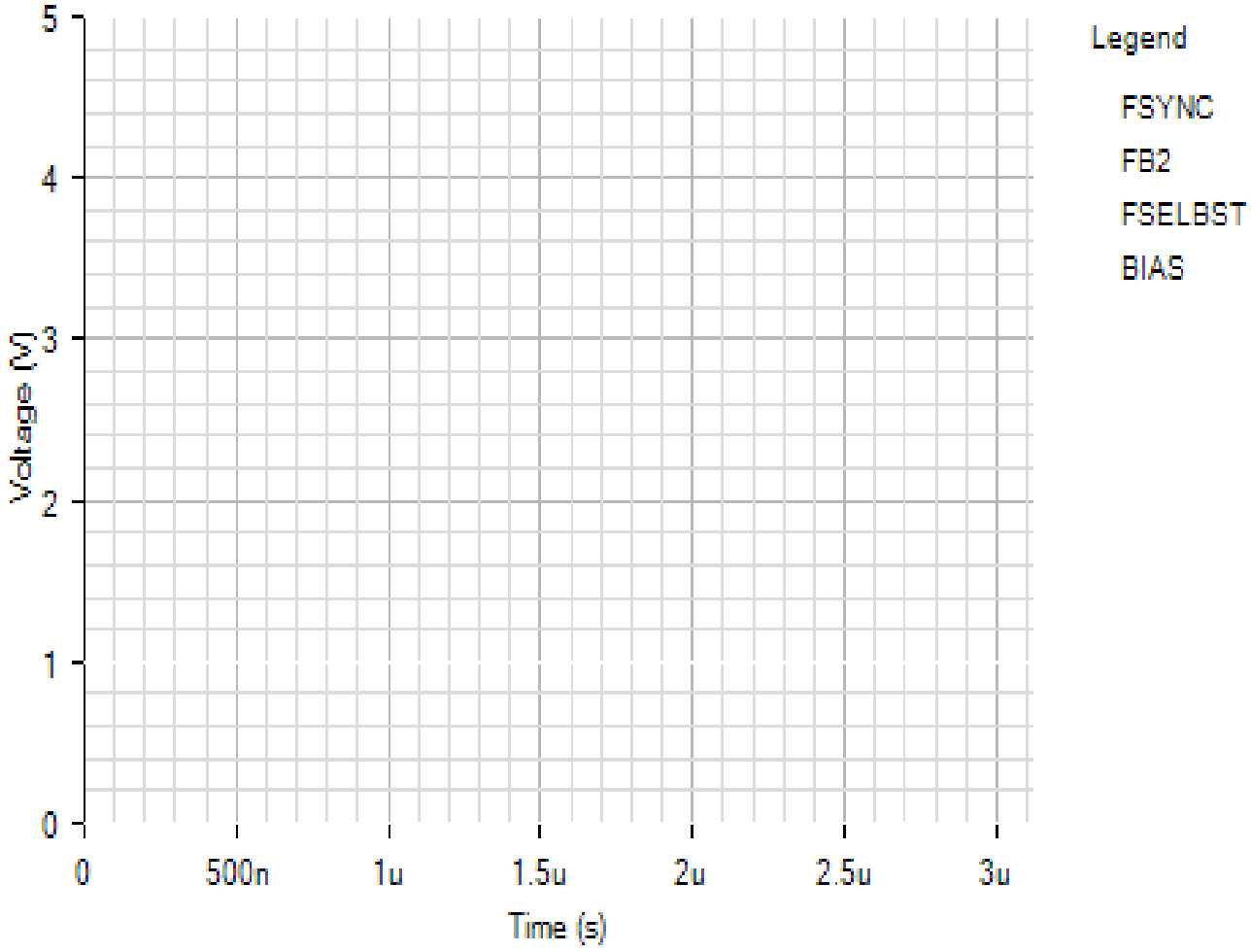
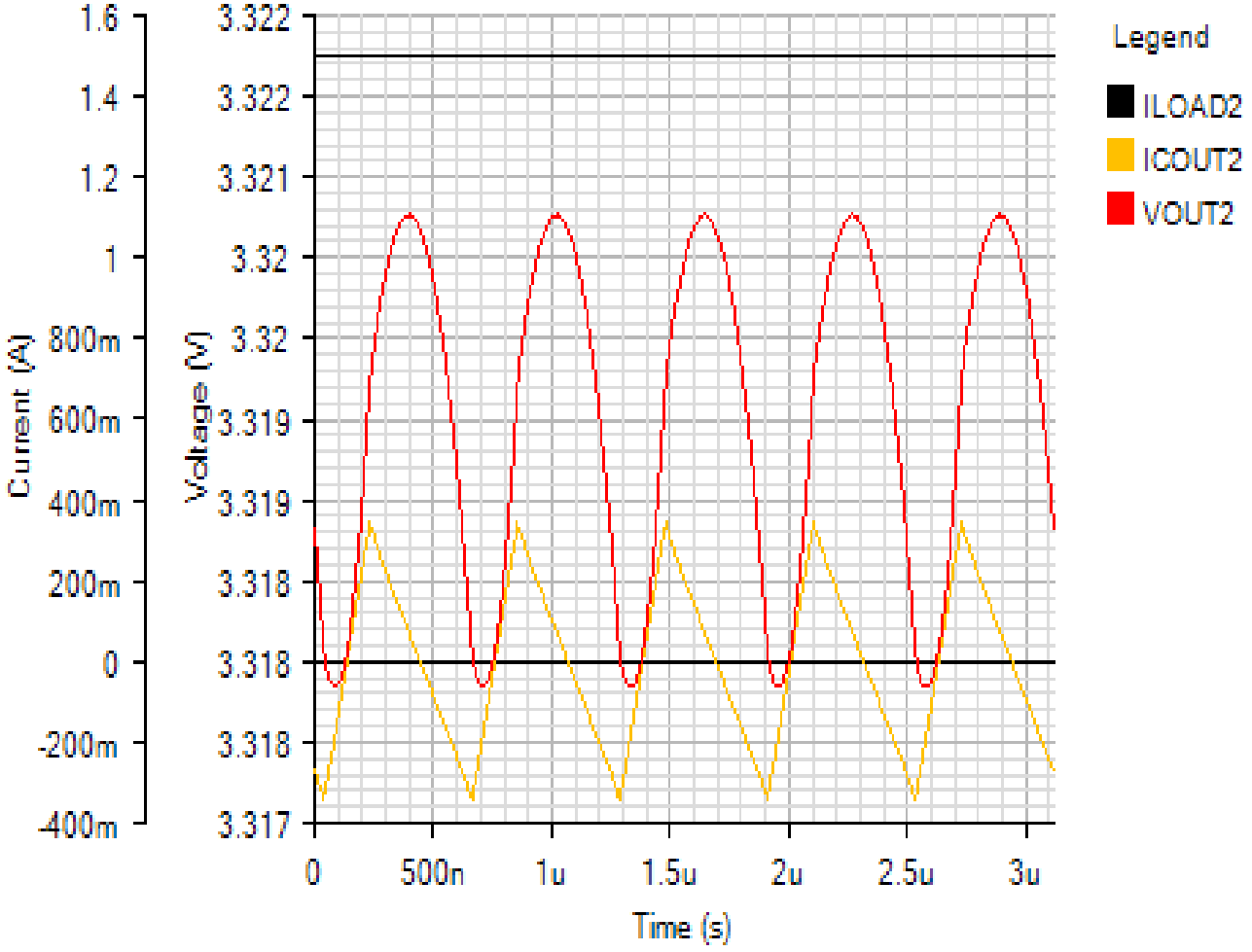
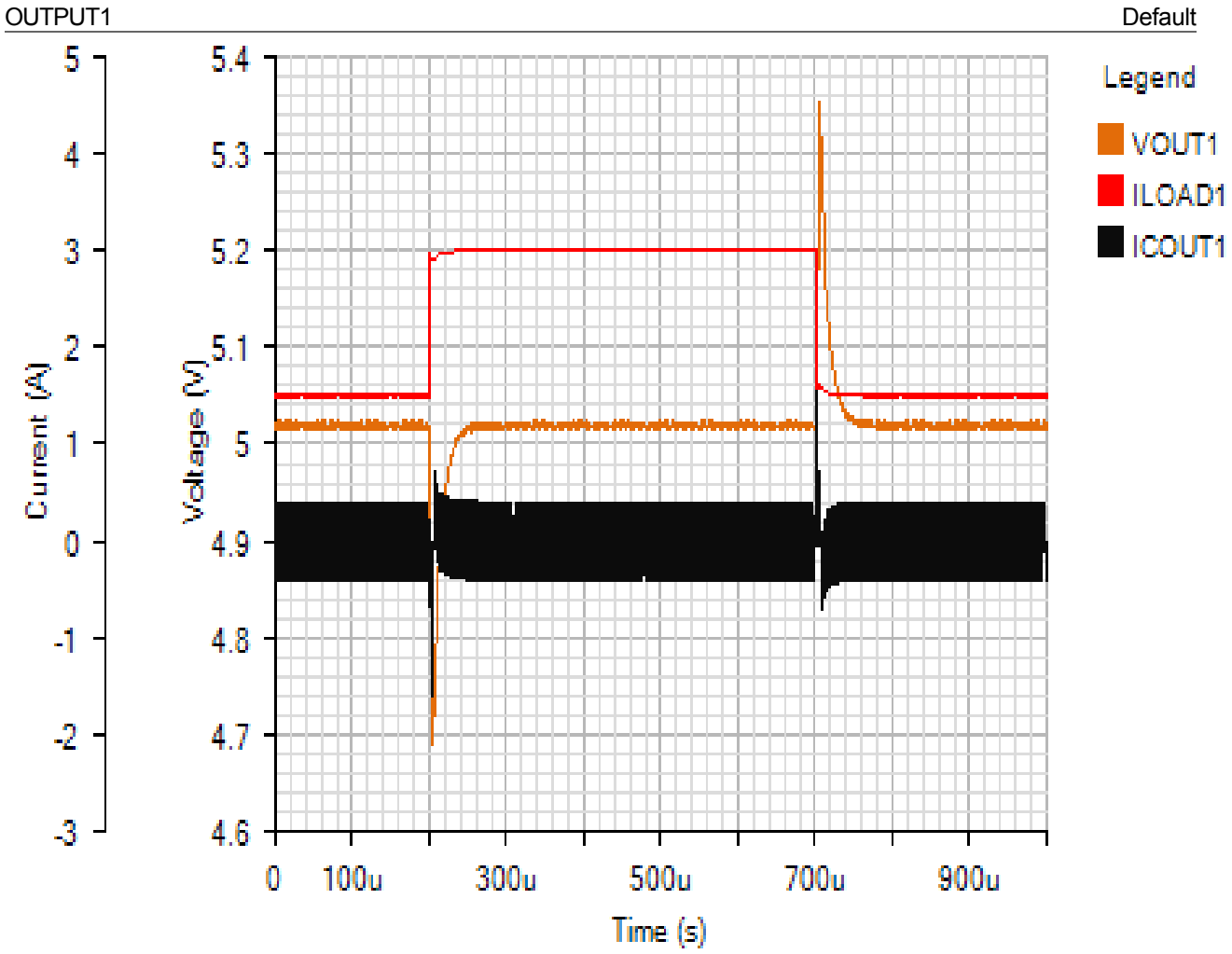


OUTPUT2 Default



**Load Step - Thu Nov 15 2018 14:55:37**



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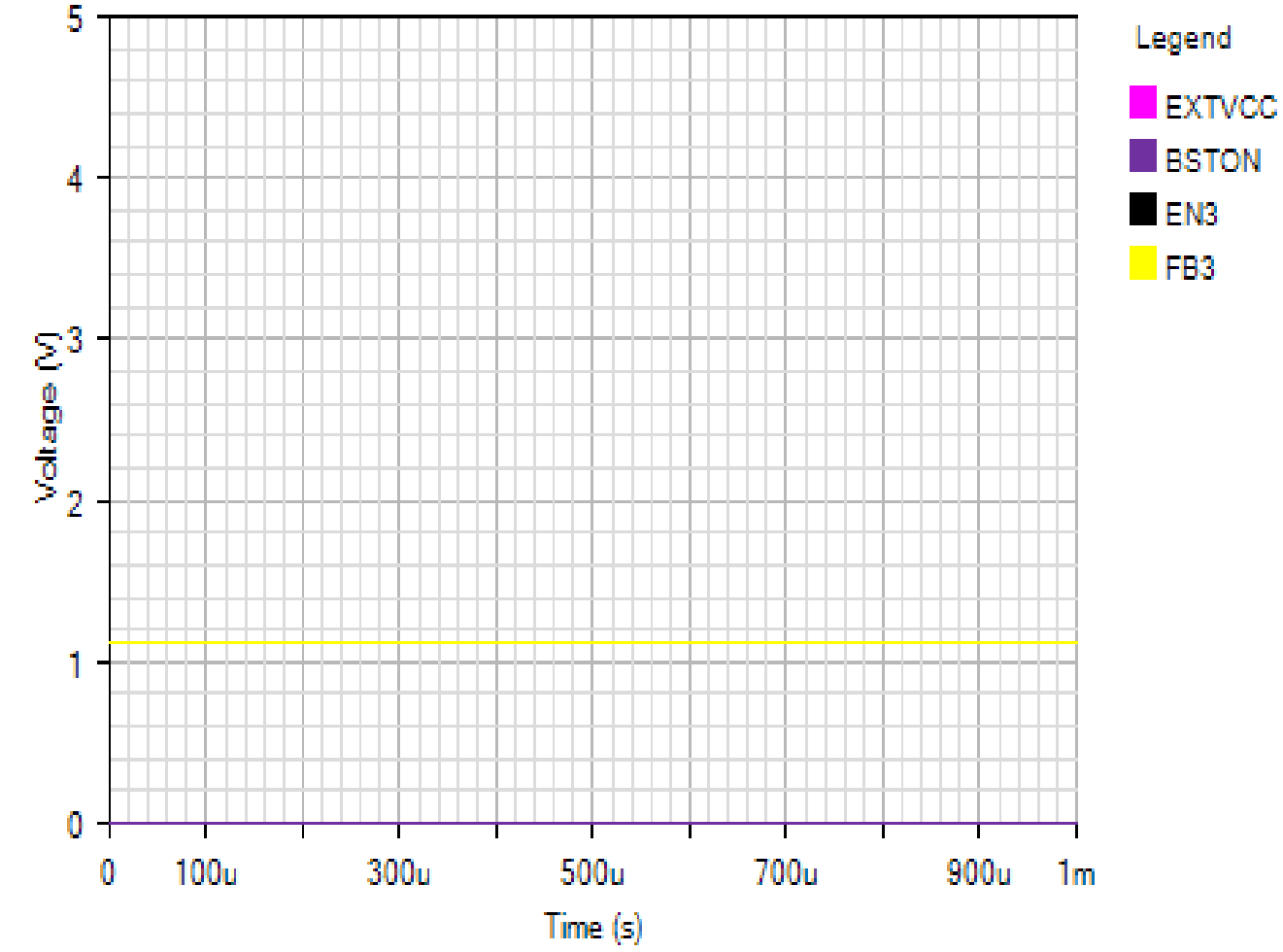

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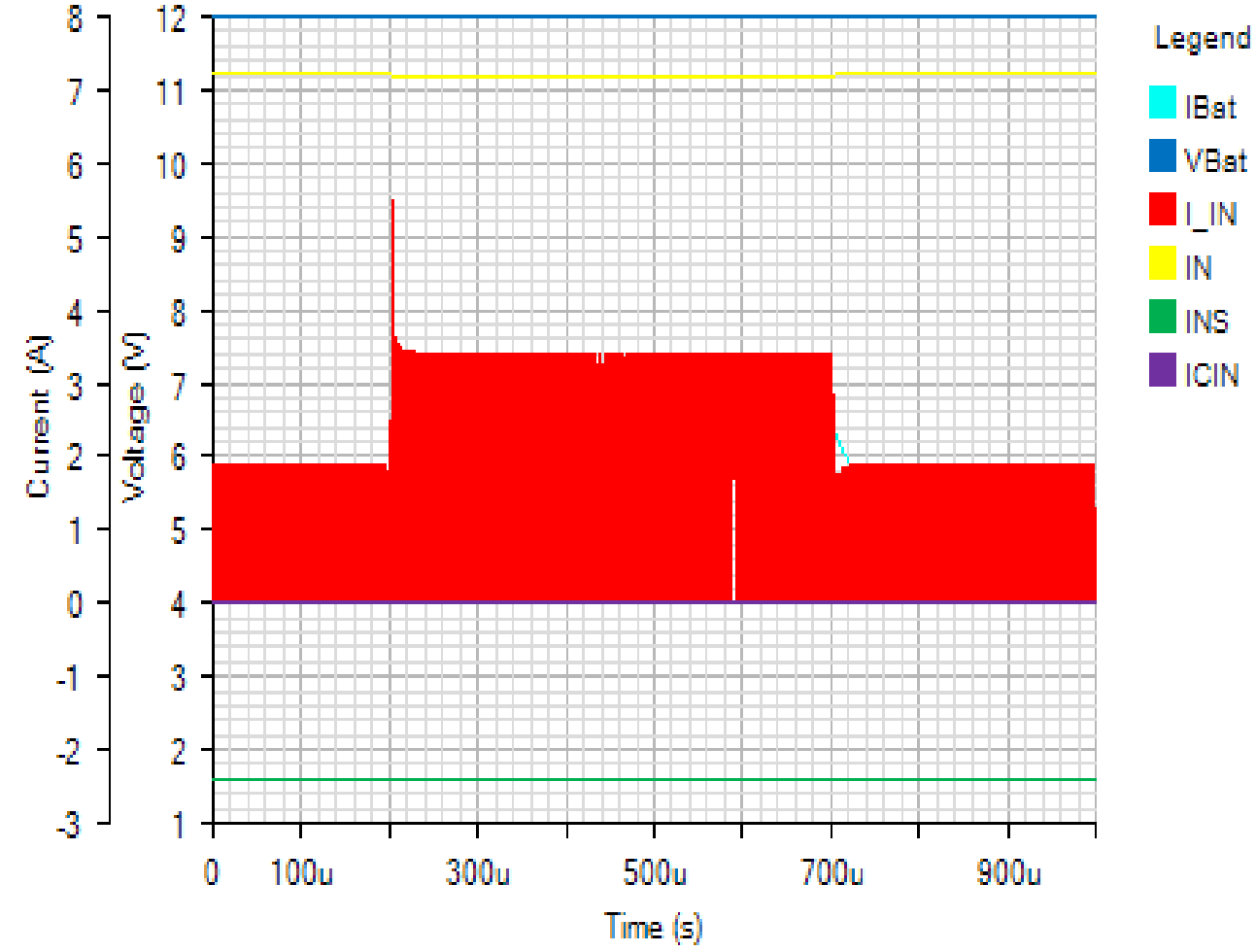

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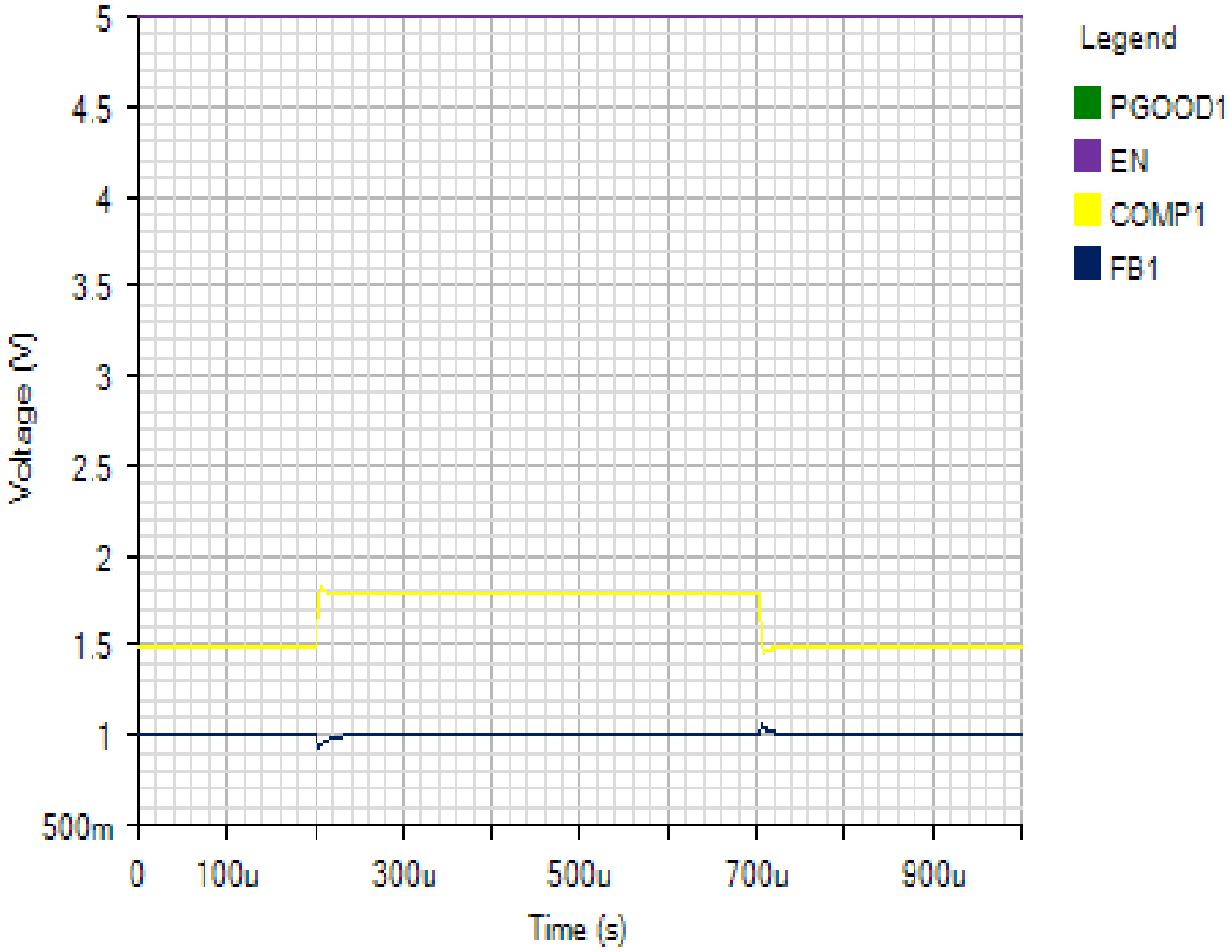

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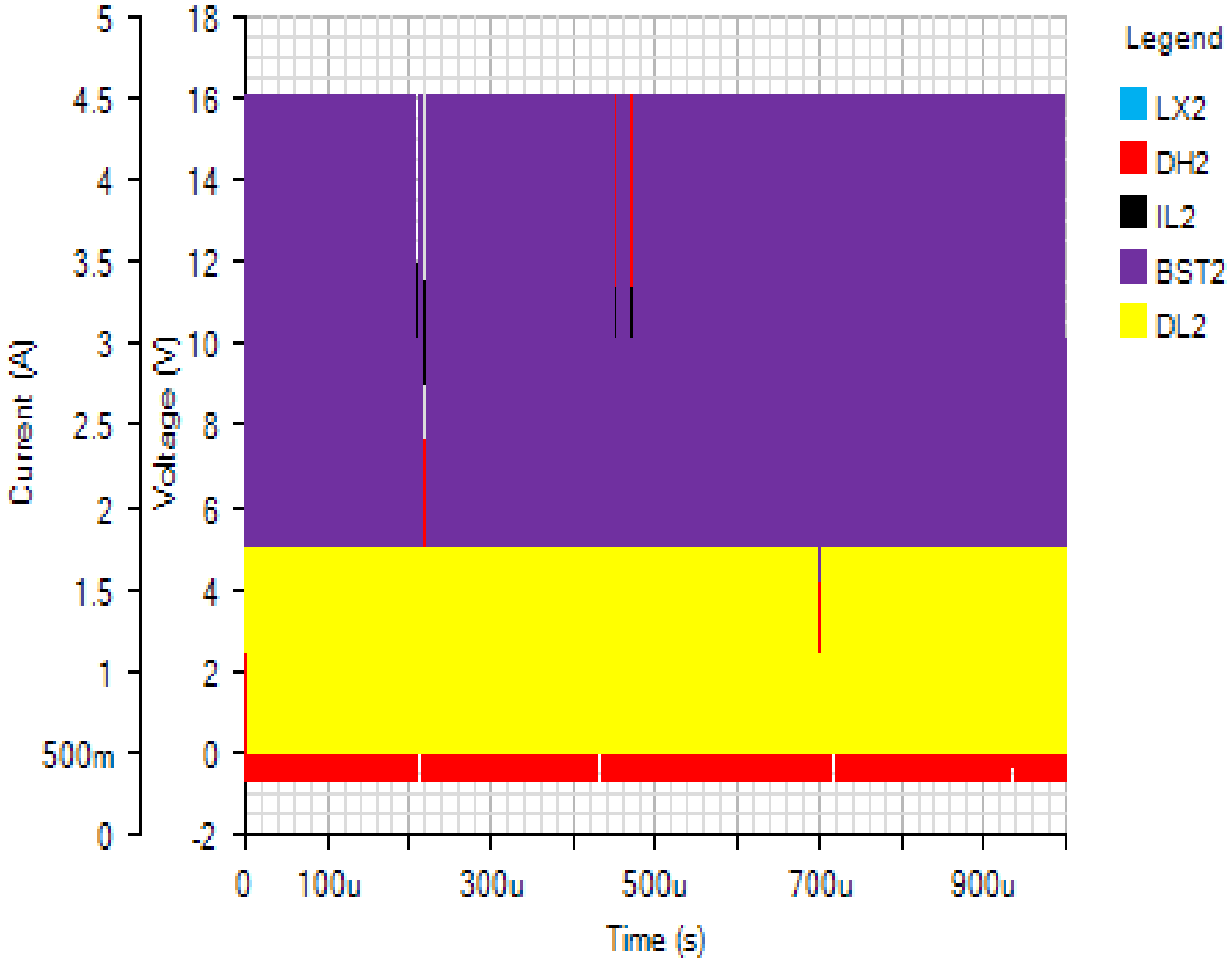

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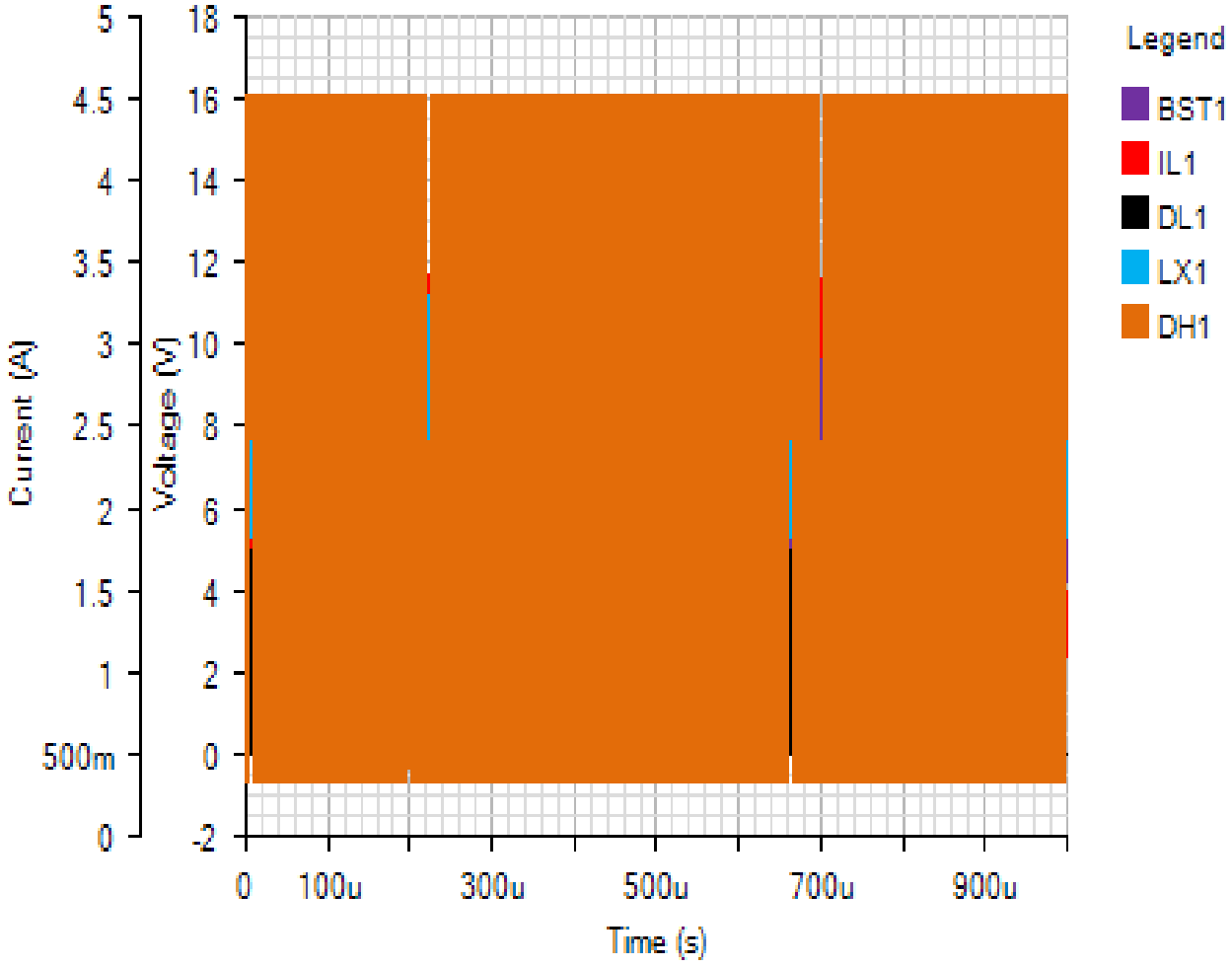

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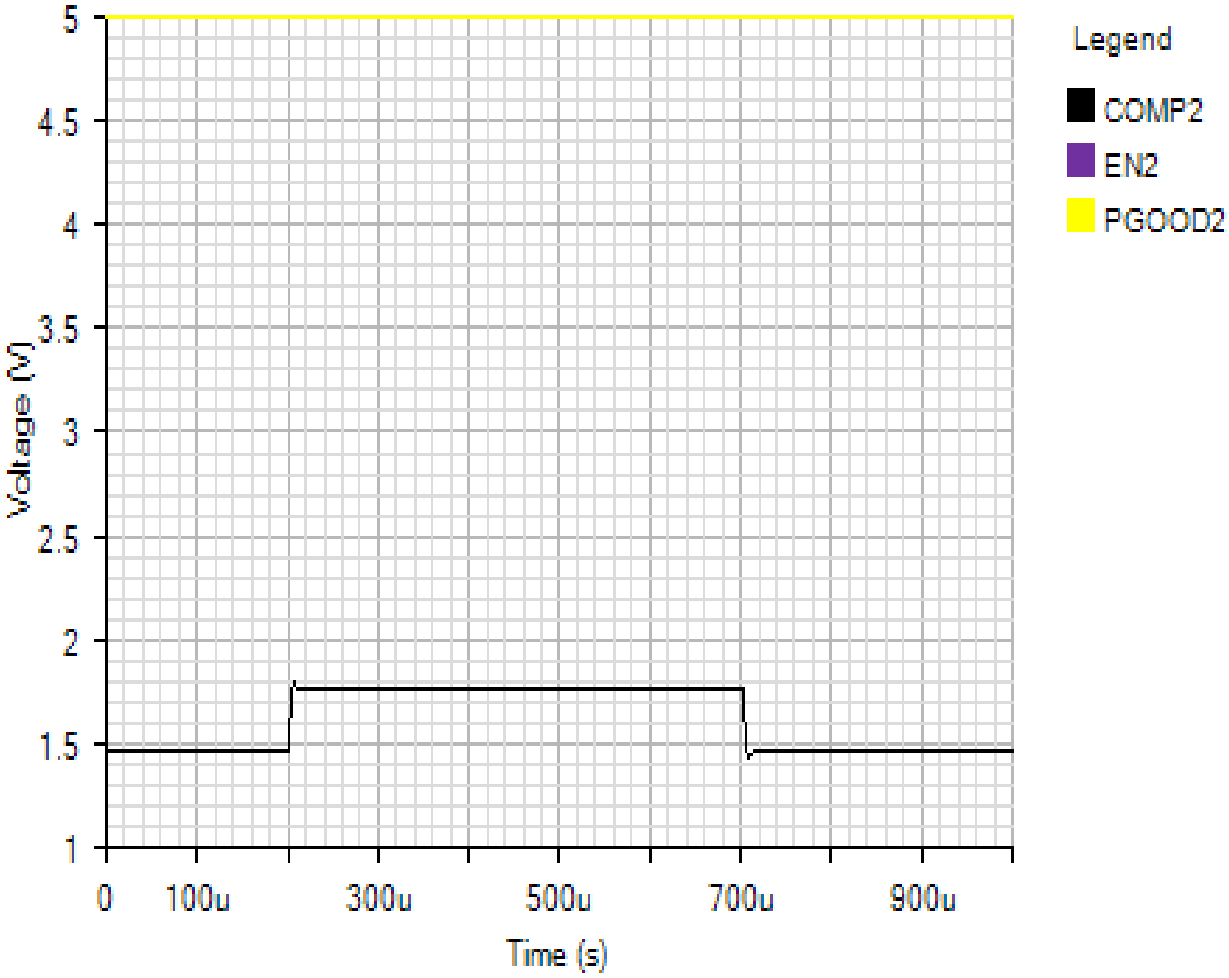

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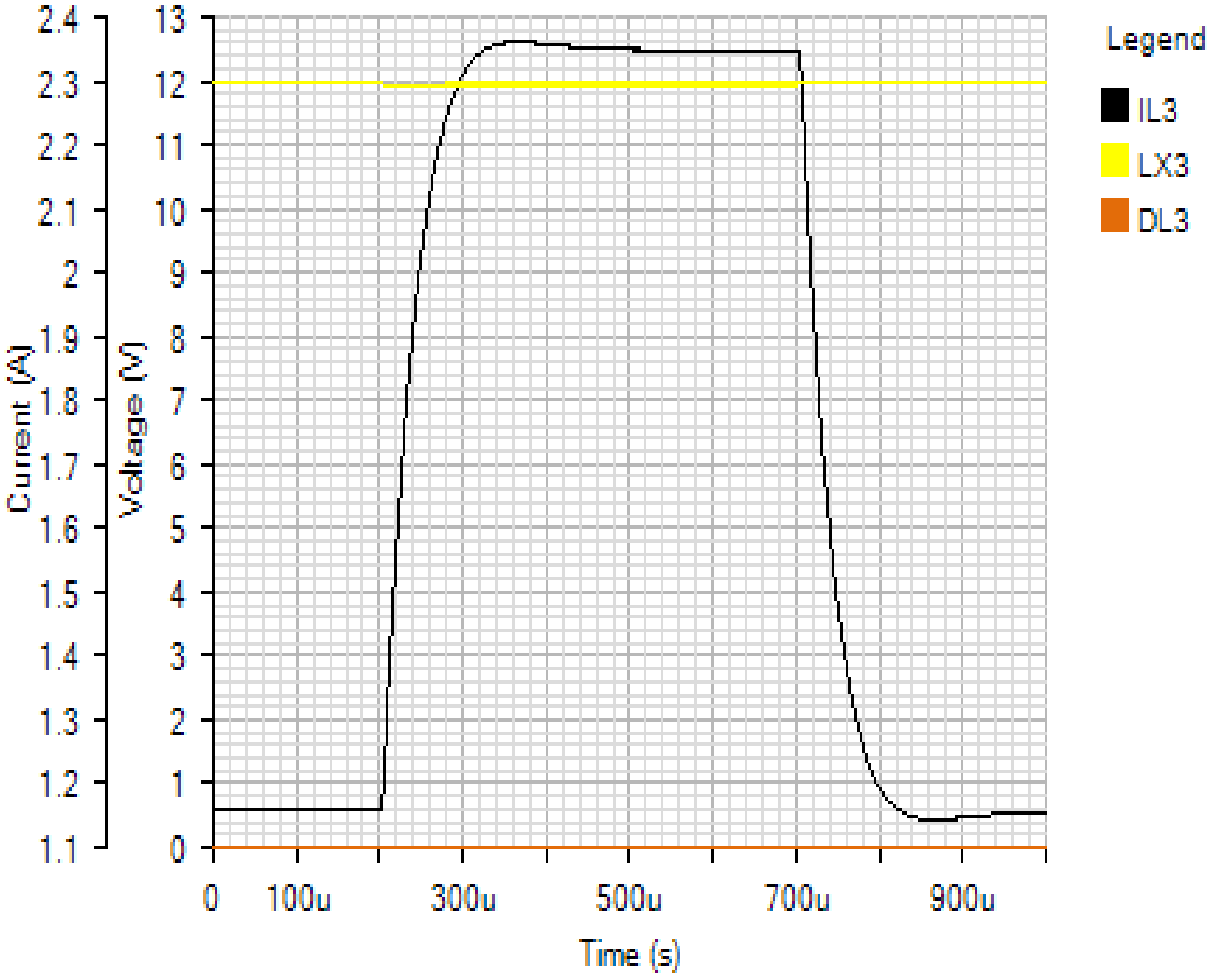
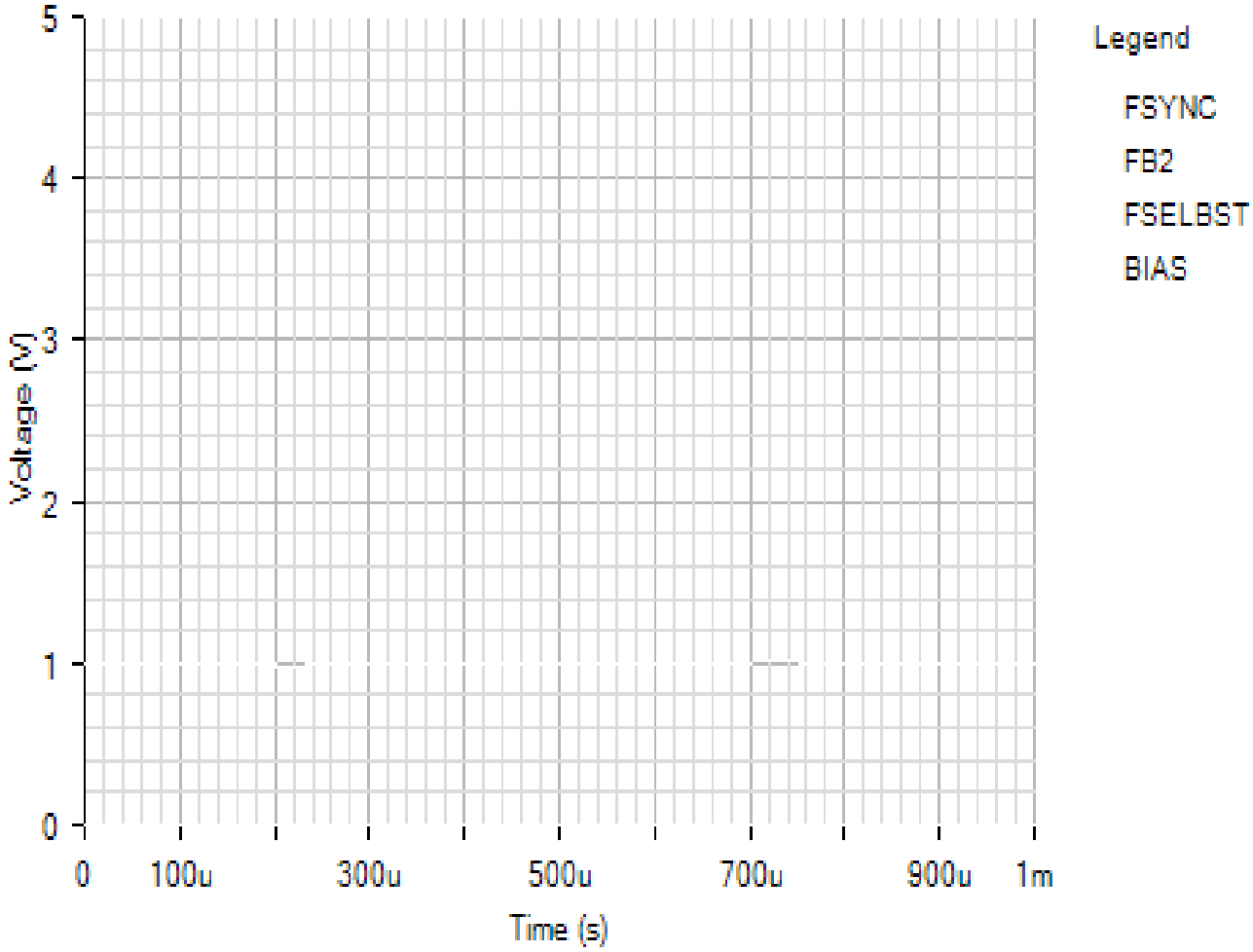
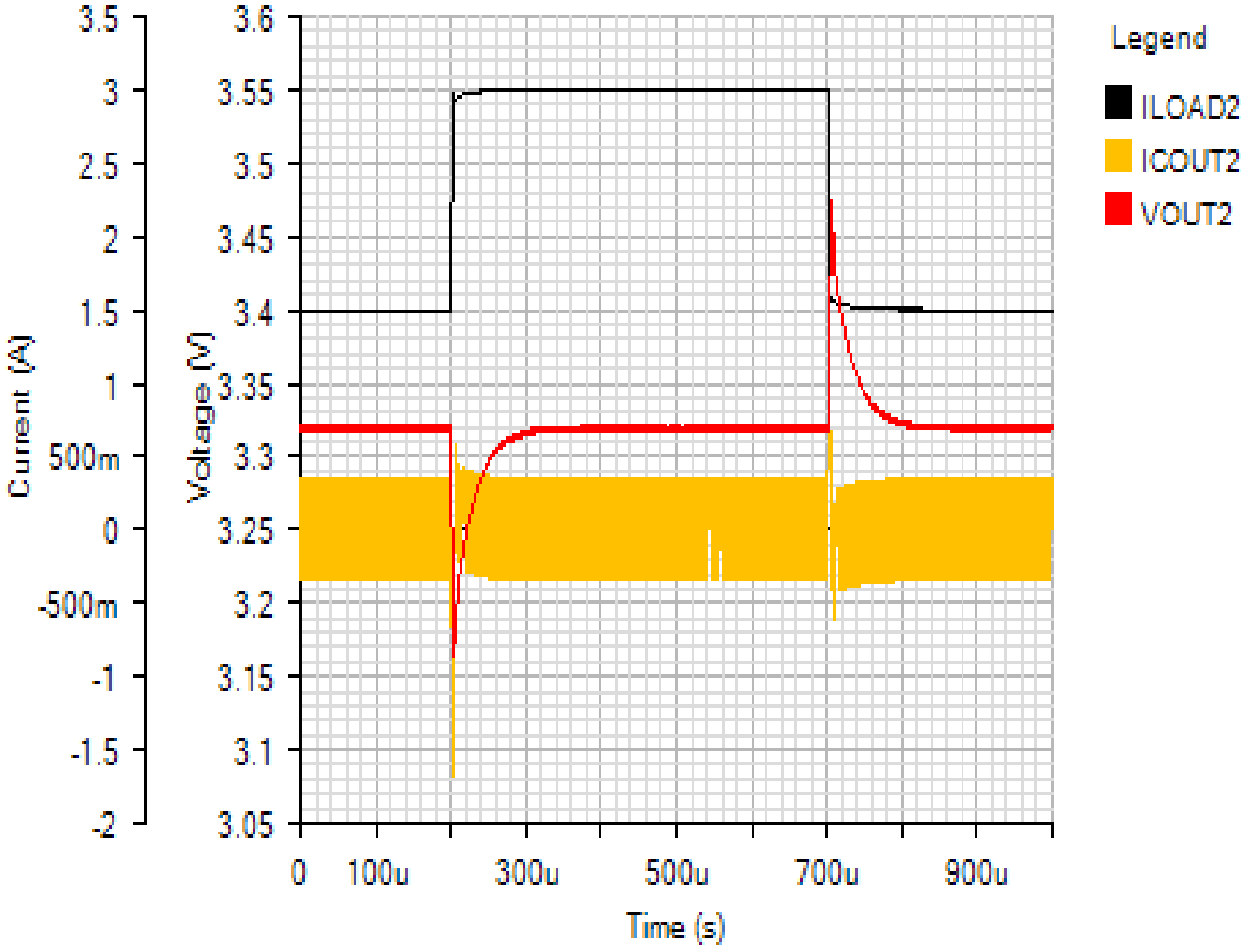


WEBSIM_VOLTAGE_ Default

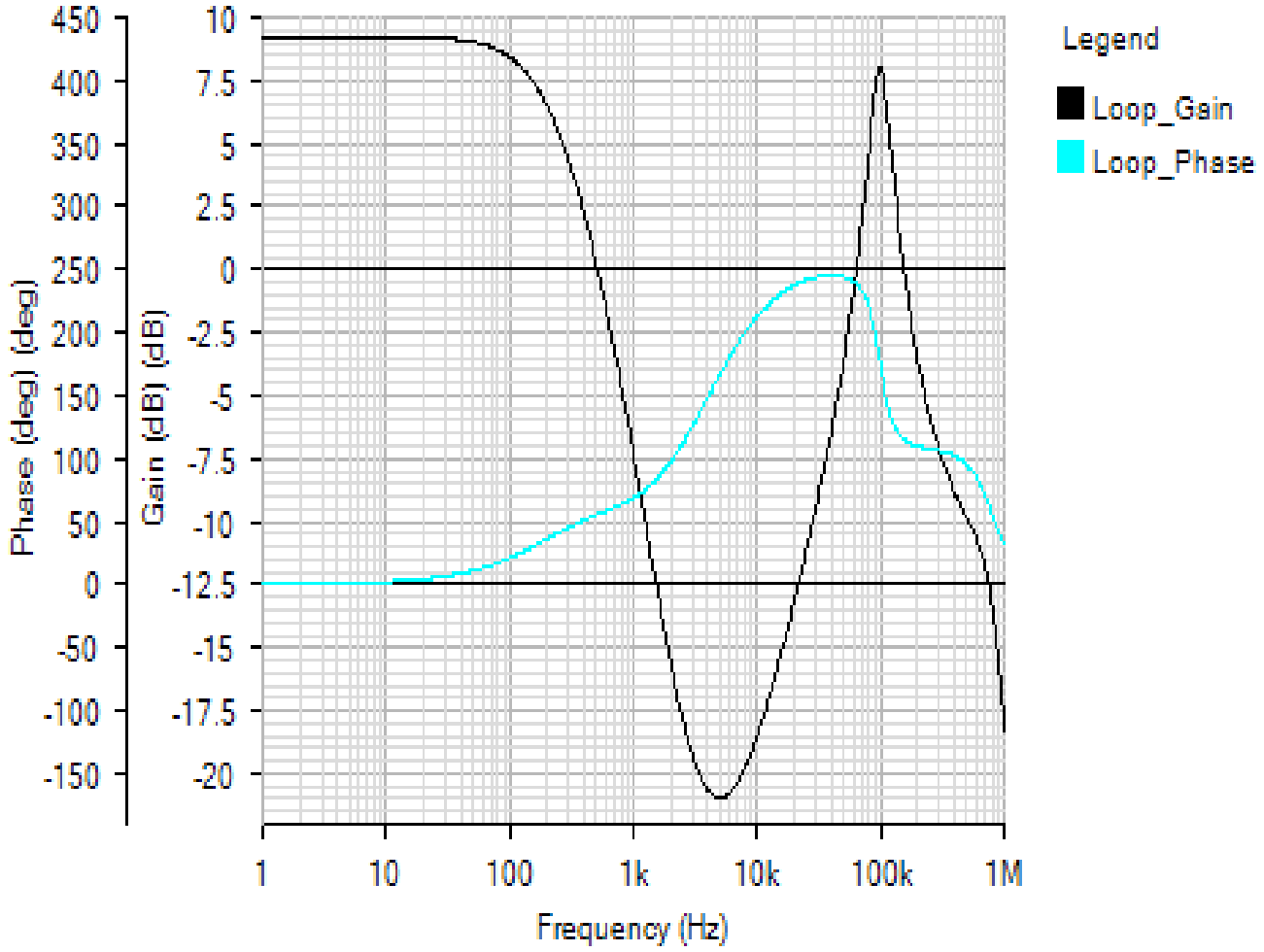


OUTPUT2 Default



**PreBoost AC - Thu Nov 15 2018 14:55:37**

BODE Default

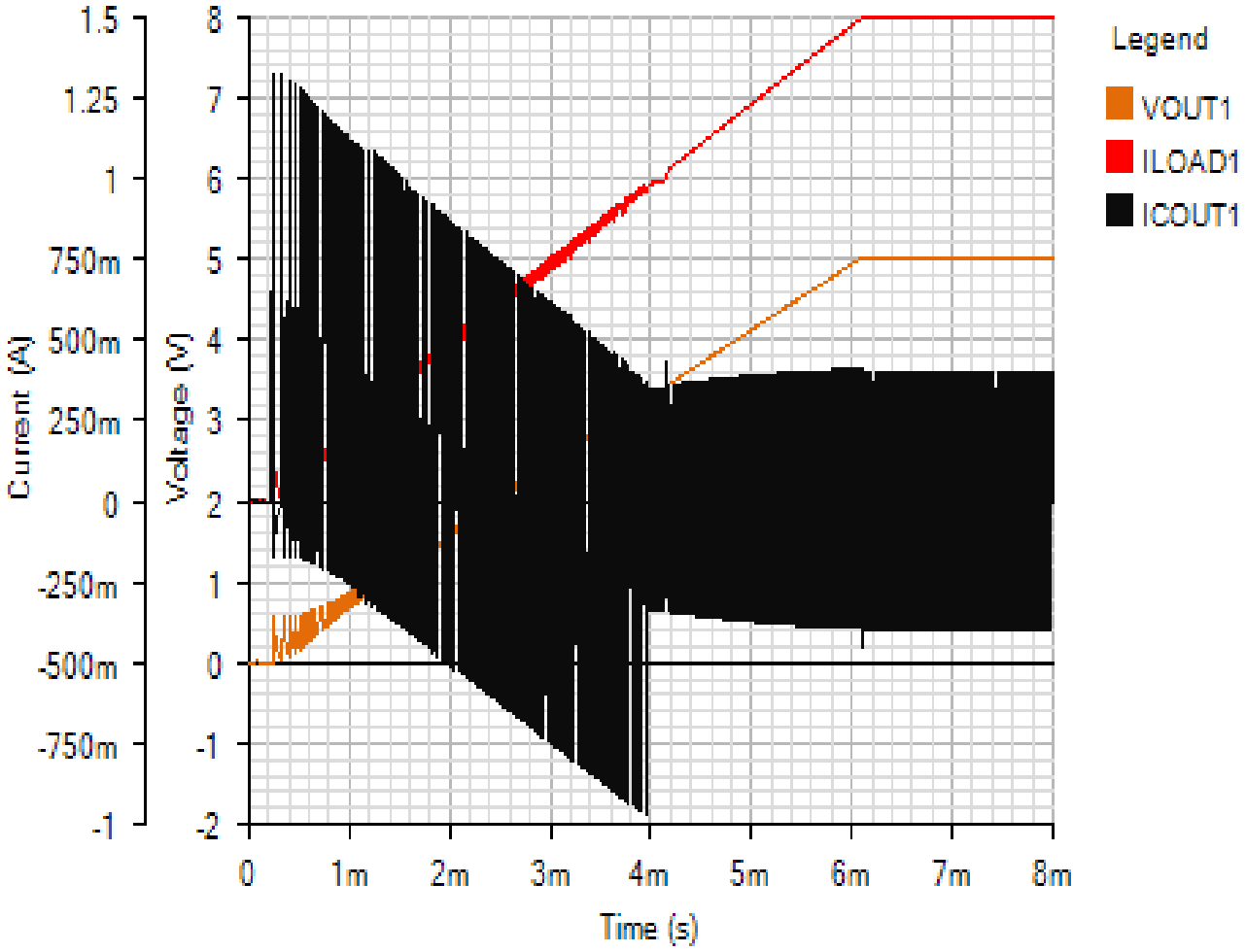



Phase Margin: 55.94° at a crossover frequency of 0.5kHz

20 30 40 50 60 70 80 90 100 110

**Start Up - Thu Nov 15 2018 14:55:37**

OUTPUT1 Default



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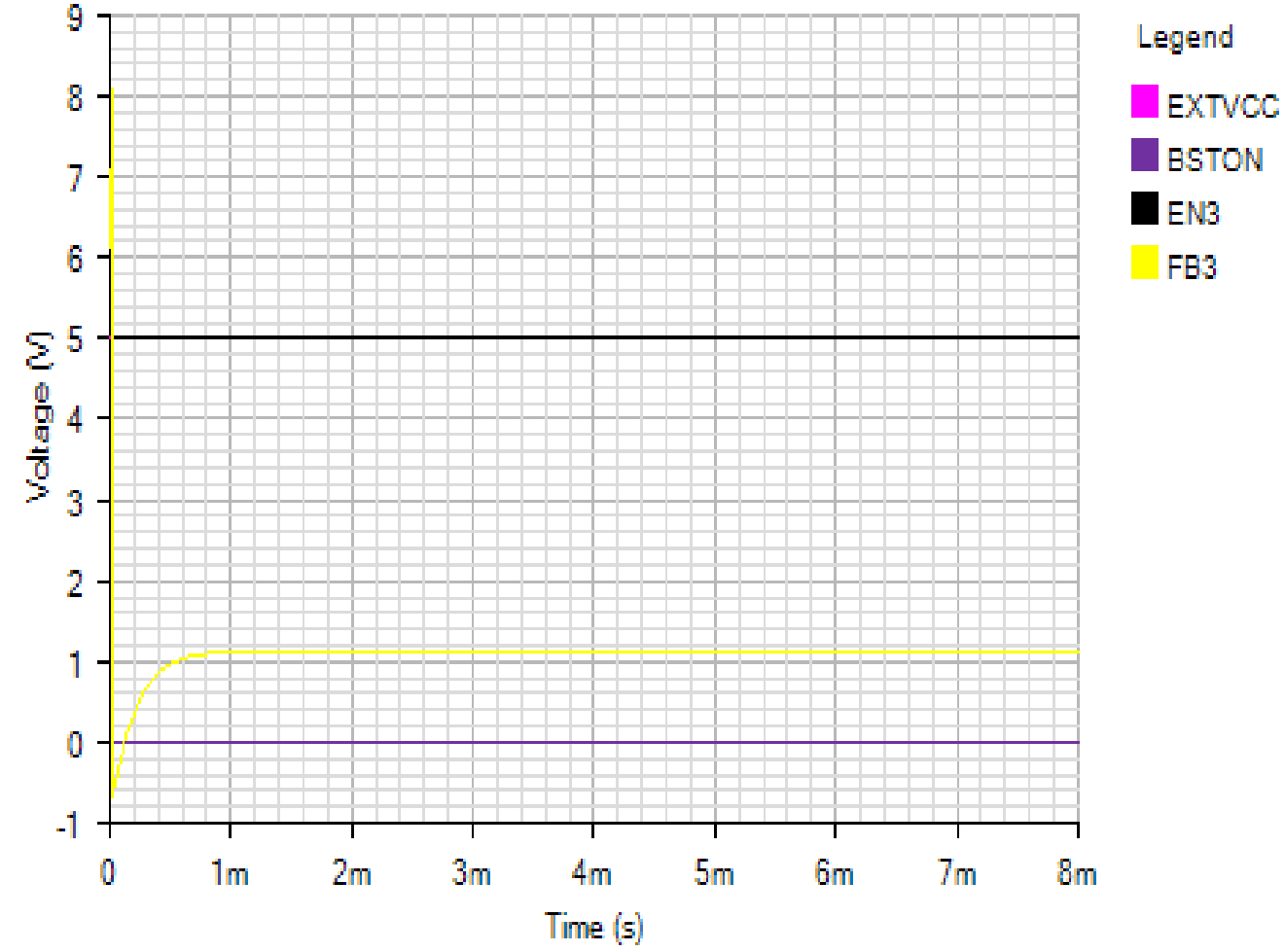
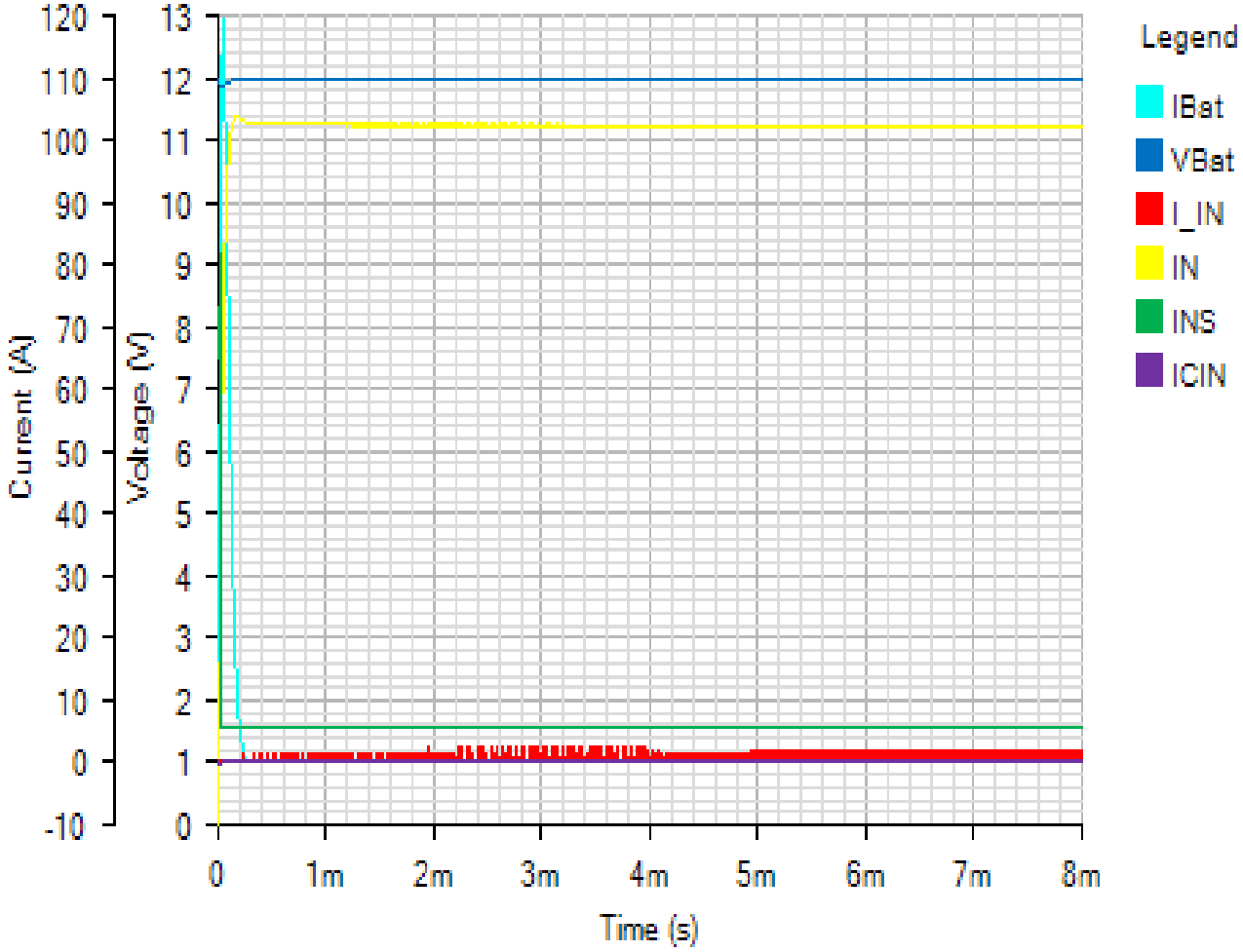


INPUT Default



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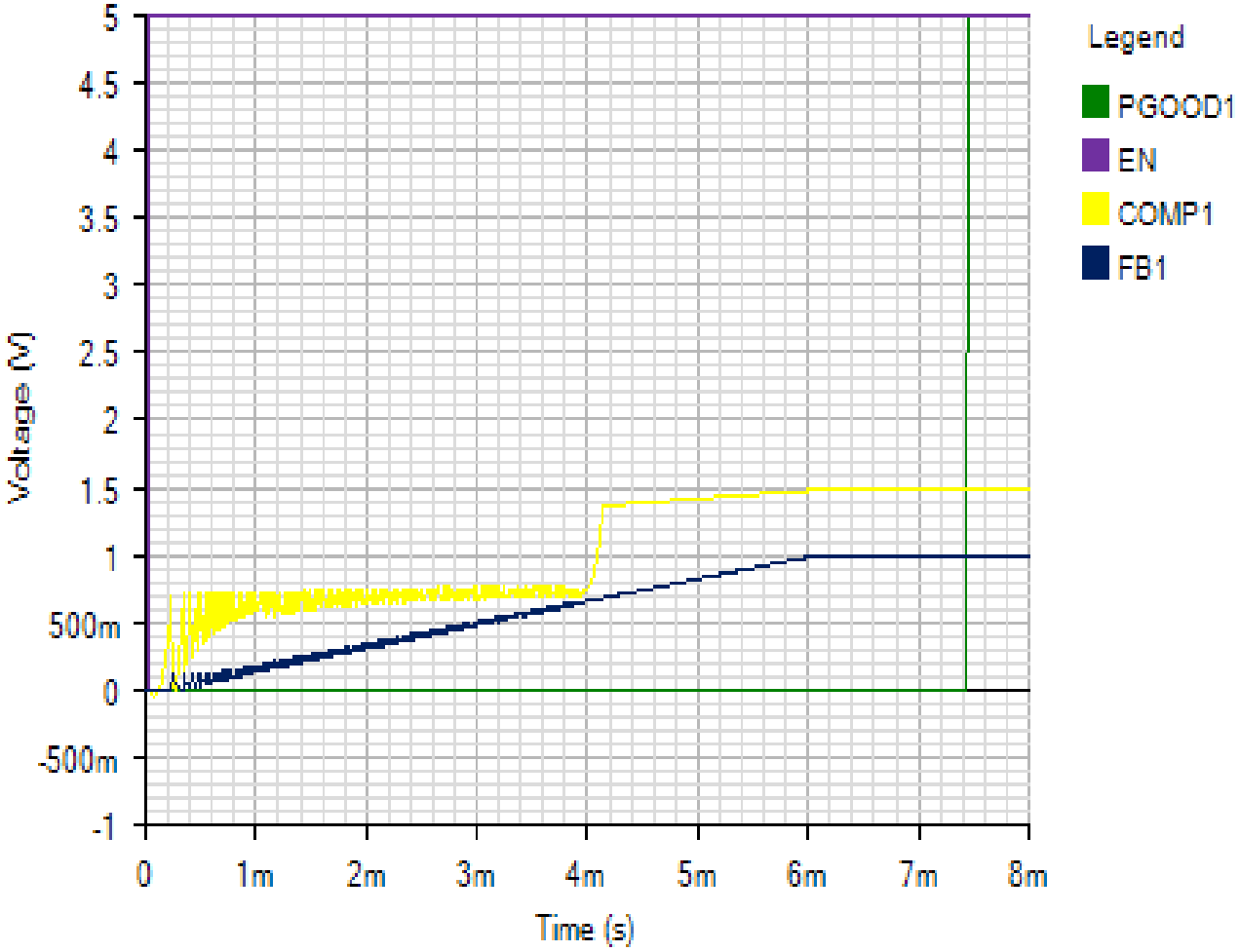

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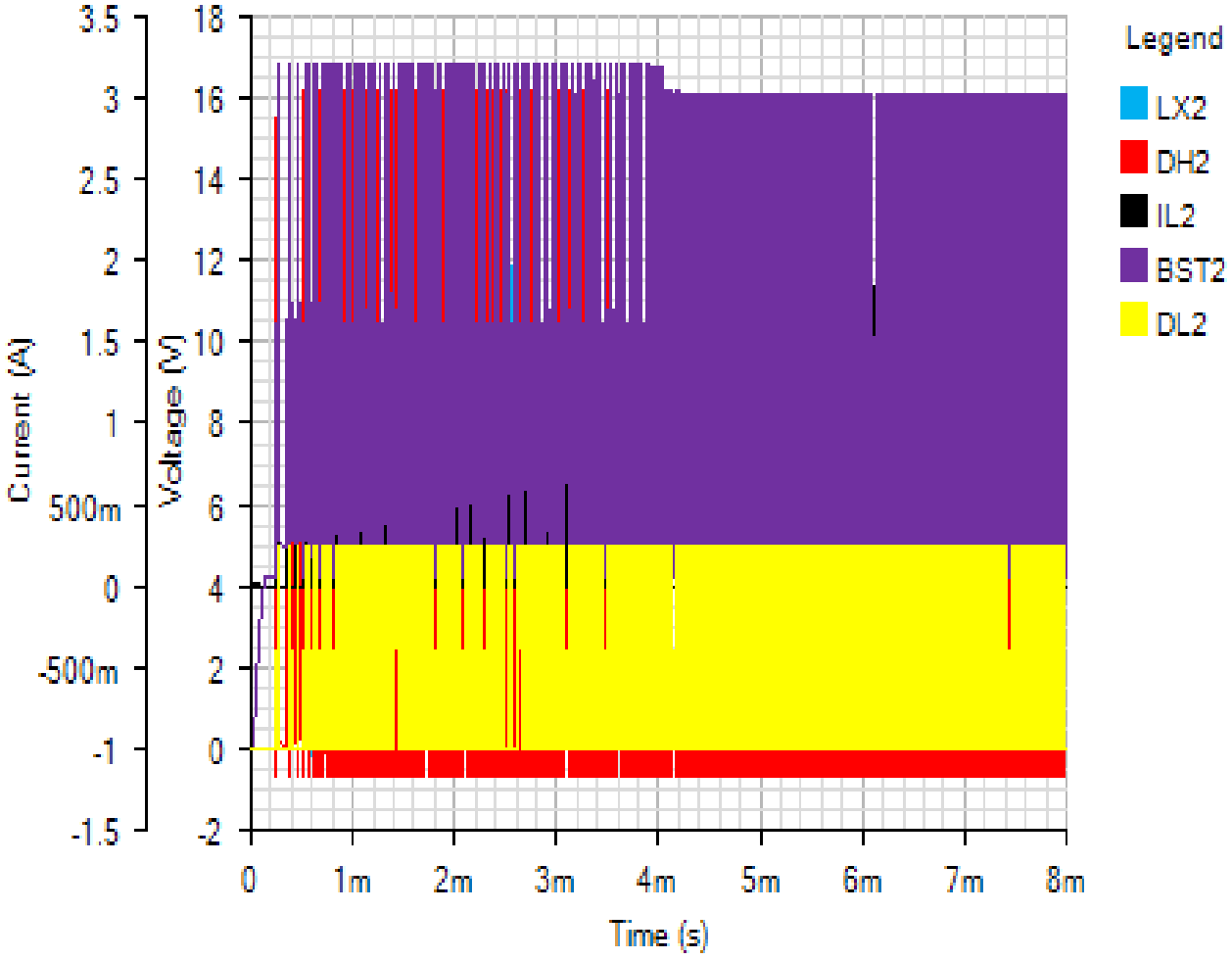

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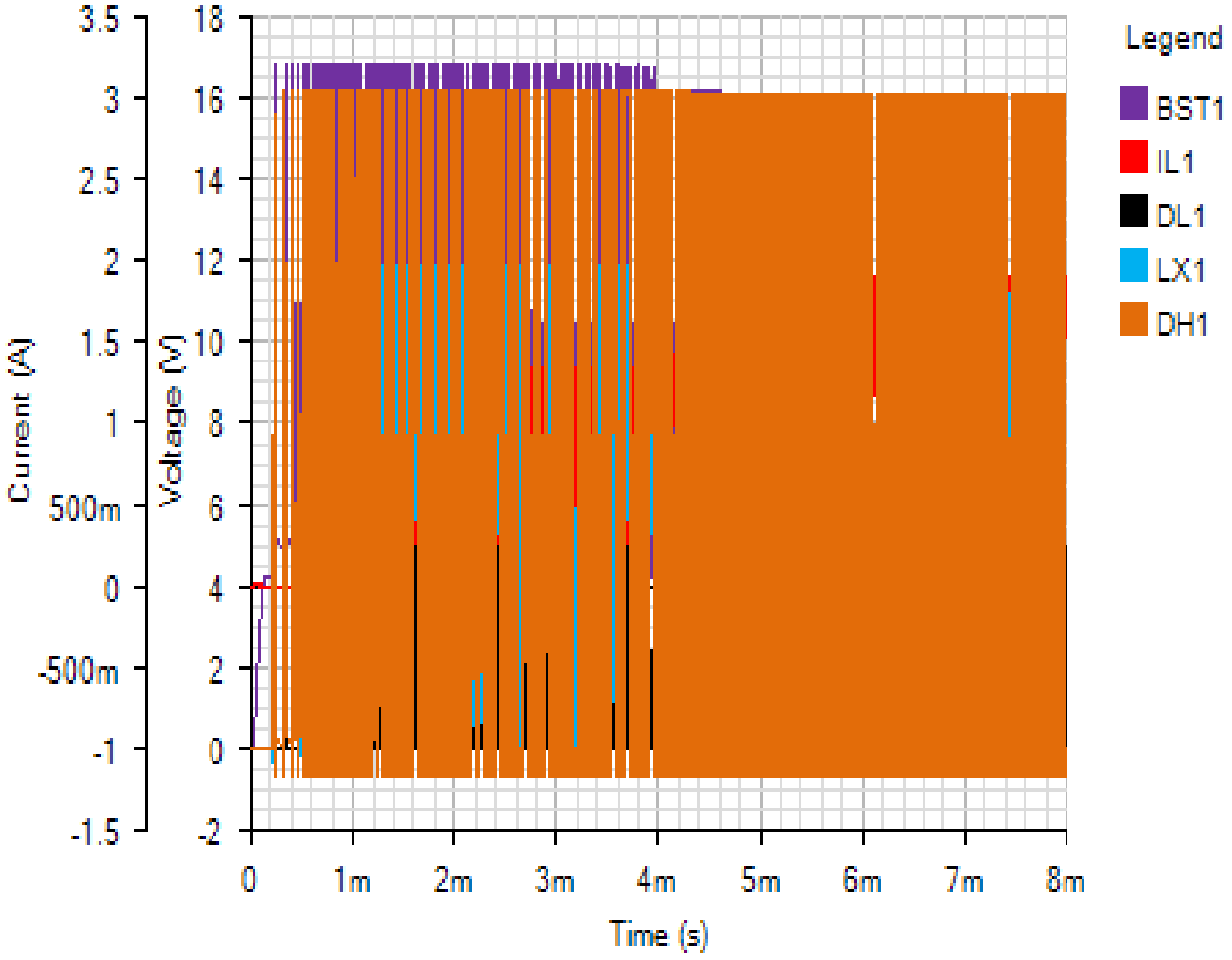

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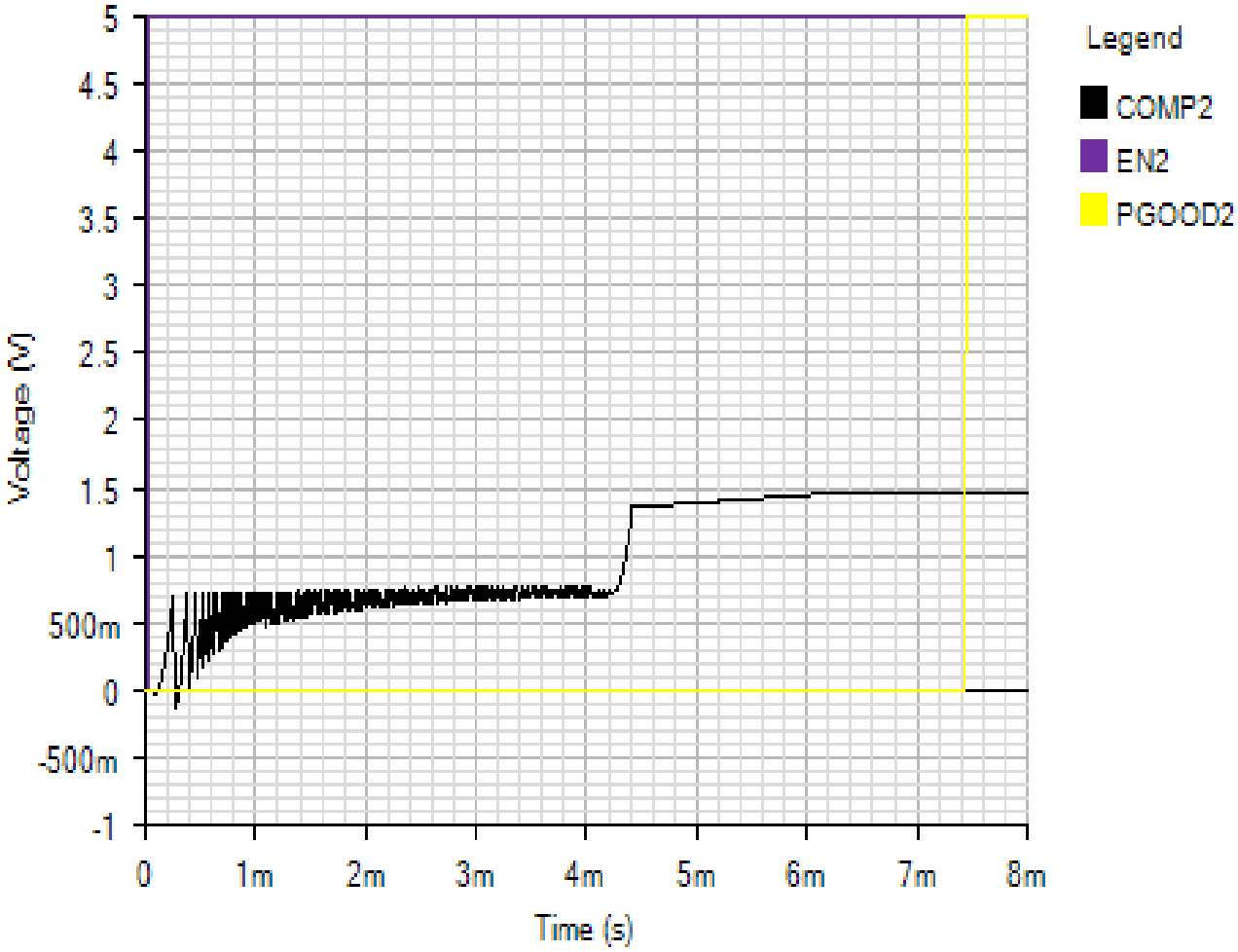

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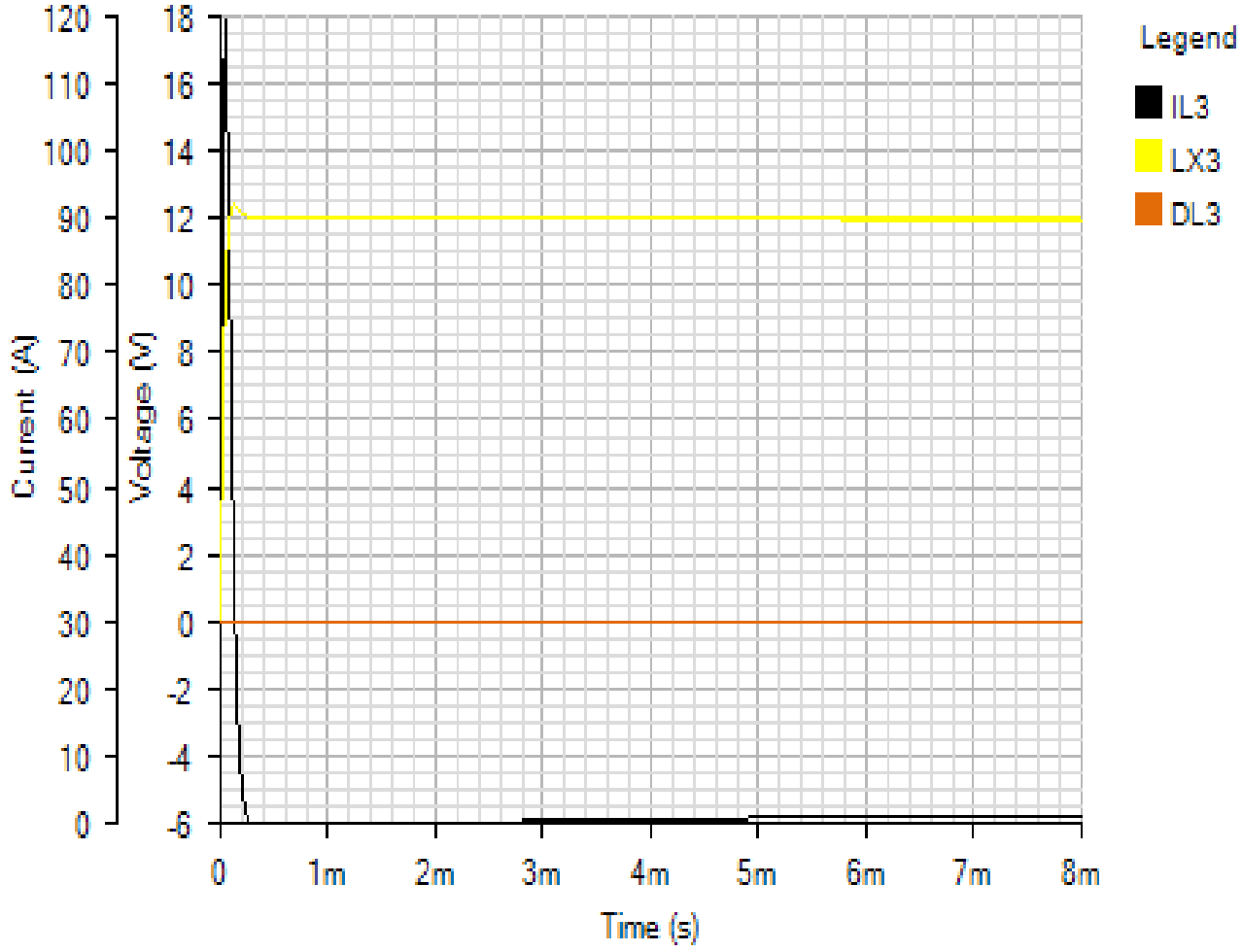
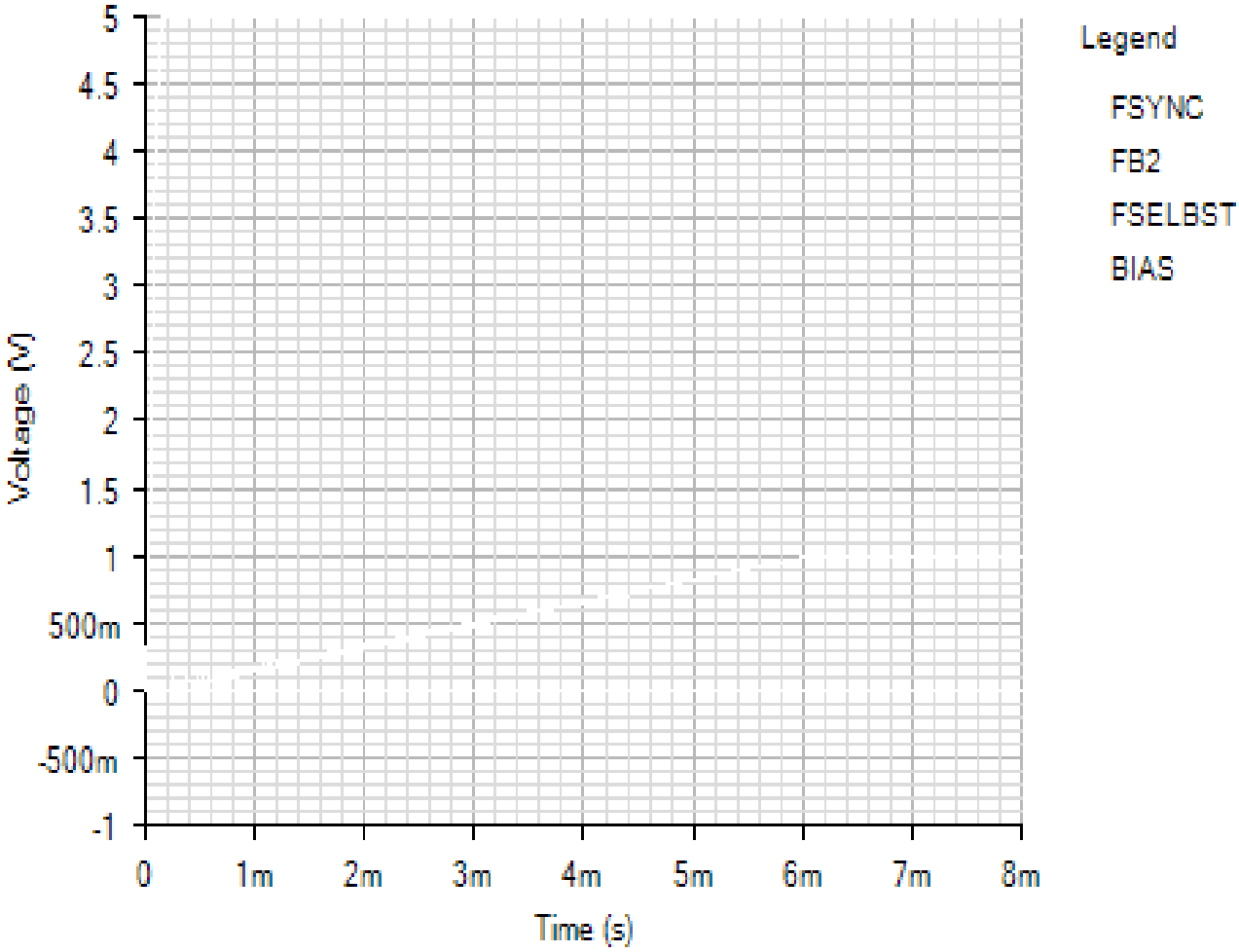
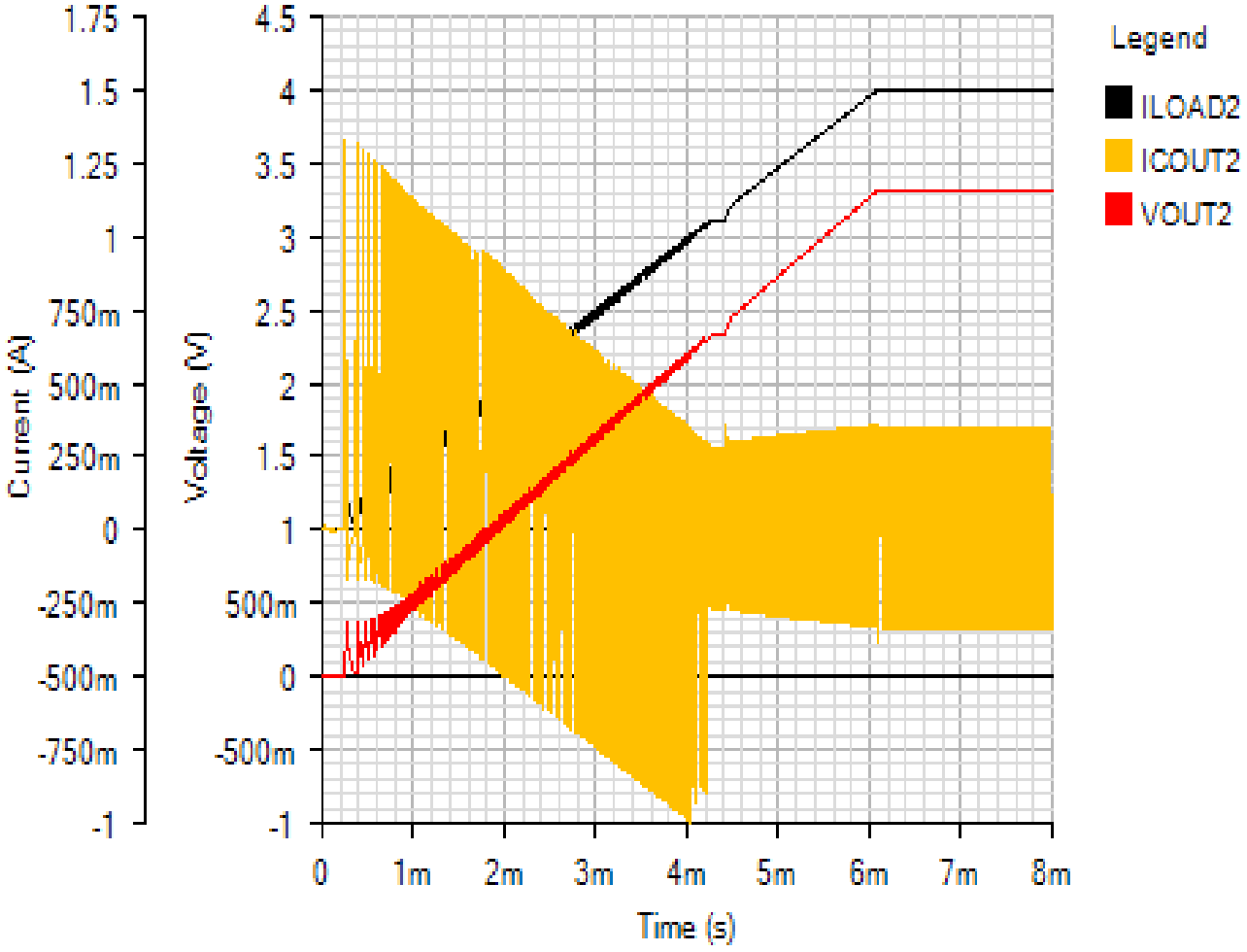


WEBSIM_VOLTAGE_ Default

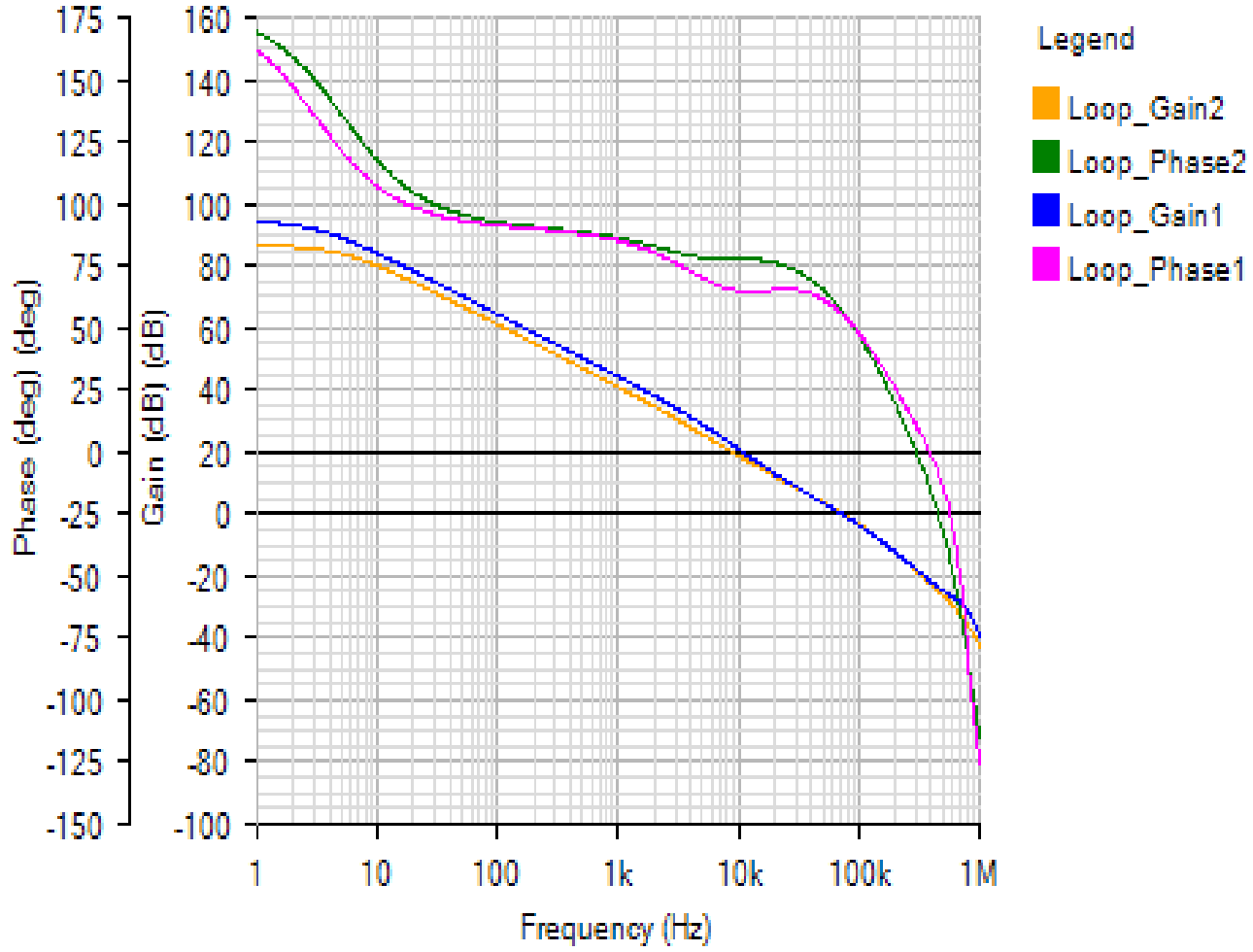


OUTPUT2 Default

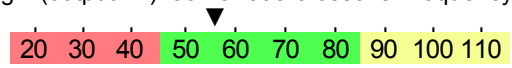


**AC Loop - Thu Nov 15 2018 14:55:37**

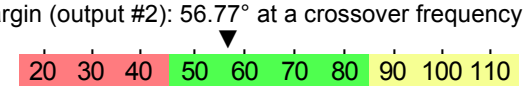
BODE Default



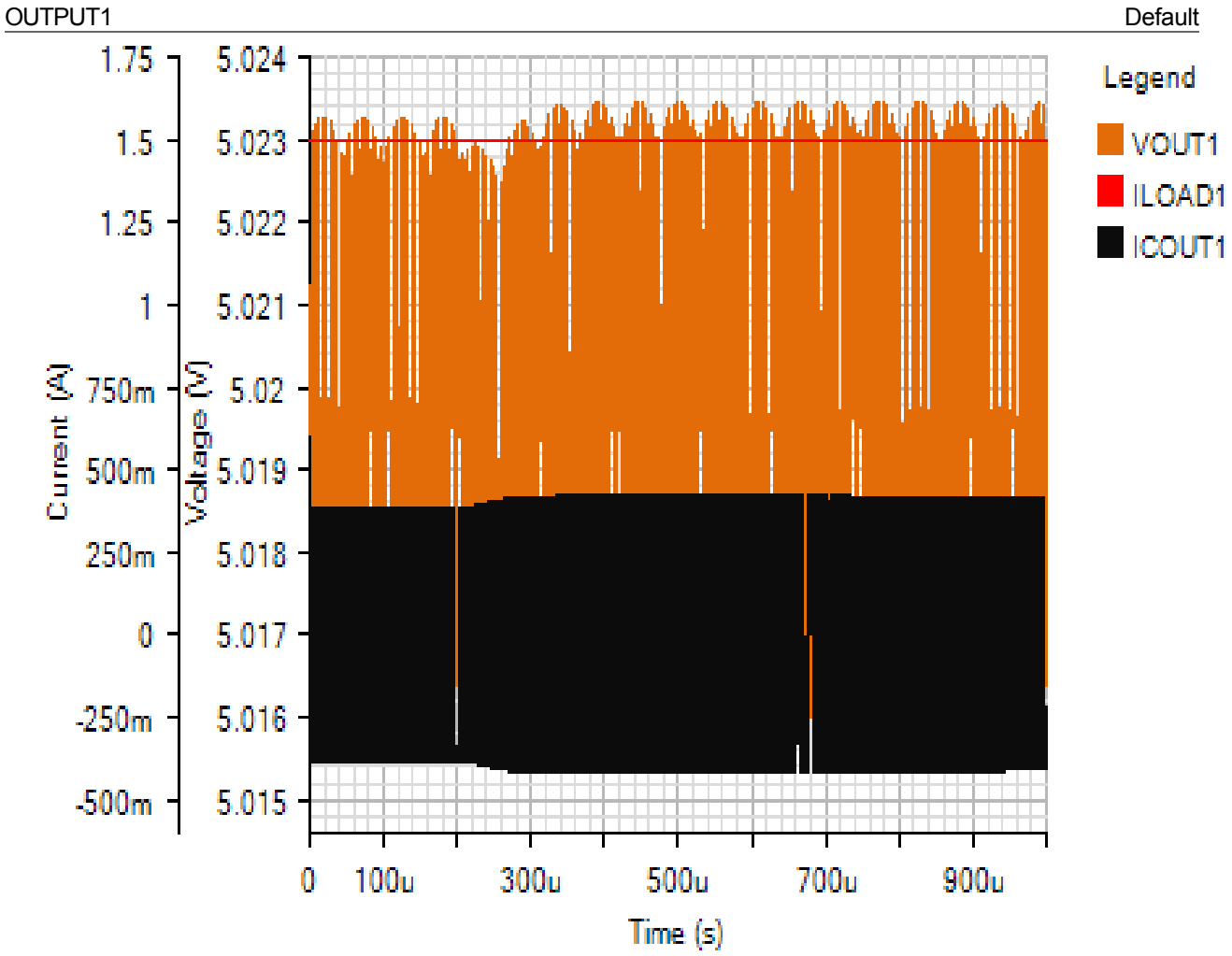

Phase Margin (output #1): 55.78° at a crossover frequency of 71.6kHz



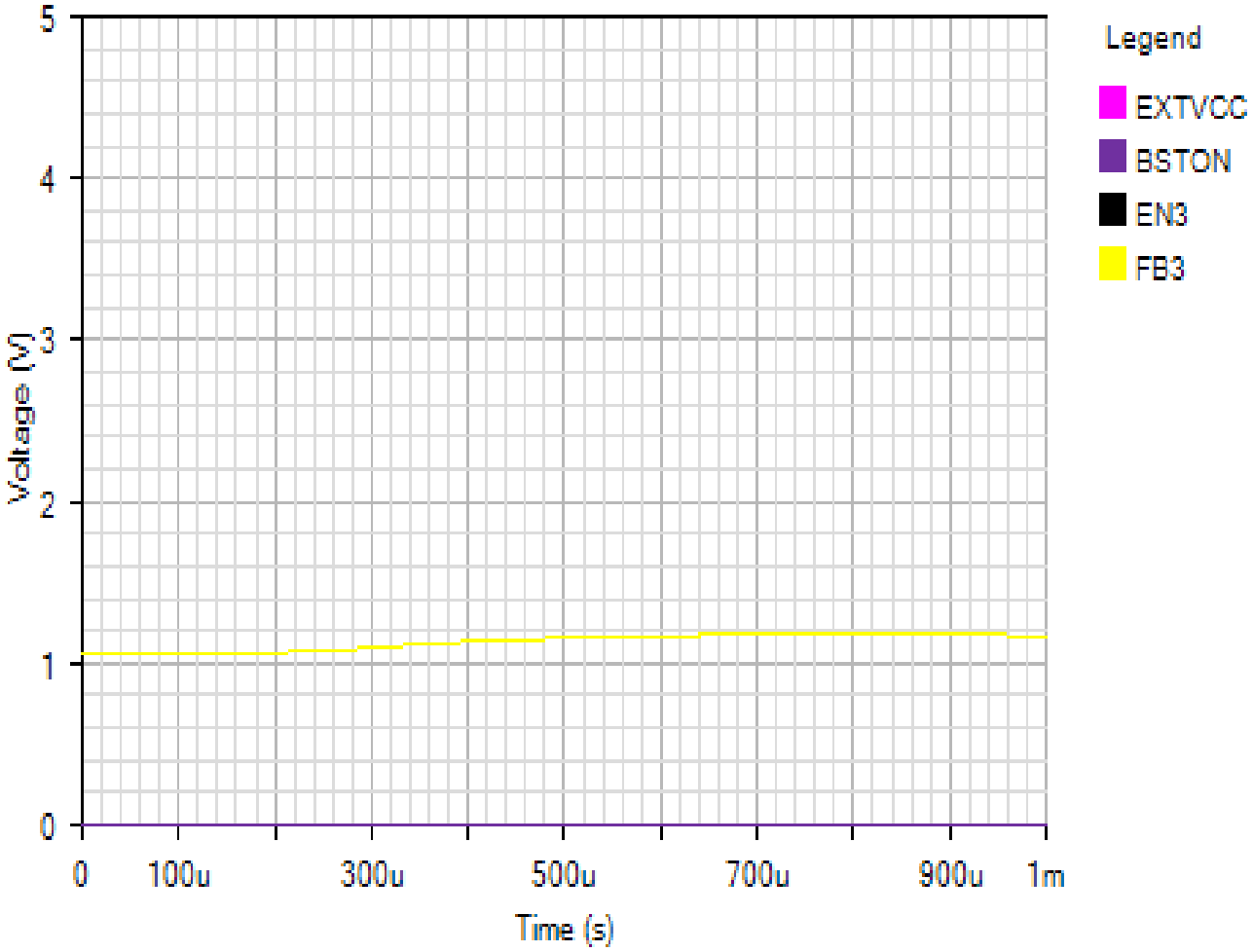

Phase Margin (output #2): 56.77° at a crossover frequency of 72.8kHz



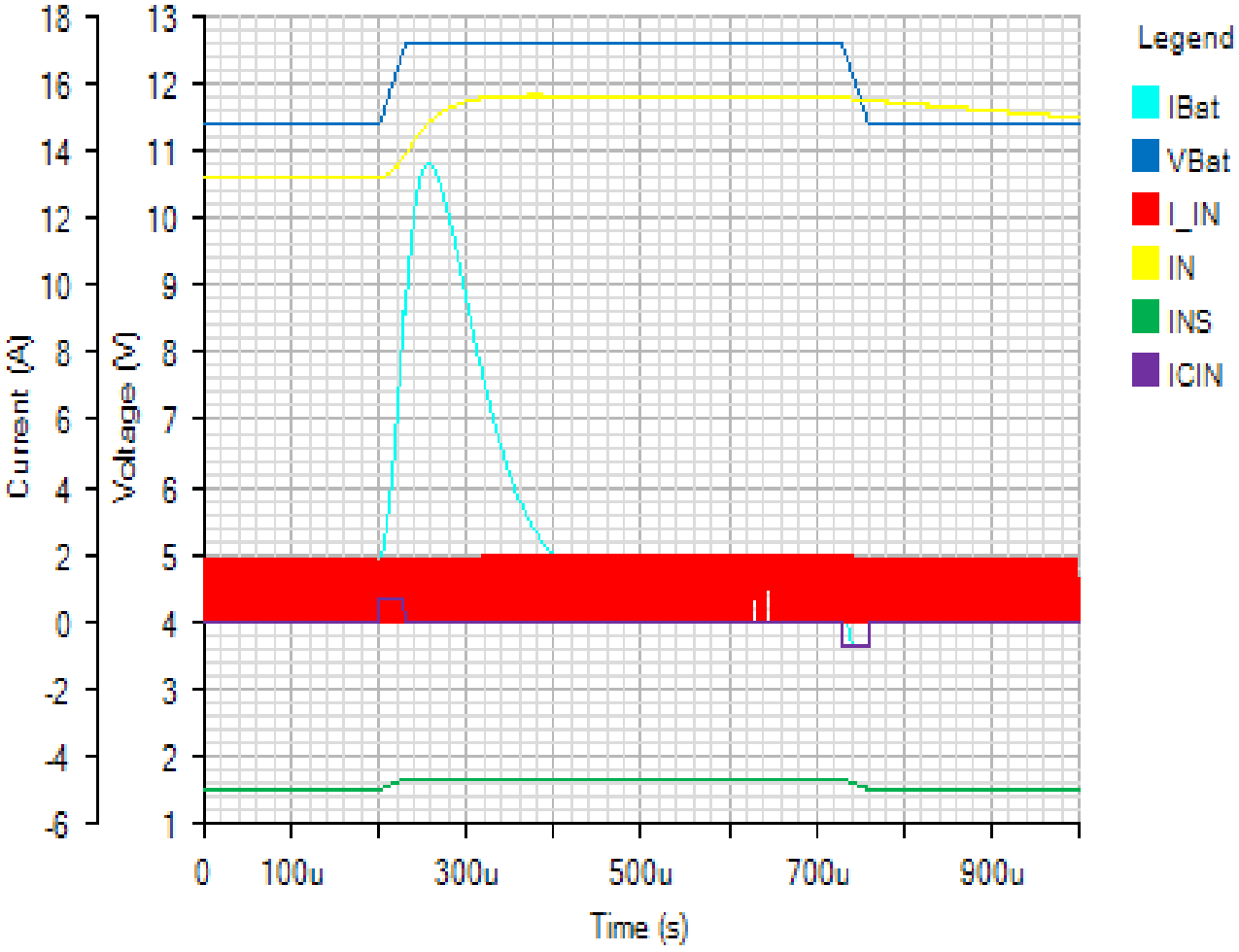
**Line Transient - Thu Nov 15 2018 14:55:37**



IC3 Default



INPUT Default



| IC1 | Default |
|---|---|

| SWITCHING2 | Default |
|---|---|

| SWITCHING1 | Default |
|---|---|

| IC2 | Default |
|---|---|

| SWITCHING3 | Default |
|---|---|

| | |
|---|---|
| WEBSIM_VOLTAGE_ | Default |

| OUTPUT2 | Default |
|---|---|