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# Cool-Power®
# ZVS Switching Regulators
# PI354x-00

## 36$V_{IN}$ to 60$V_{IN}$ Cool-Power ZVS Buck Regulator & LED Driver

### Product Description

The PI354x-00 is a family of high input voltage, wide input range DC-DC ZVS-Buck regulators integrating controller, power switches, and support components all within a high density System-in-Package (SiP). The PI354x-00 products are designed to operate within an SELV compliant system with steady state operation limited to 60V. The PI354x-00 products allow for transient voltage conditions up to 70V before shutdown is triggered. The integration of a high-performance Zero-Voltage Switching (ZVS) topology, within the PI354x-00 series, increases point of load performance providing best in class power efficiency. The PI354x-00 requires only an external inductor, two voltage selection resistors and minimal capacitors to form a complete DC-DC switching mode buck regulator.

| Device | Output Voltage | | $I_{OUT}$ Max |
|---|---|---|---|
| | Set | Range | |
| PI3542-00-LGIZ | 2.5V | 2.2V to 3.0V | 10A |
| PI3543-00-LGIZ | 3.3V | 2.6V to 3.6V | 10A |
| PI3545-00-LGIZ | 5.0V | 4.0V to 5.5V | 10A |
| PI3546-00-LGIZ | 12V | 6.5V to 14V | 9A |

PI354x-00 Family can operate in constant voltage output for typical buck regulation applications in addition to constant current output for LED lighting and battery charging applications.


### Features & Benefits

- High Efficiency HV ZVS-Buck Topology
- Wide input voltage range of 36V to 60V
- Tolerant of transient events up to 70$V_{IN}$
- Constant voltage or constant current operation
- Constant current error amplifier and reference
- Power-up into pre-biased load
- Parallel capable up to 3 regulators
- Two phase interleaving
- Input Over/Undervoltage Lockout (OVLO/UVLO)
- Output Overvoltage Protection (OVP)
- Overtemperature Protection (OTP)
- Fast and slow current limits
- Differential amplifier for output remote sensing
- User adjustable soft-start & tracking
- -40°C to 125°C operating range ($T_J$)

### Applications

- HV to PoL Buck Regulator Applications
- Computing, Communications, Industrial, Automotive Accessories
- Constant current output operation:
  - LED Lighting
  - Battery Charging

### Package Information

- 10mm x 10mm x 2.6mm LGA SiP

## Contents

## Order Information

| Cool-Power | Output Range | | $I_{OUT}$ Max | Package | Transport Media |
|---|---|---|---|---|---|
| | Set | Range | | | |
| PI3542-00-LGIZ | 2.5V | 2.2V to 3.0V | 10A | 10mm x 10mm LGA | TRAY |
| PI3543-00-LGIZ | 3.3V | 2.6V to 3.6V | 10A | 10mm x 10mm LGA | TRAY |
| PI3545-00-LGIZ | 5.0V | 4.0V to 5.5V | 10A | 10mm x 10mm LGA | TRAY |
| PI3546-00-LGIZ | 12V | 6.5V to 14V | 9A | 10mm x 10mm LGA | TRAY |

## Thermal, Storage and Handling Information

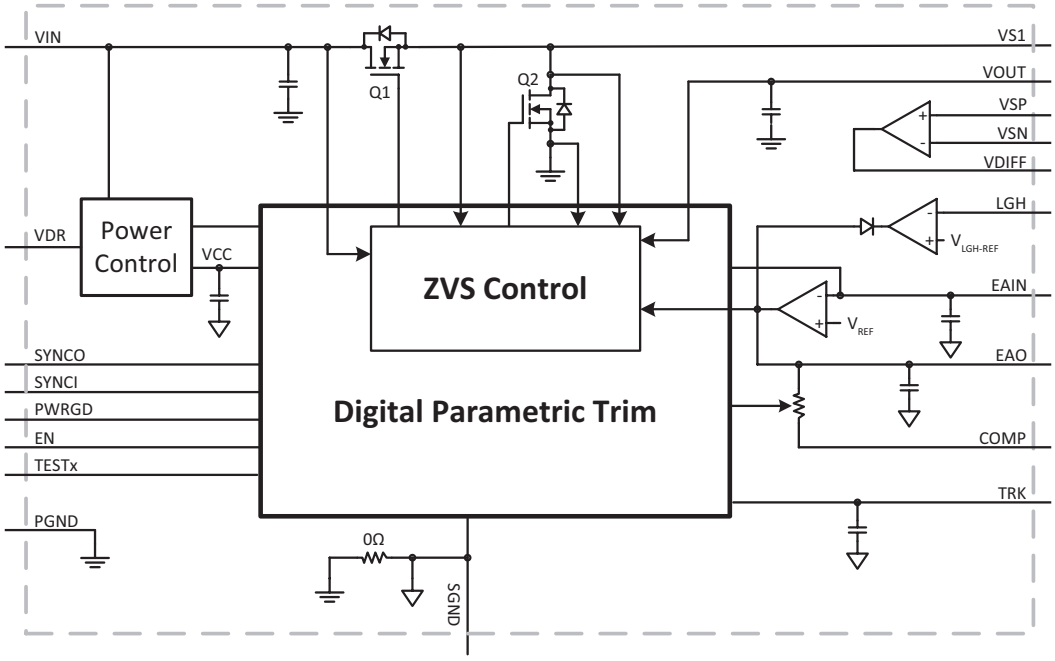
| Name | Rating |
|---|---|
| Storage Temperature | -65°C to 150°C |
| Internal Operating Temperature | -40°C to 125°C |
| Soldering Temperature for 20 seconds | 245°C |
| MSL Rating | 3 |

## Absolute Maximum Ratings

| Name | Rating |
|---|---|
| $V_{IN}$ | -0.7V to 75V |
| VS1 | -0.7$V_{DC}$ to 75V |
| $V_{OUT}$ | -0.5V to 25V |
| SGND | ±100mA |
| TRK | -0.3V to 5.5V / ±30mA |
| VDR, SYNCI, SYNCO, PWRGD, EN, LGH, COMP, EAO, EAIN, VDIFF, VSN, VSP, TESTx | -0.3V to 5.5V / ±5mA |

**Notes:** Stresses beyond these limits may cause permanent damage to the device. Operation at these conditions or conditions beyond those listed in the Electrical Specifications table is not guaranteed. All voltage nodes are referenced to PGND unless otherwise noted.

## Functional Block Diagram

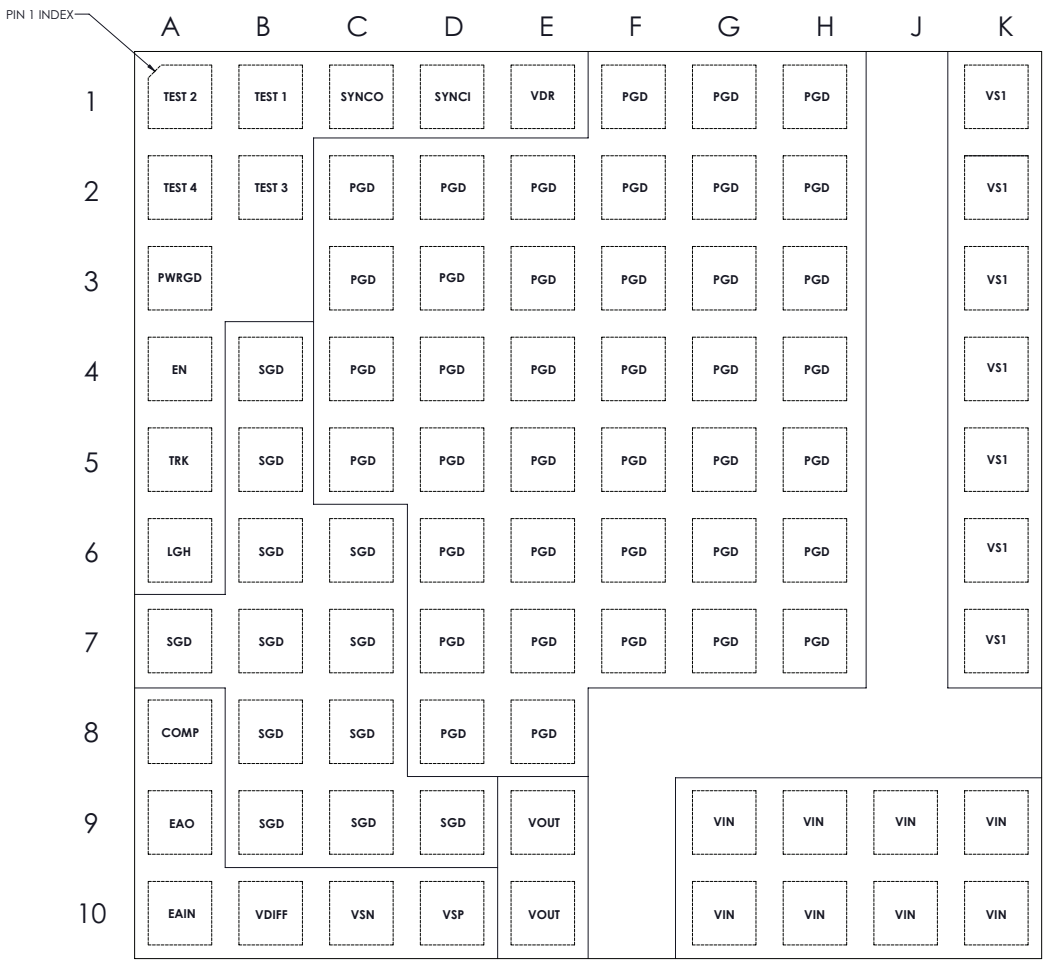



*Simplified Block Diagram*

## Pin Description

| Name | Location | I/O | Description |
|---|---|---|---|
| **VS1** | Block 2 (See Pkg Pin-Out dwg) | Power | **Switching node:** and ZVS sense for power switches. |
| **VIN** | Block 1 | Power | **Input voltage:** and sense for UVLO, OVLO and feed forward ramp. |
| **VDR** | 1E | I/O | **Gate Driver $V_{CC}$ :** Internally generated 5.1V. May be used as reference or low power bias supply for external loads. See Application Description for Important considerations. |
| **SYNCI** | 1D | I | **Synchronization input:** Synchronize to the falling edge of external clock frequency. SYNCI is a high impedance digital input node and should always be connected to SGND when not in use. |
| **SYNCO** | 1C | O | **Synchronization output:** Outputs a high signal for ½ of the minimum period for synchronization of other regulators. |
| **TESTx** | 1B, 1A, 2B, 2A | I/O | **Test Connections:** Use only with factory guidance. Connect to SGND for proper operation. |
| **PWRGD** | 3A | O | **Power Good:** High impedance when regulator is operating and $V_{OUT}$ is in regulation. Otherwise pulls to SGND. |
| **EN** | 4A | I | **Enable Input:** Regulator enable control. When asserted active or left floating: regulator is enabled. Otherwise regulator is disabled. |
| **TRK** | 5A | I | **Soft-start and track input:** An external capacitor may be connected between TRK pin and SGND to decrease the rate of rise during soft-start. |
| **LGH** | 6A | I | **Lighting (LGH)/Constant Current (CC) Sense Input:** Input with a 100mV threshold. Used for lighting and constant current type applications.When not using the constant current mode (CC mode), the LGH pin should be connected to SGND. |
| **COMP** | 8A | O | **Compensation Capacitor:** Connect capacitor for control loop dominant pole. See Error Amplifier section for details. A default CCOMP of 4.7nF is used in the example |
| **EAO** | 9A | O | **Error amp output:** External connection for additional compensation and current sharing. |
| **EAIN** | 10A | I | **Error Amp Inverting Input:** Connection for the feedback divider tap. |
| **VDIFF** | 10B | O | **Independent Amplifier Output:** Active only when module is enabled. |
| **VSN** | 10C | I | **Independent Amplifier Inverting Input:** If unused, connect in unity gain |
| **VSP** | 10D | I | **Independent Amplifier Non-Inverting Input:** If unused, connect in SGND |
| **VOUT** | 9E, 10E | Power | **Direct VOUT Connect:** for per-cycle internal clamp node and feed-forward ramp. |
| **SGND** | Block 4 | - | **Signal ground:** Internal logic ground for EA, TRK, SYNCI, SYNCO communication returns. SGND and PGND are star connected within the regulator package. |
| **PGND** | Block 3 | Power | **Power ground:** $V_{IN}$ and $V_{OUT}$ power returns. |

## Package Pin-Out




TOP THROUGH VIEW OF PRODUCT
PI354X

## Large Pin Blocks

| Pin Block Name | Group of pins |
|---|---|
| VIN | K9-10, J9-10, H9-10, G9-10 |
| VS1 | K1-7 |
| PGND | H1-7, G1-7,F1-7, E2-8, D2-8, C2-5 |
| SGND | D9, C6-9, B4-9, A7 |

## PI354x-00 Common Electrical Characteristics

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 340nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Differential Amp** | | | | | | |
| Open Loop Gain | | | 96 | 120 | 140 | dB |
| Small Signal Gain-Bandwidth | | | 5 | 7 | 12 | MHz |
| Offset | | | -1 | 0.5 | 1 | mV |
| Common Mode Input Range | | | -0.1 | | 2.5 | V |
| Differential Mode Input Range | | | | | 2 | V |
| Input Bias Current | | | -1 | | 1 | µA |
| Maximum $V_{OUT}$ | | $I_{DIFF}$ = -1mA | $V_{VDR}$ - 0.2 | | | V |
| Minimum $V_{OUT}$ | | | | | 20 | mV |
| Capacitive Load Range for Stability | | | 0 | | 50 | pF |
| Slew Rate Rising | | | | 11 | | V/µs |
| Slew Rate Falling | | | | 11 | | V/µs |
| Sink/Source Current | | | -1 | | 1 | mA |
| | | | | | | |
| **Current Source Function (LGH)** | | | | | | |
| LGH Reference | $V_{LGH-REF}$ | | 95 | 100 | 107 | mV |
| Input Offset | | | | 0.5 | | mV |
| Gain-Bandwidth Product | | | 3 | | | MHz |
| Internal Feedback Capacitance | | | | 20 | | pF |
| Gain | | | | 10 | | V/V |
| Intermediate Reference | | | | 1 | | V |
| Transconductance | | | | 1 | | mS |
| Output Current Capability | | Sink current only | 1 | | | mA |
| | | | | | | |
| **PWRGD** | | | | | | |
| PWRGD Rising Threshold | $V_{PG\_HI\%}$ | [2] | 79 | 85 | 91 | % $V_{OUT\_DC}$ |
| PWRGD Falling Threshold | $V_{PG\_LO\%}$ | [2] | 77 | 83 | 89 | % $V_{OUT\_DC}$ |
| PWRGD Output Low | $V_{PG\_SAT}$ | Sink = 4mA [2] | | | 0.4 | V |
| PWRGD Sink Current | $I_{PG\_SAT}$ | [2] | | 4 | | mA |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI354x-00 Common Electrical Characteristics (Cont.)

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 340nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Enable** | | | | | | |
| High Threshold | $V_{EN\_HI}$ | | 0.9 | 1 | 1.1 | V |
| Low Threshold | $V_{EN\_LO}$ | | 0.7 | 0.8 | 0.9 | V |
| Threshold Hysteresis | $V_{EN\_HYS}$ | | 100 | 200 | 300 | mV |
| Enable Pull-Up Voltage | $V_{EN\_PU}$ | | | 2 | | V |
| Source Current | $I_{EN\_SO}$ | | | 50 | | µA |
| | | | | | | |
| **VDR** | | | | | | |
| Voltage Setpoint | $V_{VDR}$ | $V_{IN\_DC}$ > 10V | 4.8 | 5.1 | 5.4 | V |
| External Loading | $I_{VDR}$ | See Application Description for details | 0 | | 2 | mA |
| | | | | | | |
| **Protection** | | | | | | |
| Input UVLO Start Threshold | $V_{UVLO\_START}$ | | 33.8 | 34.8 | 35.8 | V |
| Input UVLO Stop Hysteresis | $V_{UVLO\_HYS}$ | | | 0.9 | | V |
| Input UVLO Response Time | | | | 1.25 | | us |
| Input OVLO Stop Threshold | $V_{OVLO}$ | | 70 | | | V |
| Input OVLO Start Hysteresis | $V_{OVLO\_HYS}$ | | | 1.3 | | V |
| Input OVLO Response Time | $t_f$ | | | 1.25 | | µs |
| Output Overvoltage Protection | $V_{OVP}$ | Above set $V_{OUT}$ | | 20 | | % |
| | | | | | | |
| **Sync In (SYNCI)** | | | | | | |
| Synchronization Frequency Range | $\Delta f_{SYNCI}$ | Relative to set switching frequency [3] | 50 | | 110 | % |
| SYNCI Threshold | $V_{SYNCI}$ | | | $V_{VDR}$ / 2 | | V |
| | | | | | | |
| **Sync Out (SYNCO)** | | | | | | |
| SYNCO High | $V_{SYNCO\_HI}$ | Source 1mA | $V_{VDR}$ –0.5 | | | V |
| SYNCO Low | $V_{SYNCO\_LO}$ | Sink 1mA | | | 0.5 | V |
| SYNCO Rise Time | $t_{SYNCO\_RT}$ | 20pF load | | 10 | | ns |
| SYNCO Fall Time | $t_{SYNCO\_FT}$ | 20pF load | | 10 | | ns |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3542-00 ($2.5V_{OUT}$) Electrical Characteristics

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 340nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Input Specifications** | | | | | | |
| Input Voltage | $V_{IN\_DC}$ | | 36 | 48 | 60 | V |
| Input Voltage, Transient | $V_{IN\_TRANS}$ | < 1% duty cycle,entire transient duration < 10ms | | | 70 | V |
| Input Current | $I_{IN\_DC}$ | $V_{IN}$ = 48V, $T_C$ = 25°C, $I_{OUT}$ = 10A | | 0.597 | | A |
| Input Current At Output Short (Fault Condition Duty Cycle) | $I_{IN\_Short}$ | Short at terminals | | 3.1 | | mA |
| Input Quiescent Current | $I_{Q\_VIN}$ | Disabled | | 0.75 | | mA |
| | | Enabled (no load) | | 1.4 | | |
| Input Voltage Slew Rate | $V_{IN\_SR}$ | | | | 1 | V/µs |
| | | | | | | |
| **Output Specifications** | | | | | | |
| EAIN Voltage Total Regulation | $V_{EAIN}$ | [2] | 0.985 | 1.00 | 1.015 | V |
| Output Voltage Trim Range | $V_{OUT\_DC}$ | [2] [3] | 2.2 | 2.5 | 3.0 | V |
| Line Regulation | $\Delta V_{OUT}/\Delta V_{IN}$ | @ 25°C, 36V < $V_{IN}$ < 60V | | 0.10 | | % |
| Load Regulation | $\Delta V_{OUT}/\Delta I_{OUT}$ | @ 25°C, 0.5A < $I_{OUT}$ < 10A | | 0.10 | | % |
| Output Voltage Ripple | $V_{OUT\_AC}$ | $I_{OUT}$ = 10A, $C_{OUT}$ = 6 x 100µF, 20MHz BW [4] | | 47 | | mVp-p |
| Output Current | $I_{OUT\_DC}$ | [5] | 0 | | 10 | A |
| Maximum Array Size | $N_{Parallel}$ | | | | 3 | Modules |
| Output Current, Array of 2 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 17.7 | A |
| Output Current, Array of 3 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 25.4 | A |
| Current Limit | $I_{OUT\_CL}$ | Typ limit based on nominal 340nH inductor. | | 12 | | A |
| | | | | | | |
| **Timing** | | | | | | |
| Switching Frequency | $f_S$ | [6] $48V_{IN}$ to $2.5V_{OUT}$, 3A out, L1 = 340nH ±1% | - | 400 | - | kHz |
| Fault Restart Delay | $t_{FR\_DLY}$ | | | 30 | | ms |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3542-00 (2.5$V_{OUT}$) Electrical Characteristics (Cont.)

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 340nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Soft Start, Tracking and Error Amplifier** | | | | | | |
| TRK Active Range (Nominal) | $V_{TRK}$ | | 0 | | 1.4 | V |
| TRK Enable Threshold | $V_{TRK\_OV}$ | | 20 | 40 | 60 | mV |
| TRK to EAIN Offset | $V_{EIAN\_OV}$ | $V_{TRK}$ = 0.5V, EAO shorted to EAIN | 50 | 80 | 110 | mV |
| Charge Current (Soft-Start) | $I_{TRK}$ | | 70 | 50 | 30 | µA |
| Discharge Current (Fault) | $I_{TRK\_DIS}$ | $V_{TRK}$ = 0.5V | | 10 | | mA |
| Soft-Start Time | $t_{SS}$ | $C_{TRK}$ = 0µF | 0.6 | 0.94 | 1.6 | ms |
| Error Amplifier Trans-Conductance | $GM_{EAO}$ | [2] | | 5.1 | | mS |
| PSM Skip Threshold | $PSM_{SKIP}$ | [2] | | 0.8 | | V |
| Error Amplifier Output Impedance | $R_{OUT}$ | [2] | 1 | | | MΩ |
| Internal Compensation Capacitor | $C_{HF}$ | [2] | | 56 | | pf |
| Internal Compensation Resistor | $R_{ZI}$ | [2] | | 5 | | kΩ |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3542-00 (2.5$V_{OUT}$) Electrical Characteristics (Cont.)

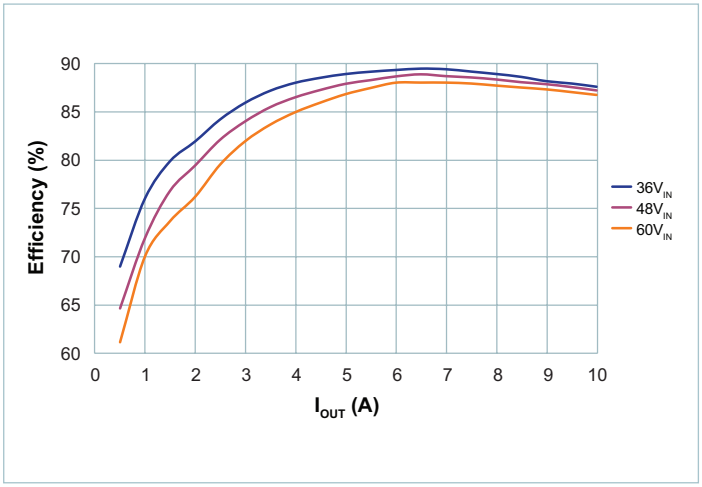



***Figure 1 —*** *Regulator Efficiency*

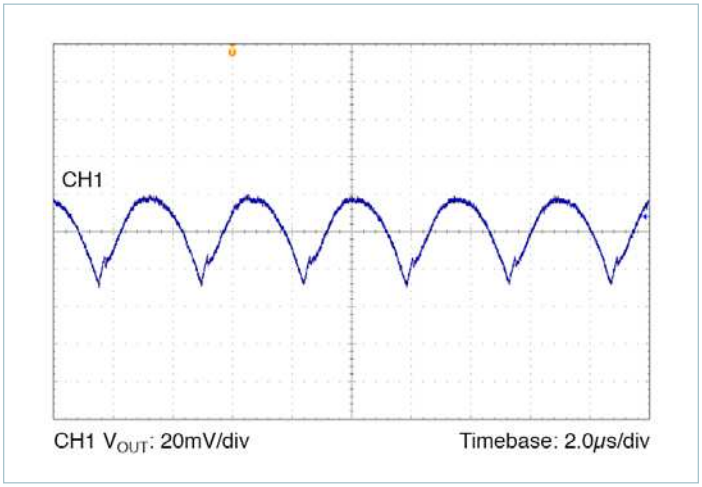



***Figure 4 —*** *Output Ripple: 48$V_{IN}$, 2.5$V_{OUT}$ at 10A. $V_{OUT}$ = 20mV/Div, 2.0µs/Div; $C_{OUT}$ = 6 x 100µF Ceramic*

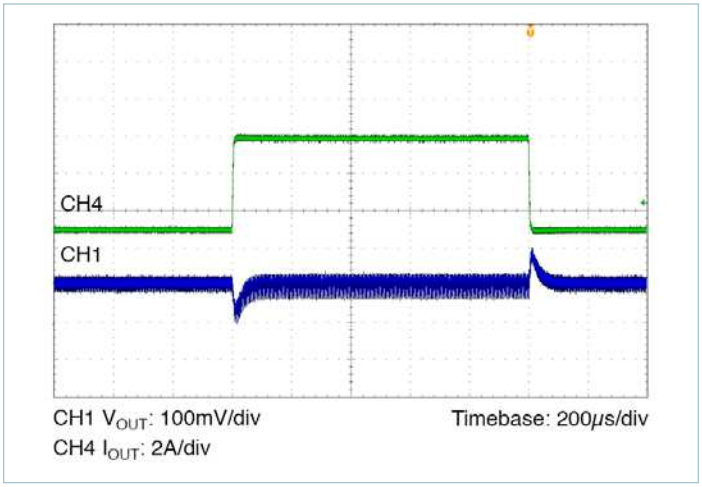



***Figure 2 —*** *Transient Response: 5A to 10A, at 1A/µs. 48$V_{IN}$ to 2.5$V_{OUT}$, $C_{OUT}$ = 6 x 100µF Ceramic*

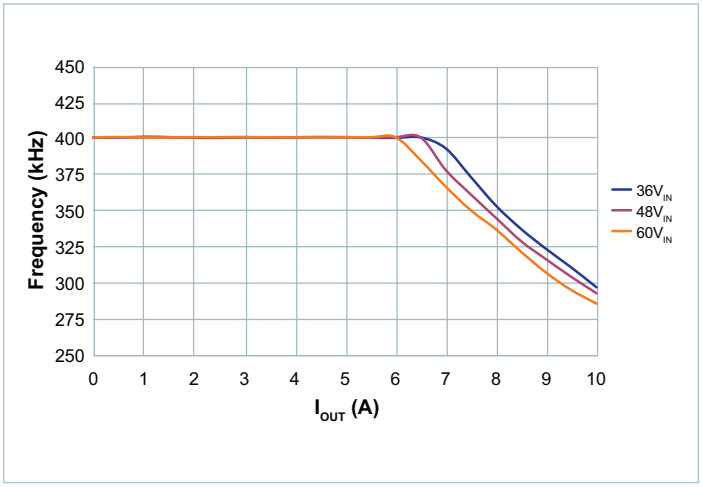



***Figure 5 —*** *Switching Frequency vs. Load Current*

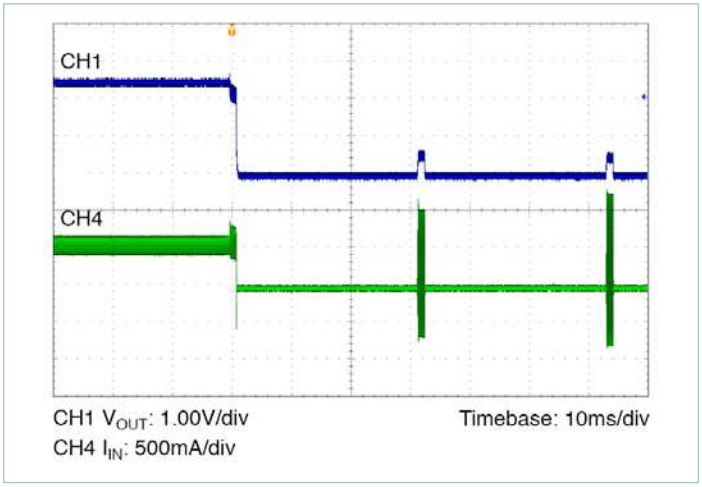



***Figure 3 —*** *Output Short Circuit @ $V_{IN}$ = 48V*

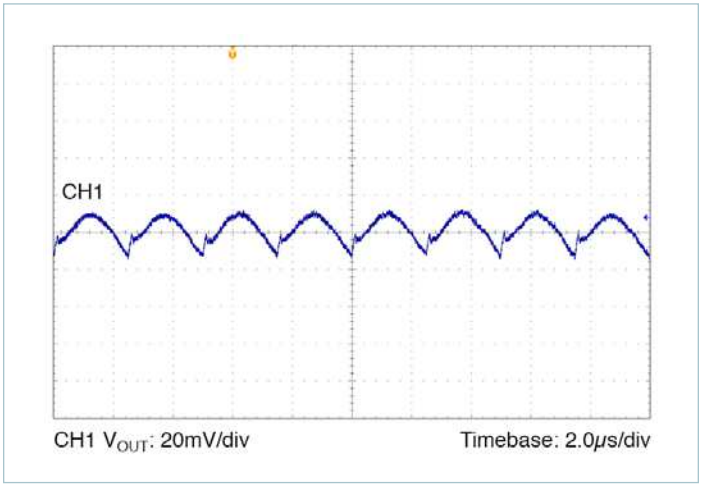



***Figure 6 —*** *Output Ripple: 48$V_{IN}$, 2.5$V_{OUT}$ at 5A. $V_{OUT}$ = 20mV/Div, 2.0µs/Div; $C_{OUT}$ = 6 x 100µF Ceramic*

## PI3542-00 (2.5$V_{OUT}$) Electrical Characteristics (Cont.)

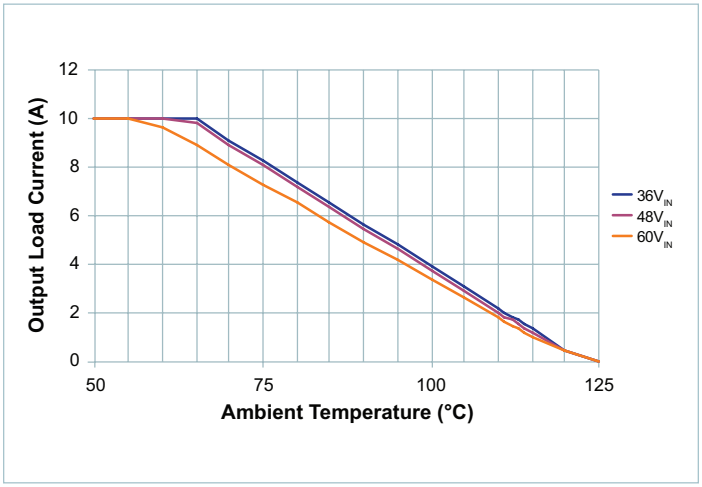



***Figure 7 —*** *Load Current vs. Ambient Temperature, 0LFM*

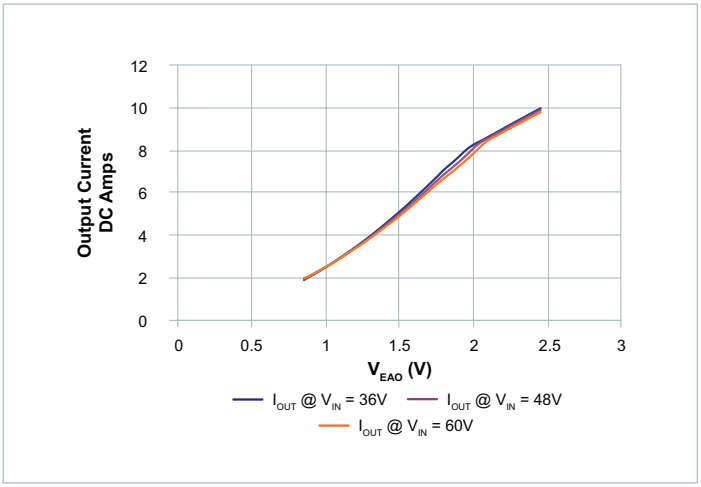



***Figure 10 —*** *Output Current vs. Error Voltage $V_{EAO}$*

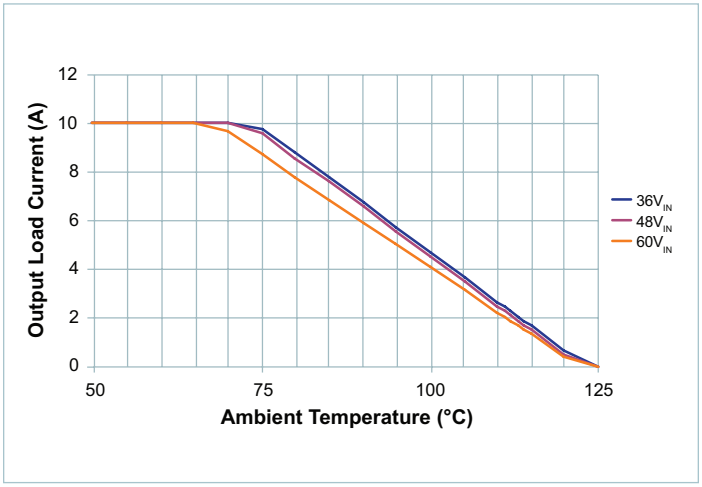



***Figure 8 —*** *Load Current vs. Ambient Temperature, 200LFM*

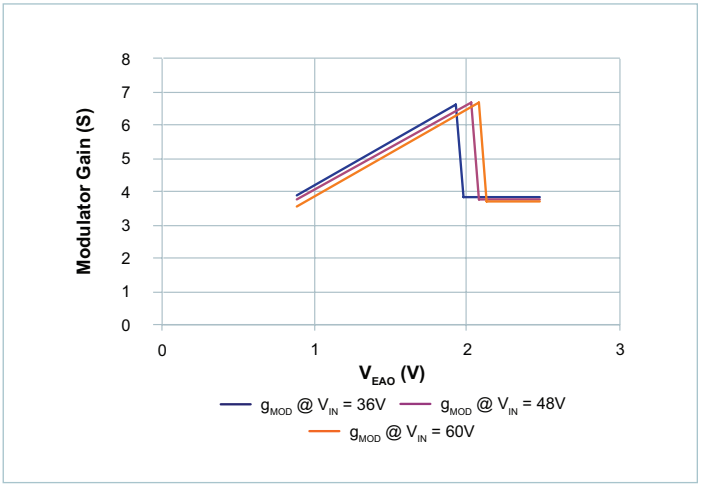



***Figure 11 —*** *Modulator Gain vs. Error Voltage $V_{EAO}$*

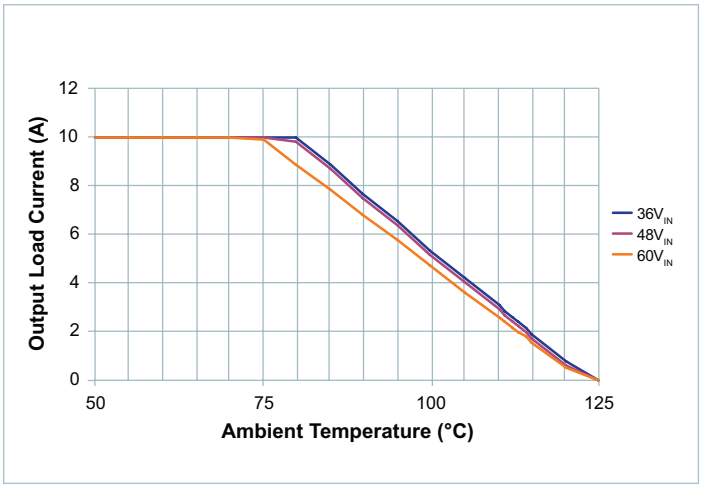



***Figure 9 —*** *Load Current vs. Ambient Temperature, 400LFM*

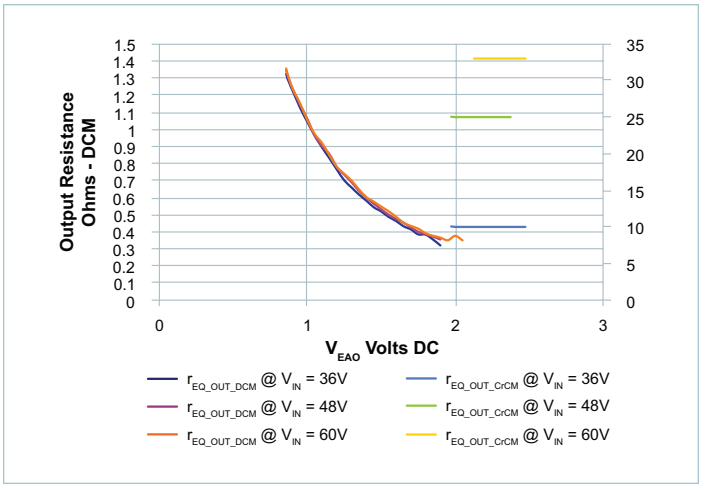



***Figure 12 —*** *Output Equivalent Resistance vs.Error Voltage $V_{EAO}$*

## PI3543-00 ($3.3V_{OUT}$) Electrical Characteristics

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 420nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Input Specifications** | | | | | | |
| Input Voltage | $V_{IN\_DC}$ | | 36 | 48 | 60 | V |
| Input Voltage, Transient | $V_{IN\_TRANS}$ | < 1% duty cycle,entire transient duration < 10ms | | | 70 | V |
| Input Current | $I_{IN\_DC}$ | $V_{IN}$ = 48V, $T_C$ = 25°C, $I_{OUT}$ = 10A | | 0.762 | | A |
| Input Current At Output Short (Fault Condition Duty Cycle) | $I_{IN\_Short}$ | Short at terminals | | 3 | - | mA |
| Input Quiescent Current | $I_{Q\_VIN}$ | Disabled | | 0.75 | | mA |
| | | Enabled (no load) | | 1.6 | | |
| Input Voltage Slew Rate | $V_{IN\_SR}$ | | | | 1 | V/µs |
| | | | | | | |
| **Output Specifications** | | | | | | |
| EAIN Voltage Total Regulation | $V_{EAIN}$ | [2] | 0.985 | 1.00 | 1.015 | V |
| Output Voltage Trim Range | $V_{OUT\_DC}$ | [2] [3] | 2.6 | 3.3 | 3.6 | V |
| Line Regulation | $\Delta V_{OUT} / \Delta V_{IN}$ | @ 25°C, 36V < $V_{IN}$ < 60V | | 0.10 | | % |
| Load Regulation | $\Delta V_{OUT} / \Delta I_{OUT}$ | @ 25°C, 0.5A < $I_{OUT}$ < 10A | | 0.10 | | % |
| Output Voltage Ripple | $V_{OUT\_AC}$ | $I_{OUT}$ = 10A, $C_{OUT}$ = 6 x 100µF, 20MHz BW [4] | | 62 | | mVp-p |
| Output Current | $I_{OUT\_DC}$ | [5] | 0 | | 10 | A |
| Maximum Array Size | $N_{Parallel}$ | | | | 3 | Modules |
| Output Current, Array of 2 | $I_{OUT\_DC-ARRAY2}$ | Total array capability, see applications section for details | 0 | | 17.7 | A |
| Output Current, Array of 3 | $I_{OUT\_DC-ARRAY2}$ | Total array capability, see applications section for details | 0 | | 25.4 | A |
| Current Limit | $I_{OUT\_CL}$ | Typ limit based on nominal 420nH inductor | | 11.5 | | A |
| | | | | | | |
| **Timing** | | | | | | |
| Switching Frequency | $f_S$ | [6] $48V_{IN}$ to $3.3V_{OUT}$, 6A out, L1 = 420nH ±1% | - | 400 | - | kHz |
| Fault Restart Delay | $t_{FR\_DLY}$ | | | 30 | | ms |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3543-00 ($3.3V_{OUT}$) Electrical Characteristics (Cont.)

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 420nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Soft Start, Tracking and Error Amplifier** | | | | | | |
| TRK Active Range (Nominal) | $V_{TRK}$ | | 0 | | 1.4 | V |
| TRK Enable Threshold | $V_{TRK\_OV}$ | | 20 | 40 | 60 | mV |
| TRK to EAIN Offset | $V_{EIAN\_OV}$ | $V_{TRK}$ = 0.5V, EAO shorted to EAIN | 50 | 80 | 110 | mV |
| Charge Current (Soft-Start) | $I_{TRK}$ | | 70 | 50 | 30 | µA |
| Discharge Current (Fault) | $I_{TRK\_DIS}$ | $V_{TRK}$ = 0.5V | | 10 | | mA |
| Soft-Start Time | $t_{SS}$ | $C_{TRK}$ = 0µF | 0.6 | 0.94 | 1.6 | ms |
| Error Amplifier Trans-Conductance | $GM_{EAO}$ | [2] | | 5.1 | | mS |
| PSM Skip Threshold | $PSM_{SKIP}$ | [2] | | 0.8 | | V |
| Error Amplifier Output Impedance | $R_{OUT}$ | [2] | 1 | | | MΩ |
| Internal Compensation Capacitor | $C_{HF}$ | [2] | | 56 | | pf |
| Internal Compensation Resistor | $R_{ZI}$ | [2] | | 6 | | kΩ |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3543-00 (3.3$V_{OUT}$) Electrical Characteristics (Cont.)

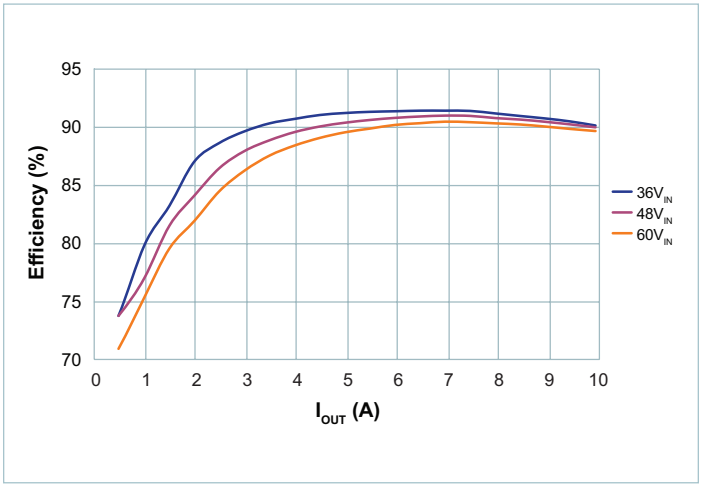



***Figure 13 —*** *Regulator Efficiency*

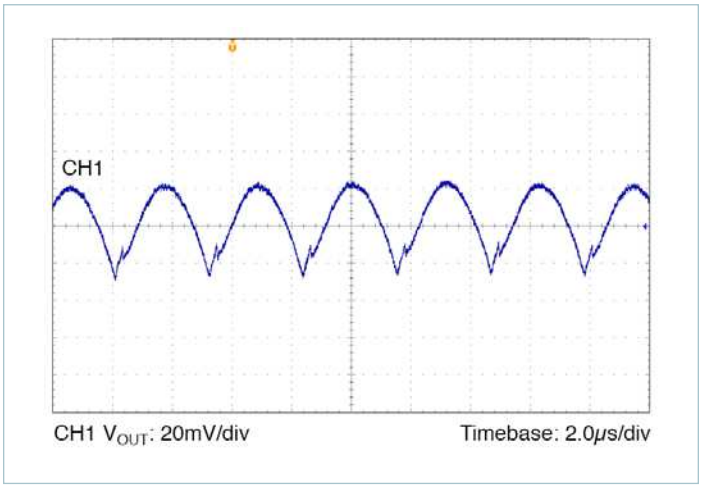



***Figure 16 —*** *Output Ripple: 48$V_{IN}$, 3.3$V_{OUT}$ at 10A.*
*$V_{OUT}$ = 20mV/Div, 2.0µs/Div;*
*$C_{OUT}$ = 6 x 100µF Ceramic*

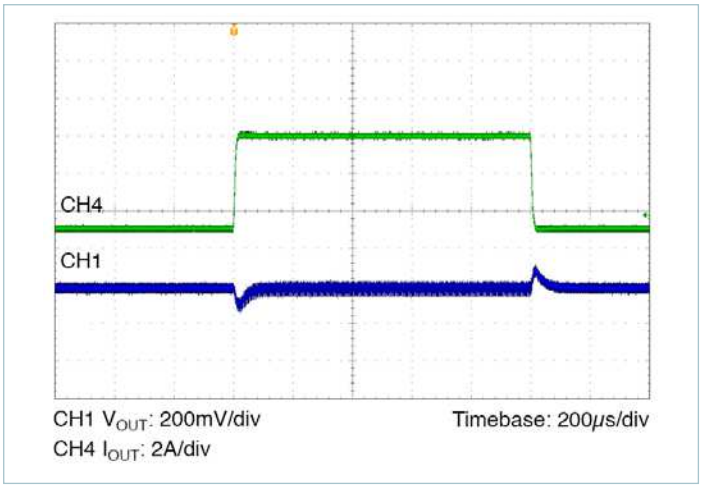



***Figure 14 —*** *Transient Response: 5A to 10A, at 1A/µs. 48$V_{IN}$ to 3.3$V_{OUT}$, $C_{OUT}$ = 6 x 100µF Ceramic*

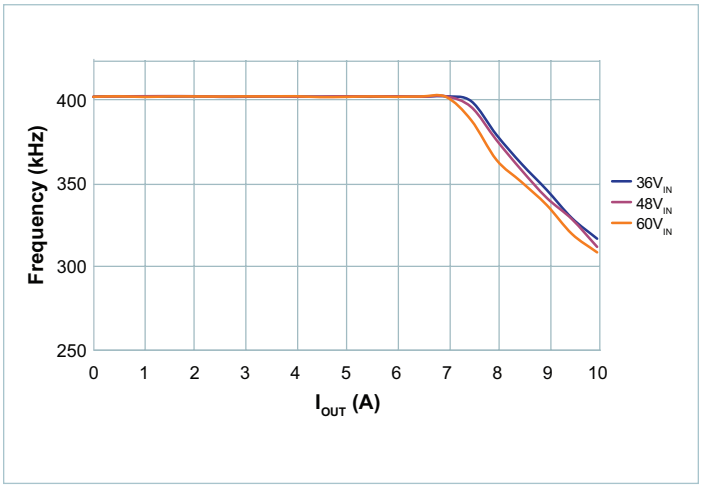



***Figure 17 —*** *Switching Frequency vs. Load Current*

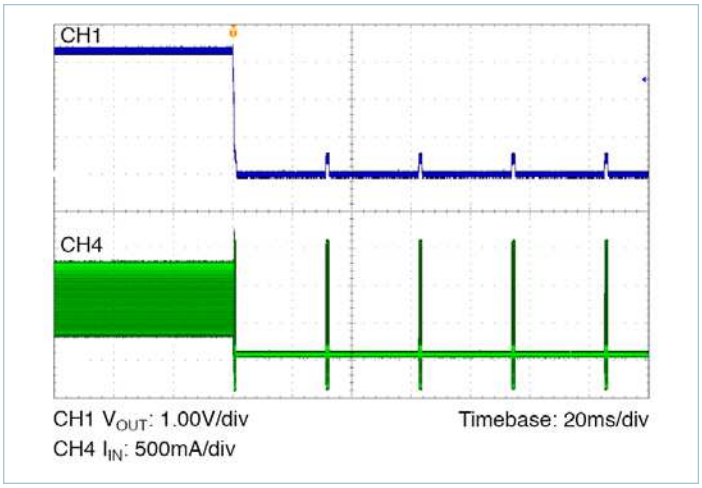



***Figure 15 —*** *Output Short Circuit @ $V_{IN}$ = 48V*

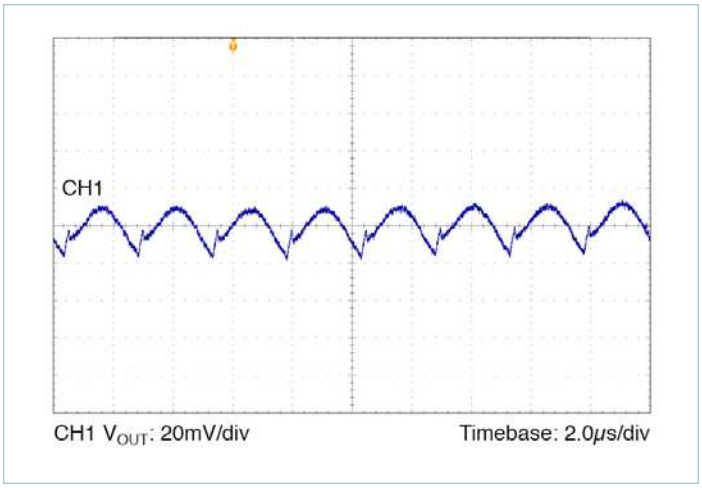



***Figure 18 —*** *Output Ripple: 48$V_{IN}$, 3.3$V_{OUT}$ at 5A.*
*$V_{OUT}$ = 20mV/Div, 2.0µs/Div;*
*$C_{OUT}$ = 6 x 100µF Ceramic*

## PI3543-00 ($3.3V_{OUT}$) Electrical Characteristics (Cont.)

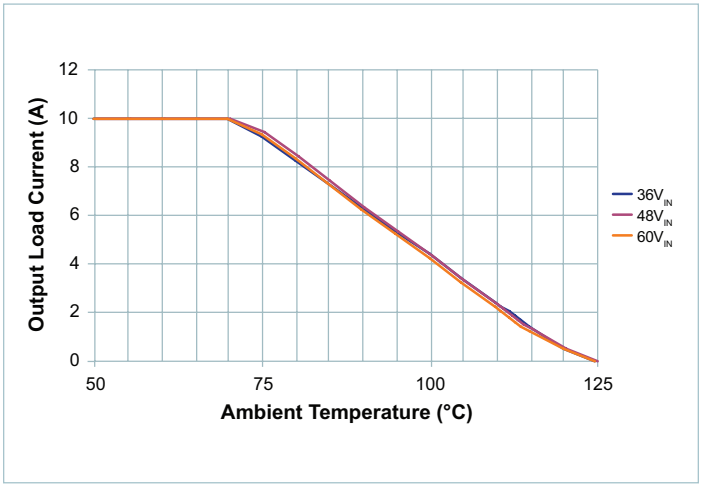



***Figure 19 —*** *Load Current vs. Ambient Temperature, 0LFM*

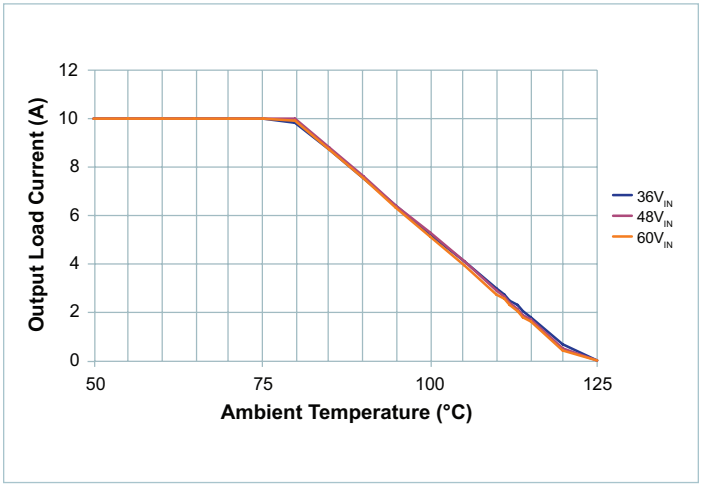



***Figure 20 —*** *Load Current vs. Ambient Temperature, 200LFM*

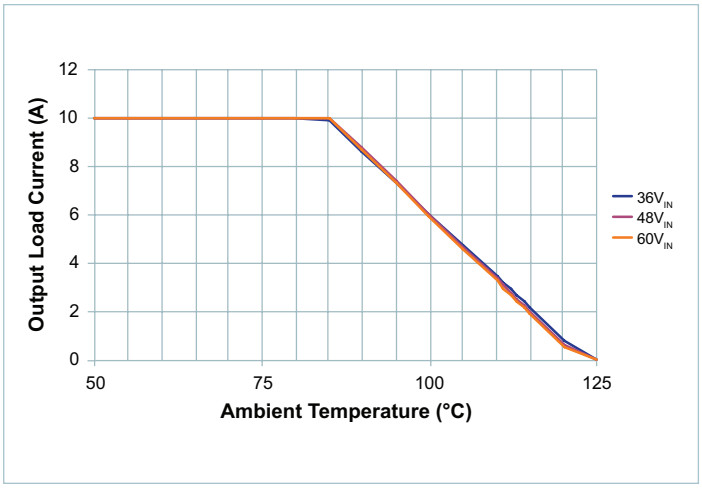



***Figure 21 —*** *Load Current vs. Ambient Temperature, 400LFM*

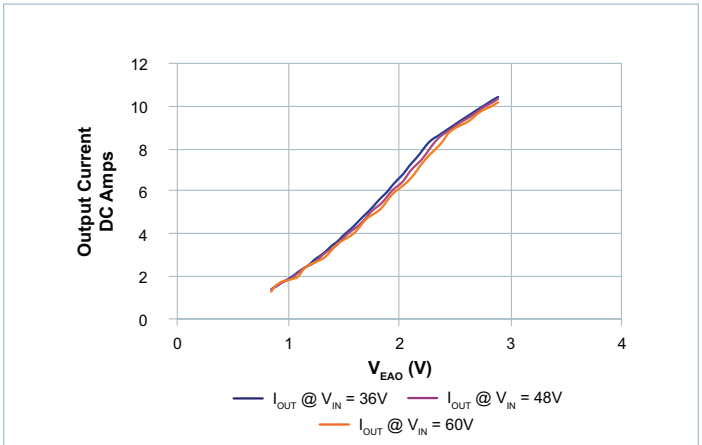



***Figure 22 —*** *Output Current vs. Error Voltage $V_{EAO}$*

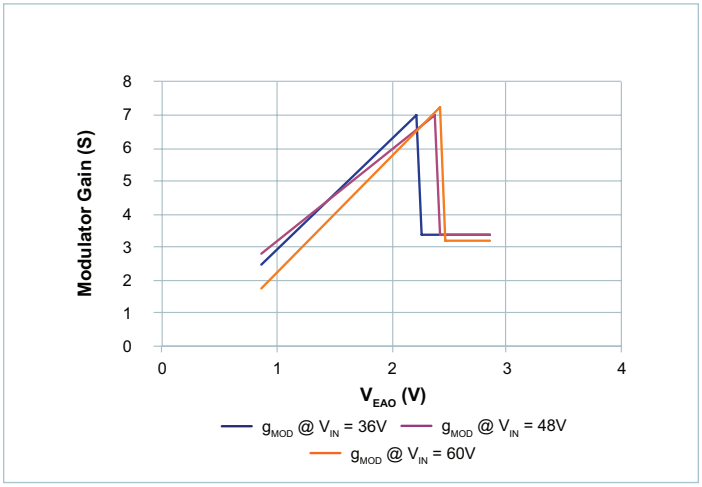



***Figure 23 —*** *Modulator Gain vs. Error Voltage $V_{EAO}$*

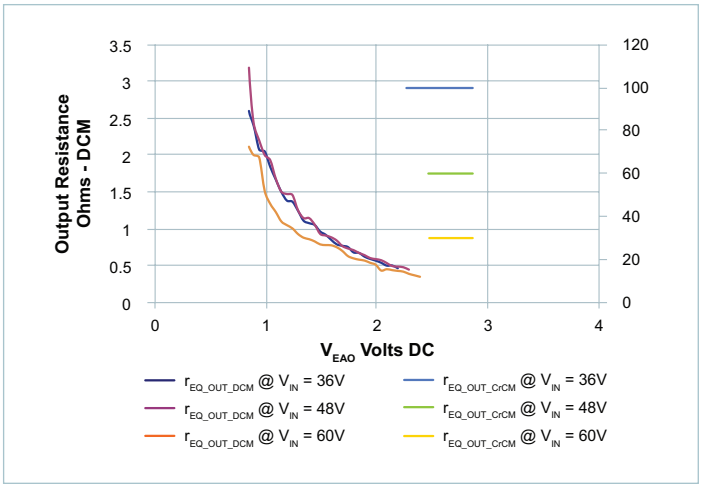



***Figure 24 —*** *Output Equivalent Resistance vs. Error Voltage $V_{EAO}$*

## PI3545-00 ($5.0V_{OUT}$) Electrical Characteristics

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 420nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Input Specifications** | | | | | | |
| Input Voltage | $V_{IN\_DC}$ | | 36 | 48 | 60 | V |
| Input Voltage, Transient | $V_{IN\_TRANS}$ | < 1% duty cycle,entire transient duration < 10ms | | | 70 | V |
| Input Current | $I_{IN\_DC}$ | $V_{IN}$ = 48V, $T_C$ = 25°C, $I_{OUT}$ = 10A | | 1.126 | | A |
| Input Current At Output Short (Fault Condition Duty Cycle) | $I_{IN\_Short}$ | Short at terminals | | 3.2 | - | mA |
| Input Quiescent Current | $I_{Q\_VIN}$ | Disabled | | 0.75 | | mA |
| | | Enabled (no load) | | 1.8 | | |
| Input Voltage Slew Rate | $V_{IN\_SR}$ | | | | 1 | V/µs |
| | | | | | | |
| **Output Specifications** | | | | | | |
| EAIN Voltage Total Regulation | $V_{EAIN}$ | [2] | 0.985 | 1.00 | 1.015 | V |
| Output Voltage Trim Range | $V_{OUT\_DC}$ | [2] [3] | 4.0 | 5.0 | 5.5 | V |
| Line Regulation | $\Delta V_{OUT}/\Delta V_{IN}$ | @ 25°C, 36V < $V_{IN}$ < 60V | | 0.10 | | % |
| Load Regulation | $\Delta V_{OUT}/\Delta I_{OUT}$ | @ 25°C, 0.5A < $I_{OUT}$ < 10A | | 0.10 | | % |
| Output Voltage Ripple | $V_{OUT\_AC}$ | $I_{OUT}$ = 10A, $C_{OUT}$ = 6 x 47µF, 20MHz BW [4] | | 62.4 | | mVp-p |
| Output Current | $I_{OUT\_DC}$ | [5] | 0 | | 10 | A |
| Maximum Array Size | $N_{Parallel}$ | | | | 3 | Modules |
| Output Current, Array of 2 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 17.7 | A |
| Output Current, Array of 3 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 25.4 | A |
| Current Limit | $I_{OUT\_CL}$ | Typ limit based on nominal 420nH inductor. | | 12 | | A |
| | | | | | | |
| **Timing** | | | | | | |
| Switching Frequency | $f_S$ | [6] $48V_{IN}$ to $5V_{OUT}$, 3A out, L1 = 420nH ±1% | - | 600 | - | kHz |
| Fault Restart Delay | $t_{FR\_DLY}$ | | | 30 | | ms |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3545-00 ($5.0V_{OUT}$) Electrical Characteristics (Cont.)

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 420nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Soft Start, Tracking and Error Amplifier** | | | | | | |
| TRK Active Range (Nominal) | $V_{TRK}$ | | 0 | | 1.4 | V |
| TRK Enable Threshold | $V_{TRK\_OV}$ | | 20 | 40 | 60 | mV |
| TRK to EAIN Offset | $V_{EIAN\_OV}$ | $V_{TRK}$ = 0.5V, EA0 shorted to EAIN | 50 | 80 | 110 | mV |
| Charge Current (Soft-Start) | $I_{TRK}$ | | 70 | 50 | 30 | µA |
| Discharge Current (Fault) | $I_{TRK\_DIS}$ | $V_{TRK}$ = 0.5V | | 10 | | mA |
| Soft-Start Time | $t_{SS}$ | $C_{TRK}$ = 0µF | 0.6 | 0.94 | 1.6 | ms |
| Error Amplifier Trans-Conductance | $GM_{EAO}$ | [2] | | 5.1 | | mS |
| PSM Skip Threshold | $PSM_{SKIP}$ | [2] | | 0.8 | | V |
| Error Amplifier Output Impedance | $R_{OUT}$ | [2] | 1 | | | MΩ |
| Internal Compensation Capacitor | $C_{HF}$ | [2] | | 56 | | pf |
| Internal Compensation Resistor | $R_{ZI}$ | [2] | | 6 | | kΩ |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3545-00 ($5.0V_{OUT}$) Electrical Characteristics (Cont.)

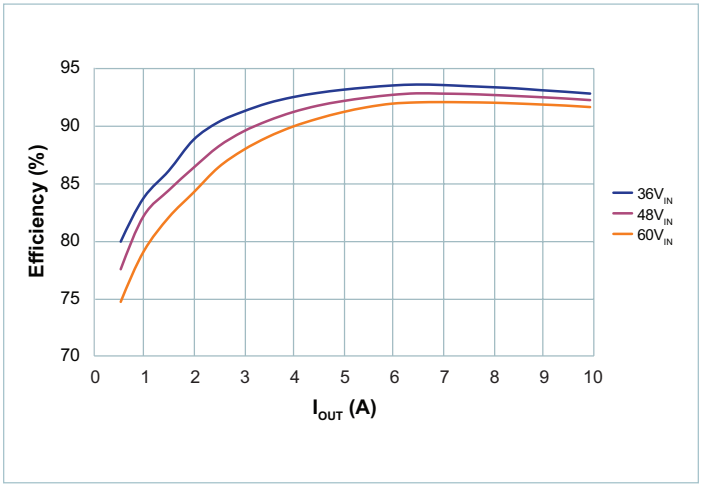



***Figure 25 —*** *Regulator Efficiency at 25°C*

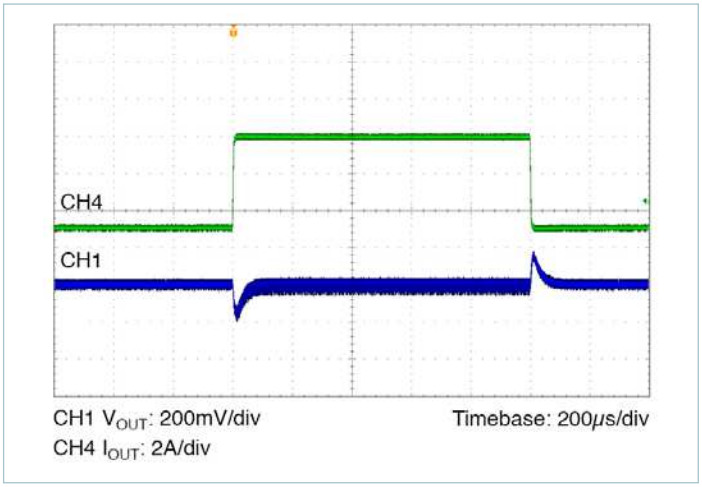



***Figure 26 —*** *Transient Response: 5A to 10A, at 1A/µs. $48V_{IN}$ to $5.0V_{OUT}$ $C_{OUT}$ = 6 x 47µF Ceramic*

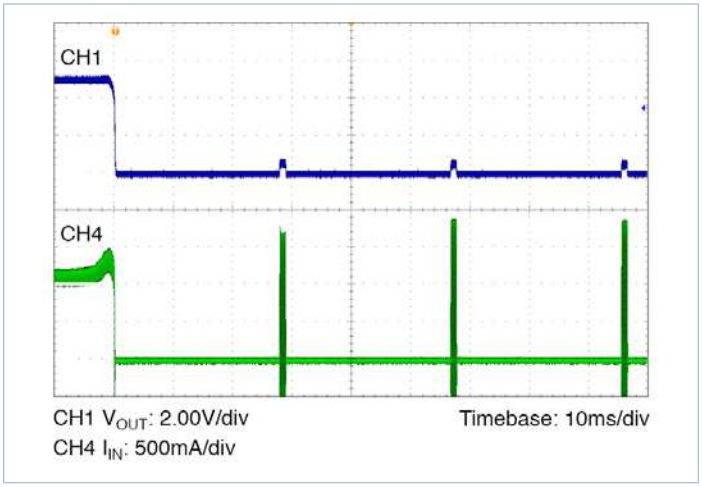



***Figure 27 —*** *Output Short Circuit @ $V_{IN}$ = 48V*

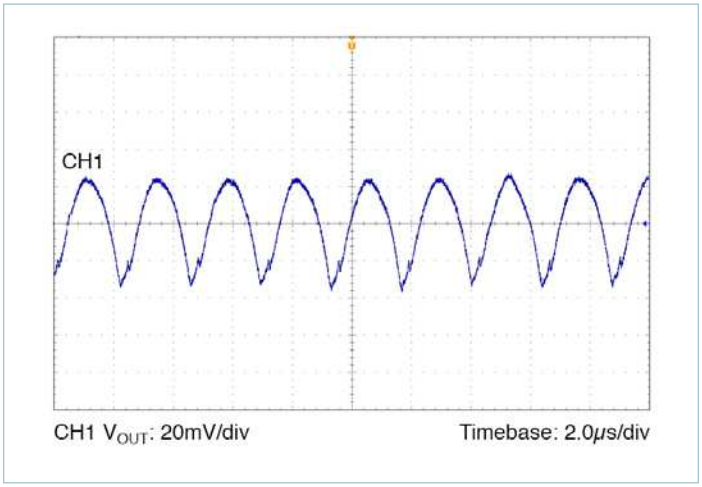



***Figure 28 —*** *Output Ripple: $48V_{IN}$, $5.0V_{OUT}$ at 10A. $V_{OUT}$ = 20mV/Div, 2.0µs/Div; $C_{OUT}$ = 6 x 47µF Ceramic*

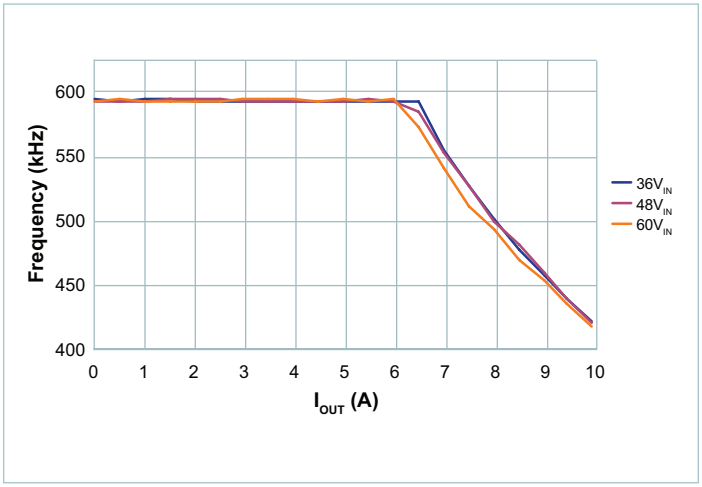



***Figure 29 —*** *Switching Frequency vs. Load Current*

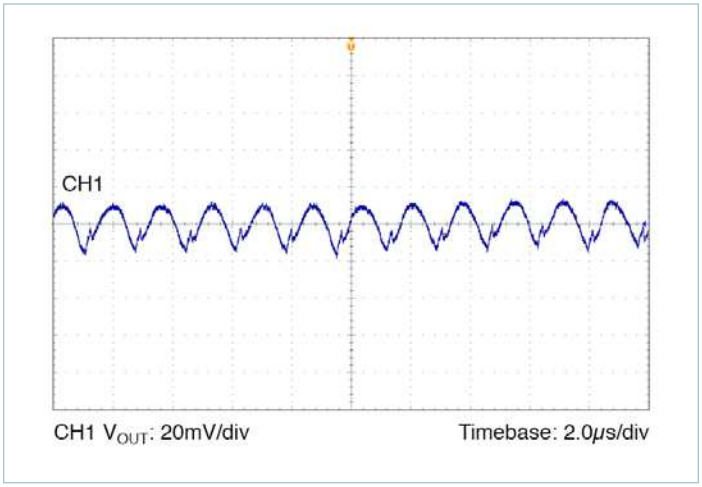



***Figure 30 —*** *Output Ripple: $48V_{IN}$, $5.0V_{OUT}$ at 5A. $V_{OUT}$ = 20mV/Div, 2.0µs/Div; $C_{OUT}$ = 6 x 47µF Ceramic*

## PI3545-00 ($5.0V_{OUT}$) Electrical Characteristics (Cont.)

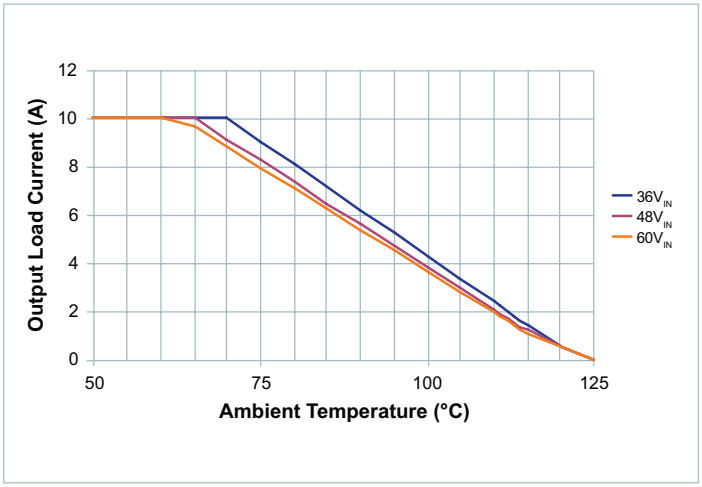



***Figure 31 —*** *Load Current vs. Ambient Temperature, 0LFM*

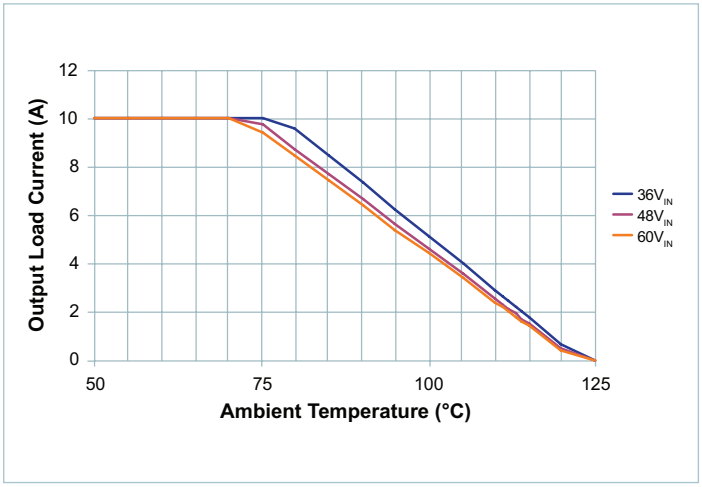



***Figure 32 —*** *Load Current vs. Ambient Temperature, 200LFM*

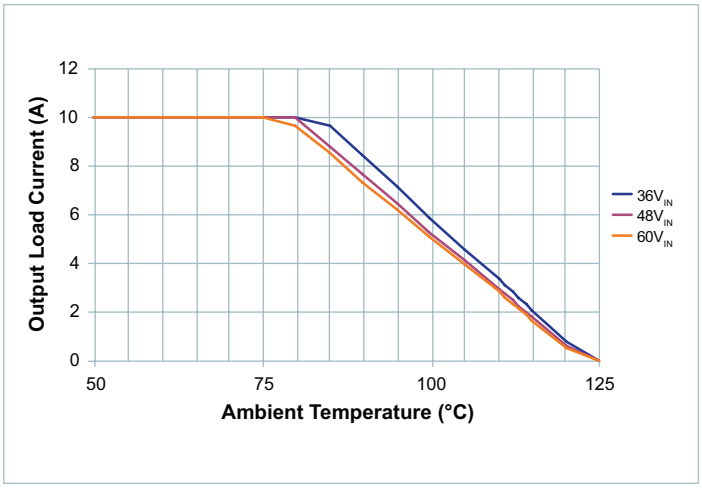



***Figure 33 —*** *Load Current vs. Ambient Temperature, 400LFM*

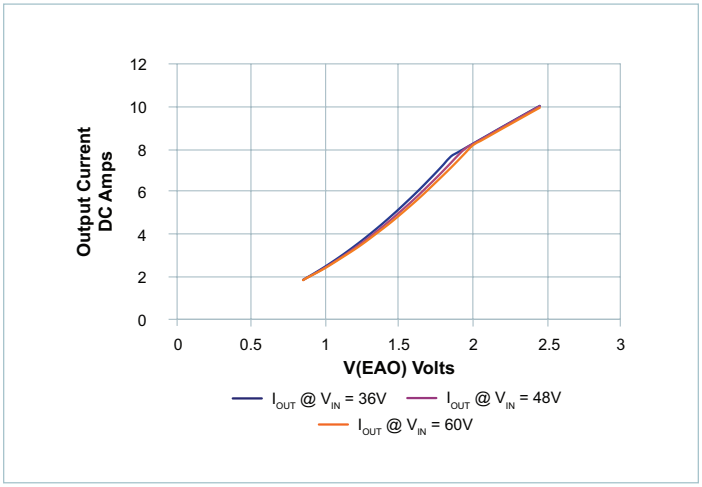



***Figure 34 —*** *Output Current vs. Error Voltage $V_{EAO}$*

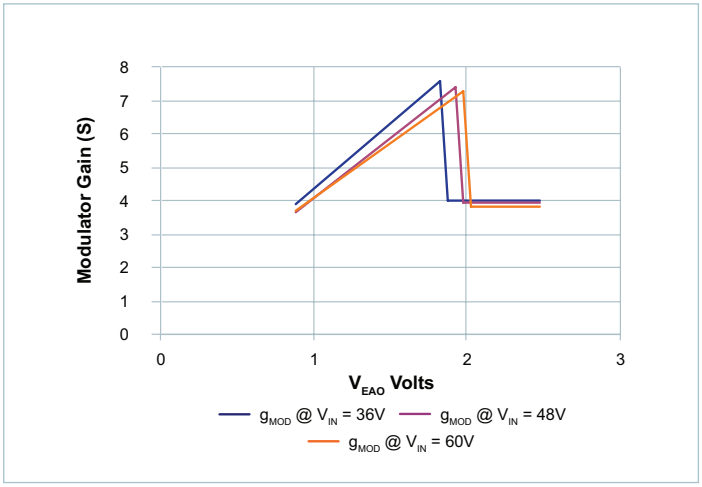



***Figure 35 —*** *Modulator Gain vs. Error Voltage $V_{EAO}$*

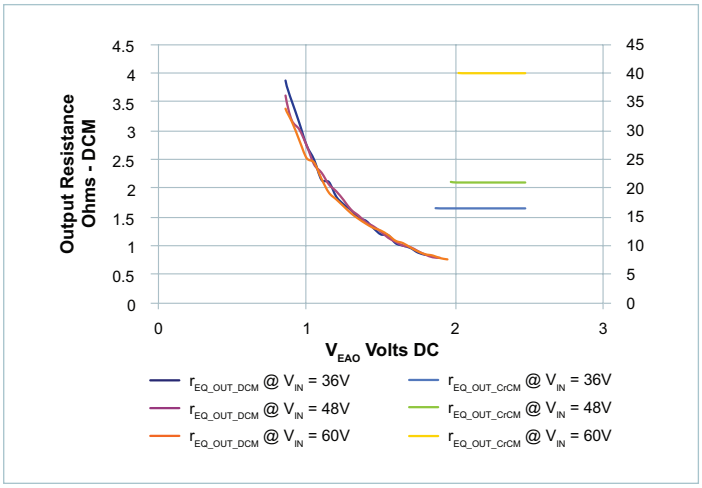



***Figure 36 —*** *Output Equivalent Resistance vs. Error Voltage $V_{EAO}$*

## PI3546-00 (12.0$V_{OUT}$) Electrical Characteristics

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 900nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Input Specifications** | | | | | | |
| Input Voltage | $V_{IN\_DC}$ | | 36 | 48 | 60 | V |
| Input Voltage, Transient | $V_{IN\_TRANS}$ | < 1% duty cycle,entire transient duration < 10ms | | | 70 | V |
| Input Current | $I_{IN\_DC}$ | $V_{IN}$ = 48V, $T_C$ = 25°C, $I_{OUT}$ = 9A | | 2.33 | | A |
| Input Current At Output Short (Fault Condition Duty Cycle) | $I_{IN\_Short}$ | Short at terminals | | 3.3 | - | mA |
| Input Quiescent Current | $I_{Q\_VIN}$ | Disabled | | 0.75 | | mA |
| | | Enabled (no load) | | 2.6 | | |
| Input Voltage Slew Rate | $V_{IN\_SR}$ | | | | 1 | V/µs |
| | | | | | | |
| **Output Specifications** | | | | | | |
| EAIN Voltage Total Regulation | $V_{EAIN}$ | [2] | 0.985 | 1.00 | 1.015 | V |
| Output Voltage Trim Range | $V_{OUT\_DC}$ | [2] [3] | 6.5 | 12 | 14 | V |
| Line Regulation | $\Delta V_{OUT}/\Delta V_{IN}$ | @ 25°C, 36V < $V_{IN}$ < 60V | | 0.10 | | % |
| Load Regulation | $\Delta V_{OUT}/\Delta I_{OUT}$ | @ 25°C, 0.5A < $I_{OUT}$ < 9A | | 0.10 | | % |
| Output Voltage Ripple | $V_{OUT\_AC}$ | $I_{OUT}$ = 9A, $C_{OUT}$ = 6 x 10µF, 20MHz BW [4] | | 114 | | mVp-p |
| Output Current | $I_{OUT\_DC}$ | [5] | 0 | | 9 | A |
| Maximum Array Size | $N_{Parallel}$ | | | | 3 | Modules |
| Output Current, Array of 2 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 15.9 | A |
| Output Current, Array of 3 | $I_{OUT\_DC\text{-}ARRAY2}$ | Total array capability, see applications section for details | 0 | | 22.9 | A |
| Current Limit | $I_{OUT\_CL}$ | Typ limit based on nominal 900nH inductor. | | 10.5 | | A |
| | | | | | | |
| **Timing** | | | | | | |
| Switching Frequency | $f_S$ | [6] 48$V_{IN}$ to 12$V_{OUT}$, 2A out, L1 = 900nH ±1% | - | 800 | - | kHz |
| Fault Restart Delay | $t_{FR\_DLY}$ | | | 30 | | ms |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3546-00 (12.0$V_{OUT}$) Electrical Characteristics (Cont.)

Specifications apply for -40°C < $T_J$ < 125°C, $V_{IN}$ = 48V, EN = High, $V_{VDR}$ = 5.1V +/- 2%, L1 = 900nH [1] unless other conditions are noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Soft Start, Tracking and Error Amplifier** | | | | | | |
| TRK Active Range (Nominal) | $V_{TRK}$ | | 0 | | 1.4 | V |
| TRK Enable Threshold | $V_{TRK\_OV}$ | | 20 | 40 | 60 | mV |
| TRK to EAIN Offset | $V_{EIAN\_OV}$ | $V_{TRK}$ = 0.5V, EA0 shorted to EAIN | 50 | 80 | 110 | mV |
| Charge Current (Soft-Start) | $I_{TRK}$ | | 70 | 50 | 30 | µA |
| Discharge Current (Fault) | $I_{TRK\_DIS}$ | $V_{TRK}$ = 0.5V | | 10 | | mA |
| Soft-Start Time | $t_{SS}$ | $C_{TRK}$ = 0µF | 0.6 | 0.94 | 1.6 | ms |
| Error Amplifier Trans-Conductance | $GM_{EAO}$ | [2] | | 7.6 | | mS |
| PSM Skip Threshold | $PSM_{SKIP}$ | [2] | | 0.8 | | V |
| Error Amplifier Output Impedance | $R_{OUT}$ | [2] | 1 | | | MΩ |
| Internal Compensation Capacitor | $C_{HF}$ | [2] | | 56 | | pf |
| Internal Compensation Resistor | $R_{ZI}$ | [2] | | 5 | | kΩ |

[1] All parameters reflect regulator and inductor system performance. Measurements were made using a standard PI354x evaluation board with 2.5 x 4" dimensions and 4 layer, 2 oz copper. Refer to inductor pairing table within Application Description section for specific inductor manufacturer and value.
[2] Regulator is assured to meet performance specifications by design, test correlation, characterization, and/or statistical process control. Output voltage is determined by an external feedback divider ratio.
[3] Output current capability may be limited and other performance may vary from noted electrical characteristics when $V_{OUT}$ is not set to nominal.
[4] Refer to Output Ripple plots.
[5] Refer to Load Current vs. Ambient Temperature curves.
[6] Refer to Switching Frequency vs. Load current curves.

## PI3546-00 (12.0$V_{OUT}$) Electrical Characteristics (Cont.)

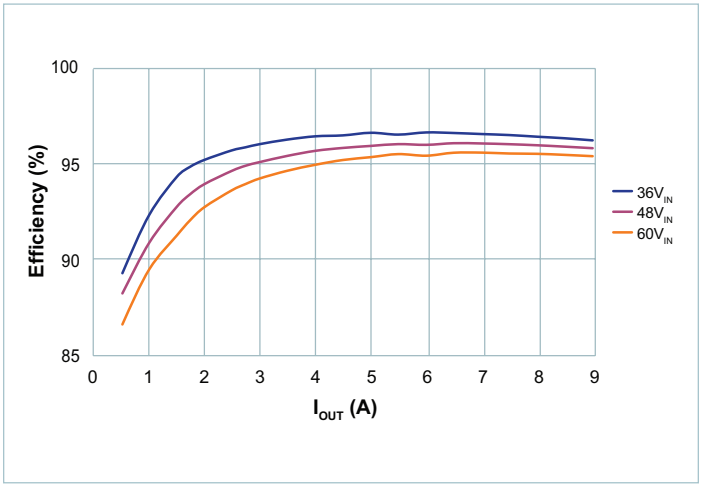



***Figure 37 —*** *Regulator Efficiency*

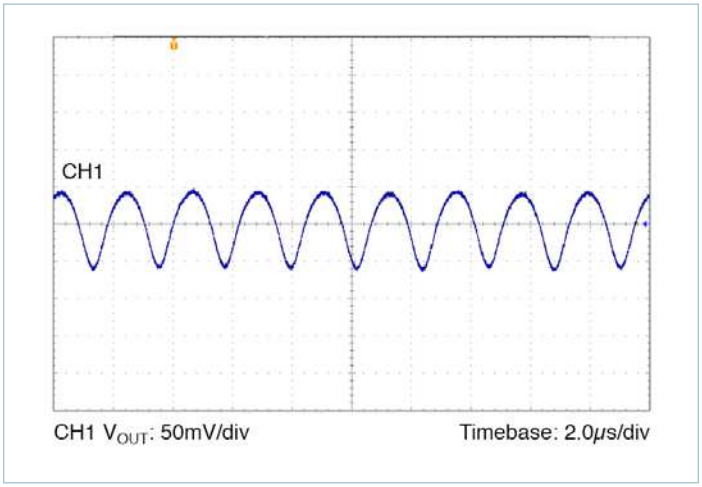



***Figure 40 —*** *Output Ripple: 48$V_{IN}$, 12.0$V_{OUT}$ at 9A.*
*$V_{OUT}$ = 50mV/Div, 2.0µs/Div;*
*$C_{OUT}$ = 6 x 10µF Ceramic*

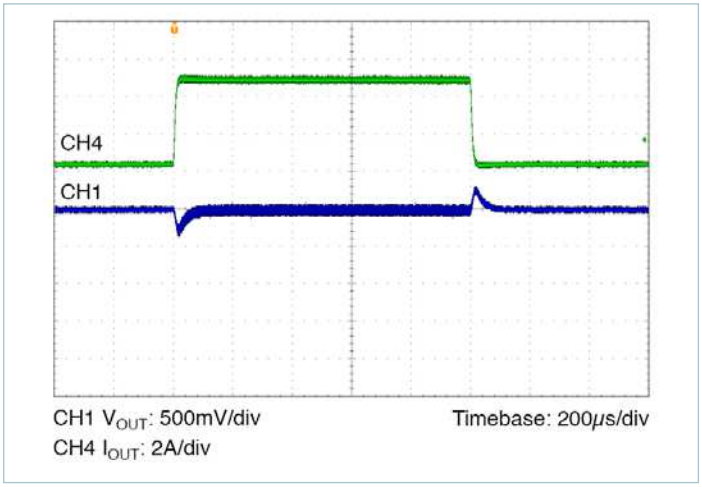



***Figure 38 —*** *Transient Response: 5A to 10A, at 1A/µs. 48$V_{IN}$ to 12.0$V_{OUT}$, $C_{OUT}$ = 6 x 10µF Ceramic*

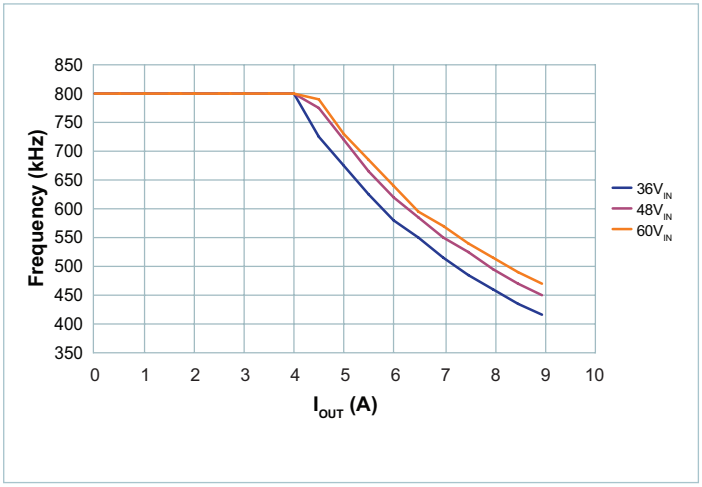



***Figure 41 —*** *Switching Frequency vs. Load Current*

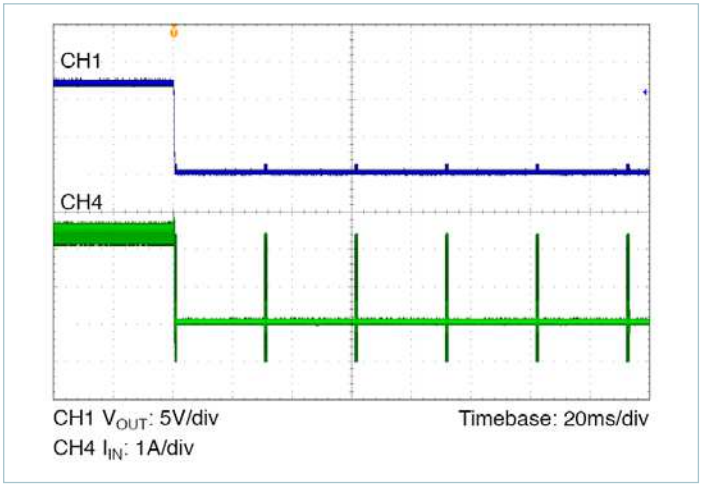



***Figure 39 —*** *Output Short Circuit @ $V_{IN}$ = 48V*

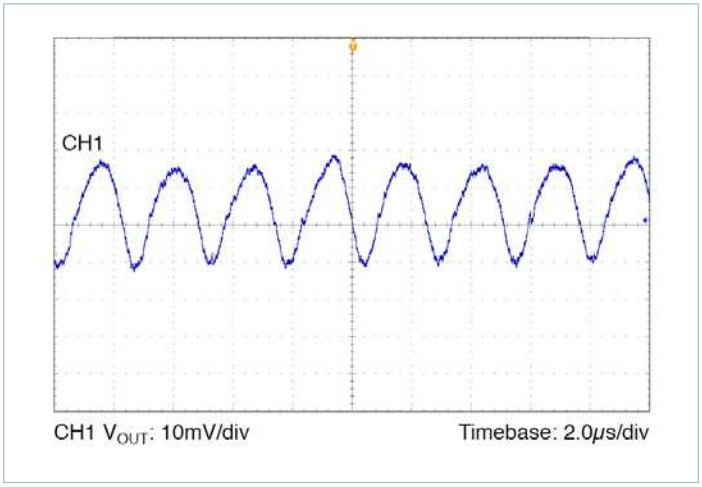



***Figure 42 —*** *Output Ripple: 48$V_{IN}$, 12.0$V_{OUT}$ at 4.5A.*
*$V_{OUT}$ = 10mV/Div, 2.0µs/Div;*
*$C_{OUT}$ = 6 x 10µF Ceramic*

## PI3546-00 (12.0$V_{OUT}$) Electrical Characteristics (Cont.)

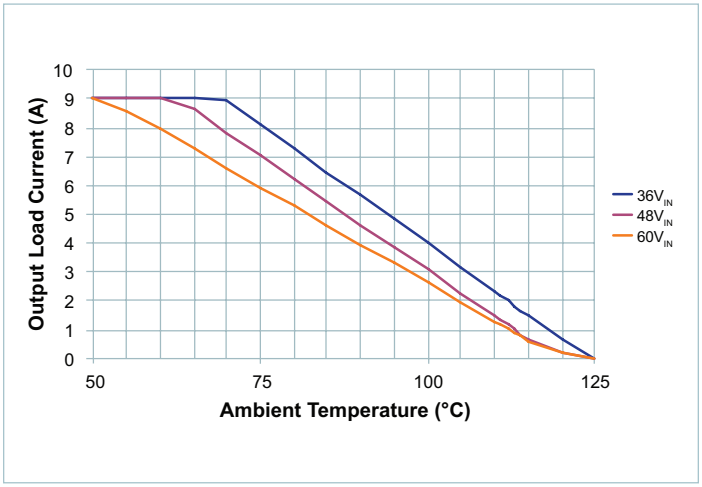



***Figure 43 —*** *Load Current vs. Ambient Temperature, 0LFM*

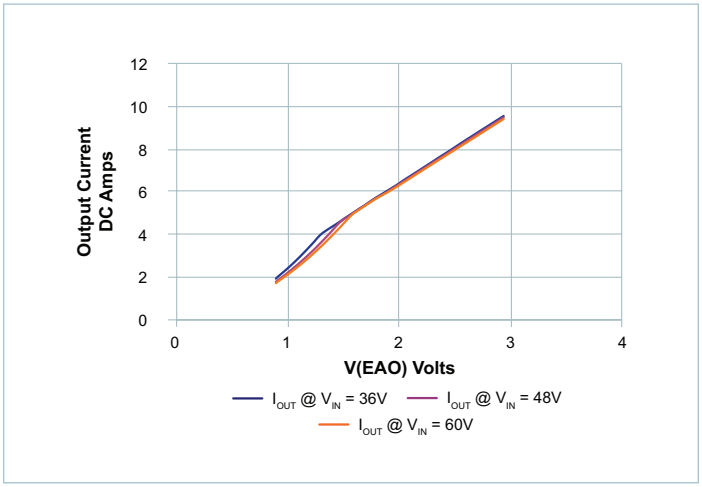



***Figure 46 —*** *Output Current vs. Error Voltage $V_{EAO}$*

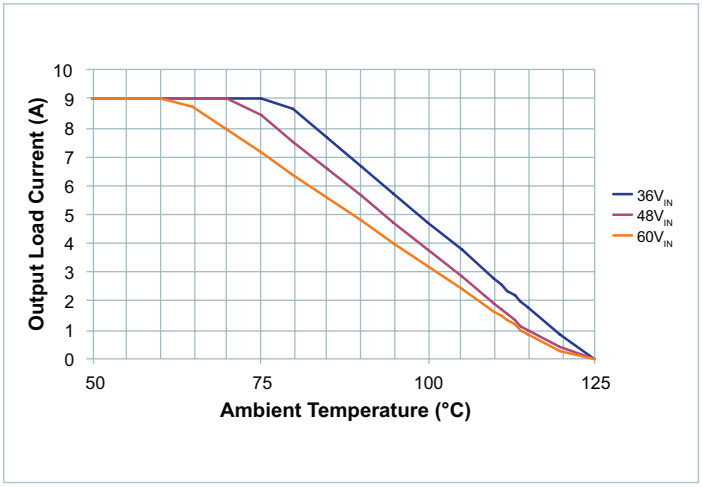



***Figure 44 —*** *Load Current vs. Ambient Temperature, 200LFM*

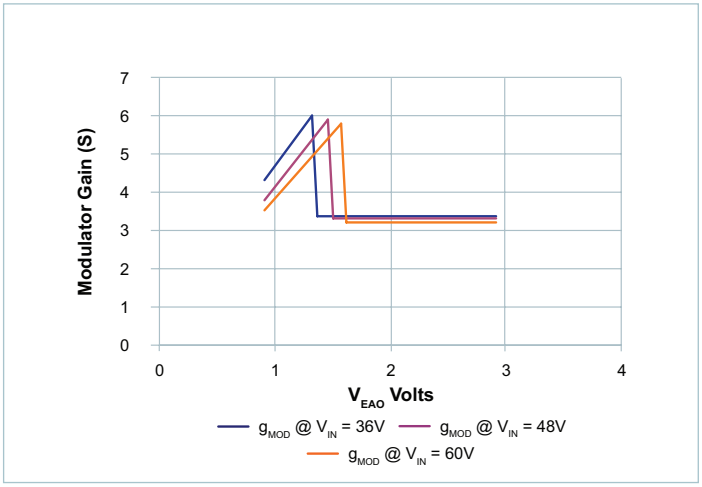



***Figure 47 —*** *Modulator Gain vs. Error Voltage $V_{EAO}$*

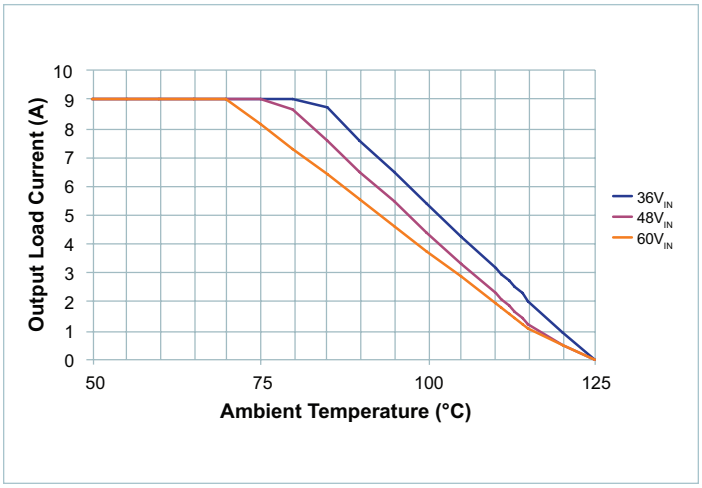



***Figure 45 —*** *Load Current vs. Ambient Temperature, 400LFM*

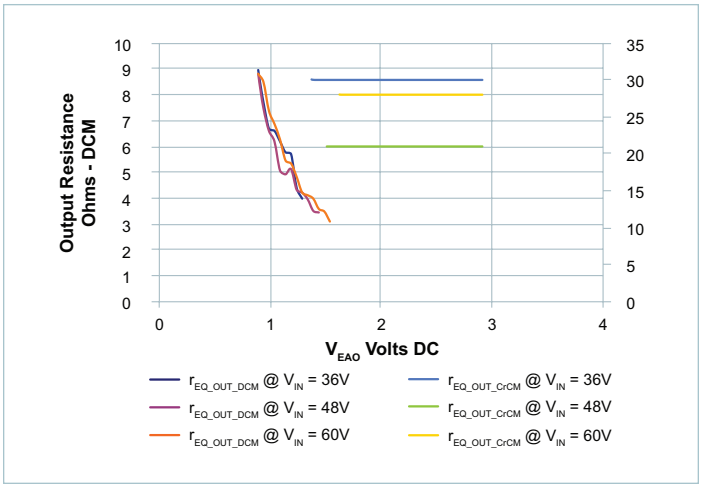



***Figure 48 —*** *Output Equivalent Resistance vs. Error Voltage $V_{EAO}$*

## Functional Description

The PI354x-00 is a family of highly integrated ZVS-Buck regulators. The PI354x-00 has an output voltage that can be set within a prescribed range shown in Table 1. Performance and maximum output current are characterized with a specific external power inductor (see Table 2).

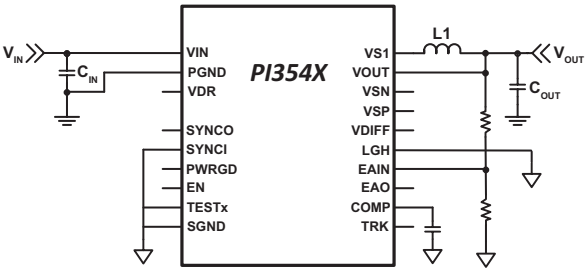



***Figure 49 —*** *ZVS-Buck with required components*

For basic operation, Figure 49 shows the connections and components required. No additional design or settings are required.

### ENABLE (EN)

EN is the enable pin of the converter. The EN Pin is referenced to SGND and permits the user to turn the regulator on or off. The EN default polarity is a positive logic assertion. If the EN pin is left floating or asserted high, the converter output is enabled. Pulling EN pin below $0.8V_{DC}$ with respect to SGND will disable the regulator output.

### Remote Sensing

If remote sensing is required, the PI354x-00 product family is equipped with an undedicated differential amplifier. This amplifier can allow full differential remote sense by configuring it as a differential follower and connecting the VDIFF pin to the EAIN pin.

### Switching Frequency Synchronization

The SYNCO pin provides a 5V level clock that can be used to monitor the internal clock of the regulator, or synchronize other regulators to it. The start of the switching cycles will coincide with the rising edge of SYNCO, and SYNCO will remain high for ½ the period of the preset switching frequency ($f_S$), or T1, whichever is longer. The SYNCI input allows the controller to synchronize its internal clock to an external clock source. The SYNCI pin should be connected to SGND through a 0Ω resistor when not in use and should never be left floating. The controller can synchronize to frequencies between 50% and 110% of the preset switching frequency ($f_S$). When using SYNCI, the PI354x-00 phase synchronizes to the falling edge of the applied clock on SYNCI. When SYNCI is driven from a second module's SYNCO, there is an effective 180 degrees of phase shift between the start of the switching cycles, provided the modules are switching at the preset switching frequency. At higher loads when pulse stretching occurs and the operating frequency is lowered, the phase shift is no longer 180 degrees. Also when the switching frequency of a module is reduced due to an external clock source driving SYNCI, the current limit threshold may be significantly reduced.

### Soft-Start

The PI354x-00 includes an internal soft-start capacitor to control the rate of rise of the output voltage. See the Electrical Characteristics Section for the default value. Connecting an external capacitor from the TRK pin to SGND will increase the start-up ramp period. See, "Soft Start Adjustment and Track," in the Applications Description section for more details.

### Output Voltage Selection

The PI354x-00 output voltage can be selected by connecting a resistor from EAIN pin to SGND and a resistor from Vout to the EAIN pin as shown in Figure 49. Table 1 defines the allowable operational voltage ranges for the PI354x-00 family.

| Device | Output Voltage | |
|---|---|---|
| | Nom. | Range |
| PI3542-00-LGIZ | 2.5V | 2.2V to 3.0V |
| PI3543-00-LGIZ | 3.3V | 2.6V to 3.6V |
| PI3545-00-LGIZ | 5.0V | 4.0V to 5.5V |
| PI3546-00-LGIZ | 12V | 6.5V to 14.0V |

***Table 1 —*** *PI354x-00 family output voltage ranges*

### Output Current Limit Protection

PI354x-00 has two methods implemented to protect from output short or over current condition.

*Slow Current Limit protection:* prevents the output from sourcing current higher than the regulator's maximum rated current. If the output current exceeds the Current Limit ($I_{OUT\_CL}$) for 1024µs, a slow current limit fault is initiated and the regulator is shutdown which eliminates output current flow. After Fault Restart Delay ($t_{FR\_DLY}$), a soft-start cycle is initiated. This restart cycle will be repeated indefinitely until the excessive load is removed.

*Fast Current Limit protection:* PI354x-00 monitors the regulator inductor current pulse-by-pulse to prevent the output from supplying very high current due to sudden low impedance short. If the regulator senses a high inductor current pulse, it will initiate a fault and stop switching until Fault Restart Delay ends and then initiate a soft-start cycle.

### Input Undervoltage Lockout

If $V_{IN}$ falls below the input Undervoltage Lockout (UVLO) threshold, but remains high enough to power the internal bias supply, the PI354x-00 will complete the current cycle and stop switching. The system will soft start once the input voltage is reestablished and after the Fault Restart Delay.