EVAL_38060_PMAC1 / EV104 User Guide

Starter Guide

About this document

Scope and purpose

EVAL_IR38060_PMAC1 / EV104 evaluation board provides the user access to six IR38060 rails and two IR3892 rails. This document explains the basic features of the board and provides information on the the typical performance of the rails.

Intended audience

Mutli Macro Evaluation Board: Start Guide is intended for users who want to use the EVAL_38060_PMAC1 / EV104 Evaluation board and understand the abilities of the board.

Table of Contents

1 Introduction

The EVAL_38060-PMAC1 / EV104 Multi-Macro board showcases the IR38060 and the IR3892 on a single board. By combining multiple ready-to-use power rail solutions on a single board with PMBus/I2C capability, the bountiful features of the IR3806X family can be explored along with compact dual output IR3892 SupIRBuck.

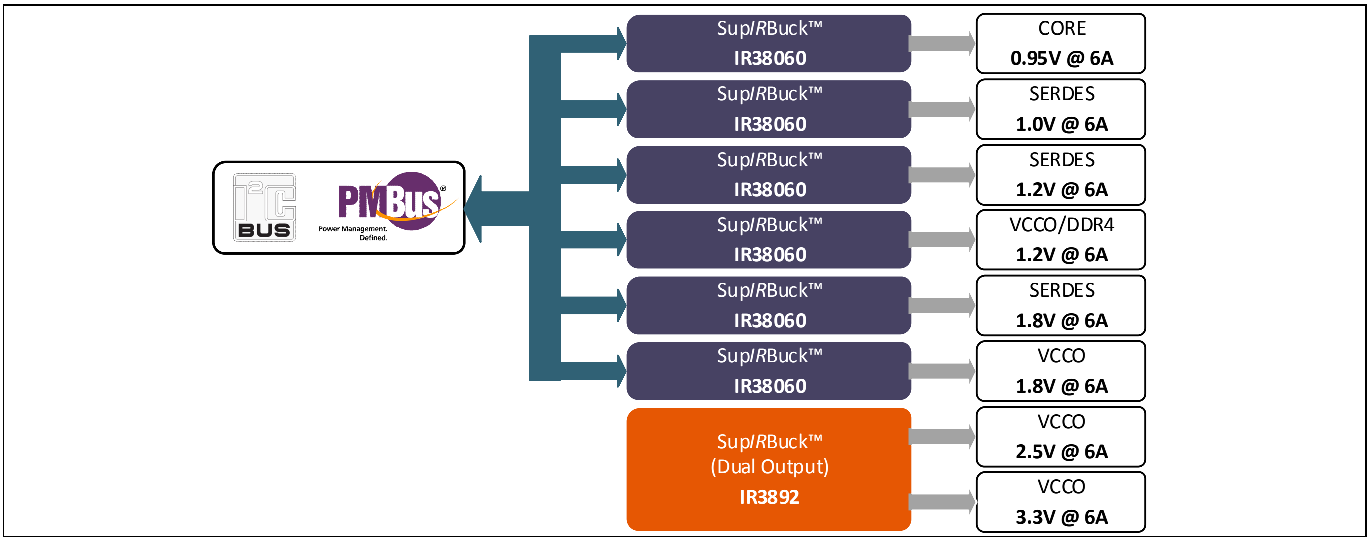

Figure 1 **EVAL_38060-PMAC1 Block Diagram**

List of rails and voltages [contains six IR38060 macros and one dual output IR3892 macro]:

Table 1 **Summary of Multi-Macro Evaluation Board Rails**

Part Number	Rail Name	Output Voltage [V]	Maximum Current [A]	Address [PMBus / I2C]	Schematic	Layout	BOM
IR38060	CORE	0.95	6	0x42h / 0x12h	OrCad	Allegro	Available
IR38060	SERDES	1.0	6	0x44h / 0x13h	OrCad	Allegro	Available
IR38060	VCCO/DDR4	1.2	6	0x45h / 0x14h	OrCad	Allegro	Available
IR38060	SERDES	1.2	6	0x45h / 0x15h	OrCad	Allegro	Available
IR38060	SERDES	1.8	6	0x46h / 0x16h	OrCad	Allegro	Available
IR38060	VCCO	1.8	6	0x47h / 0x17h	OrCad	Allegro	Available
IR3892	VCCO	2.5	6	N/A	OrCad	Allegro	Available
IR3892	VCCO	3.3	6	N/A	OrCad	Allegro	Available

Table 2 **Rail Specifications**

Part Number	Rail Name	Output Voltage [V]	Switching Frequency [kHz]	Maximum Current [A]	Output Ripple Vpk-pk (% of Vout)	Transient Response Over /Undershoot Iout: 0.6-2.4A @ 2.5A / uS (% of Vout)
IR38060	CORE	0.95	607	6	< 10 mV	+/-3 %
IR38060	SERDES	1.0	607	6	< 1%	+/-3%
IR38060	VCCO	1.2	607	6	< 1%	+/-3%
IR38060	DDR4/VCCO	1.2	607	6	< 1%	+/-3%
IR38060	SERDES	1.8	607	6	< 1%	+/-3%
IR38060	VCCO	1.8	607	6	< 1%	+/-3%
IR3892	VCCO	2.5	600	6	< 1%	+/-3%
IR3892	VCCO	3.3	600	6	< 1%	+/-3%

More information on Infineon's power supply reference designs can be found at www.infineon.com/xilinx.

2 Purpose/Usage:

EVAL_38060-PMAC1 / EV104 Multi-Macro board allows easy interface to multiple IR38060 voltage rails. Allowing the quick development, optimize power sequencing, understanding PMBus commands and operation.

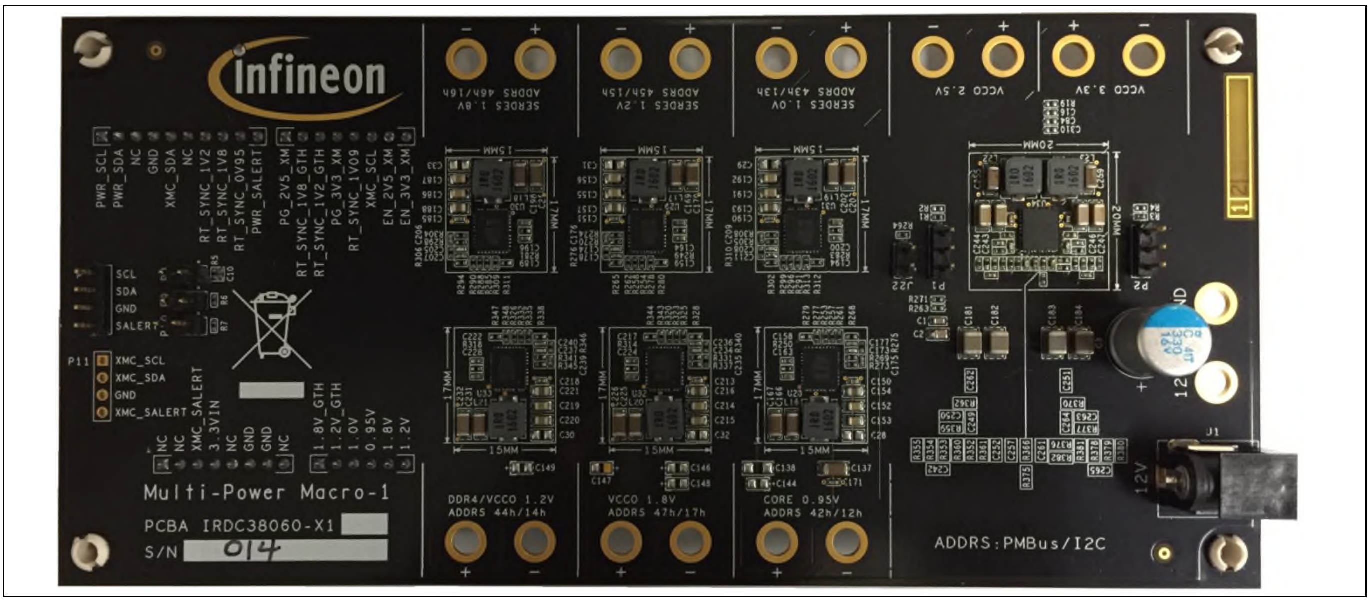

Figure 2 **Multi Macro Evaluation Board: EVAL_38060-PMAC1**

- Power Connectors
  - 12V
  - DC 12V [Optional connector for wall adapter]
  - Outputs [8 Sets]
- XMC Connections
  - EN
  - RT/SYNC
  - I2C/PMBus [XMC]
- I2C/PMBus for IR38060 rails

2.1 Quick Start

Power Up Procedure:

1. Install jumpers on pins 1 and 2 of the 2 headers marked in **ORANGE** to enable IR3892 rails [2.5V and 3.3V]
2. Connect 12V power supply to connectors in **GREEN**.
3. Rail output connectors are marked in **RED**. Upto a 6A load can be connected to each of the rails.

Optional [I2C/PMBus Connection]:

- Connect USB005 dongle/host to the header in **BLUE** to access I2C/PMBus features.

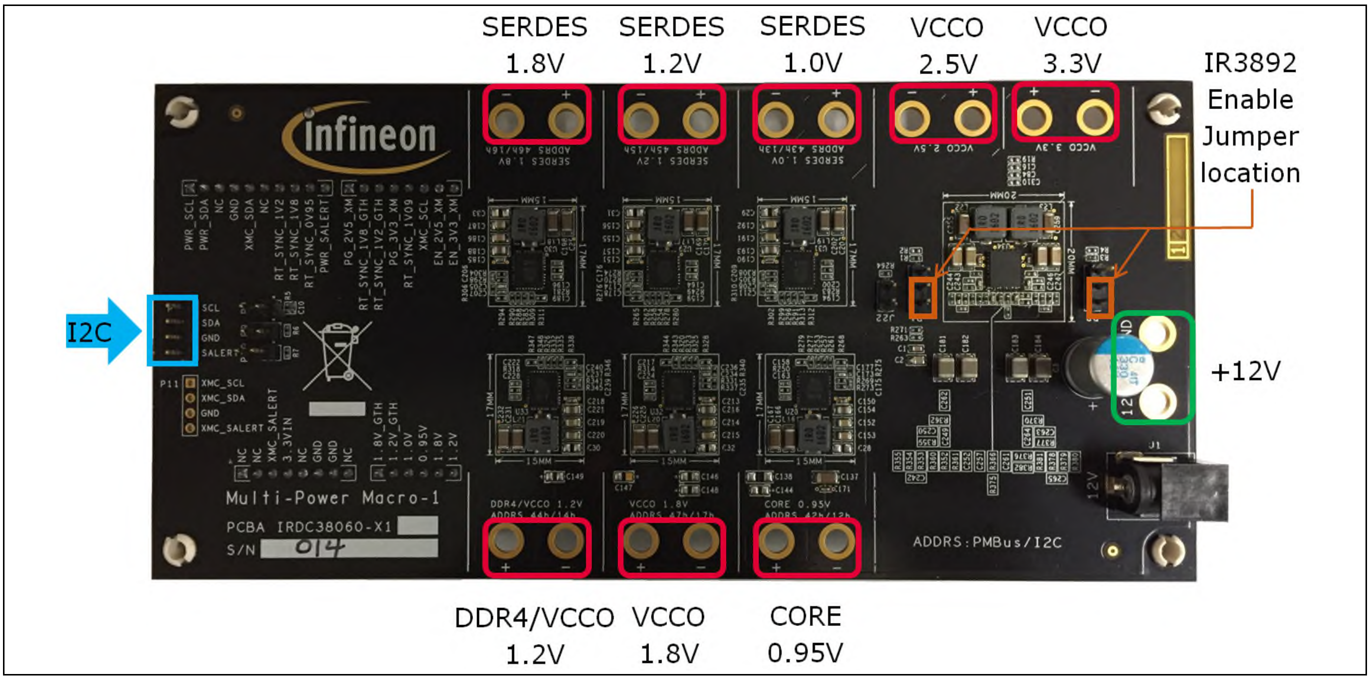

Figure 3 **Connections for Quick Start**

2.2 Connections

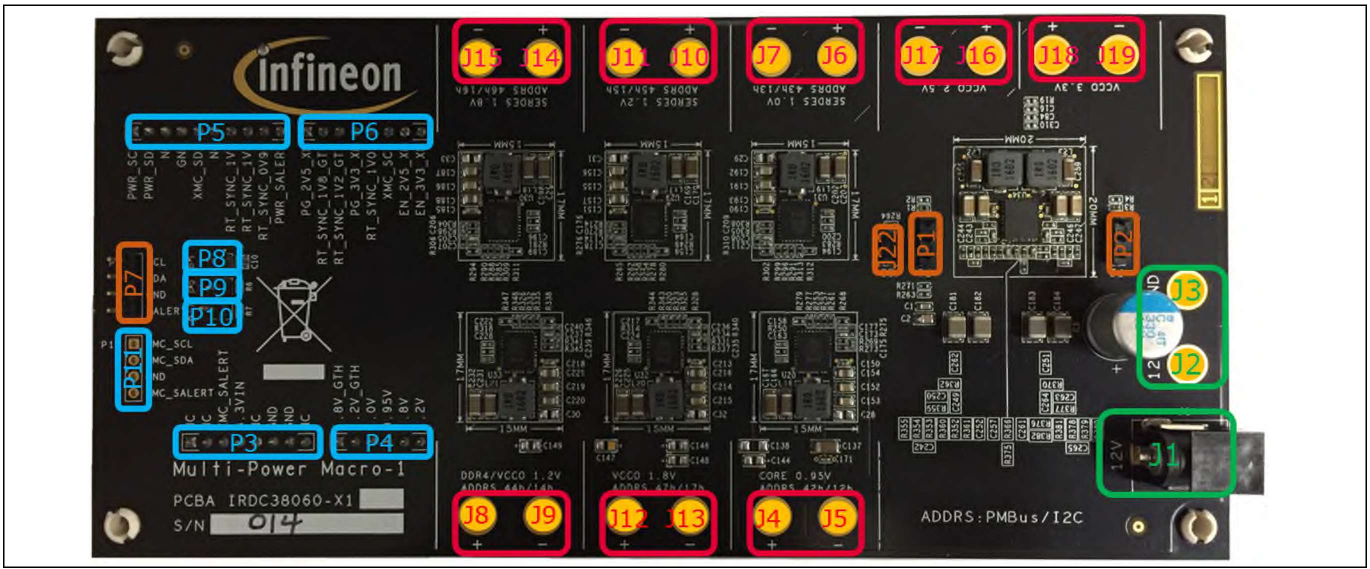

Figure 4 **Map of connectors**

Table 3

Connectors	Description
J1	DC jack for 12 wall adapter
J2, J3	12V input connector
J4, J5	CORE 0.95V output
J6, J7	SERDES 1.0V output
J8, J9	VCCO/DDR4 1.2V output
J10, J11	SERDES 1.2V output
J12, J13	VCCO 1.8V output
J14, J15	SERDES 1.8V output
J16, J17	VCCO 2.5V output
J18, J19	VCCO 3.3V output
J22	Jumper for lowering PWR_EN voltage
P1	2.5V Enable selector: Pin 1-2 for 12V enable; Pin 2-3 for XMC GPIO enable
P2	3.3V Enable selector: Pin 1-2 for 12V enable; Pin 2-3 for XMC GPIO enable
P3, P4, P5, P6	XMC connector
P7	IR38060 I2C Bus Header
P8	Place jumper to attach PWR_SCL to XMC 3.3V through pull up
P9	Place jumper to attach PWR_SDA to XMC 3.3V through pull up
P10	Place jumper to attach PWR_SALERT to XMC 3.3V through pull up
P11	XMC I2C Header

3 Configuring IR38060

Users can customize the behavior of each rail through PMBus commands. Step-by-step instructions on how to customize the rails are provided below. The instructions below assume the commands are being sent trhough PowIR Center GUI.

3.1 PowIR Center GUI

PowIR Center is a program that provides a graphical interface for communicating with Infineon products though PMBus and I2C protocols.

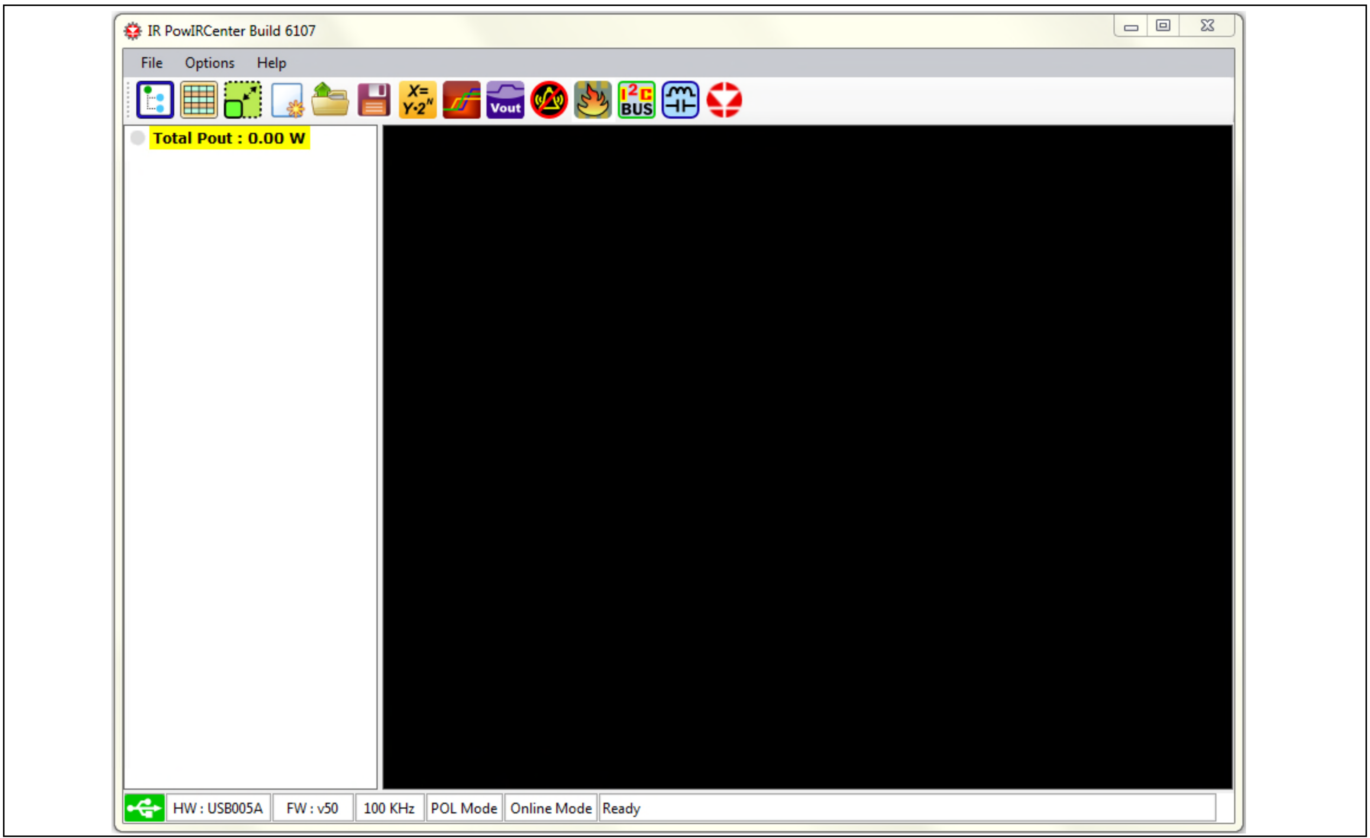

Figure 5 **Screen shot of PowIR Center Default screen**

3.2 Loading Evaluation board into PowIR Center GUI

1. Connect computer to EVAL_IR38060 Board via USB005 dongle
2. Turn on PowIR center GUI
3. Apply power to board
4. Click  to auto detect board and compatible devices.

   NOTE: Names of the rails will be different.

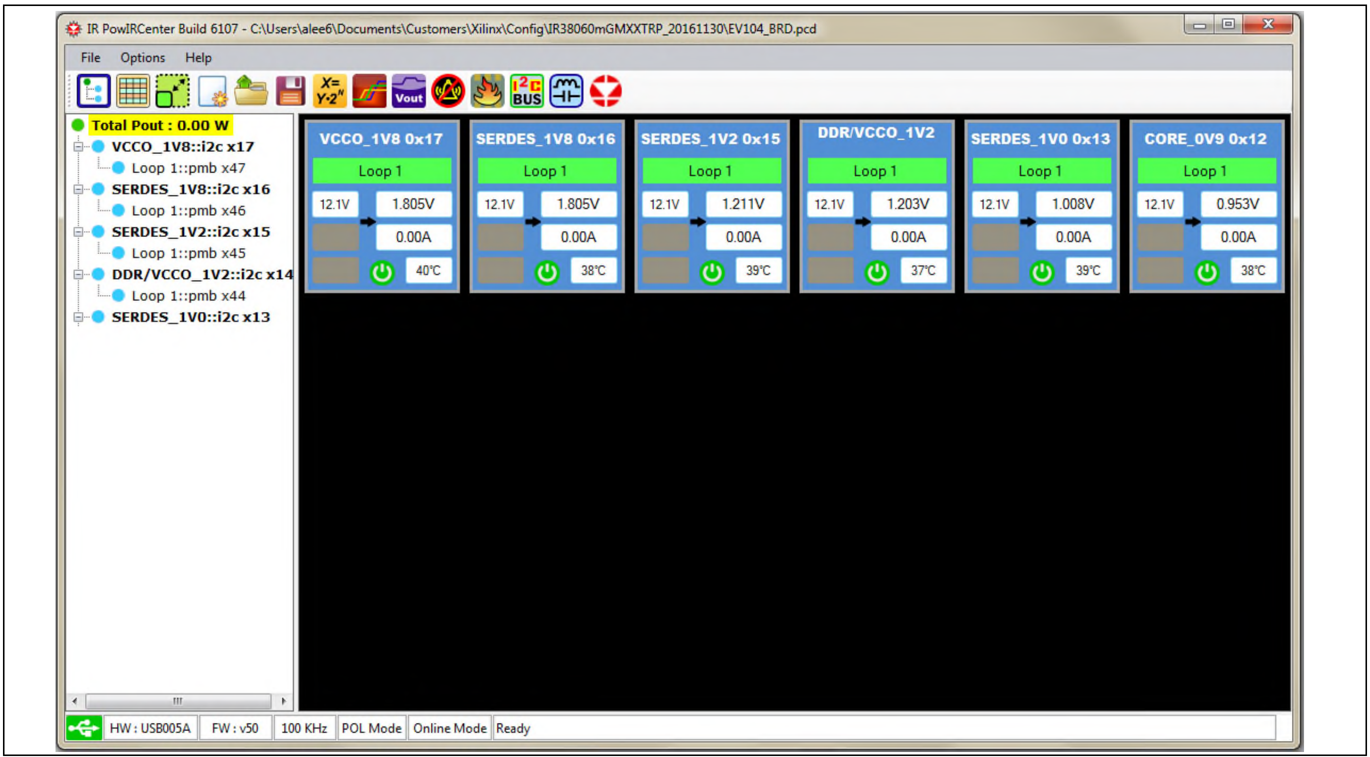

Figure 6 **Screen shot of PowIR Center GUI populated with IR38060 rails**

3.3 Group Sequencing through GUI

Sequencing the six IR38060 is simple when using the group sequencing feature [ ]. PowIR Center GUI shows the startup sequence graphically. The feature also allows the user to conveniently adjust the TON_DELAY, TON_RISE, TOFF_DELAY and TOFF_FALL parameters in the same window.

Figure 7 **Screenshot of Group Sequencing screen from PowIR Center GUI**

Select the rails to be displayed by clicking the box on the left.

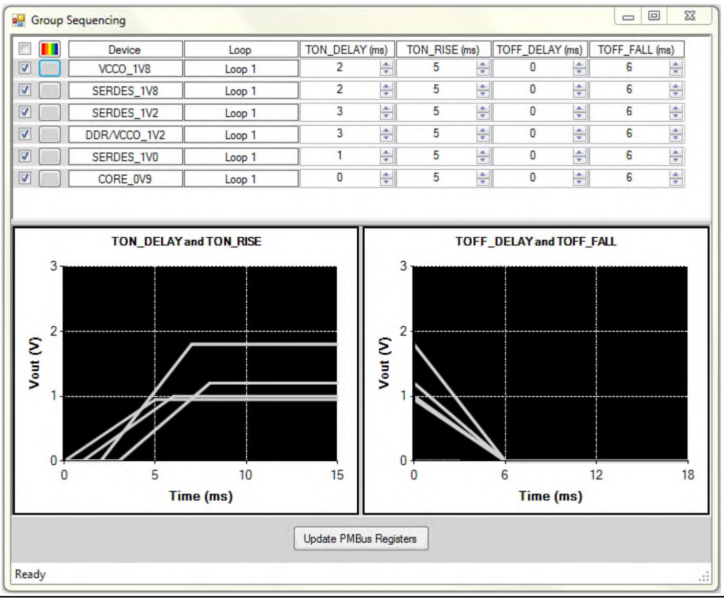

Figure 8 **Screenshot of Group Sequencing screen from PowIR Center GUI with Multi-Macro Evalution board rails loaded.**

More information can be found in "PowIRCenter Installation and User Guide document" (AN-0035).
[www.infineon.com/cms/en/product/promopages/power-center-software/]

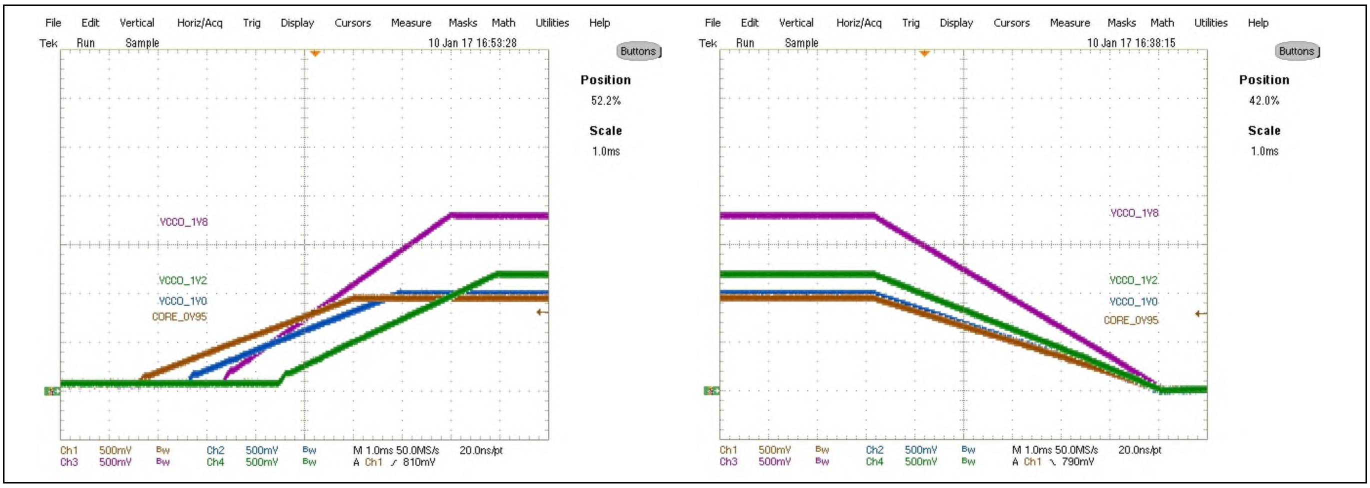

Figure 9 **12V startup (left) and soft off (right) with default TON_DELAY and TON_RISE settings**

3.4 Adjusting the TON_DELAY

Steps for adjusting TON_DELAY:

1. Select the loop to be changed. Selected loop is highlighted in yellow.
2. Select the “All Commands” to reveal the TON_DELAY command.
3. Select the TON_DELAY PMBus command
4. Change TON_DELAY value (Units are in mS. Resolution is 1 mS).
5. Click **Write** button (A green check mark appears by the button if command was successful).

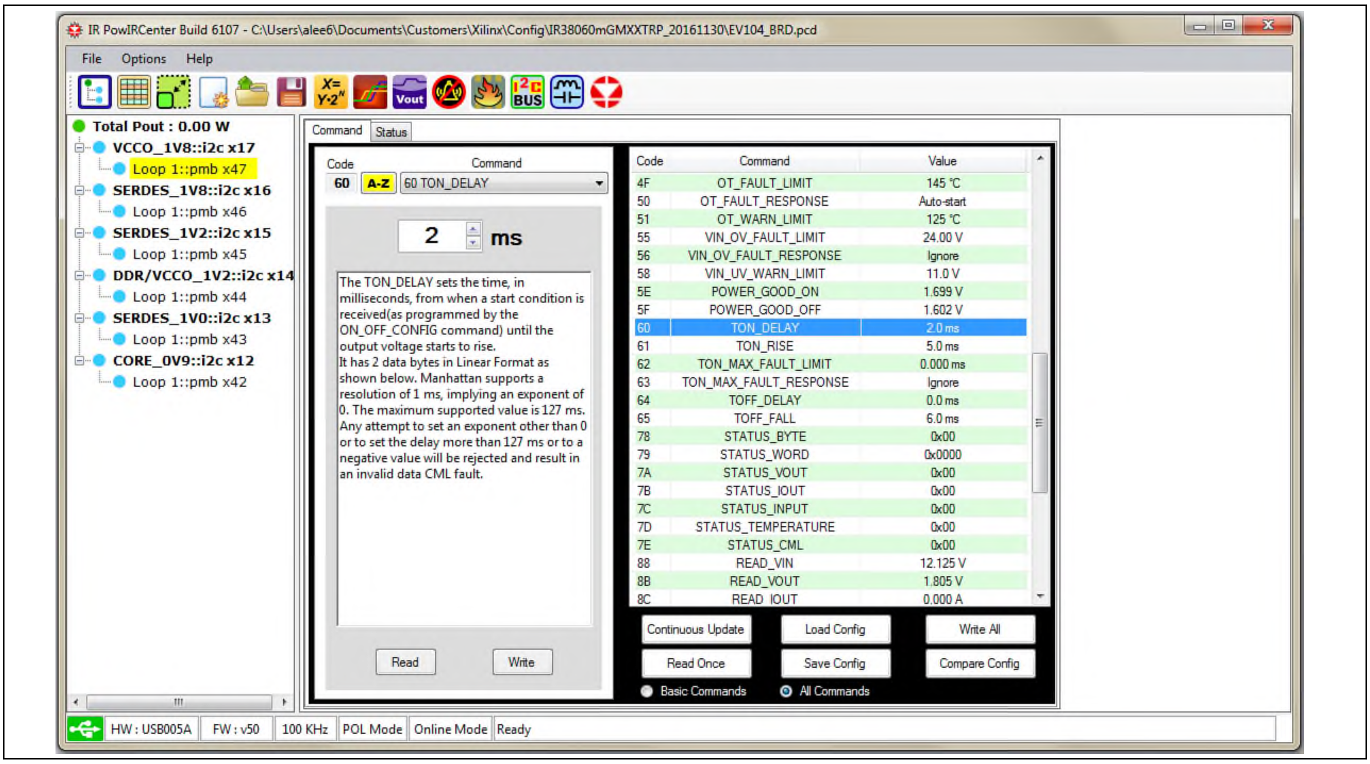

Figure 10 **PowIR Center GUI screenshot of TON_DELAY PMBus command for VCCO 1.8V rail Loop 1**

3.5 Rise time adjustment: TON_RISE

Steps for adjusting TON_RISE:

1. Select the loop to be changed. Selected loop is highlighted in yellow.
2. Select the “All Commands” option at the bottom to reveal the TON_RISE command.
3. Change the TON_RISE value (Units are in mS. Resolution is 1 mS).
4. Click **Write** button (A green check mark appears by the button if command was successful).

Figure 11 **PowIR Center GUI screenshot of TON_RISE PMBus command for VCCO 1.8V rail Loop 1**

3.6 Enable / Shutdown: Operation command

Steps for enabling and disabling the rail through PMBus:

1. Select the loop to be changed. Selected loop is highlighted in yellow.
2. Select the "All Commands" to reveal the OPERATION command.
3. Select desired OPERATION value
    a. "Soft Off", to disable the conversion.
    b. "On", to enable the converter.
4. Click the **Write** button (A green check mark appears by the button if command was successful).

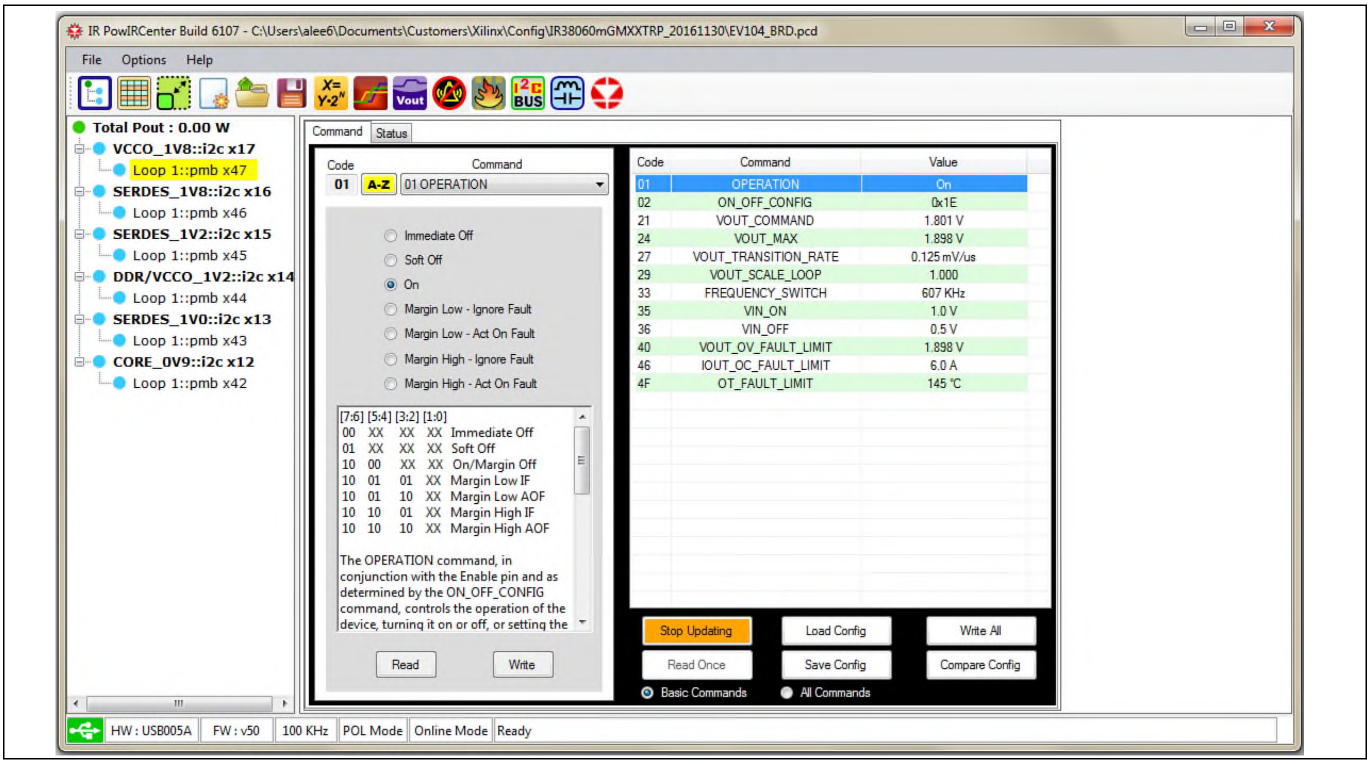

Figure 12 **PowIR Center GUI screenshot of OPERATION PMBus command for VCCO 1.8V rail Loop 1**

3.7 Changing output voltages: Margining HIGH / LOW

The output voltage can be change through the OPERATION PMBus command.

1. Select the loop to be changed. Selected loop is highlighted in yellow.
2. Select OPERATION option
   a. “Margin Low – Ignore Fault”, change vout to the Margin Low voltage and ignores over/under voltage faults and warnings.
   b. “Margin Low – Act on Fault”, change vout to the Margin Low voltage and respond as programmed to over/under voltage faults and warnings.
   c. “Margin High – Ignore Fault”, change vout to the Margin High voltage and ignores over/under voltage faults and warnings.
   d. “Margin Low – Act on Fault”, change vout to the Margin High voltage and respond as programmed to over/under voltage faults and warnings.
3. Click the **Write** button (A green check mark appears by the button if command was successful).

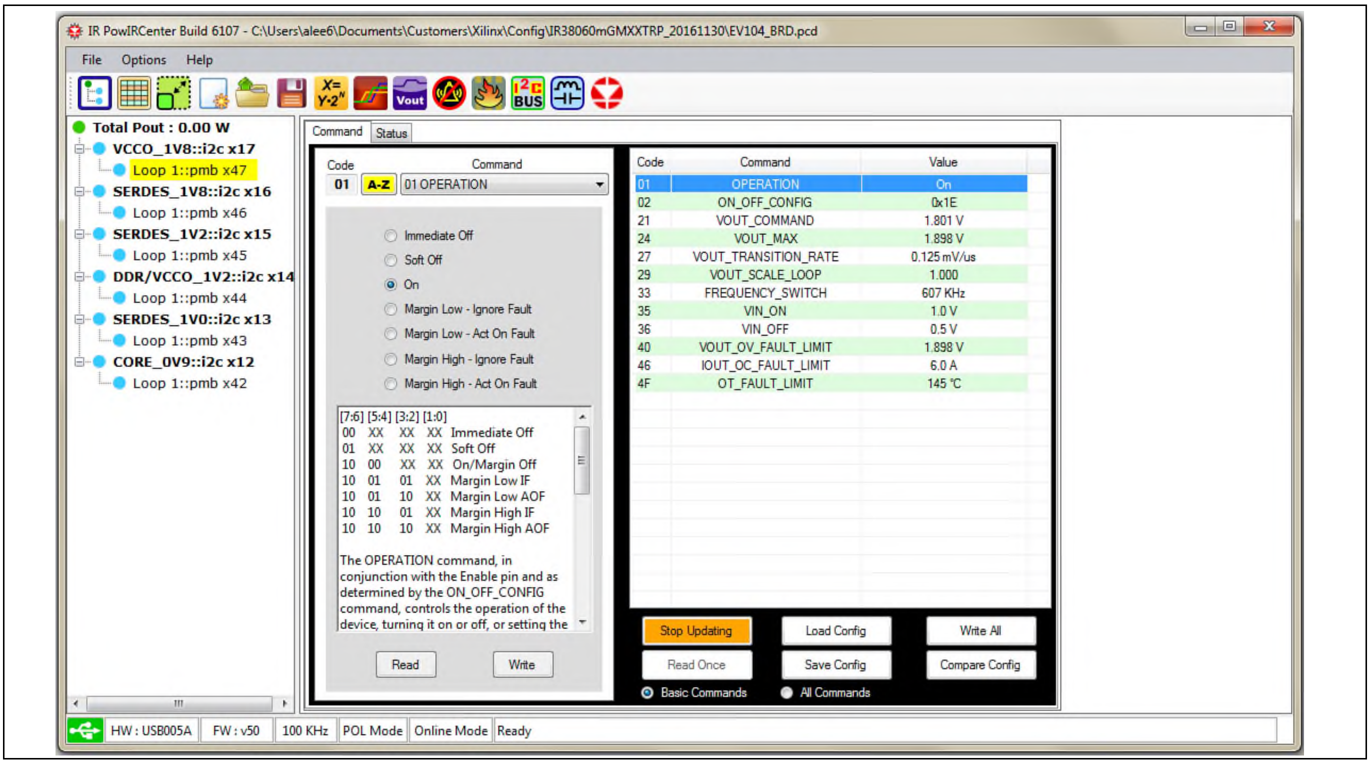

Figure 13 **Change to Margin Voltage**

3.8 Address Offset

IR38060 uses an address resistor to set the I2C and PMBus address. The address resistor is used to change the I2C and PMBus offset from +0 to +16. The offset is added to the bases I2C and PMBus offset which are pre-programmed in the IR38060 to 0x10h and 0x40h respectively. Below is a table listing what resistance to use for a speficied offset.

Table 4 **ADDR resistor offset values**

ADDR Resistor (Ohm)	Address Offset (0x0h)
499	+0 (+0x0h)
1050	+1 (+0x1h)
1540	+2 (+0x2h)
2050	+3 (+0x3h)
2610	+4 (+0x4h)
3240	+5 (+0x5h)
3830	+6 (+0x6h)
4530	+7 (+0x7h)
5230	+8 (+0x8h)
6040	+9 (+0x9h)
6980	+10 (+0xAh)
7870	+11 (+0xBh)
8870	+12 (+0xCh)
9760	+13 (+0xDh)
10700	+14 (+0xEh)
11800	+15 (+0xFh)

3.9 Synchronizing Switching Frequency

Users can synchronize the macros to a single or multiple clock signals using the RT/Sync pin. IR38060 and IR3892 can synchronize to an appropriate clock signal applied to the device. This feature is useful when trying to filter out noise. The switching frequency can be set to an appropriate frequency and then filtered out. The six IR38060 Rt/Sync pins are routed to the XMC headers to allow a XMC controller to determine the switching frequency and phase shift of each IR38060 rail.

When synchronizing switching frequencies, the clock signal should be six times greater than the highest cross over frequency to keep the rail stable. Crossover frequencies are showing in the bode plots under the macro section.

4 Evaluation Board

The performance and details of the different portions of the evaluation board will be reviewed in the following sections. The board will separated into Power/Miscellaneous, six IR38060 Macros and one IR3892 Macro. Schematics, bill of materials (BOM), waveforms, efficiency and thermal image are provided.

4.1 Macro Schematics

The evaluation board simplifies the rail design by building on two macro schematics. There is a schematic for IR38060 macro and a schematic the IR3892 macro. The IR38060 macro schematic Macro can be used for voltage between 0.5V and 2.0V. The IR3892 macro schematic can be used from 0.5V to the maximum allowed duty cycle. The schematics can adapt to other voltages and specifications by updating the components. IR38060 and IR3892 macro schematics are shown below.

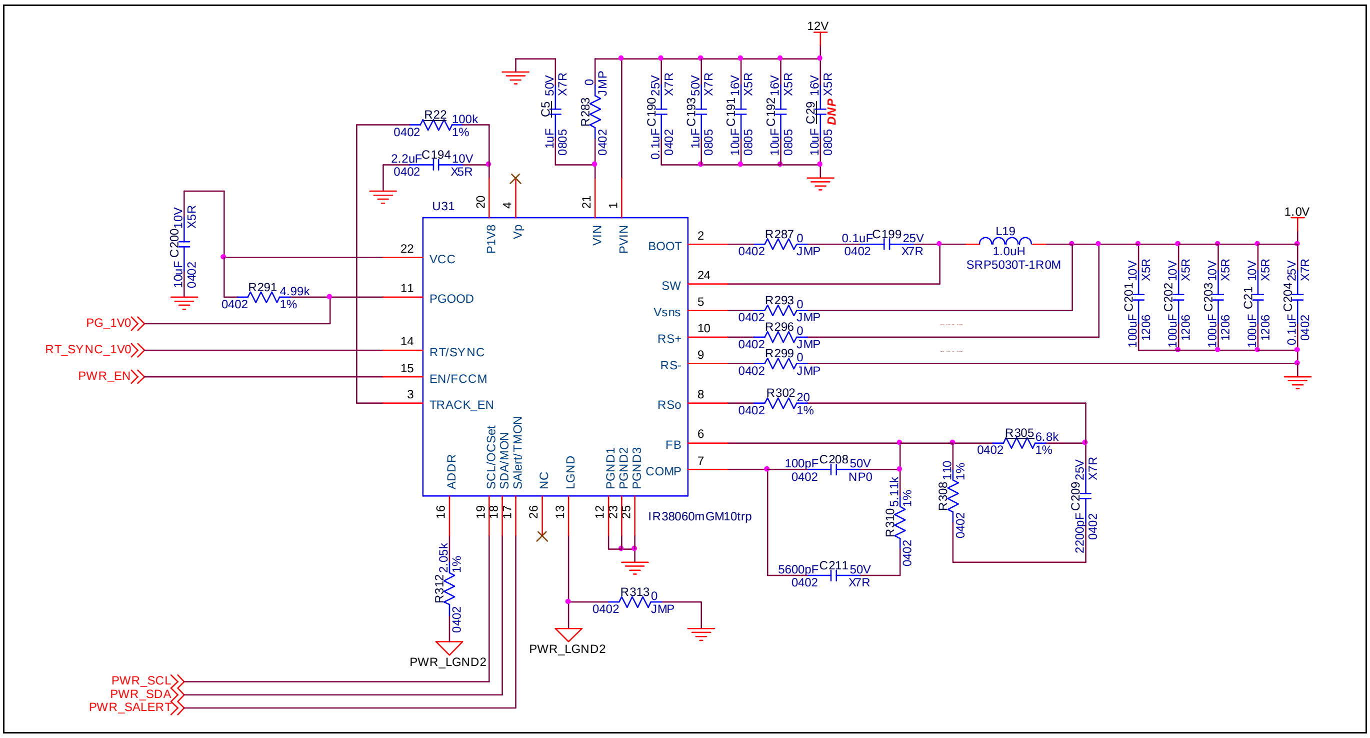

Figure 14 **IR38060 Macro Schematic**

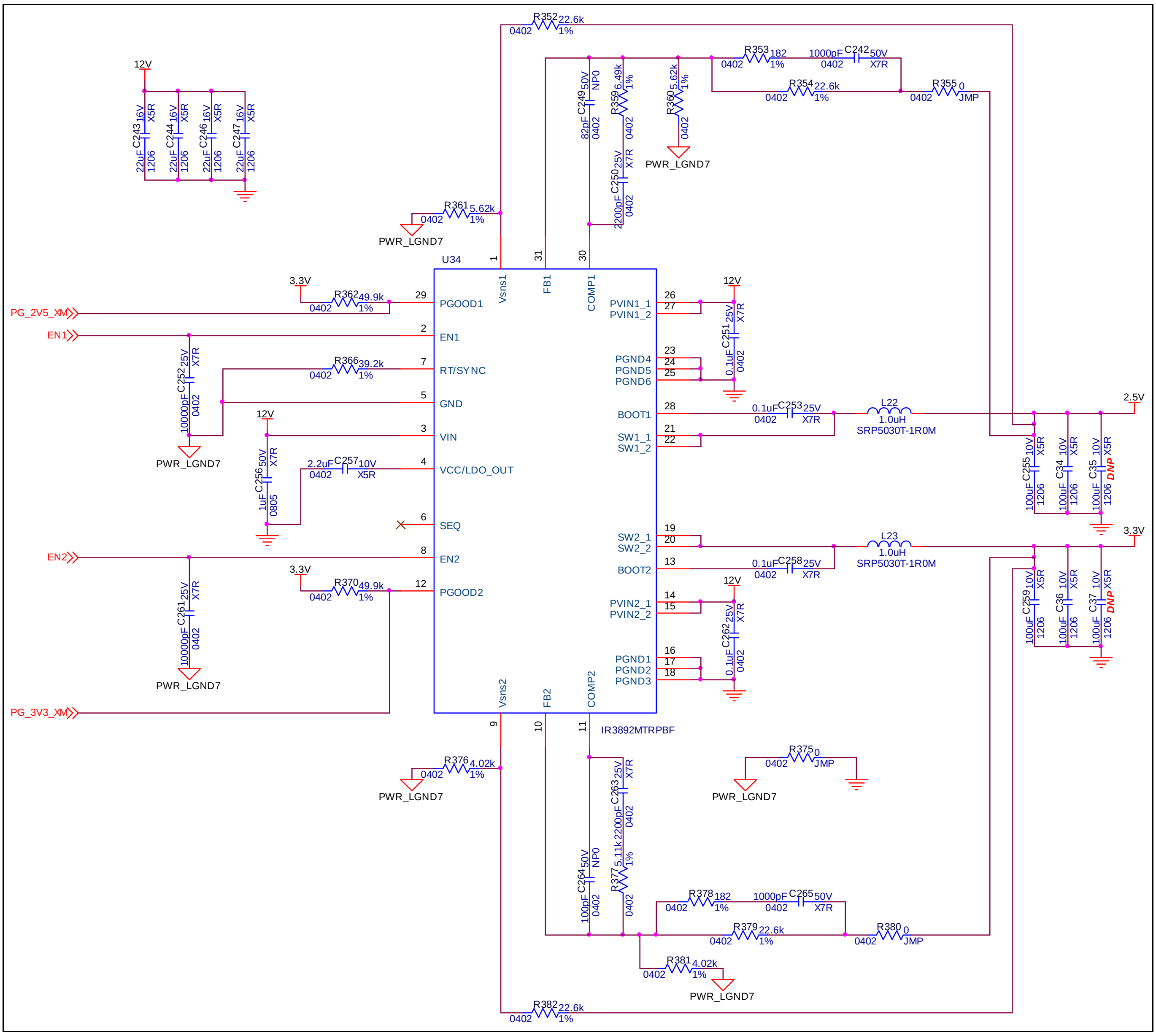

Figure 15 **IR3892 Macro Schematic**

4.2 Macro Layout

The evaluation board is comprised of six layers of 2oz copper and FR4 material. The layouts of the rails are based off the IR38060 macro layout or IR3892 macro layout. These layouts offer the user quick layout solutions and help the user approximate the area needed. The top layer and bottom layer of the IR38060 and IR3892 macros are shown below.

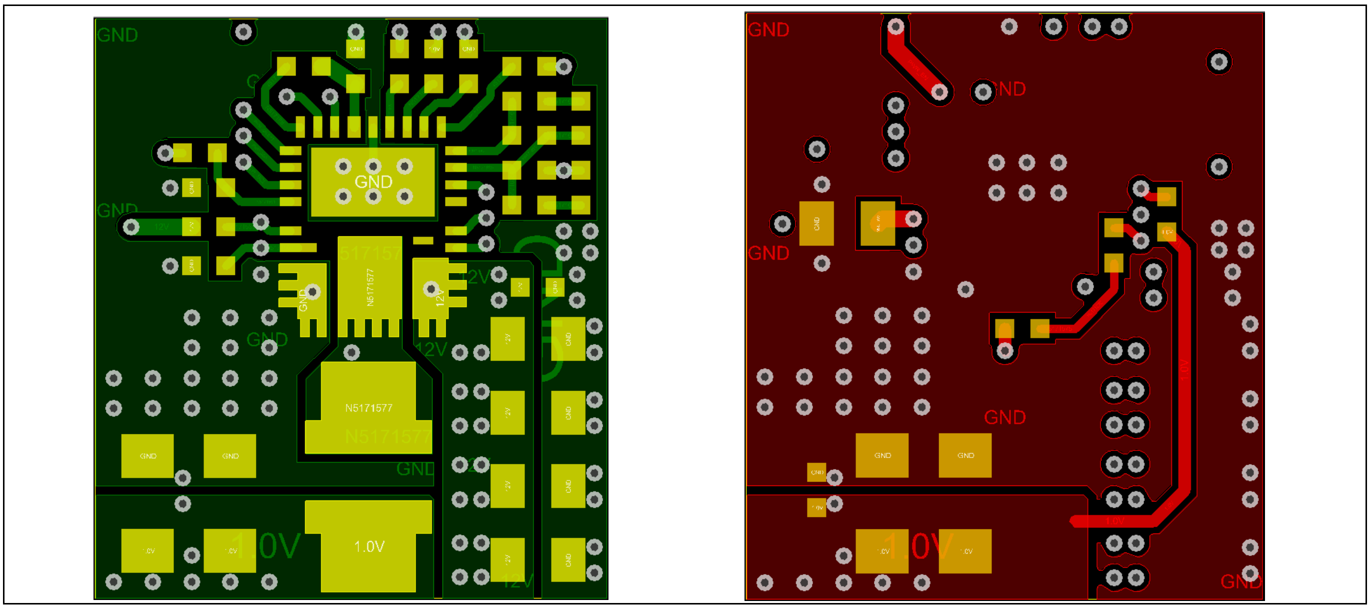

Figure 16 **Top layer of the IR38060 macro layout (15 mm x 17 mm): Top (left) and Bottom (right)**

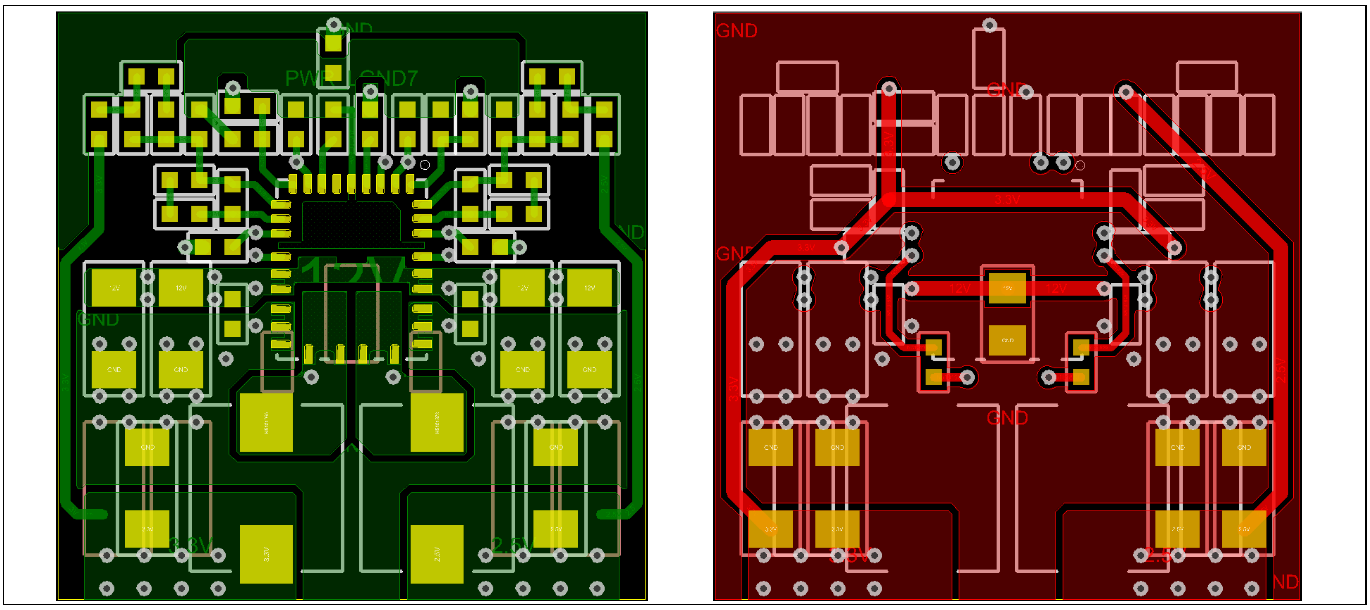

Figure 17 **Top layer of the IR3892 macro layout (20 mm x 20 mm): Top (left) and Bottom (right)**

4.3 Macro Components

Components in the macro can be changed. Inductors, input capacitors and output capacitors are critical component that are usually changed. There are guidelines for changing these components to ensure the components selected have the proper rating and parameter values.

4.3.1 Inductor

The user can substitute the Bourns SRP5030T-1R0M inductor with another comparable inductor. The replacement part should meet or exceed the IDC, ISAT and the size parameters of the proposed inductor. A few possible inductor options are listed in the table below. Some adjustment to the layout may be required to fit the inductor.

Table 5 **Inductors**

Manufacturer	P/N	Value [uH]	DCR [mΩ]	I_RMS [A]	I_SAT [A]
Bourns Inc.	SRP5030T-1R0M	1.0	14	7	11
Coilcraft	XAL5030-102ME	1.0	8.5	8.7	14
TDK Corporation	SPM6530T-1R0M120	1.0	7.81	13	14.1

4.3.2 Output Capacitor

Output capacitor can be substitute for another part, but the de-rate value and ESR should need to match. The capacitance of a ceramic capacitor depends on the voltage across the capacitor and the voltage ripple applied. In most cases, the value is reduces as the voltage increases and the ripple gets smaller. The macros are design with ceramic caps which have a low ESR values, so it will be easier to substitute the proposed cap with another brand or model of ceramic caps to mitigate the effect of the zero formed from the ESR.

Table 6 **Output Capacitor Parameters**

Manufacturer	P/N	Value [uF]	Size	Temperature	DC Rating	Description
TDK	C3216X5R1A107M160AC	1.0	1206	X5R	10V	CAP CER 100UF 10V 20% X5R 1206

4.3.3 Input Capacitors / Filter

Changing input capacitors is possible. Input capacitance is usually comprised of ceramic capacitors whose capacitance is dependent on the input voltage/DC biasing. The ceramic capacitor is required to have the proper voltage rating and the derated capacitance value should maintain a proper input voltage ripple.

Input filters with a bead or inductor are occasionally used. Input filters can alter the response and stability of the rail. If an input filter is added to the macro or the supply to the macro, bode plot measurement should be checked.

5 Interface / Connectors

5.1 Schematic

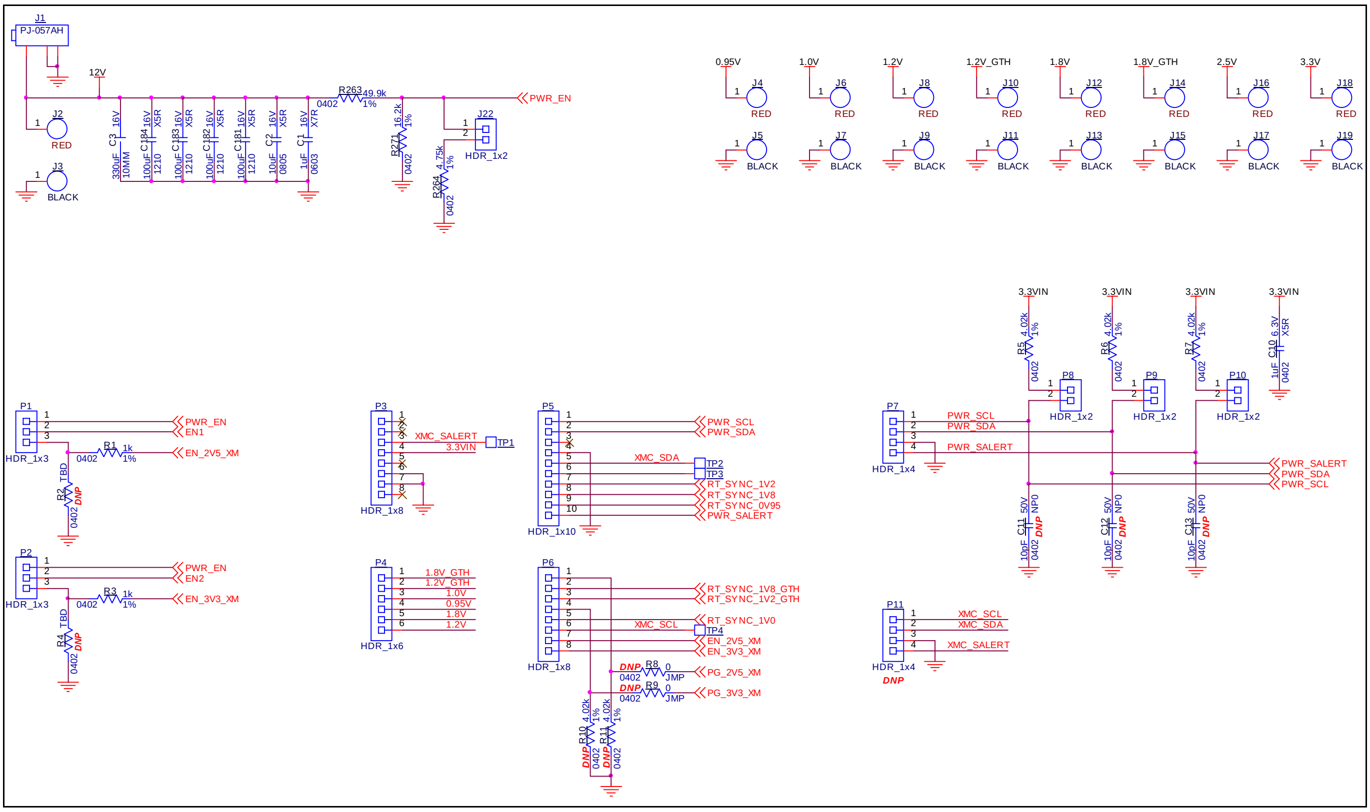

Figure 18 **Power and miscellaneous portion of the schematic**

5.2 Bill of Materials

Table 7 **Bill of materials for IR38060 0.95V (CORE) rail**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
1	C1	1uF	Murata	GRM188R71C105MA12D	-
1	C2	10uF	Murata	0805YD106KAT2A	-
1	C3	330uF	United Chemi-Con	APSC160ELL331MJC5S	-
1	C10	1uF	Murata	GRM155R60J105KE19D	-
3	C11,C12,C13	10pF	Murata	GRM1555C1H100JA01D	DNP
4	C181,C182,C183 ,C184	100uF	Taiyo Yuden	EMK325ABJ107MM-T	-
1	J1	PJ-057AH	CUI Inc.	PJ-057AH	-
9	J2,J4,J6,J8,J10,J 12,J14,	RED			-
	J16,J18				
9	J3,J5,J7,J9,J11,J 13,J15,	BLACK			-
	J17,J19				
4	P8,P9,P10,J22	HDR_1x2	-	-	-
2	P1,P2	HDR_1x3	-	-	-
2	P3,P6	HDR_1x8	-	-	-
1	P4	HDR_1x6	-	-	-
1	P5	HDR_1x10	-	-	-
1	P7	HDR_1x4	-	-	-
1	P11	HDR_1x4	-	-	DNP
2	R1,R3	1k	Yageo	RC0402FR-071KL	-
2	R2,R4	TBD	TBD	TBD	DNP
3	R5,R6,R7	4.02k	Vishay Dale	CRCW04024K02FKED	-
2	R8,R9	0	Vishay Dale	CRCW04020000Z0ED	DNP
2	R10,R11	4.02k	Vishay Dale	CRCW04024K02FKED	DNP
1	R263	49.9k	Panasonic	ERJ-2RKF4992X	-
1	R264	4.75k	Bourns	CR0402-FX-4751GLF	-
1	R271	16.2k	Vishay Dale	CRCW040216K2FKED	-
4	TP1,TP2,TP3,TP 4	TP_SMD_PAD			

6 IR38060: CORE 0.95V

6.1 Schematic

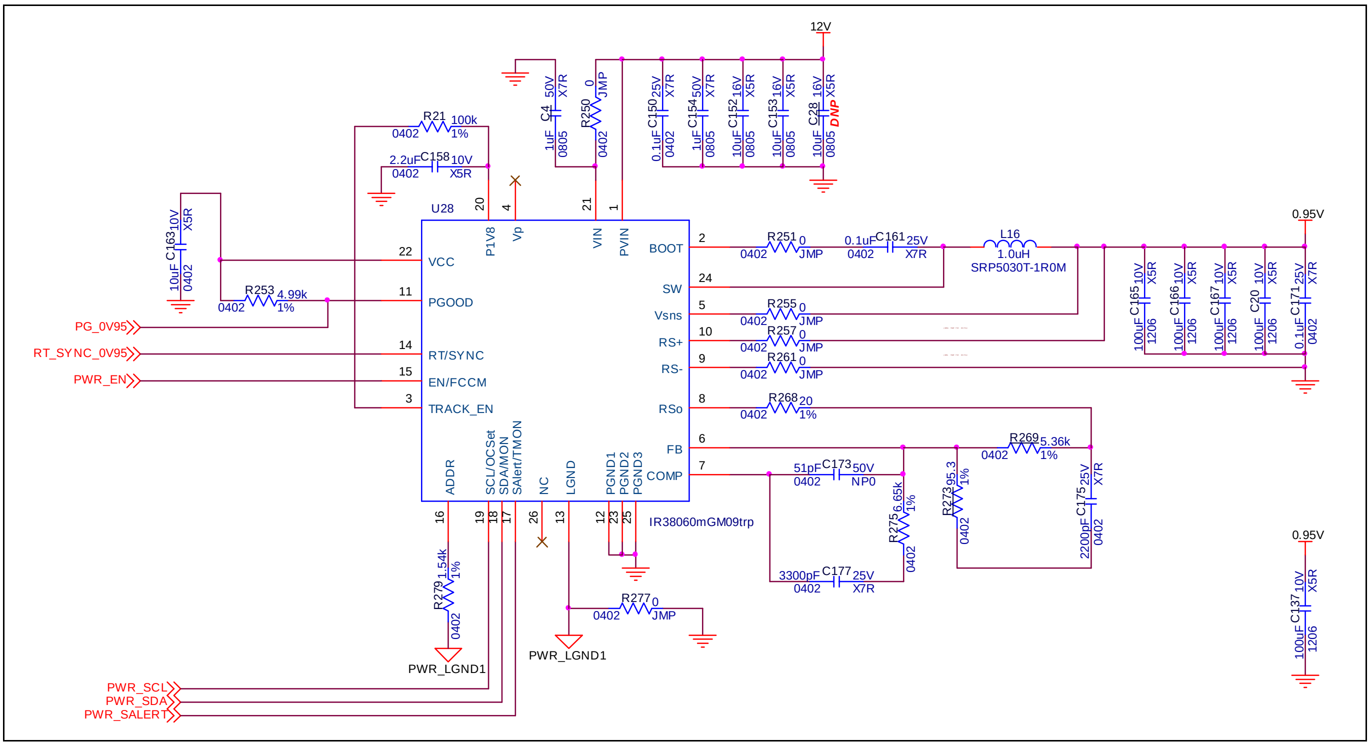

Figure 19 **Schematic for IR38060 0.95V (CORE) rail**

6.2 Bill of Materials

Table 8 **Bill of materials for IR38060 0.95V (CORE) rail**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C4, C154	1uF	Taiyo Yuden	UMK212B7105KG-T	-
5	C20, C137, C165, C166, C167	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C28	10uF	Murata	0805YD106KAT2A	DNP
3	C150, C161, C171	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C152, C153	10uF	Murata	0805YD106KAT2A	-
1	C158	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C163	10uF	Panasonic	CL05A106MP5NUNC	-
1	C173	51pF	Murata	GRM1555C1H510JA01D	-
1	C175	2200pF	Kemet	C0402C222K3RACTU	-
1	C177	3300pF	Kemet	C0402C332K3RACTU	-
1	L16	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R21	100k	Panasonic	ERJ-2RKF1003X	-
6	R250, R251, R255, R257, R261, R277	0	Vishay Dale	CRCW04020000Z0ED	-
1	R253	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R268	20	Panasonic	ERJ-2RKF20R0X	-
1	R269	5.36k	Yageo	RC0402FR-075K36L	-
1	R273	95.3	Vishay Dale	CRCW040295R3FKED	-
1	R275	6.65k	Panasonic	ERJ-2RKF6651X	-
1	R279	1.54k	Vishay Dale	CRCW04021K54FKED	-
1	U28	IR38060mGM09trp	Infineon Technologies	IR38060mGM09trp	-

6.3 Typical Waveforms

PVin = Vin = 12V; Vout = 0.95V; Fsw = 607kHz

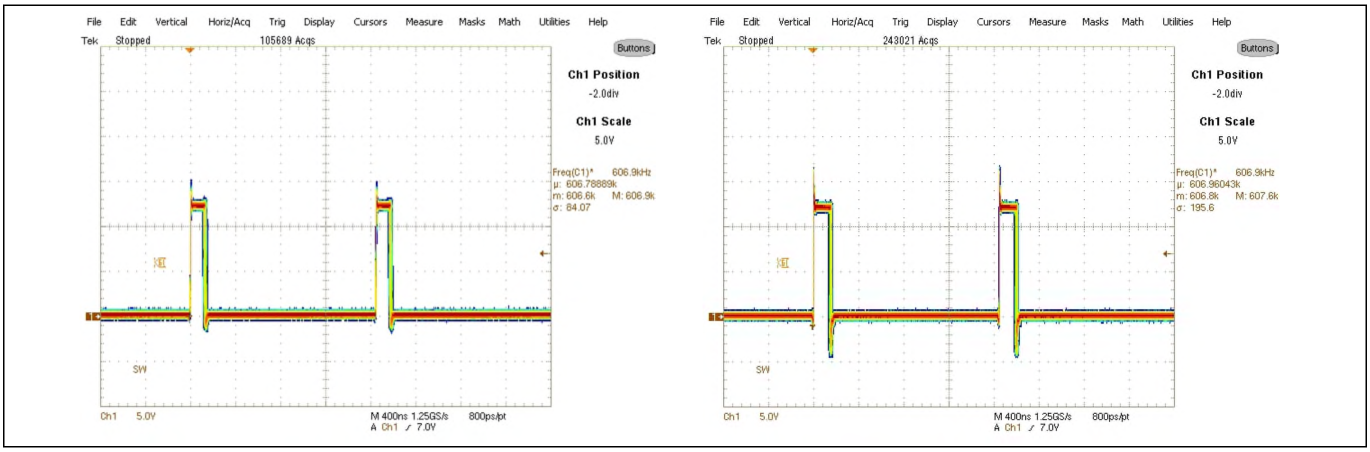

Figure 20 **IR38060 0.95V (CORE) switch node waveforms: 0A (left) and 6A (right)**

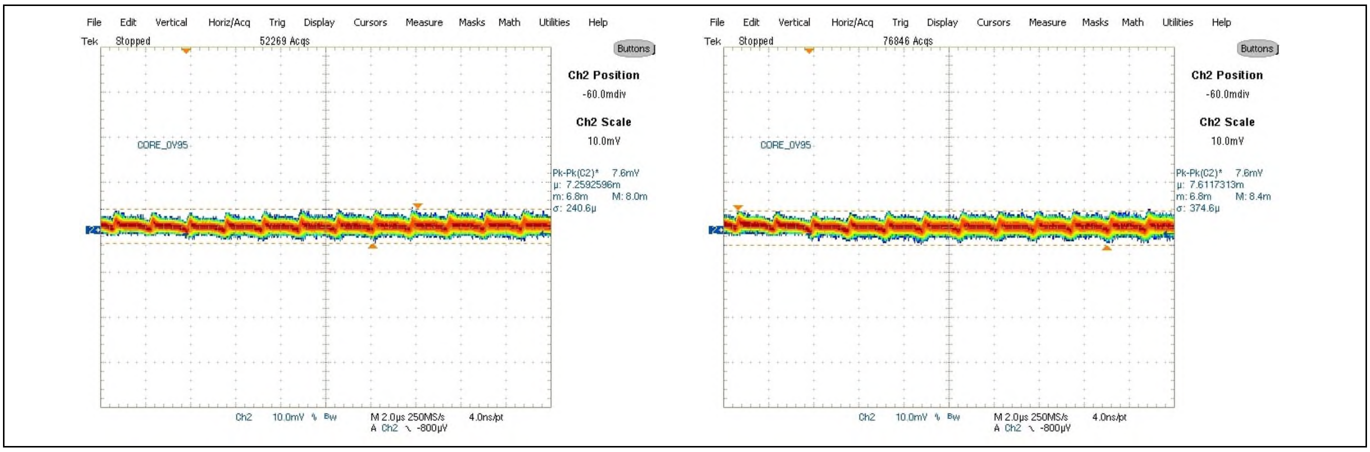

Figure 21 **IR38060 0.95V (CORE) output ripple @ C20: 0A (left) and 6A (right)**

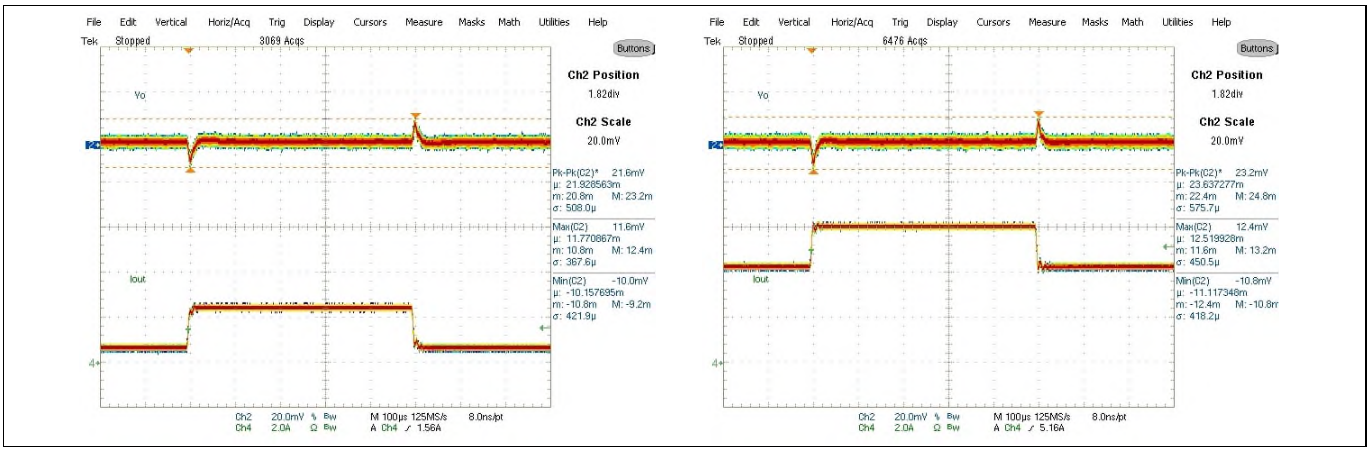

Figure 22 **IR38060 0.95V (CORE) transient response @ C20: 0.6A-2.4A @ 2.5/uS (left) and 4.2A-6A @ 2.5/uS (right)**

6.4 Bode Plot

PVin = Vin = 12V; Vout = 0.95V; Fsw = 607kHz

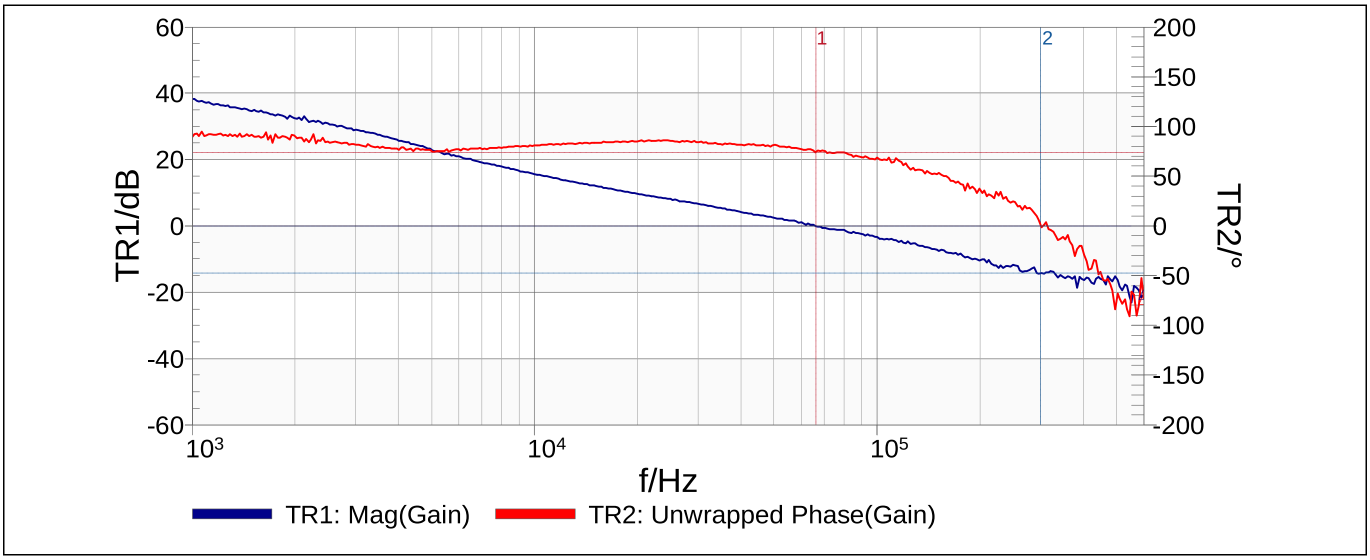

Figure 23 **Bode plot of IR38060 0.95V (CORE) with 0A load**

Fo = 66.1 kHz
Phase Margin = 74.0 Degrees
Gain Margin = -14.2 dB

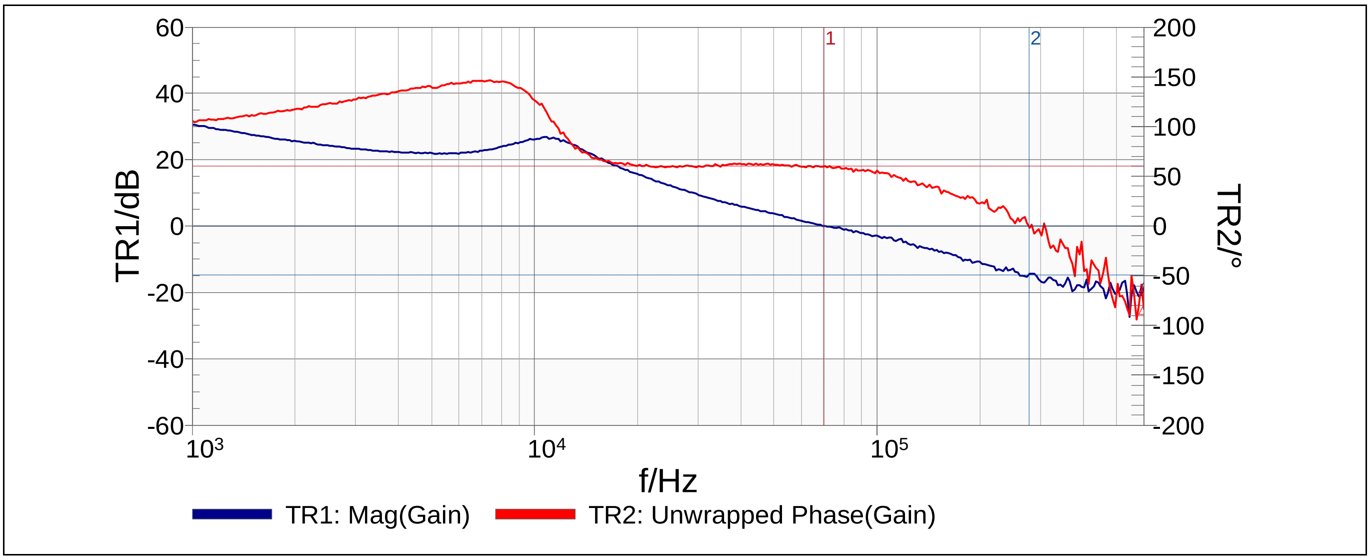

Figure 24 **Bode plot of IR38060 0.95V (CORE) with 6A load**

Fo = 69.9 kHz
Phase Margin = 60.0 Degrees
Gain Margin = -14.8 dB

6.5 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 0.95V, Fsw = 607kHz

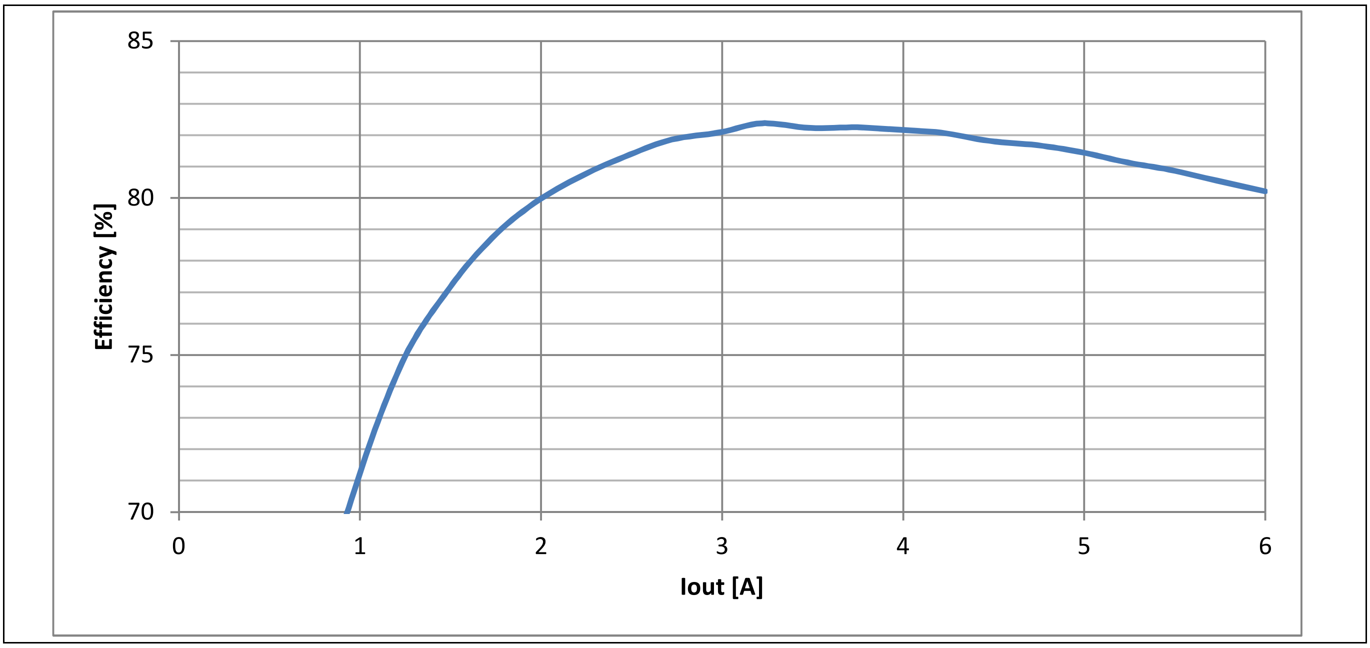

Figure 25 **Efficiency of the IR38060 regulating 0.95V (CORE) @ 6A from a 12V input**

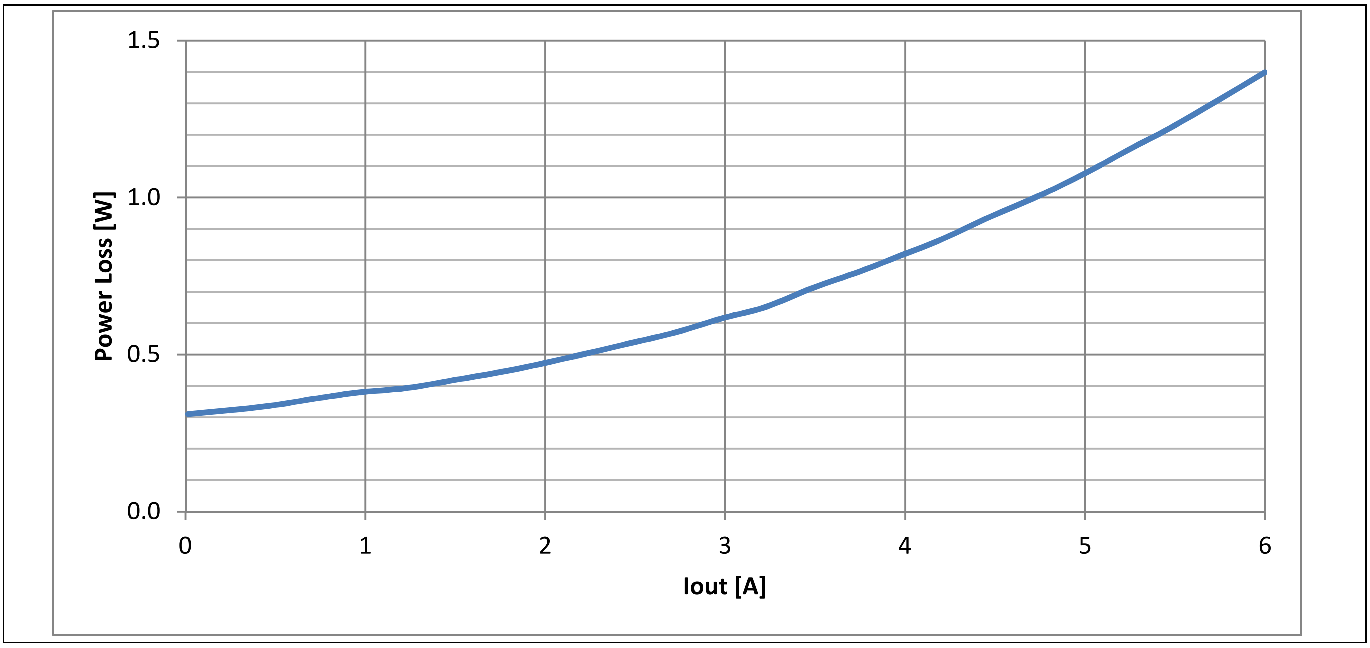

Figure 26 **IR38060 power loss while regulating 0.95V (CORE) @ 6A from a 12V input**

6.6 Thermal Image

PVin = Vin = 12V, Vout = 0.95V, Fsw = 607kHz, Iout = 6A

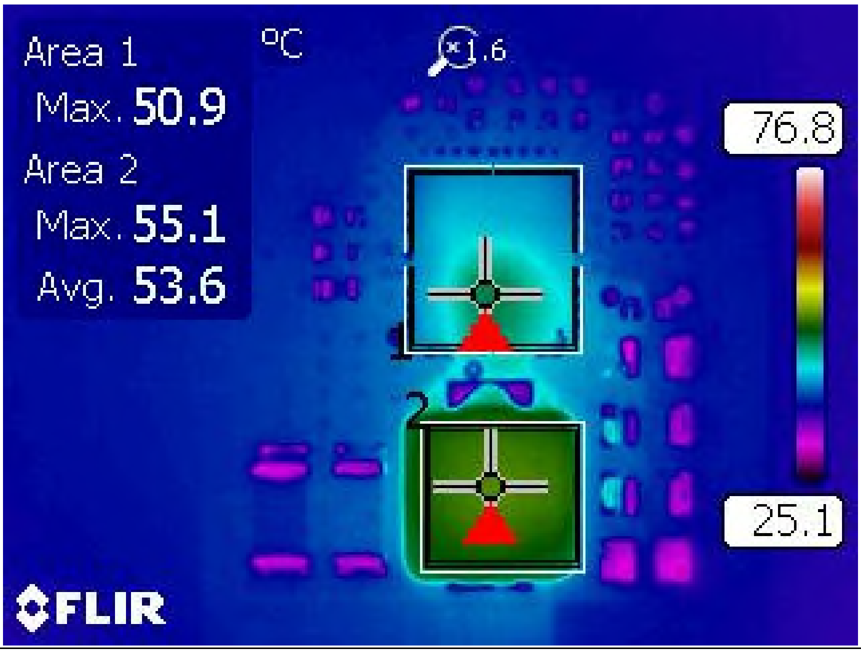

Figure 27 **Thermal image of IR38060 running 1.0V @ 6A from 12V Input**

IR38060	50.9°C
Inductor	55.1 °C
Ambient Temperature	28 °C

7 IR38060: SERDES 1.0V

7.1 Schematic

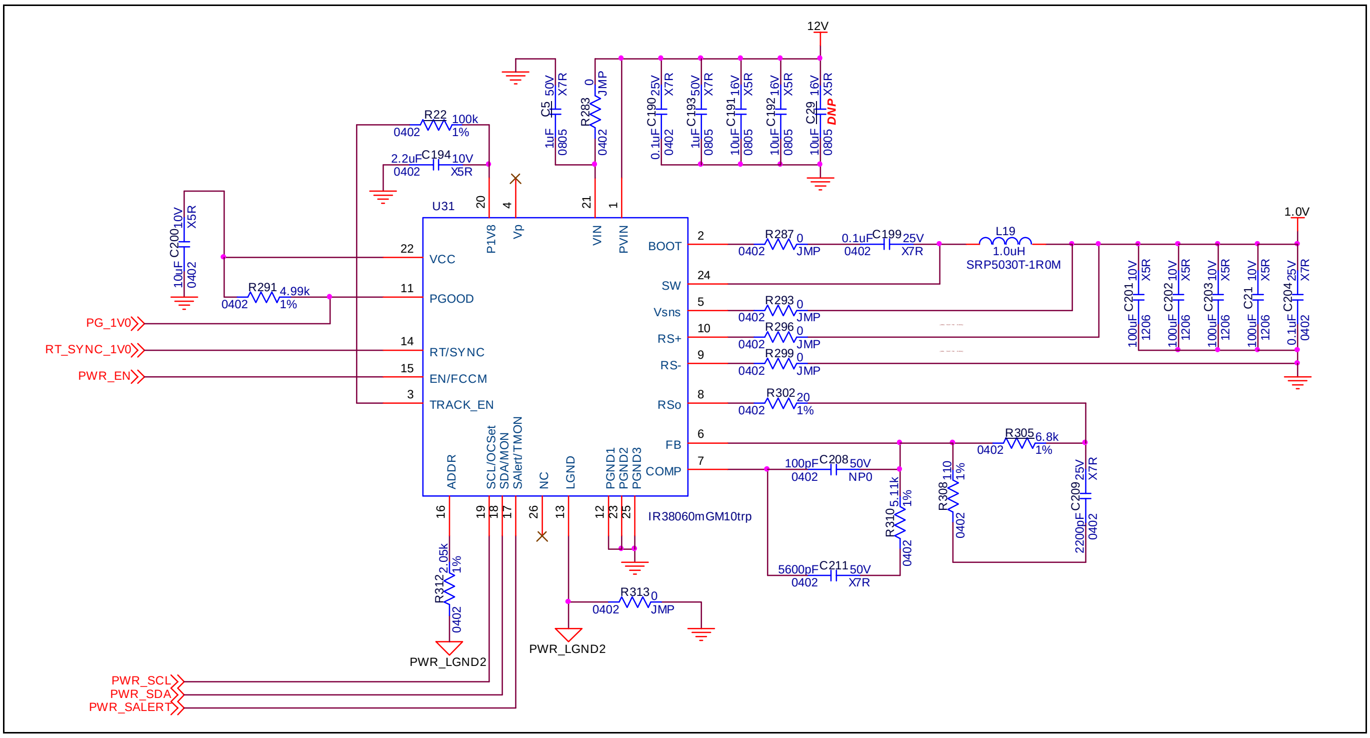

Figure 28 **Schematic of IR38060 1.0v SERDES**

7.2 Bill of Material

Table 9 **Bill of materials for IR38060 1.0V (SERDES)**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C5,C193	1uF	Taiyo Yuden	UMK212B7105KG-T	-
4	C21, C201, C202, C203	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C29	10uF	Murata	0805YD106KAT2A	DNP
3	C190, C199, C204	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C191, C192	10uF	Murata	0805YD106KAT2A	-
1	C194	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C200	10uF	Panasonic	CL05A106MP5NUNC	-
1	C208	100pF	Murata	GRM1555C1H101JA01D	-
1	C209	2200pF	Kemet	C0402C222K3RACTU	-
1	C211	5600pF	Murata	GRM155R71H562KA88D	-
1	L19	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R22	100k	Panasonic	ERJ-2RKF1003X	-
6	R283, R287, R293, R296, R299, R313	0	Vishay Dale	CRCW04020000Z0ED	-
1	R291	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R302	20	Panasonic	ERJ-2RKF20R0X	-
1	R305	6.8k	Panasonic	ERJ-2RKF6801X	-
1	R308	110	Panasonic	ERJ-2RKF1100X	-
1	R310	5.11k	Vishay Dale	CRCW04025K11FKED	-
1	R312	2.05k	Vishay Dale	CRCW04022K05FKED	-
1	U31	IR38060mGM10trp	Infineon Technologies	IR38060mGM10trp	-

7.3 Typical Waveforms

PVin = Vin = 12V; Vout = 1.0V; Fsw = 607kHz

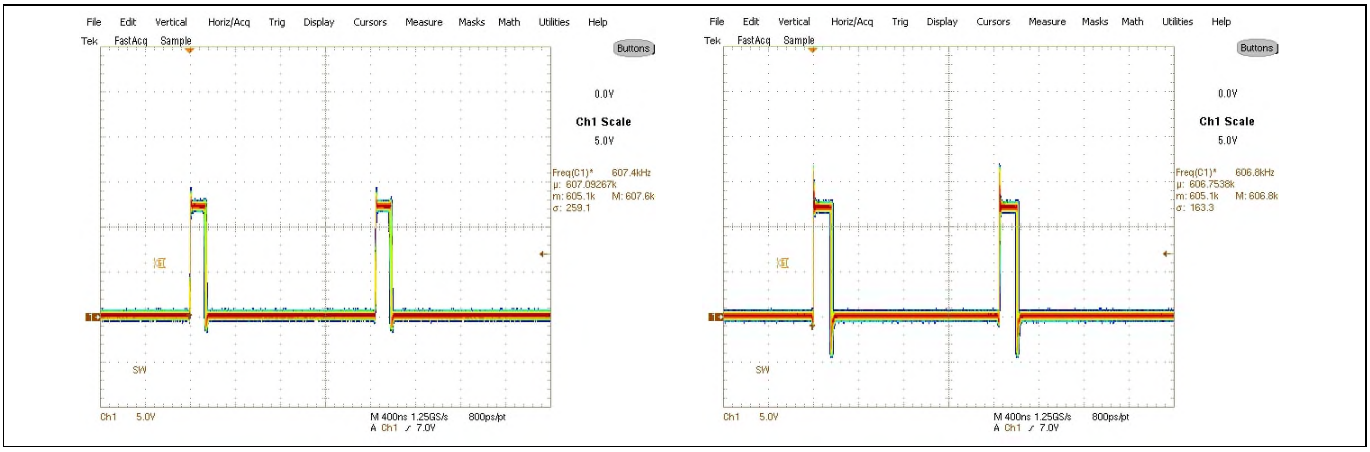

Figure 29 **IR38060 1.0V (SERDES) switch node: 0A (left) and 6A (right)**

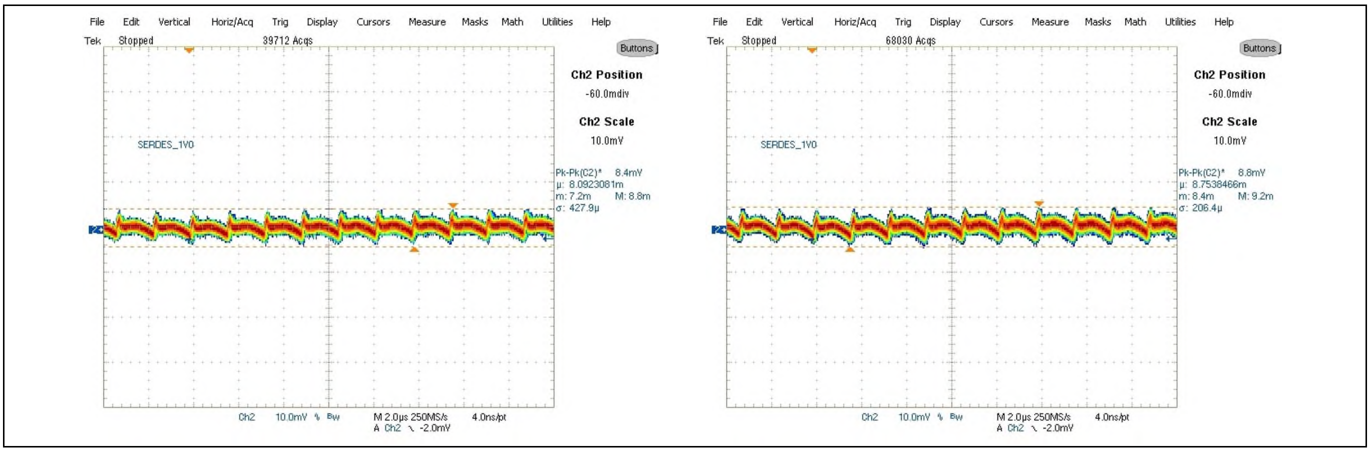

Figure 30 **IR38060 1.0V (SERDES) output ripple @ C21: 0A (left) and 6A (right)**

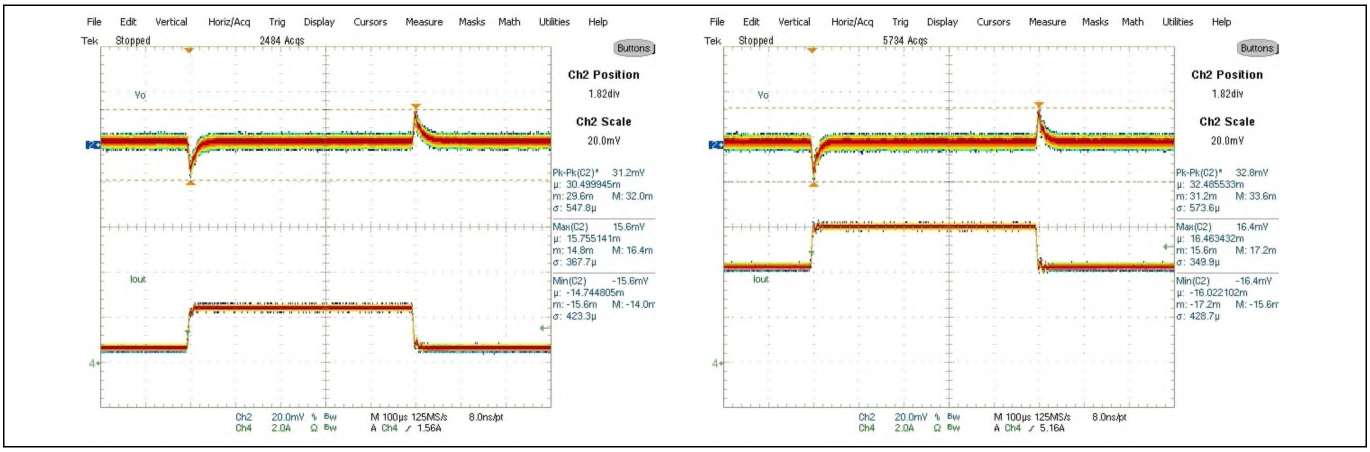

Figure 31 **IR38060 1.0V (SERDES) transient response @ C21: 0.6A-2.4A @ 2.5/uS (left) and 4.2A-6A @ 2.5/uS (right)**

7.4 Bode Plot

PVin = Vin = 12V; Vout = 1.0V; Fsw = 607kHz

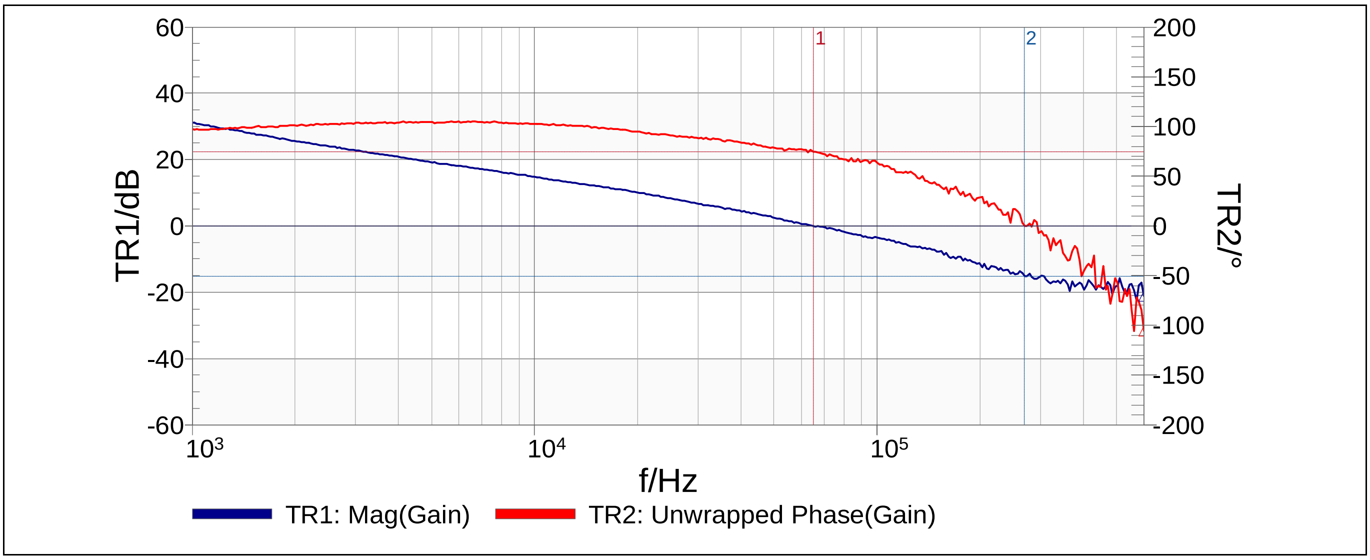

Figure 32 **Bode plot of IR38060 1.0V (SERDES) with 0A load**

Fo = 65.1 kHz
Phase Margin = 74.6 Degrees
Gain Margin = -15.1 dB

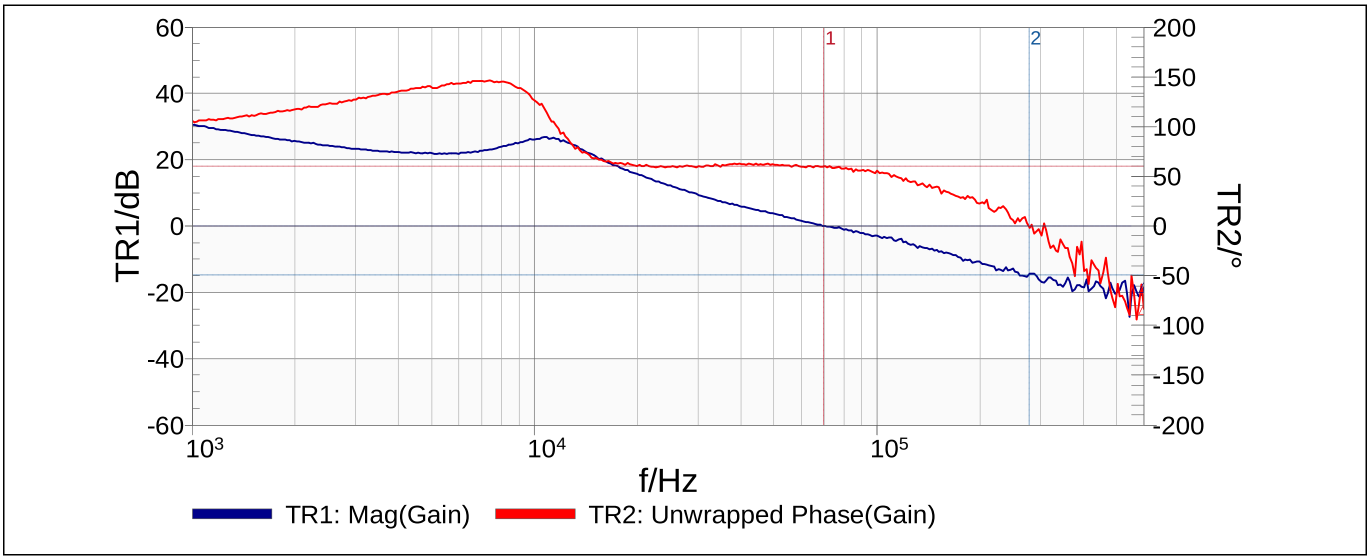

Figure 33 **Bode plot of IR38060 1.0V (SERDES) with 0A load**

Fo = 69.9 kHz
Phase Margin = 60.0 Degrees
Gain Margin = -14.8 dB

7.5 Efficiency and Power Loss

PVin = Vin = 12v, Vout = 1.0V, Fsw = 607kHz

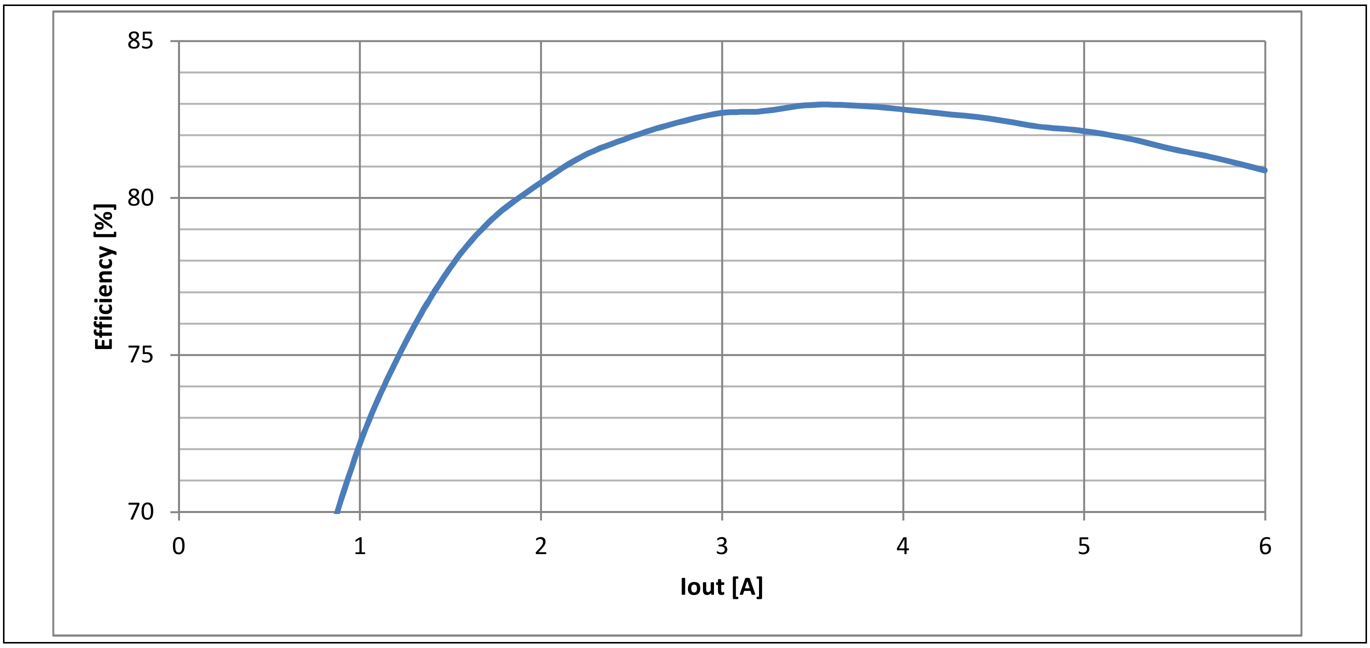

Figure 34 **Efficiency of the IR38060 regulating 1.0V @ 6A from a 12V input**

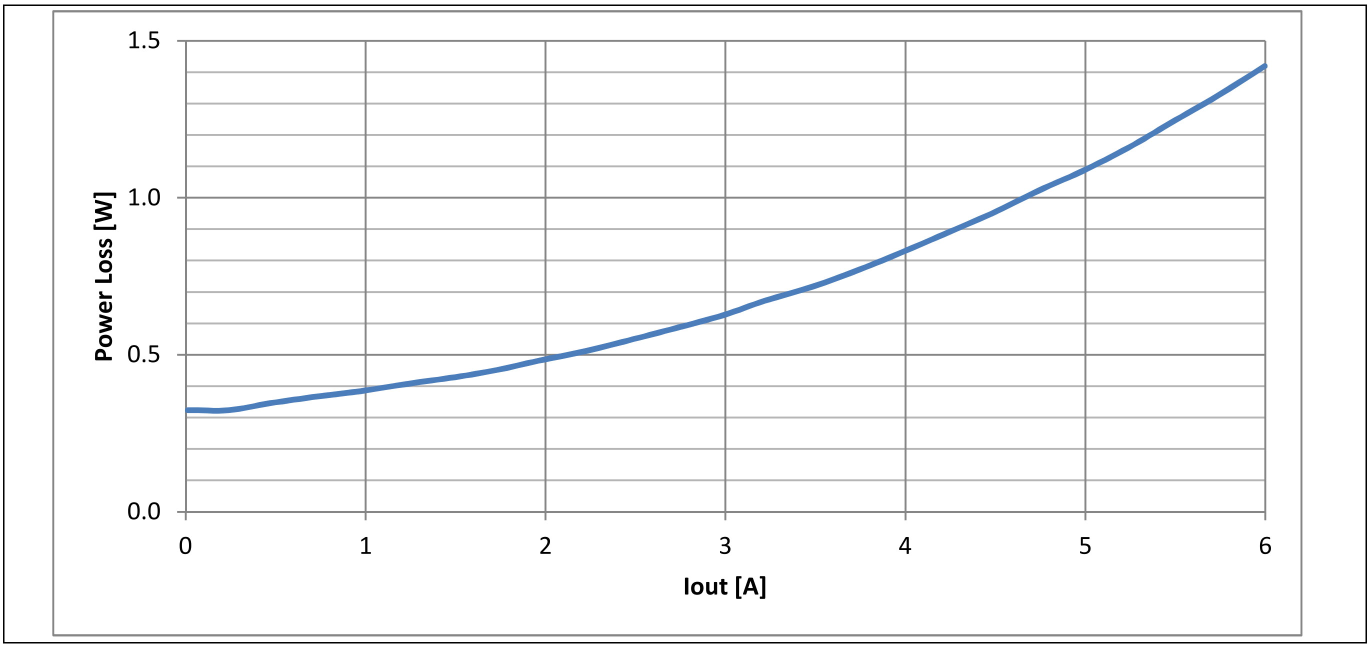

Figure 35 **IR38060 power loss while regulating 1.0V @ 6A from a 12V input**

7.6 Thermal Image

PVin = Vin = 12V, Vout = 1.0V, Fsw = 607kHz, Iout = 6A

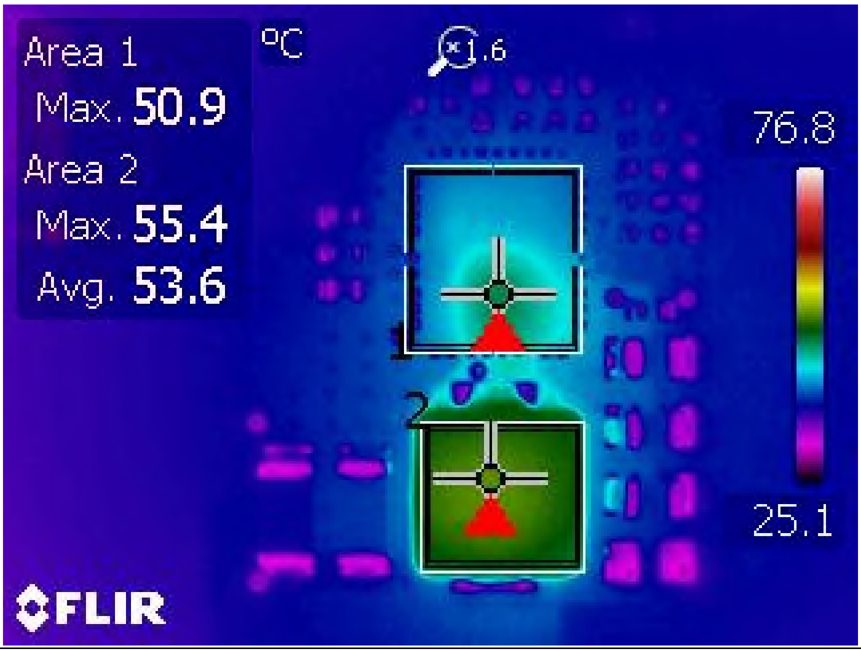

Figure 36 **Thermal image of IR38060 running 1.0V @ 6A from 12V Input**

IR38060	50.9°C
Inductor	55.5 °C
Ambient Temperature	28 °C

8 IR38060: VCCO / DDR4 1.2V

8.1 Schematic

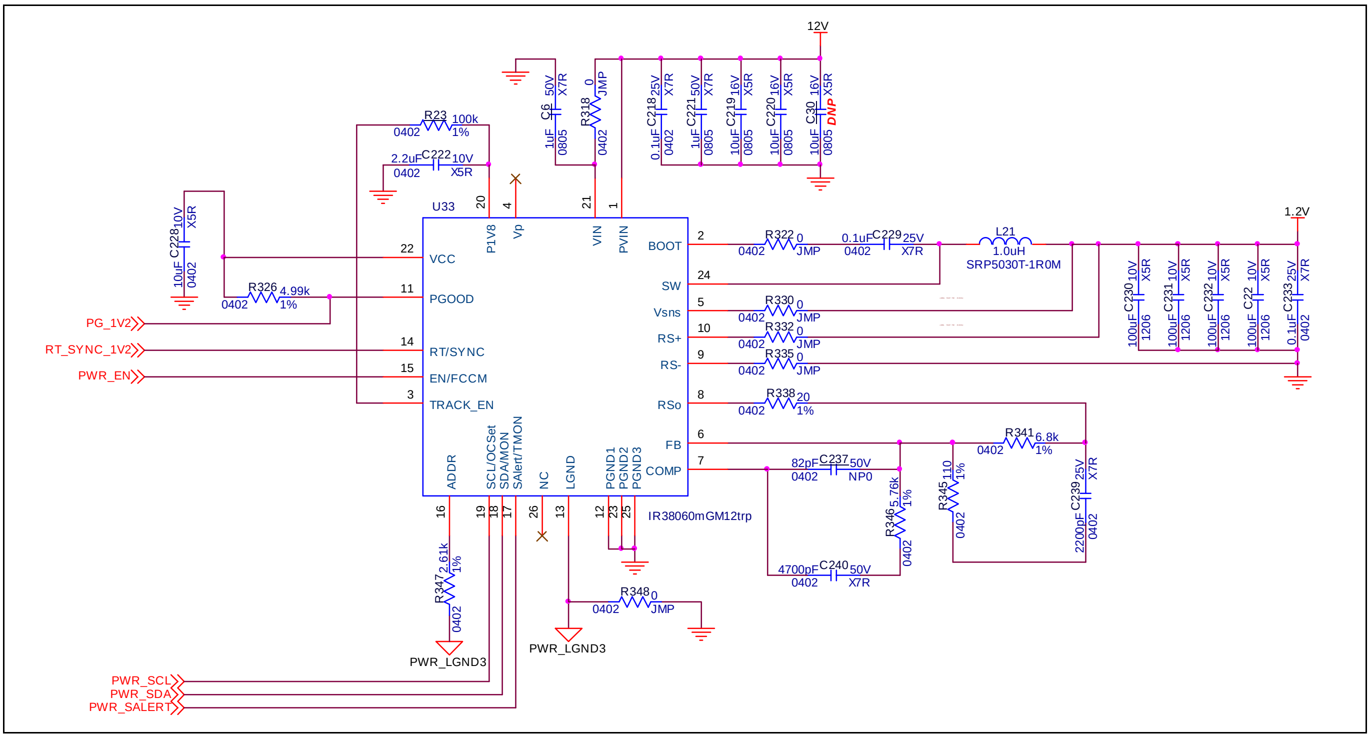

Figure 37 **Schematic for IR38060 1.2V (VCCO/DDR4)**

8.2 Bill of Materials

Table 10 **Bill of materials for IR38060 1.2V (VCCO / DDR4)**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C6, C221	1uF	Taiyo Yuden	UMK212B7105KG-T	-
4	C22, C230, C231, C232	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C30	10uF	Murata	0805YD106KAT2A	DNP
3	C218, C229, C233	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C219, C220	10uF	Murata	0805YD106KAT2A	-
1	C222	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C228	10uF	Panasonic	CL05A106MP5NUNC	-
1	C237	82pF	Murata	GRM1555C1H820JA01D	-
1	C239	2200pF	Kemet	C0402C222K3RACTU	-
1	C240	4700pF	Murata	GRM155R71H472KA01J	-
1	L21	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R23	100k	Panasonic	ERJ-2RKF1003X	-
6	R318, R322, R330, R332, R335, R348	0	Vishay Dale	CRCW04020000Z0ED	-
1	R326	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R338	20	Panasonic	ERJ-2RKF20R0X	-
1	R341	6.8k	Panasonic	ERJ-2RKF6801X	-
1	R345	110	Panasonic	ERJ-2RKF1100X	-
1	R346	5.76k	Panasonic	ERJ-2RKF5761X	-
1	R347	2.61k	Vishay Dale	CRCW04022K61FKED	-
1	U33	IR38060mGM12trp	Infineon Technologies	IR38060mGM12trp	-

8.3 Typical Waveforms

PVin = Vin = 12V; Vout = 1.2V; Fsw = 607kHz

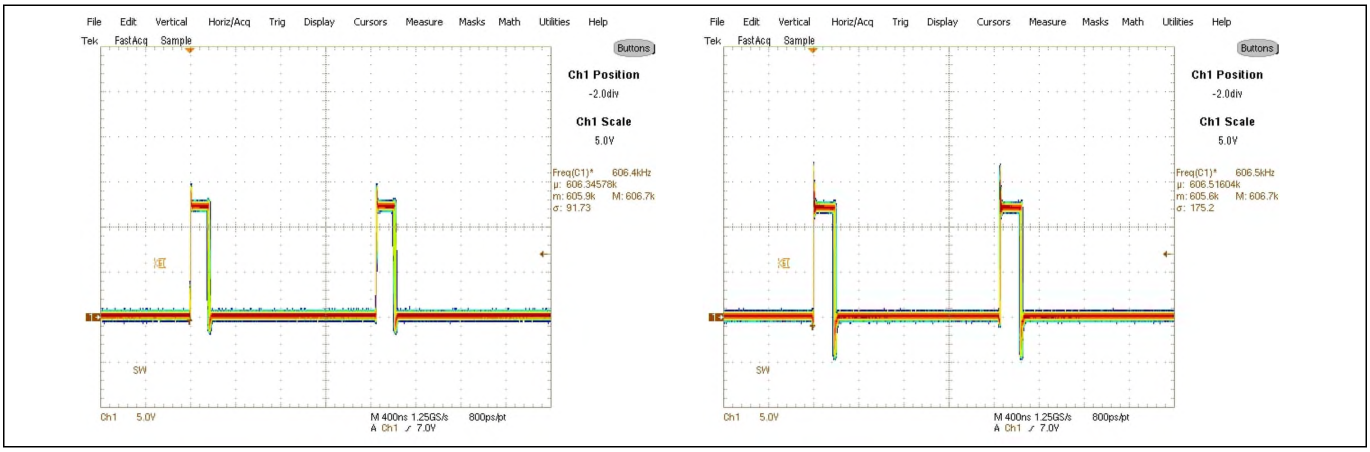

Figure 38 **IR38060 1.2V (VCCO/DDR4) switch node: 0A (left) and 6A (right)**

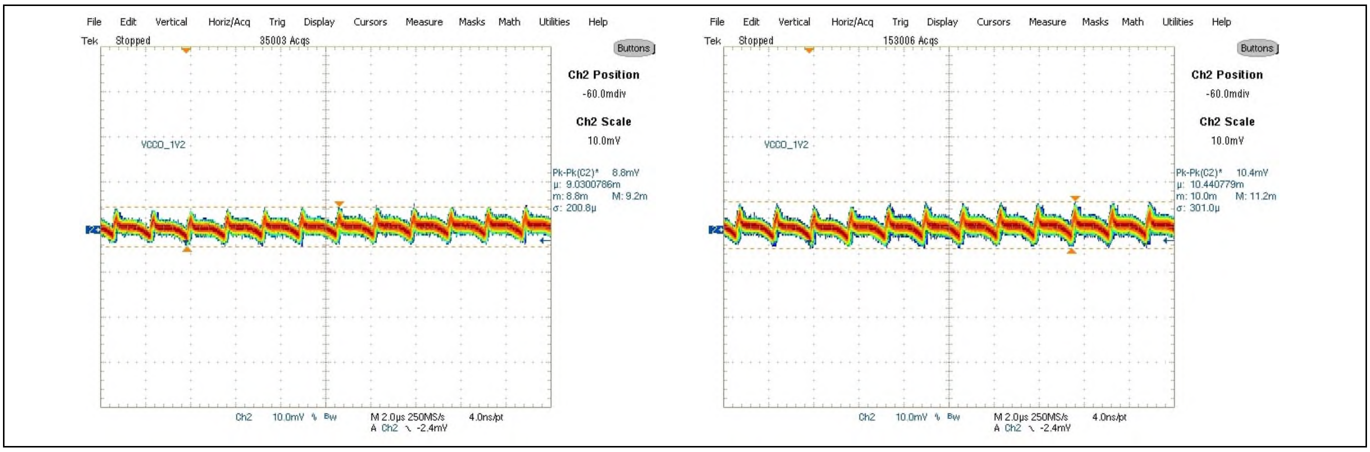

Figure 39 **IR38060 1.2V (VCCO/DDR4) output ripple @ C22: 0A (left) and 6A (right)**

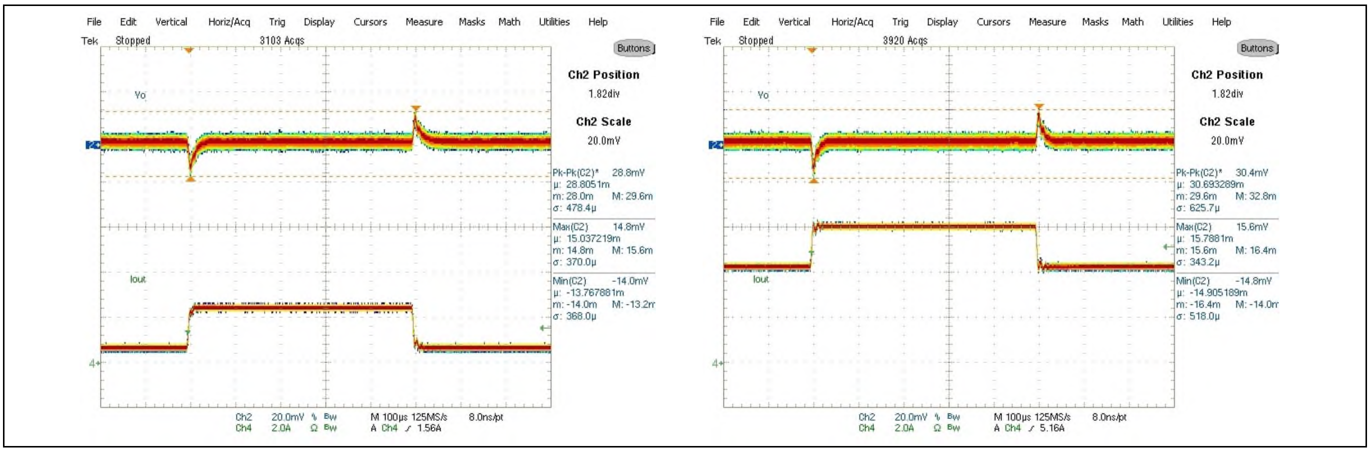

Figure 40 **IR38060 1.2V (VCCO/DDR4) transient response @ C22: 0.6A-2.4A @ 2.5/uS (left) and 4.2A-6A @ 2.5/uS (right)**

8.5 Bode Plot

PVin = Vin = 12V; Vout = 1.2V; Fsw = 607kHz

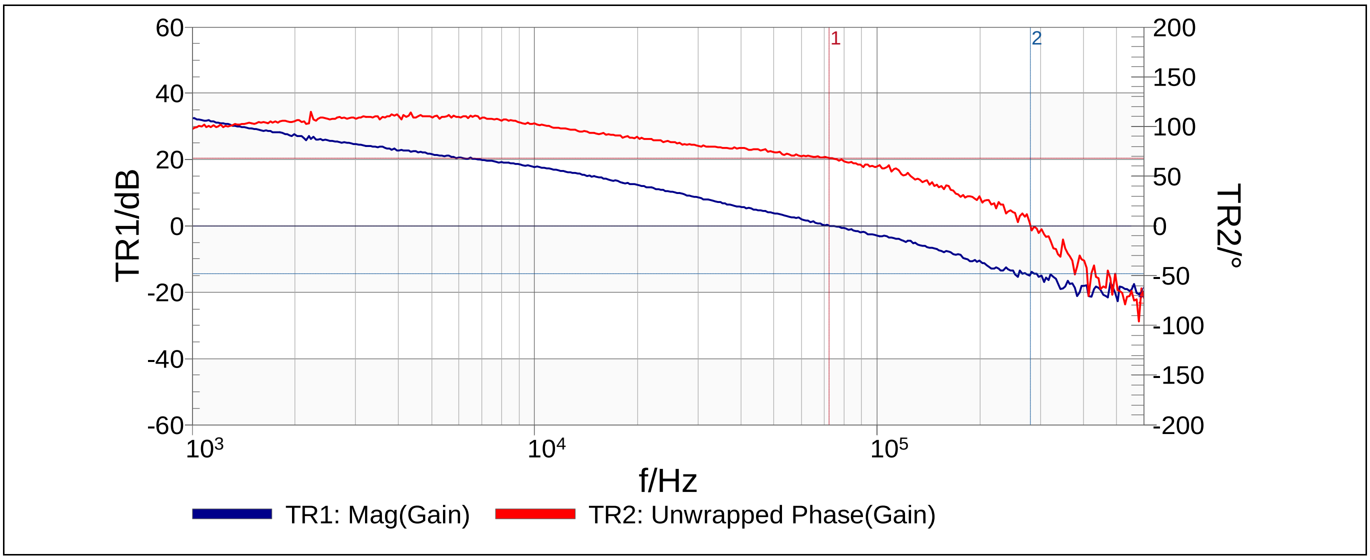

Figure 41 **Bode plot of IR38060 1.0V (SERDES) with 0A load**

Fo = 72.5 kHz
Phase Margin = 68.1 Degrees
Gain Margin = -14.5 dB

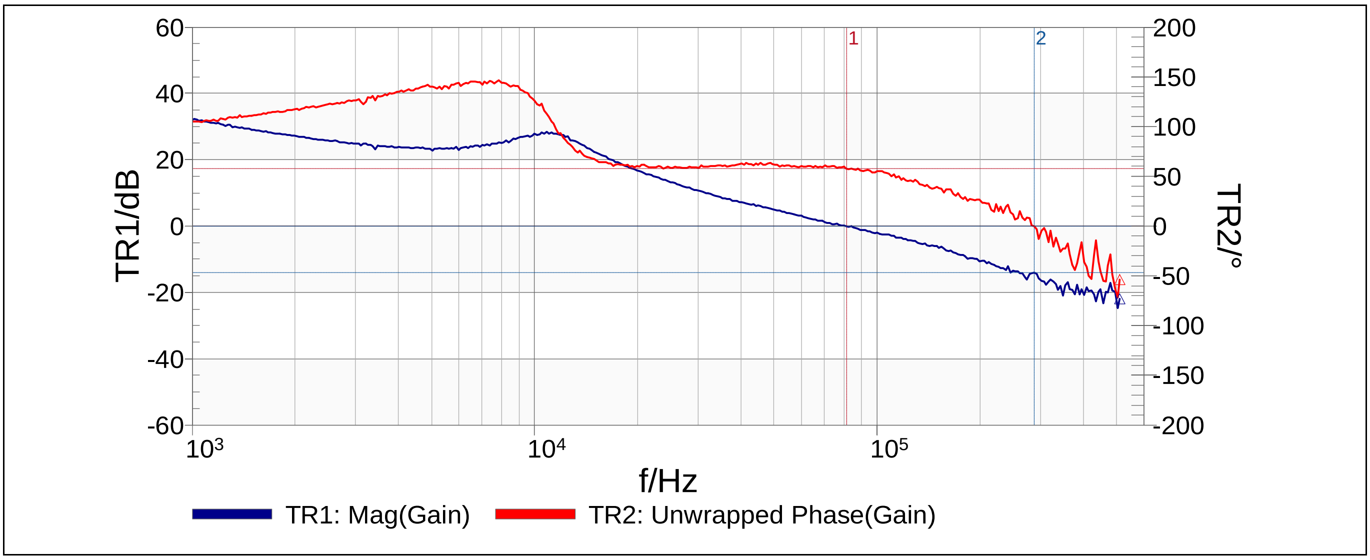

Figure 42 **Bode plot of IR38060 1.0V (SERDES) with 6A load**

Fo = 81.5 kHz
Phase Margin = 57.6 Degrees
Gain Margin = -14.0 dB

8.6 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 1.2V, Fsw = 607kHz

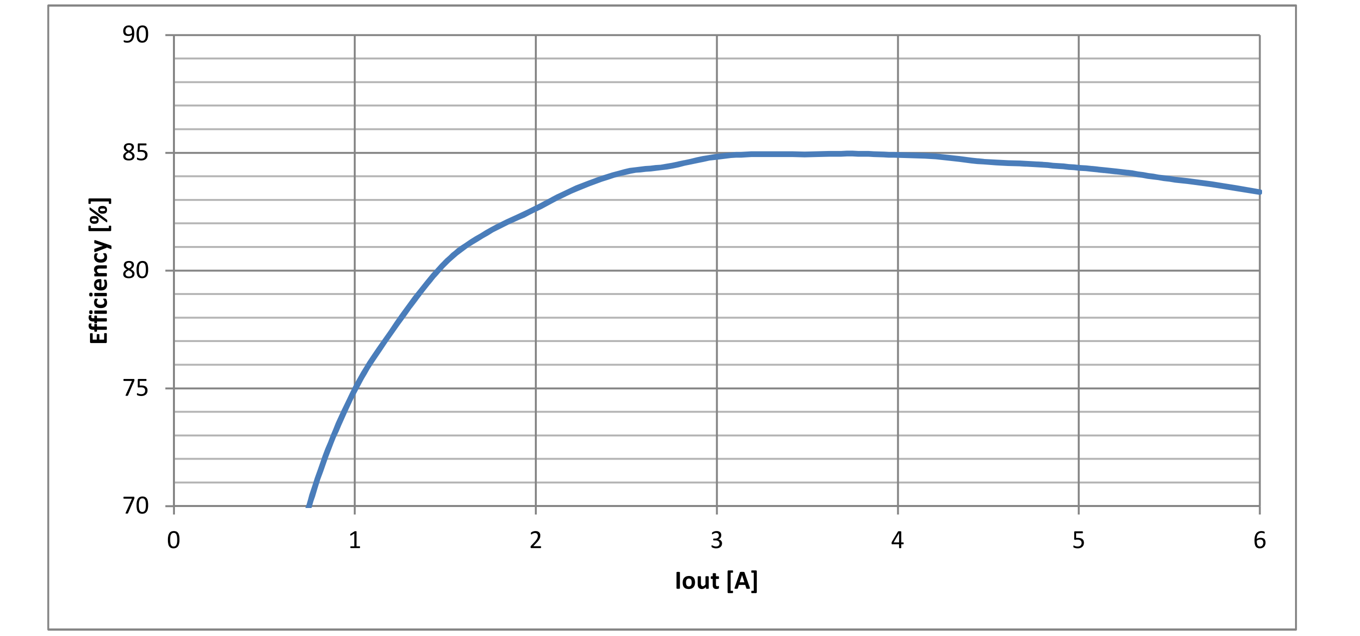

Figure 43 **Efficiency of the IR38060 regulating 1.2V @ 6A from a 12V input**

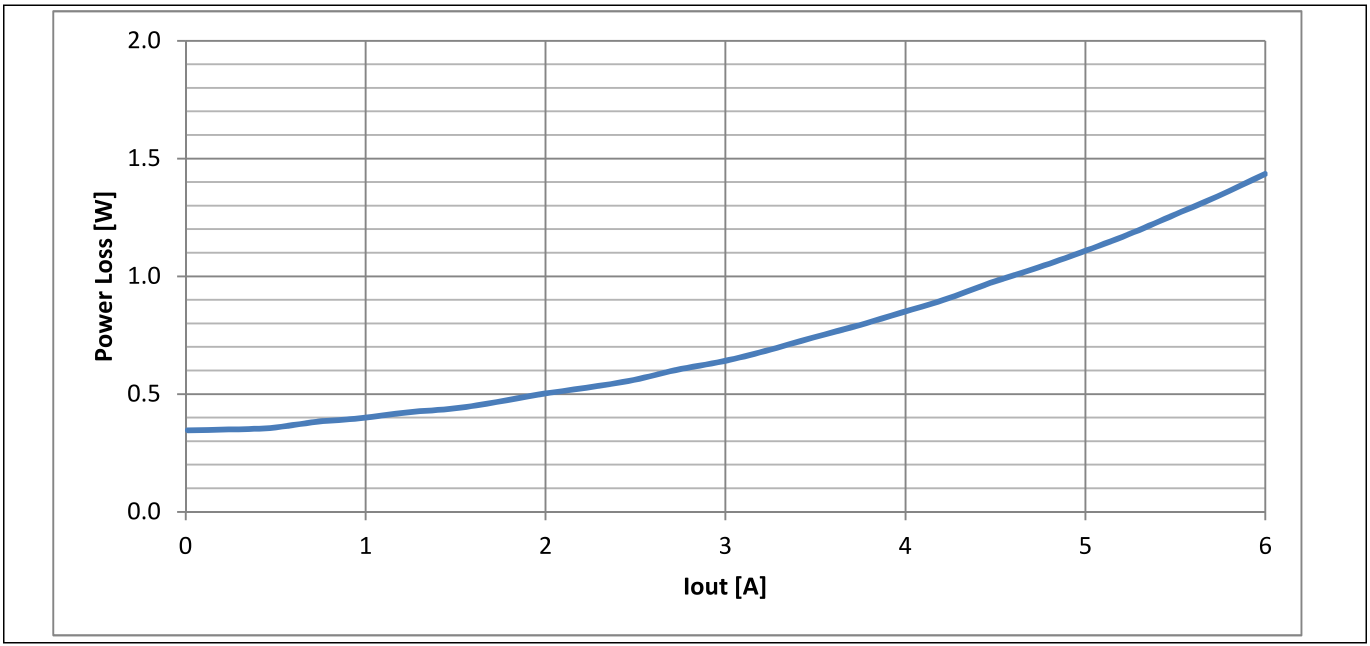

Figure 44 **IR38060 power loss while regulating 1.2V @ 6A from a 12V input**

8.7 Thermal Image

PVin = Vin = 12V, Vout = 1.2V, Fsw = 607kHz, Iout = 6A

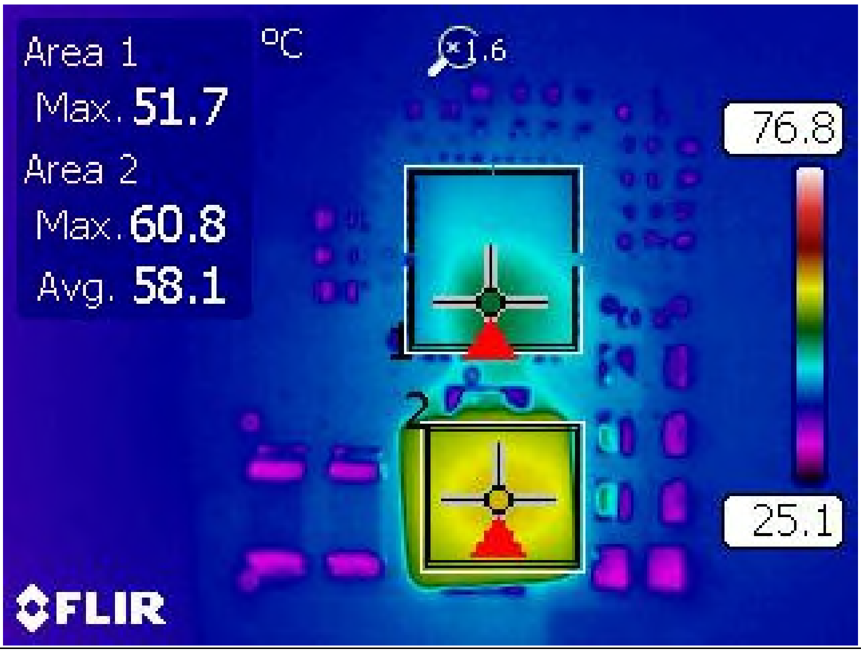

Figure 45 **Thermal image of IR38060 running 1.2V @ 6A from 12V Input**

IR38060	51.7 °C
Inductor	60.8 °C
Ambient Temperature	28 °C

9 IR38060: SERDES 1.2V

9.1 Schematic

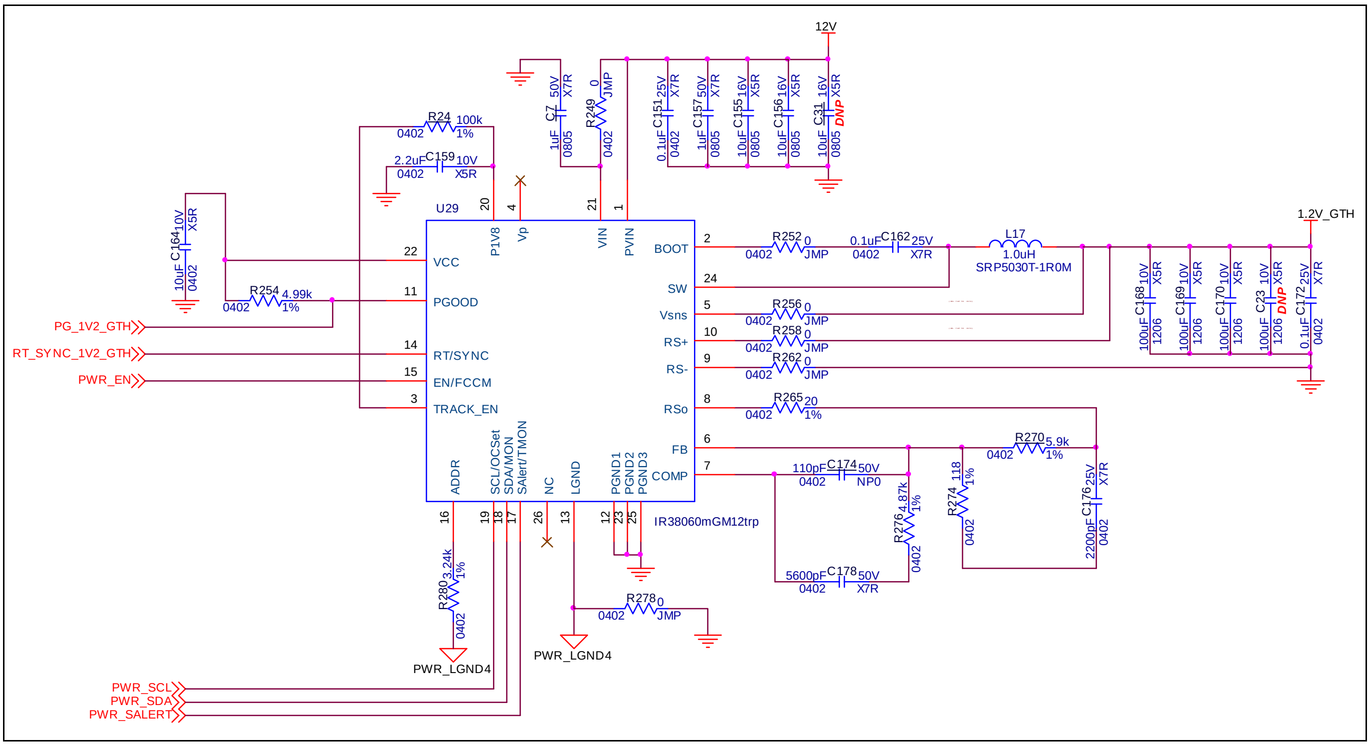

Figure 46 **Schematic of IR38060 1.2V (SERDES)**

9.2 Bill of Materials

Table 11 **Bill of materials for IR38060 1.2V (SERDES)**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C7,C157	1uF	Taiyo Yuden	UMK212B7105KG-T	-
1	C23	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C31	10uF	Murata	0805YD106KAT2A	DNP
3	C151,C162,C172	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C155,C156	10uF	Murata	0805YD106KAT2A	-
1	C159	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C164	10uF	Panasonic	CL05A106MP5NUNC	-
3	C168,C169,C170	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C174	110pF	Murata	GRM1555C1H111JA01D	-
1	C176	2200pF	Kemet	C0402C222K3RACTU	-
1	C178	5600pF	Murata	GRM155R71H562KA88D	-
1	L17	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R24	100k	Panasonic	ERJ-2RKF1003X	-
6	R249,R252,R256,R258,R262,R278	0	Vishay Dale	CRCW04020000Z0ED	-
1	R254	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R265	20	Panasonic	ERJ-2RKF20R0X	-
1	R270	5.9k	Panasonic	ERJ-2RKF5901X	-
1	R274	118	Vishay Dale	CRCW0402118RFKED	-
1	R276	4.87k	Panasonic	ERJ-2RKF4871X	-
1	R280	3.24k	Vishay Dale	CRCW04023K24FKED	-
1	U29	IR38060mGM12trp	Infineon Technologies	IR38060mGM12trp	

9.3 Typical Waveforms

PVin = Vin = 12V; Vout = 1.2V; Fsw = 607kHz

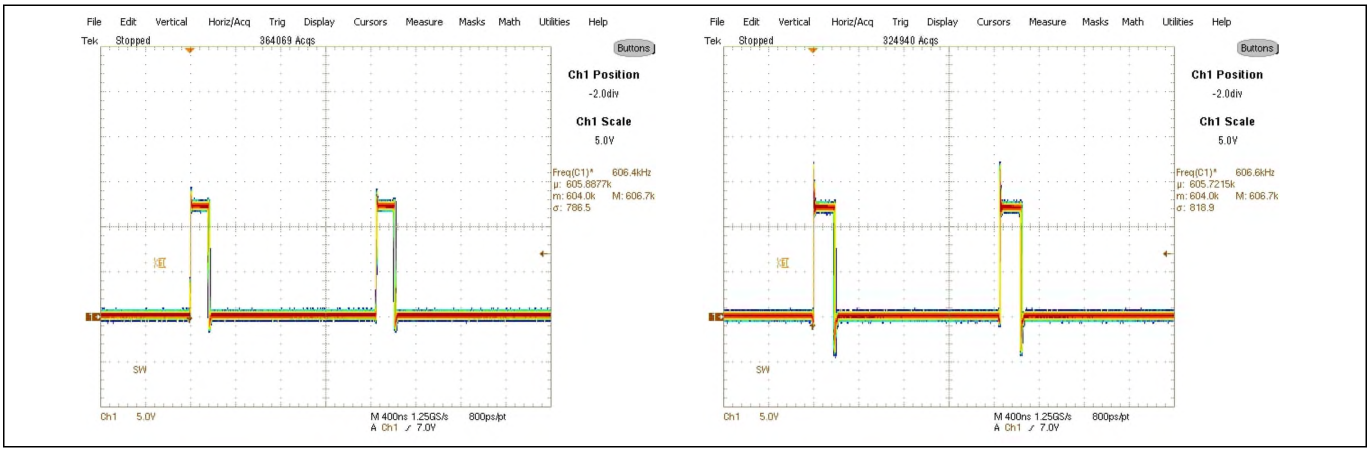

Figure 47 **IR38060 1.2V (SERDES) switch node: 0A (left) and 6A (right)**

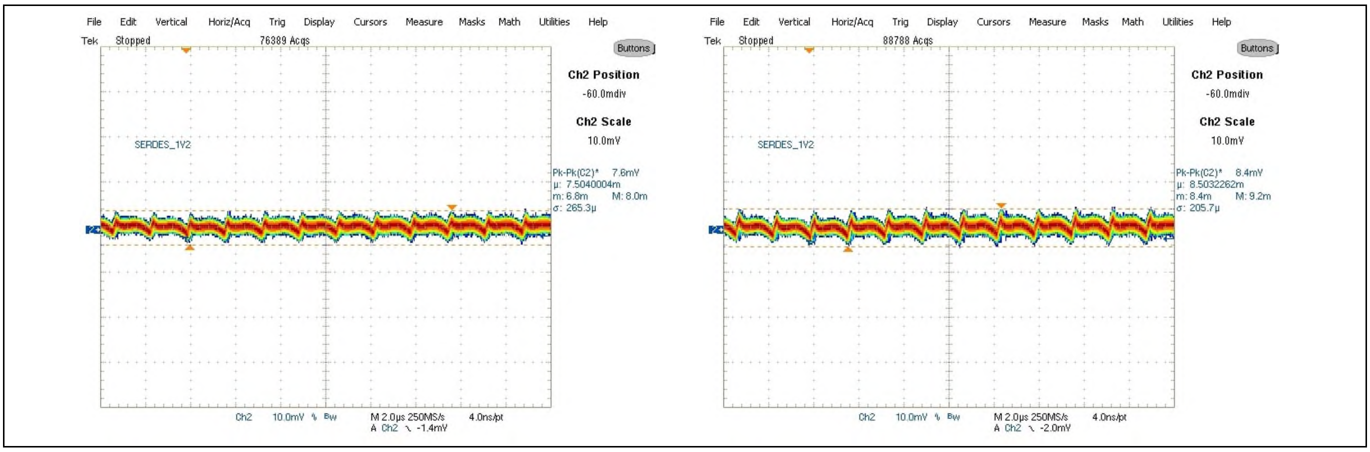

Figure 48 **IR38060 1.2V (SERDES) output ripple @ C27: 0A (left) and 6A (right)**

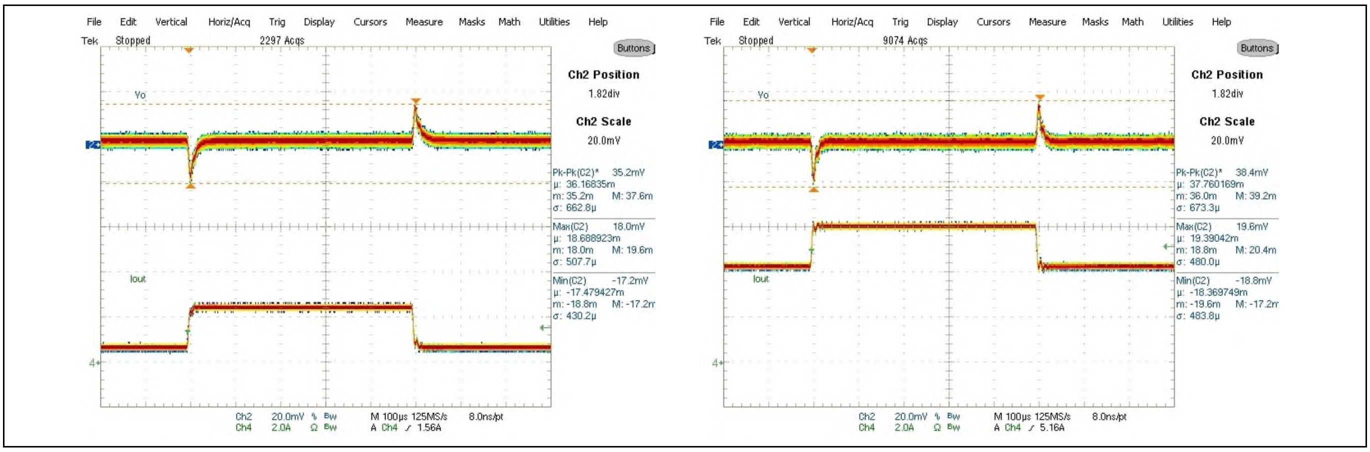

Figure 49 **IR38060 1.2V (SERDES) transient response: 0.6A-2.4A @ 2.5A/uS (left) and 4.2A-6A @ 2.5A/uS (right)**

9.4 Bode Plot

PVin = Vin = 12V; Vout = 1.2V; Fsw = 607kHz

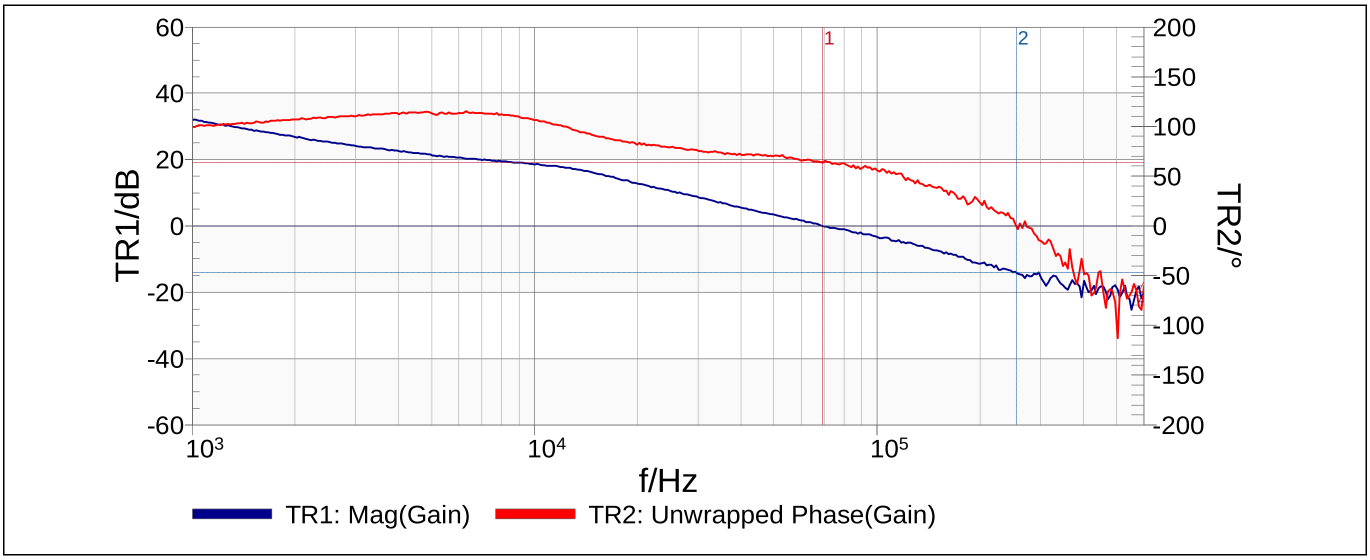

Figure 50 Bode plot of IR38060 1.2V (SERDES) with 0A load

Fo = 69.2 kHz
Phase Margin = 63.8 Degrees
Gain Margin = -14.1 dB

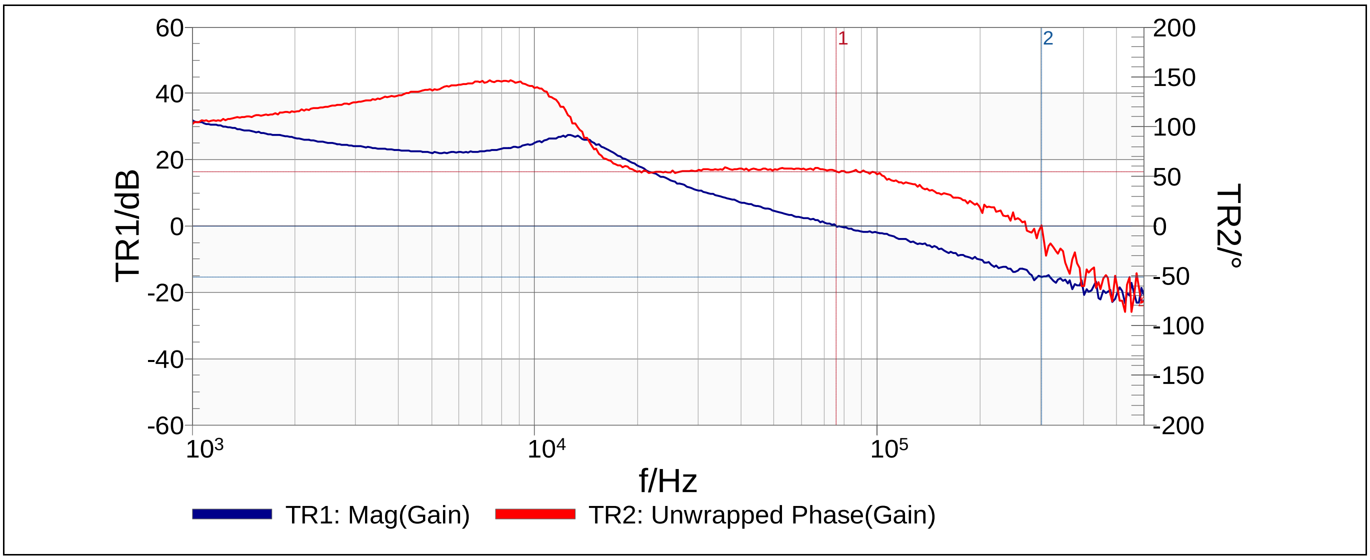

Figure 51 Bode plot of IR38060 1.2V (SERDES) with 6A load

Fo = 76.0 kHz
Phase Margin = 54.7 Degrees
Gain Margin = -15.3 dB

9.5 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 1.2V, Fsw = 607kHz

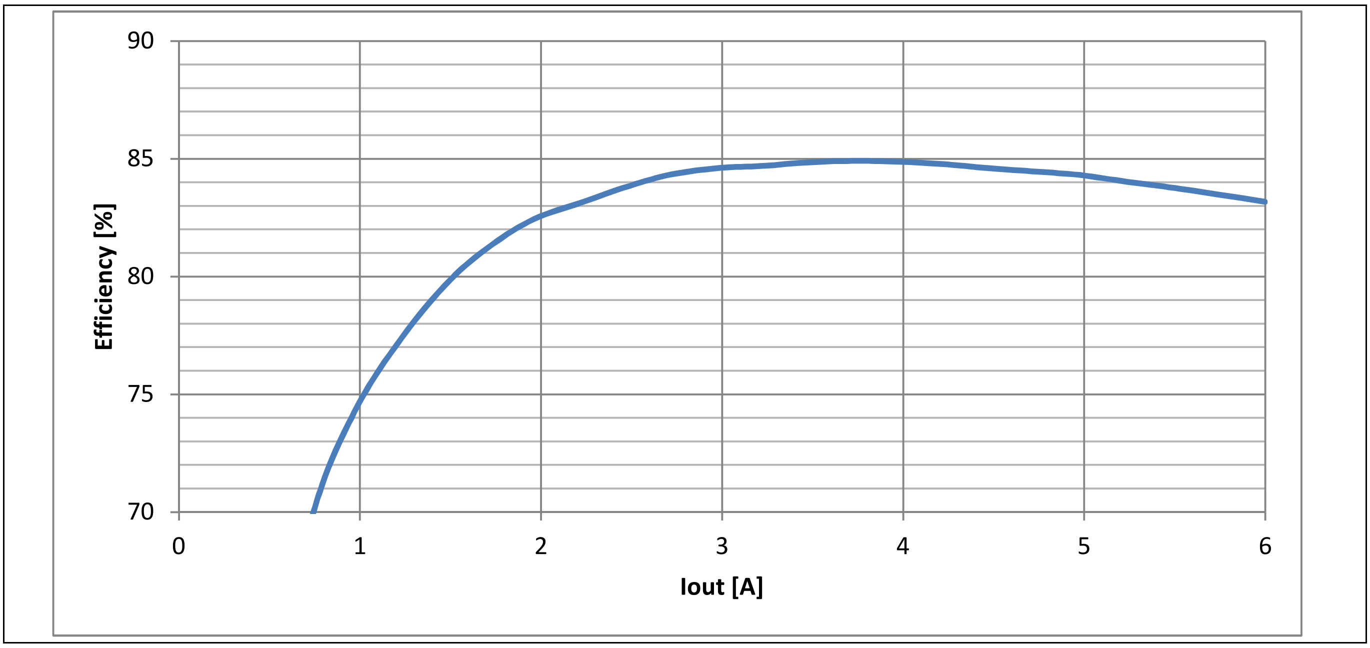

Figure 52 **Efficiency of the IR38060 regulating 1.2V @ 6A from a 12V input**

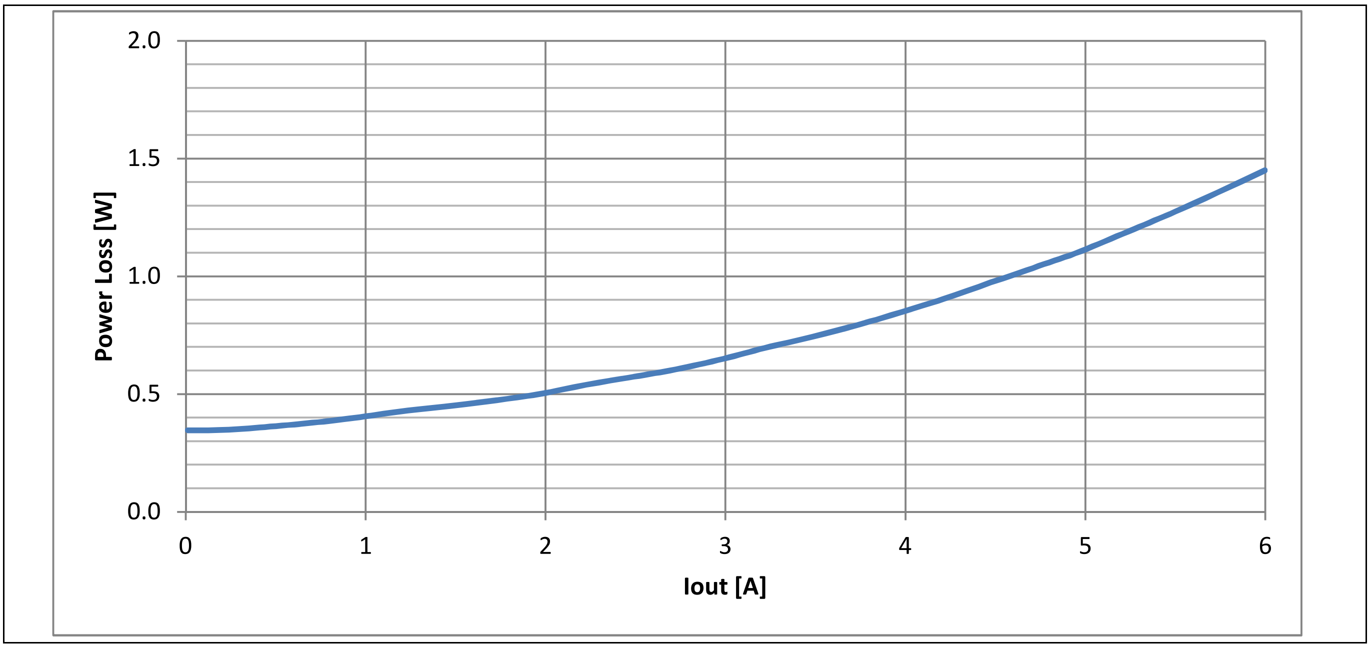

Figure 53 **IR38060 power loss while regulating 1.2V @ 6A from a 12V input**

9.6 Thermal Image

PVin = Vin = 12V, Vout = 1.2V, Fsw = 607kHz, Iout = 6A

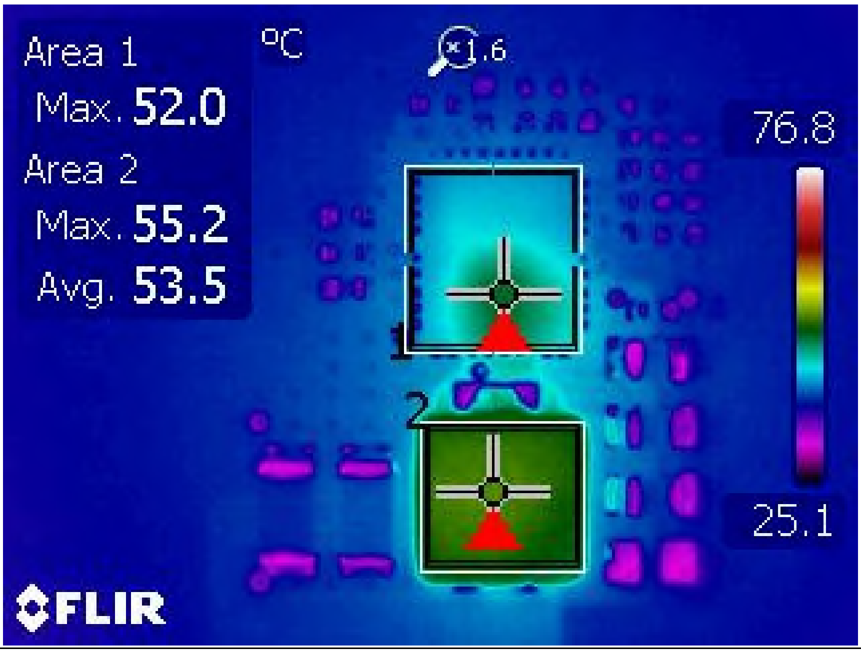

Figure 54 **Thermal image of IR38060 running 1.2V @ 6A from 12V Input**

IR38060	52.0 °C
Inductor	55.2 °C
Ambient Temperature	28 °C

10 IR38060: VCCO 1.8V

10.1 Schematic

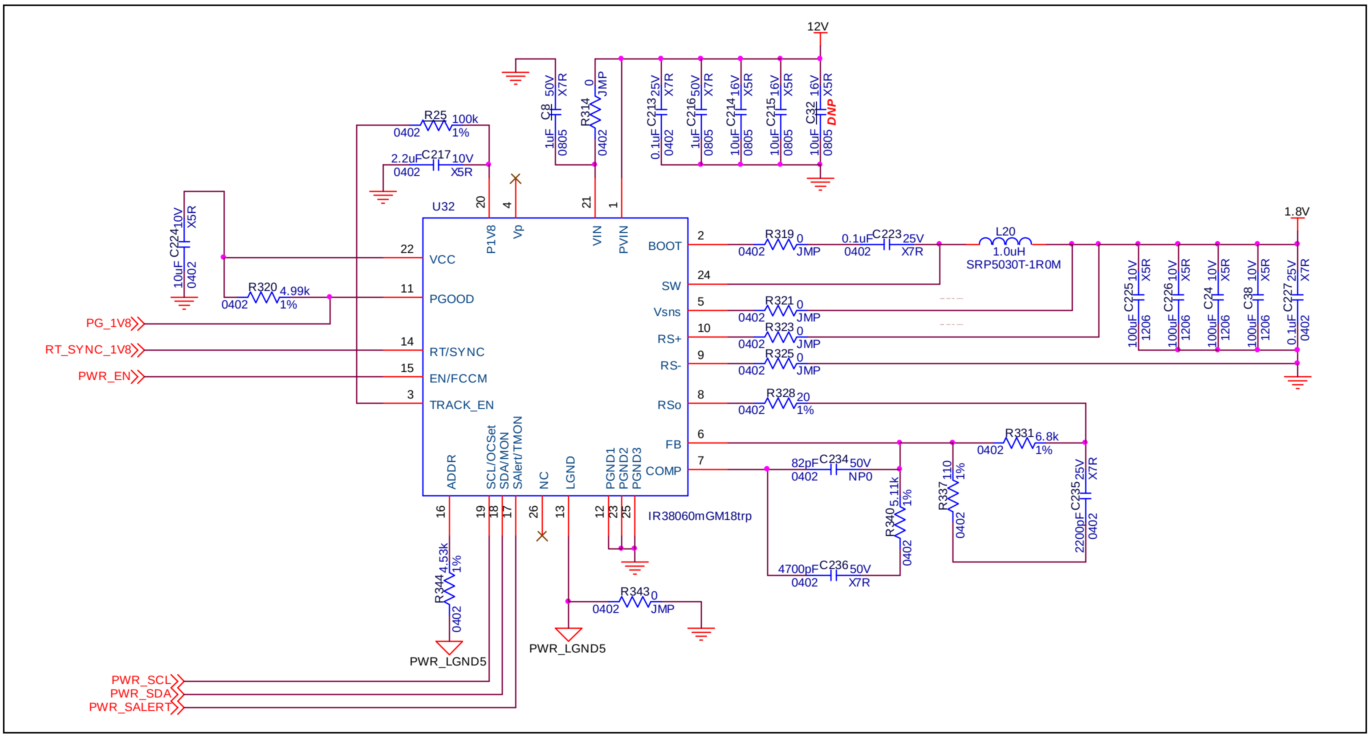

Figure 55 **Schematic for IR38060 1.8V (VCCO)**

10.2 Bill of Materials

Table 12 **Bill of materials for Manhattan (IR38060) 1.8V VCCO**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C8,C216	1uF	Taiyo Yuden	UMK212B7105KG-T	-
4	C24,C38,C225,C226	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C32	10uF	Murata	0805YD106KAT2A	DNP
3	C213,C223,C227	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C214,C215	10uF	Murata	0805YD106KAT2A	-
1	C217	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C224	10uF	Panasonic	CL05A106MP5NUNC	-
1	C234	82pF	Murata	GRM1555C1H820JA01D	-
1	C235	2200pF	Kemet	C0402C222K3RACTU	-
1	C236	4700pF	Murata	GRM155R71H472KA01J	-
1	L20	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R25	100k	Panasonic	ERJ-2RKF1003X	-
6	R314,R319,R321,R323,R325,R343	0	Vishay Dale	CRCW04020000Z0ED	-
1	R320	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R328	20	Panasonic	ERJ-2RKF20R0X	-
1	R331	6.8k	Panasonic	ERJ-2RKF6801X	-
1	R337	110	Panasonic	ERJ-2RKF1100X	-
1	R340	5.11k	Vishay Dale	ERJ-2RKF5761X	-
1	R344	4.53k	Vishay Dale	CRCW04022K61FKED	-
1	U32	IR38060mGM18trp	Infineon Technologies	IR38060mGM12trp	-

10.3 Typical Waveforms

PVin = Vin = 12V; Vout = 1.8V; Fsw = 607kHz

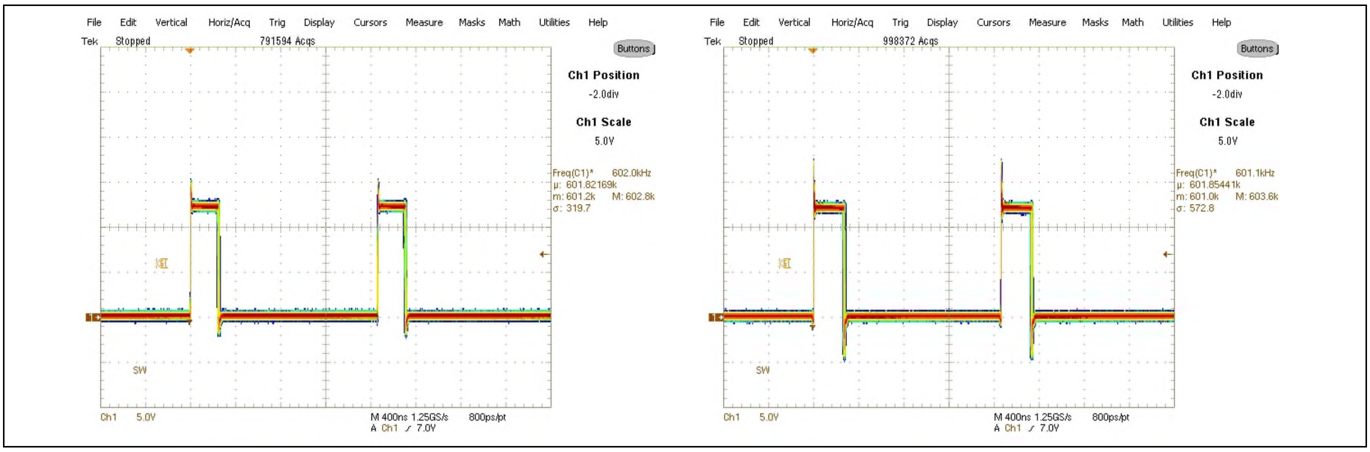

Figure 56 **IR38060 1.8V (VCCO) switch node: 0A (left) and 6A (right)**

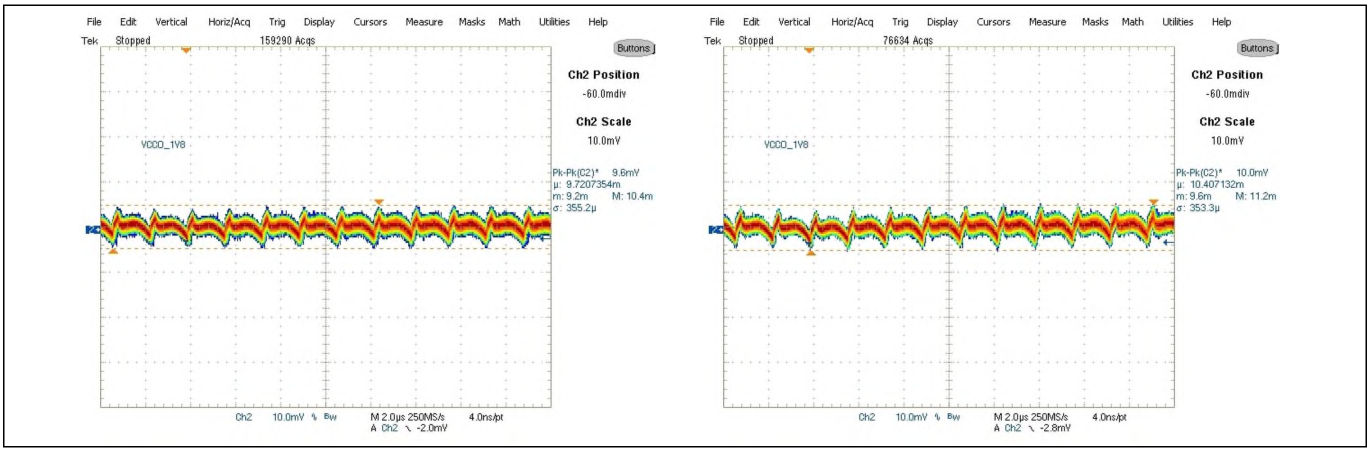

Figure 57 **IR38060 1.8V (VCCO) output ripple at C24: 0A (left) and 6A (right)**

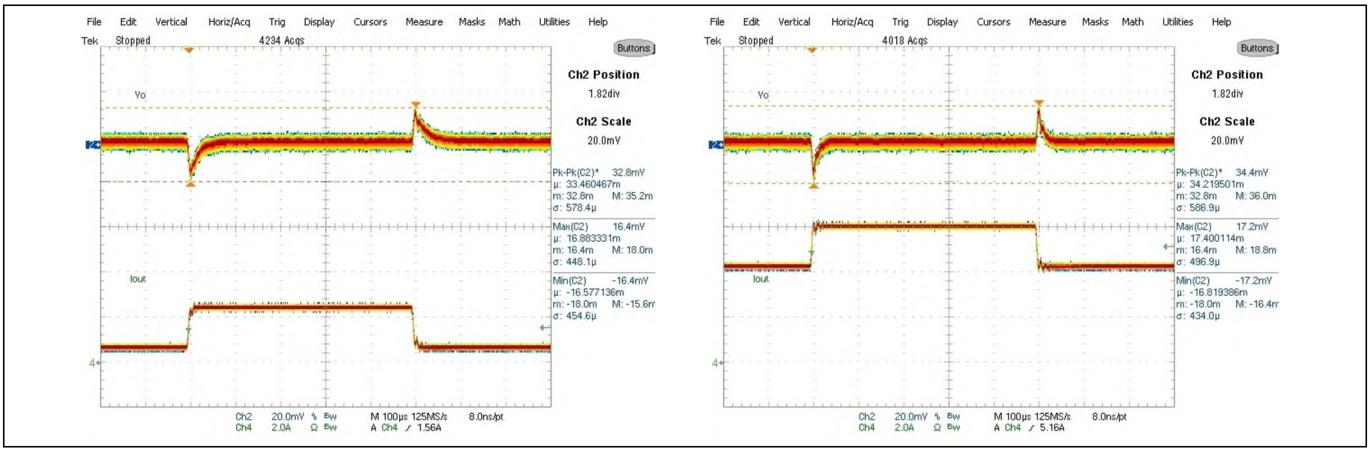

Figure 58 **IR38060 1.8V (VCCO) transient response @ C24: 0.6A-2.4A @ 2.5A/uS (left) and 4.2A-6A @ 2.5A/uS (right)**

10.4 Bode Plot

PVin = Vin = 12V; Vout = 1.8V; Fsw = 607kHz

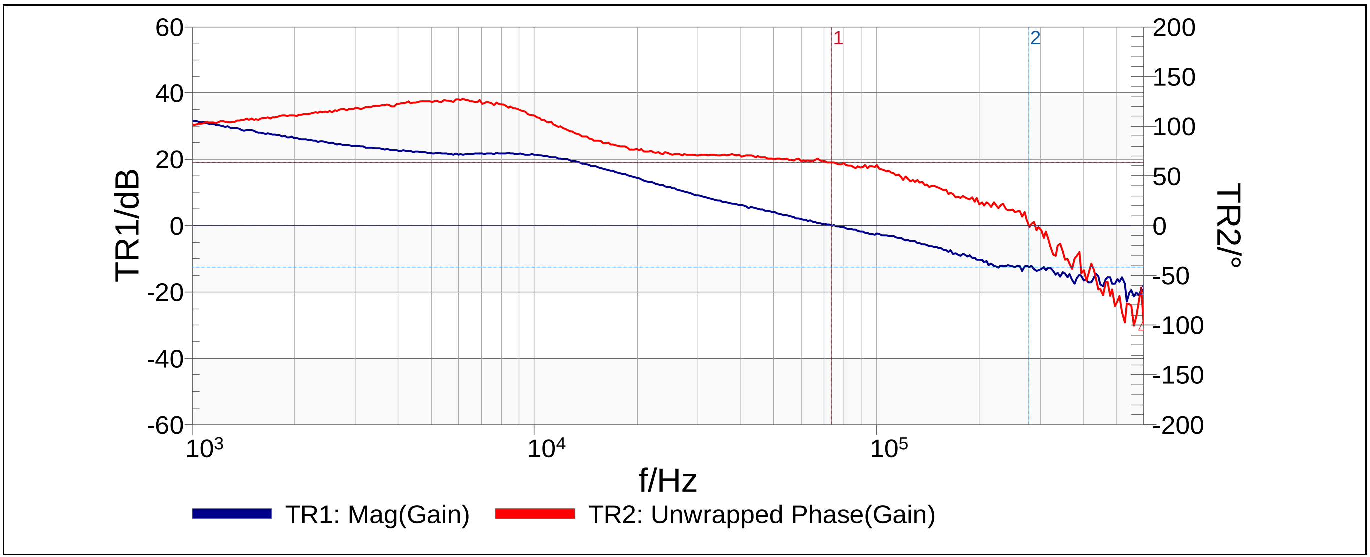

Figure 59 **Bode plot of IR38060 1.8V (VCCO) with 0A load**

Fo = 73.8 kHz
Phase Margin = 63.4 Degrees
Gain Margin = -12.4 dB

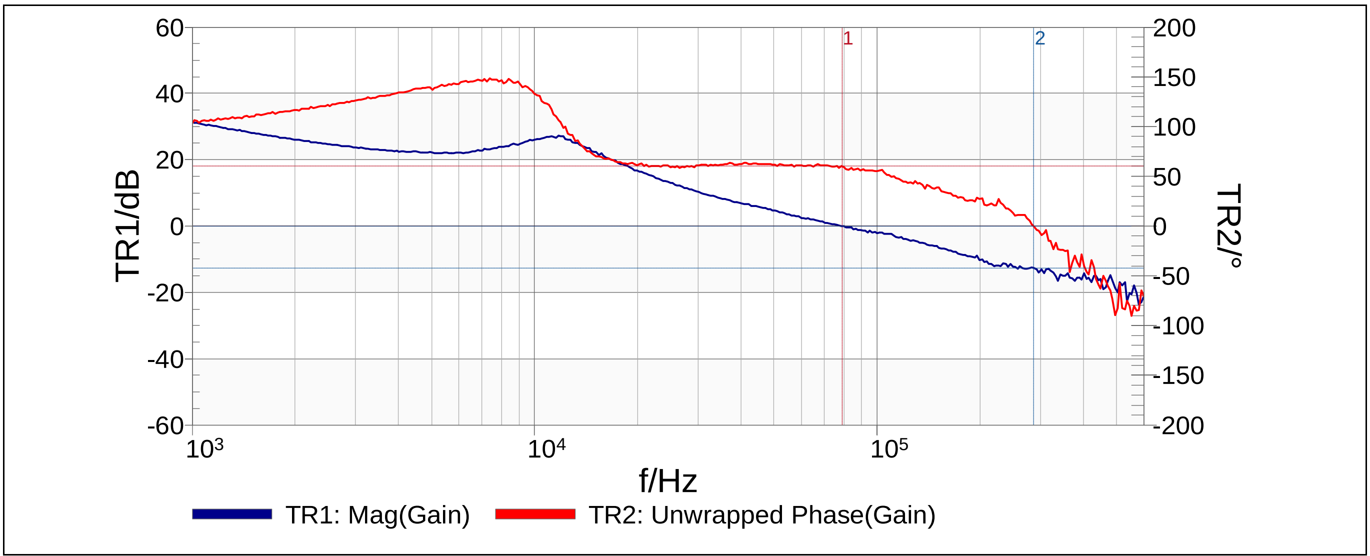

Figure 60 **Bode plot of IR38060 1.8V (VCCO) with 6A load**

Fo = 79.1 kHz
Phase Margin = 60.0 Degrees
Gain Margin = -12.6 dB

10.5 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 1.8V, Fsw = 607kHz

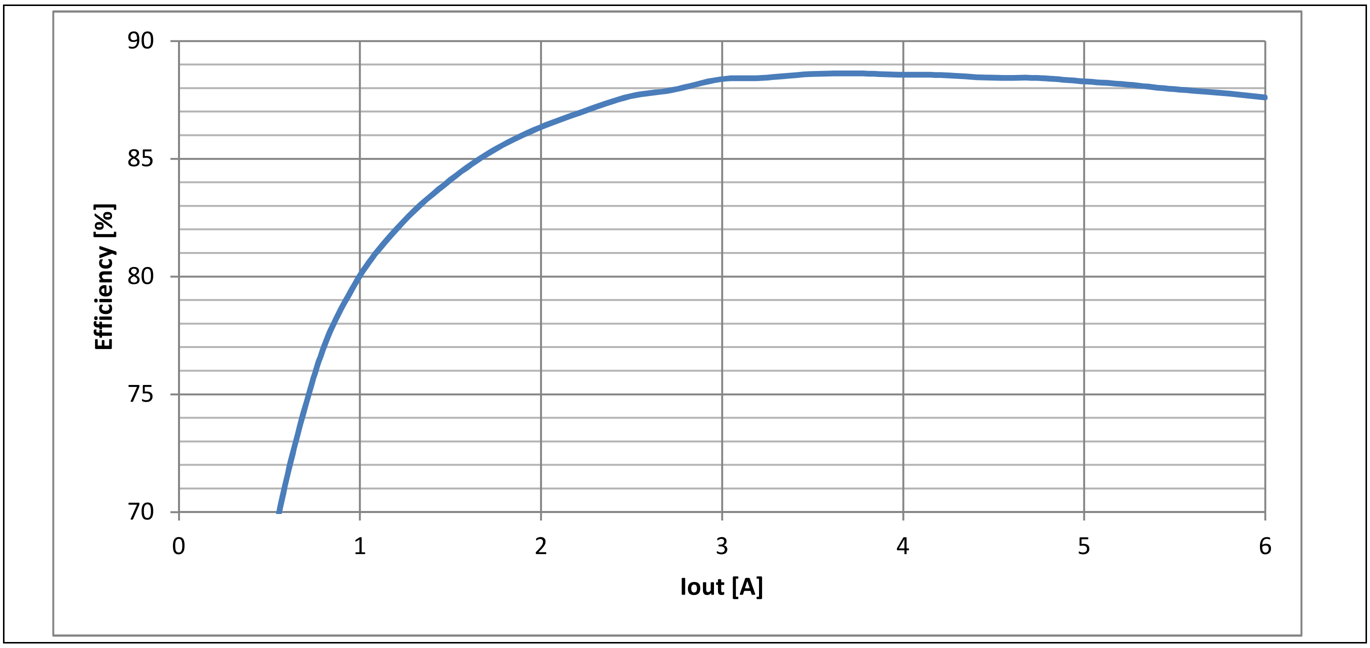

Figure 61 **Efficiency of the IR38060 regulating 1.8V @ 6A from a 12V input**

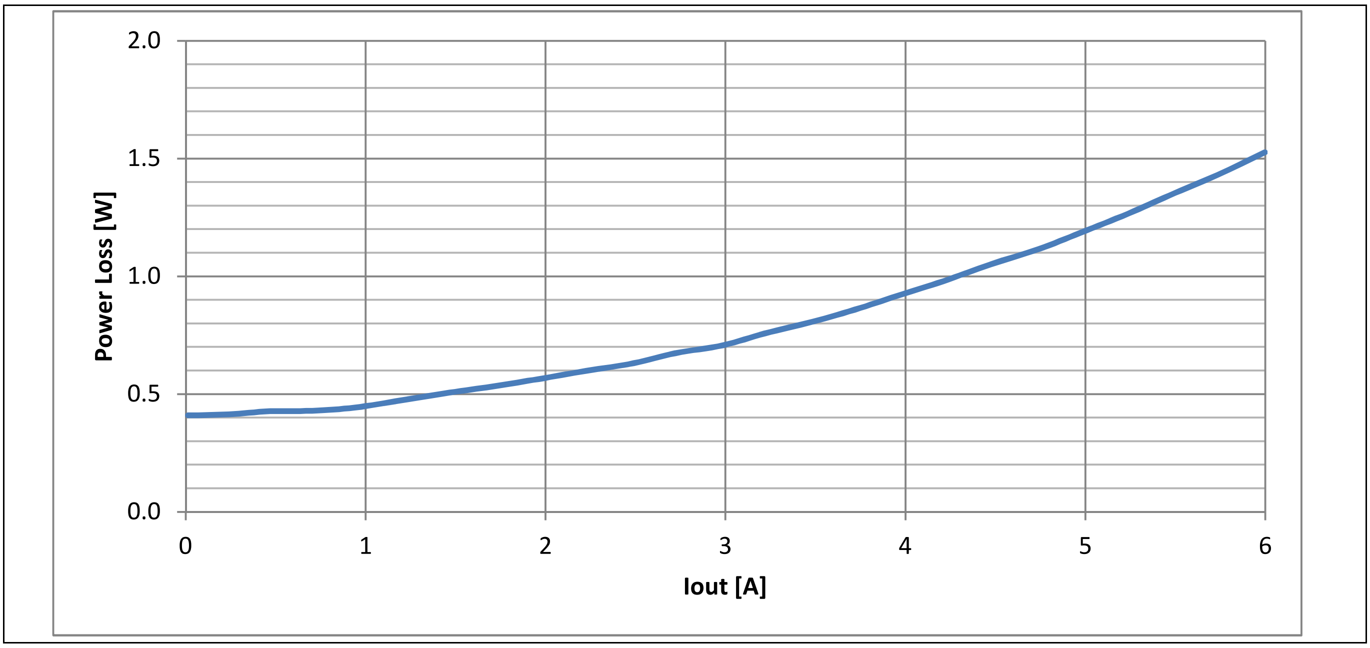

Figure 62 **IR38060 power loss while regulating 1.8V @ 6A from a 12V input**

10.6 Thermal Image

PVin = Vin = 12V, Vout = 1.8V, Fsw = 607kHz, Iout = 6A

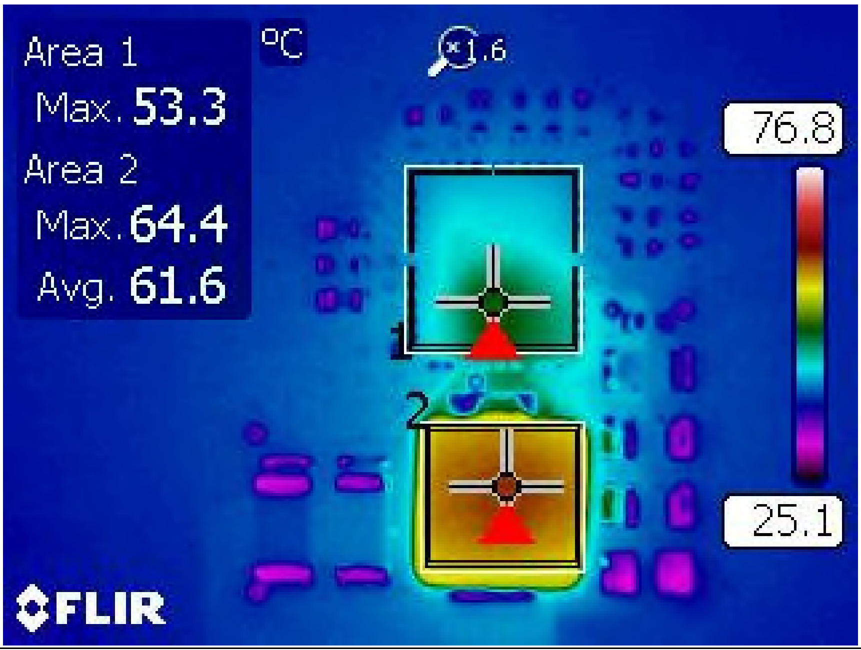

Figure 63 **Thermal image of IR38060 running 1.8V @ 6A from 12V Input**

IR38060	53.3 °C
Inductor	64.4 °C
Ambient Temperature	28 °C

11 IR38060: SERDES 1.8V

11.1 Schematic

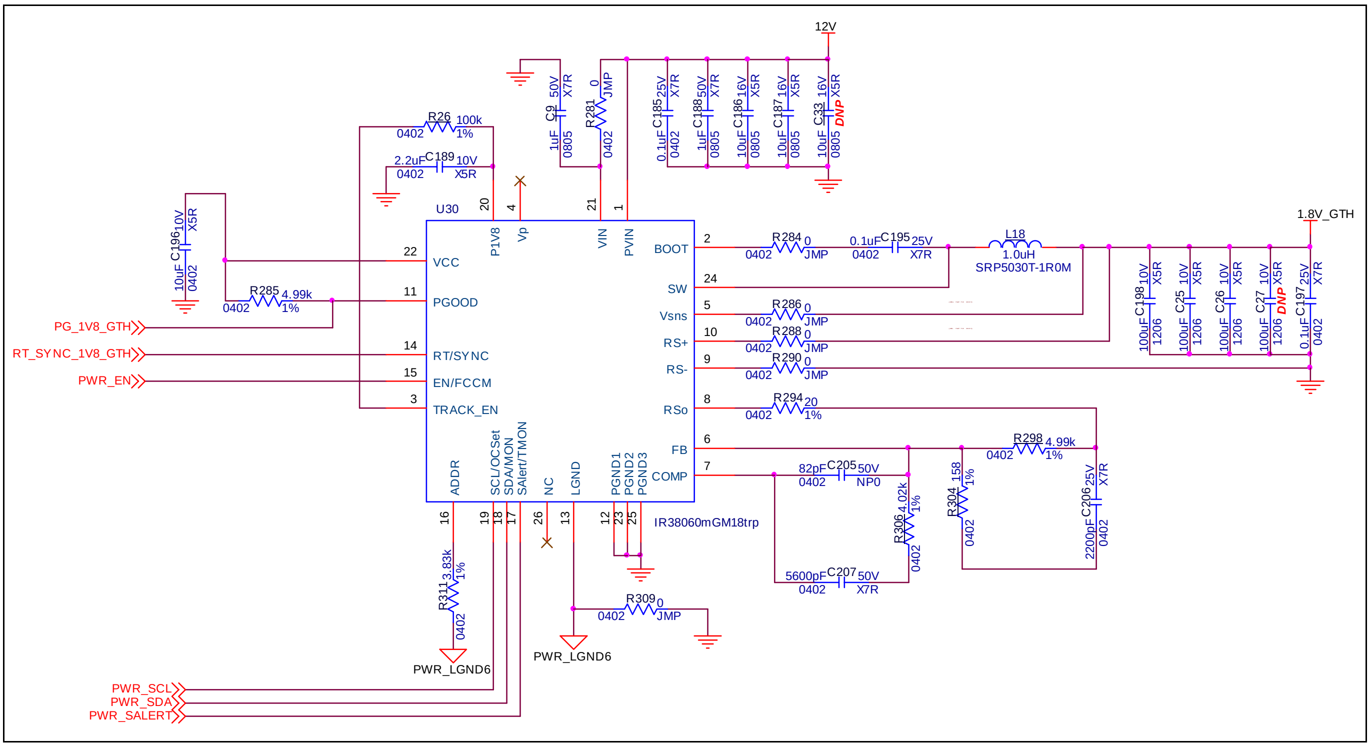

Figure 64 **Schematic for IR38060 1.8V (SERDES)**

11.2 Bill of Material

Table 13 **Bill of materials for Manhattan (IR38060) 1.8 SERDES**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
2	C9,C188	1uF	Taiyo Yuden	UMK212B7105KG-T	-
3	C25,C26,C198	100uF	TDK Corporation	C3216X5R1A107M160AC	-
1	C27	100uF	TDK Corporation	C3216X5R1A107M160AC	DNP
1	C33	10uF	Murata	0805YD106KAT2A	DNP
3	C185,C195,C197	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C186,C187	10uF	Murata	0805YD106KAT2A	-
1	C189	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C196	10uF	Panasonic	CL05A106MP5NUNC	-
1	C205	82pF	Murata	GRM1555C1H820JA01D	-
1	C206	2200pF	Kemet	C0402C222K3RACTU	-
1	C207	5600pF	Murata	GRM155R71H562KA88D	-
1	L18	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
1	R26	100k	Panasonic	ERJ-2RKF1003X	-
6	R281,R284,R286,R288,R290,R309	0	Vishay Dale	CRCW04020000Z0ED	-
2	R285,R298	4.99k	Vishay Dale	CRCW04024K99FKED	-
1	R294	20	Panasonic	ERJ-2RKF20R0X	-
1	R304	158	Vishay Dale	CRCW0402158RFKED	-
1	R306	4.02k	Vishay Dale	CRCW04024K02FKED	-
1	R311	3.83k	Vishay Dale	CRCW04023K83FKED	-
1	U30	IR38060mGM18trp	Infineon Technologies	IR38060mGM18trp	-

11.3 Typical Waveforms

PVin = Vin = 12V; Vout = 1.8V; Fsw = 607kHz

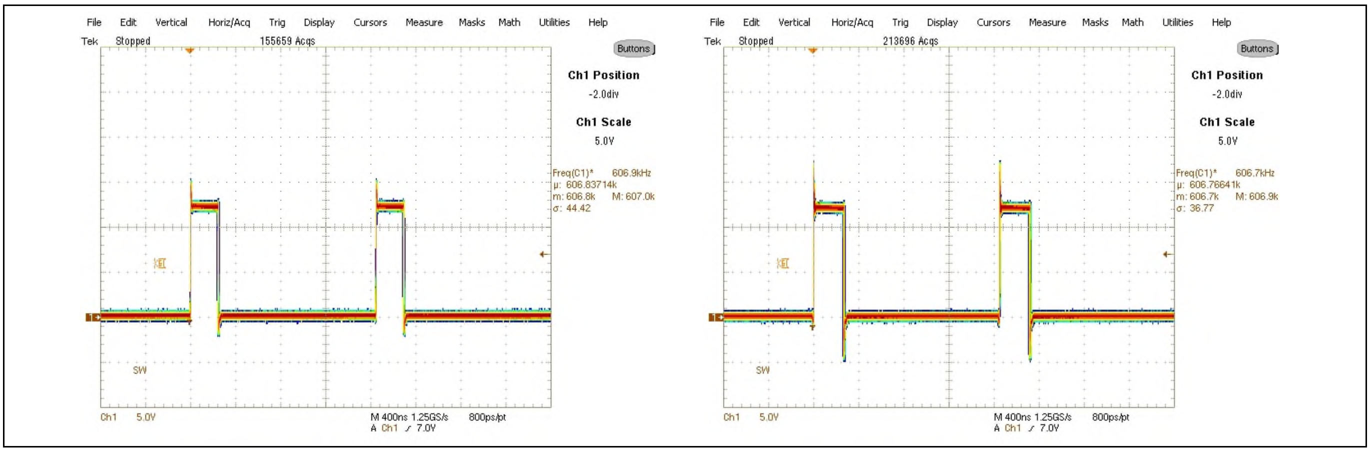

Figure 65 **IR38060 1.8V (SERDES) switch node: 0A (left) and 6A (right)**

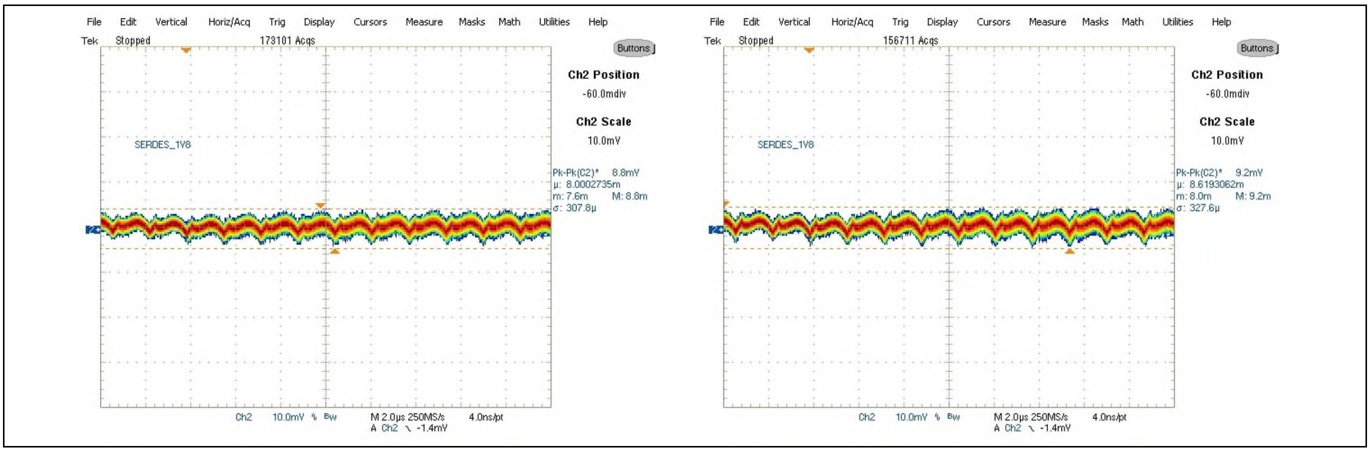

Figure 66 **IR38060 1.8V (SERDES) output ripple @ C26: 0A (left) and 6A (right)**

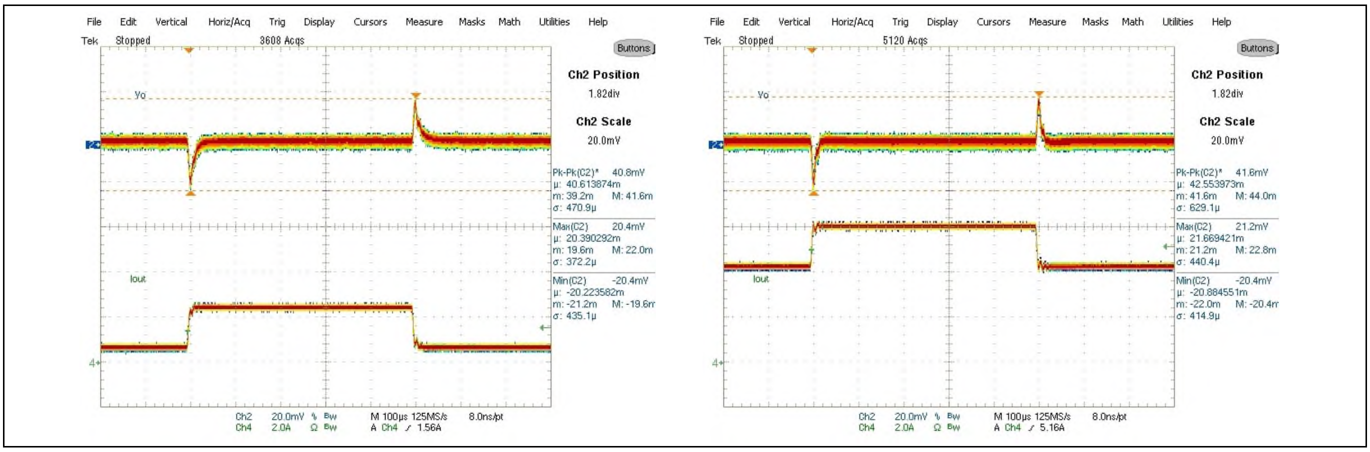

Figure 67 **IR38060 1.8V (SERDES) transient response @ C26: 0.6A-2.4A @ 2.5A/uS (left) and 4.2A-6A @ 2.5A/uS (right)**

11.4 Bode Plot

PVin = Vin = 12V; Vout = 1.8V; Fsw = 607kHz

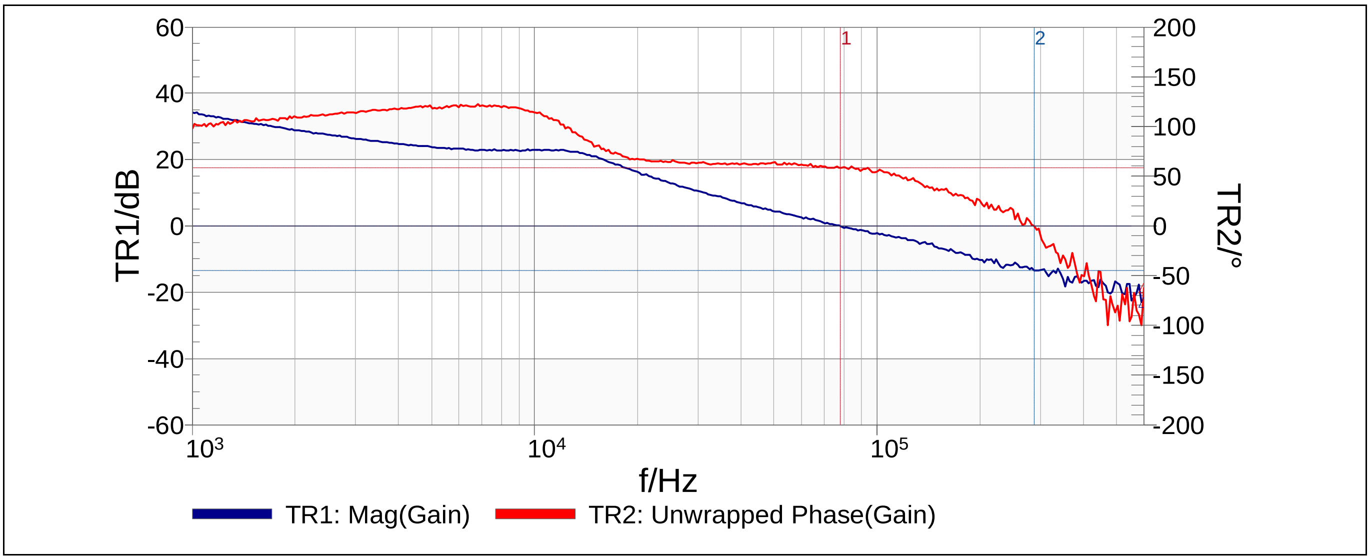

Figure 68 **Bode plot of IR38060 1.8V (SERDES) with 0A load**

Fo = 78.0 kHz
Phase Margin = 58.3 Degrees
Gain Margin = -13.3 dB

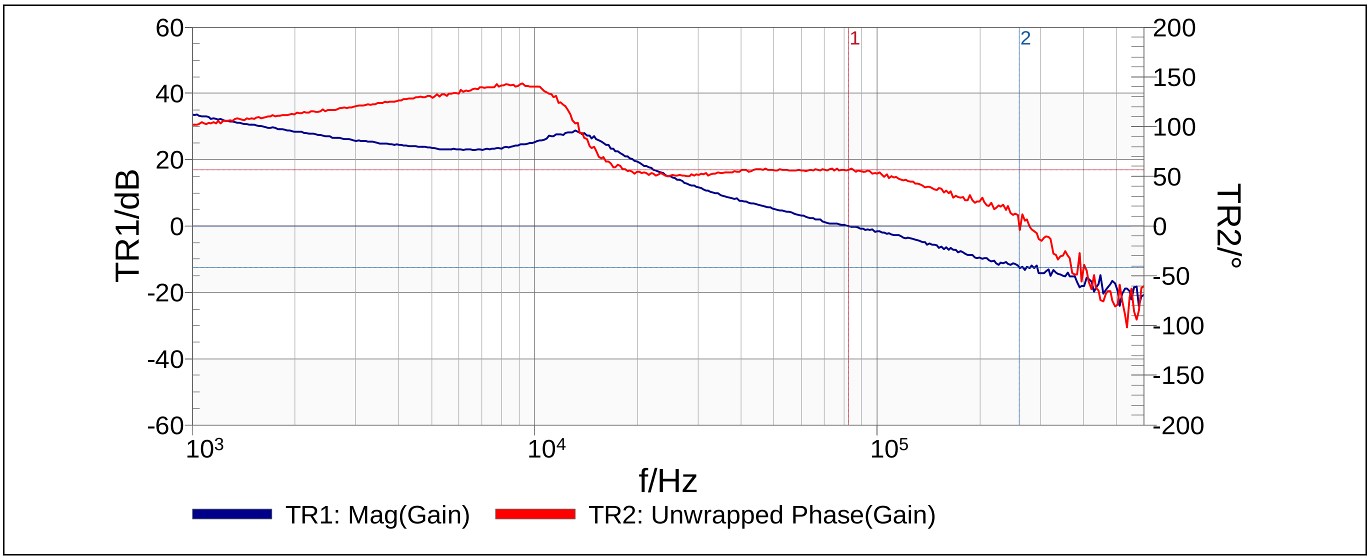

Figure 69 **Bode plot of IR38060 1.8V (SERDES) with 6A load**

Fo = 82.5 kHz
Phase Margin = 56.6 Degrees
Gain Margin = -12.4 dB

11.5 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 1.8V, Fsw = 607kHz

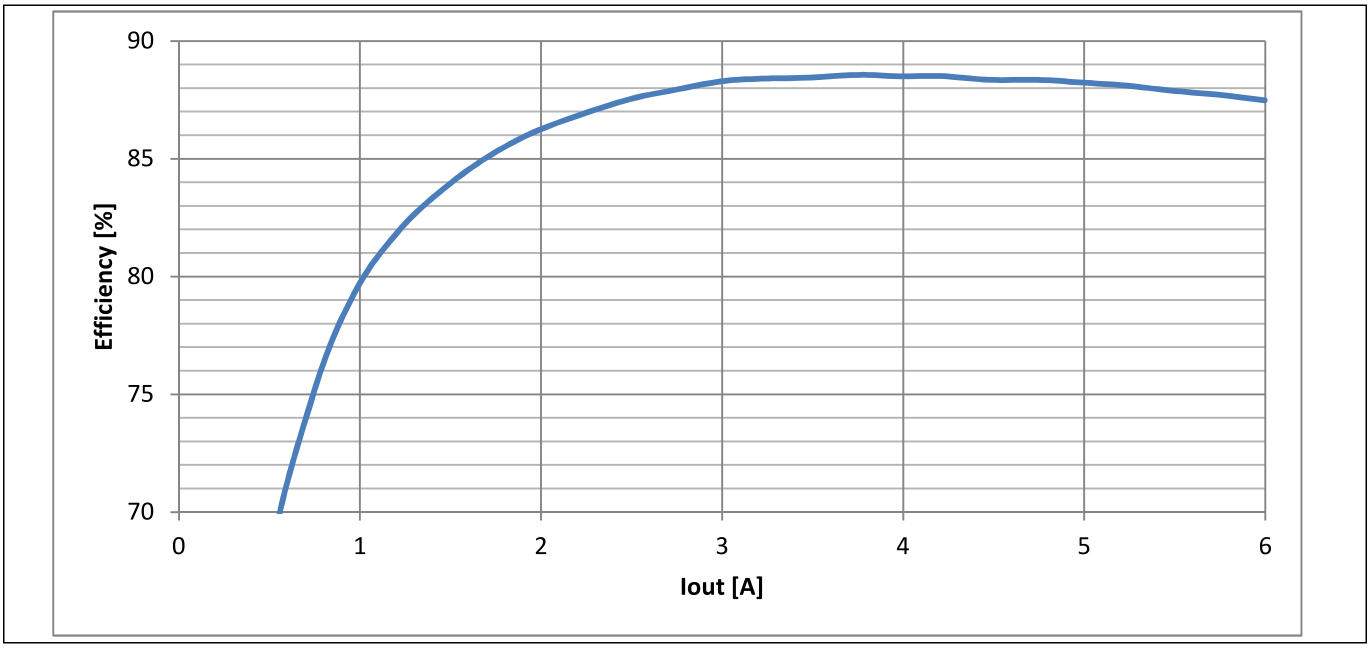

Figure 70 **Efficiency of the IR38060 regulating 1.8V @ 6A from a 12V input**

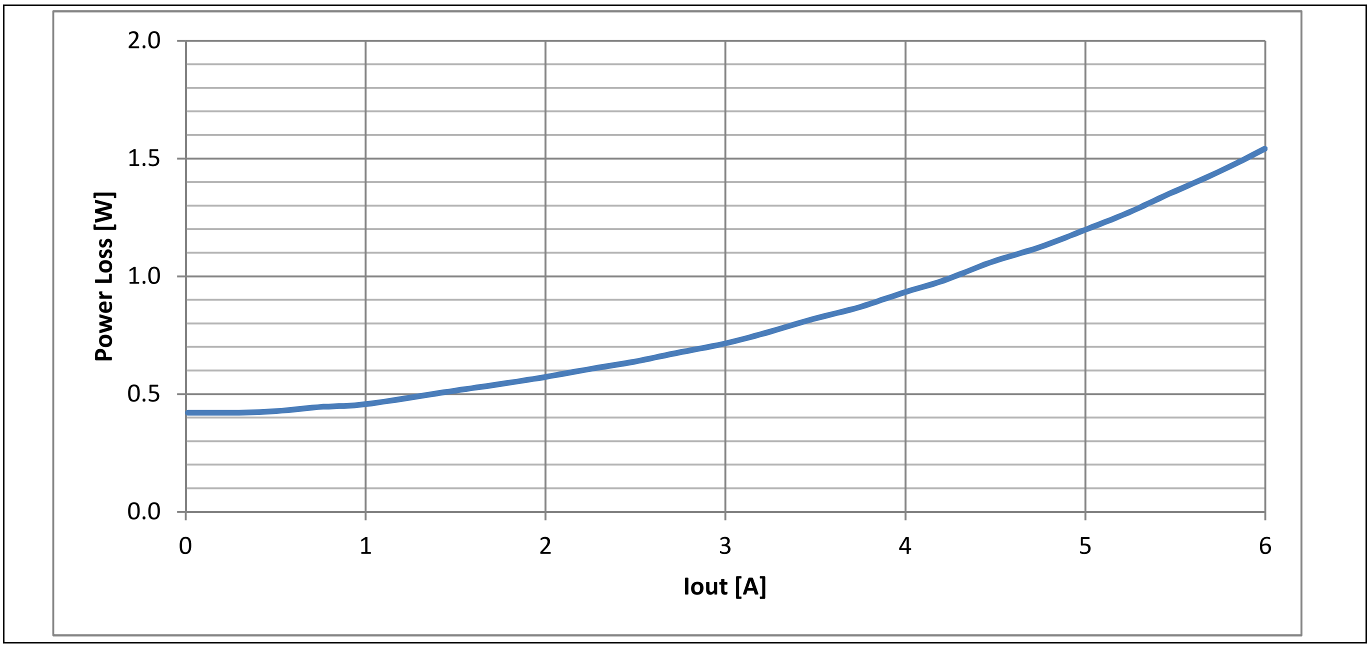

Figure 71 **IR38060 power loss while regulating 1.8V @ 6A from a 12V input**

11.6 Thermal Image

PVin = Vin = 12V, Vout = 1.2V, Fsw = 607kHz, Iout = 6A

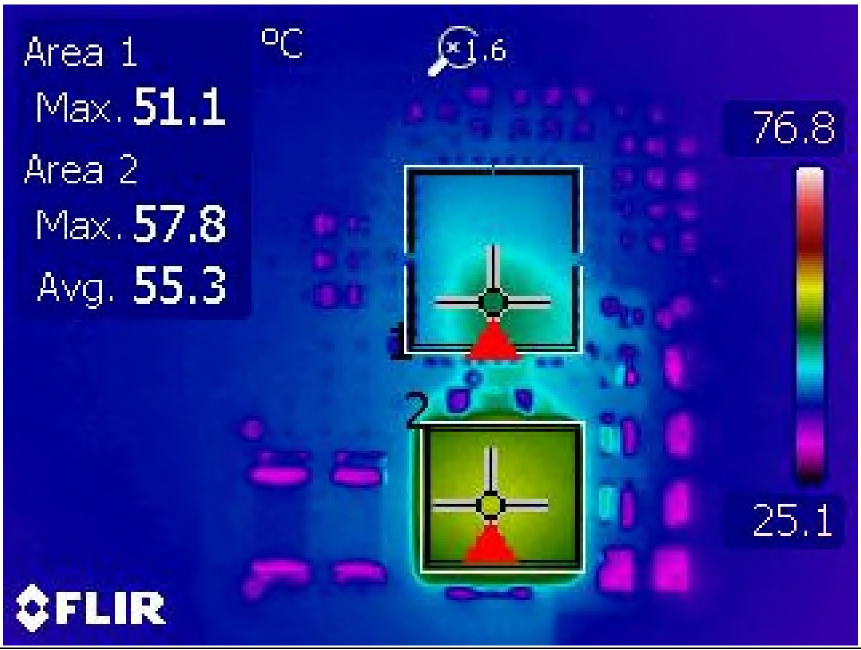

Figure 72 **Thermal image of IR38060 running 1.8V @ 6A from 12V Input**

IR38060	51.1 °C
Inductor	57.8 °C
Ambient Temperature	28 °C

12 IR3892: Vout = 2.5V & 3.3V

12.1 Schematic

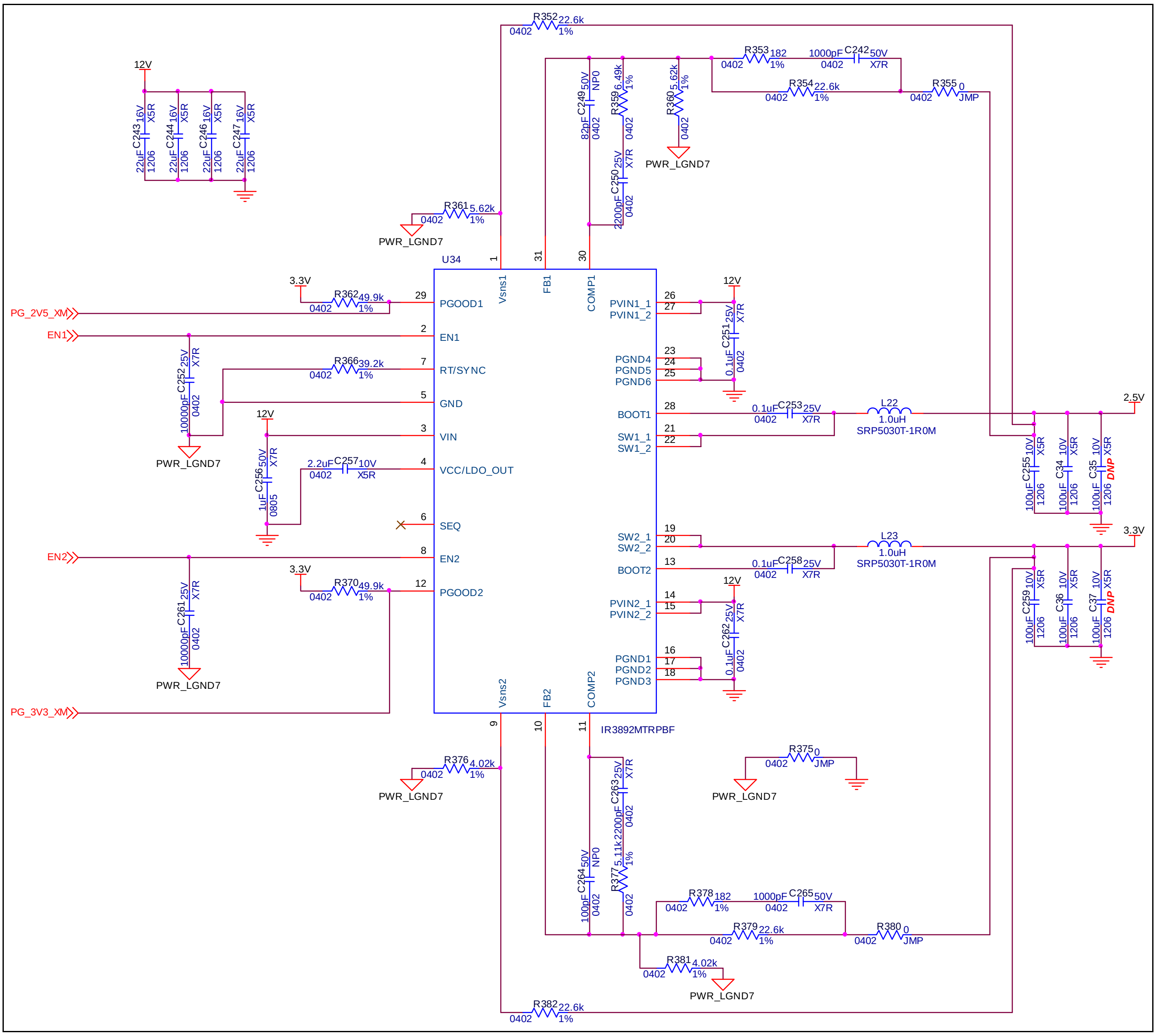

Figure 73 **IR3892 Schematic for 2.5 and 3.3V rails**

12.2 Bill of Materials (BOM)

Table 14 **Bill of materials for IR3892: 2.5V and 3.3V**

Quantity	Reference	Value	MFR	MFR PN	Assembly Inst.
4	C34,C36,C255,C259	100uF	TDK Corporation	C3216X5R1A107M160AC	-
2	C35,C37	100uF	TDK Corporation	C3216X5R1A107M160AC	DNP
2	C242,C265	1000pF	Murata	GRM155R71H102KA01D	-
4	C243,C244,C246,C247	22uF	Murata	GRM31CR61C226KE15L	-
1	C249	82pF	Murata	GRM1555C1H820JA01D	-
2	C250,C263	2200pF	Kemet	C0402C222K3RACTU	-
4	C251,C253,C258,C262	0.1uF	AVX Corporation	04023C104KAT2A	-
2	C252,C261	10000pF	AVX Corporation	04023C103KAT2A	-
1	C256	1uF	Taiyo Yuden	UMK212B7105KG-T	-
1	C257	2.2uF	TDK Corporation	C1005X5R1A225K050BC	-
1	C264	100pF	Murata	GRM1555C1H101JA01D	-
2	L22,L23	1.0uH	Bourns Inc.	SRP5030T-1R0M	-
4	R352,R354,R379,R382	22.6k	Vishay Dale	CRCW040222K6FKED	-
2	R353,R378	182	Panasonic	ERJ-2RKF1820X	-
3	R355,R375,R380	0	Vishay Dale	CRCW04020000Z0ED	-
1	R359	6.49k	Rohm	MCR01MZPF6491	-
2	R360,R361	5.62k	Rohm	MCR01MZPF5621	-
2	R362,R370	49.9k	Panasonic	ERJ-2RKF4992X	-
1	R366	39.2k	Vishay Dale	CRCW040239K2FKED	-
2	R376,R381	4.02k	Vishay Dale	CRCW04024K02FKED	-
1	R377	5.11k	Vishay Dale	CRCW04025K11FKED	-
1	U34	IR3892MTRPBF	Infineon Technologies	IR3892MTRPBF	-

12.3 Typical Waveforms for 2.5V Rail

PVin = Vin = 12V; Vout = 2.5V; Fsw = 600kHz

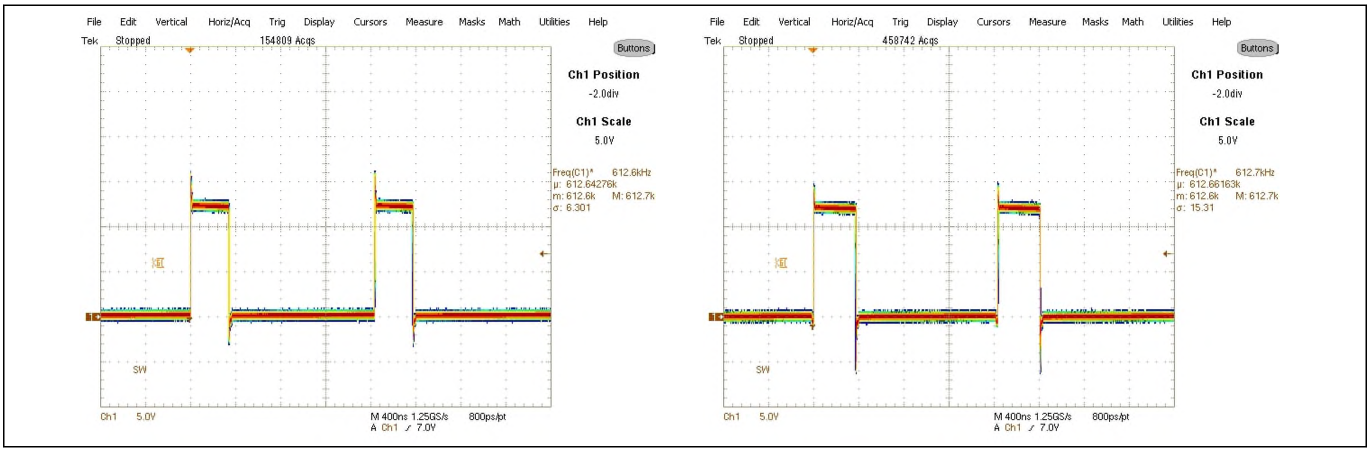

Figure 74 **IR3892 2.5V (SERDES) switch node: 0A (left) and 6A (right)**

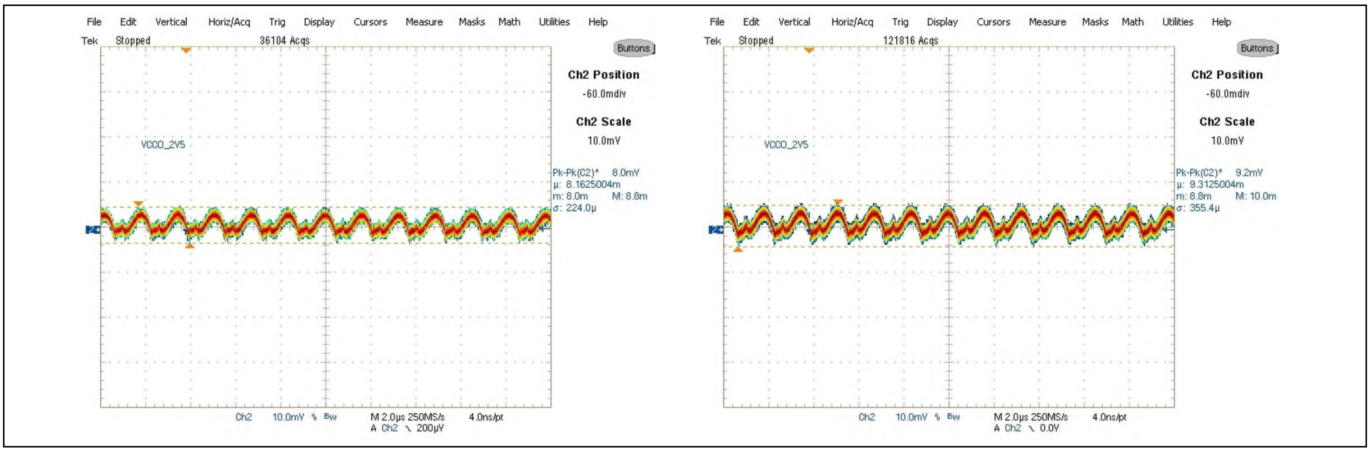

Figure 75 **IR3892 2.5V (VCCO) output ripple @ C34: 0A (left) and 6A (right)**

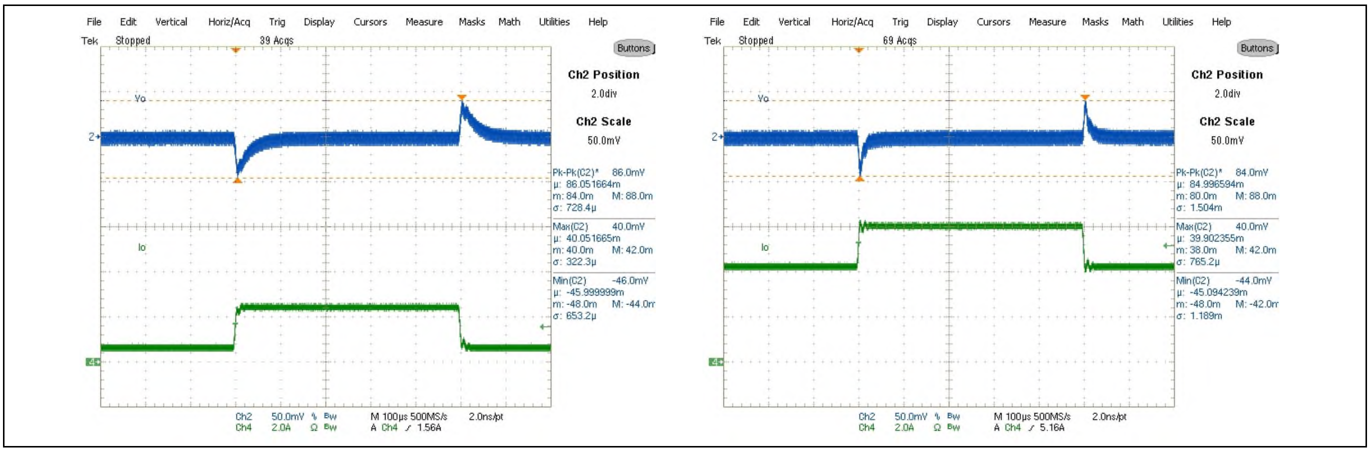

Figure 76 **IR3892 2.5V (VCCO) transient response @ C34: 0.6A-2.4A (left) and 4.2A-6A (right)**

12.4 Bode Plot [2.5V]

PVin = Vin = 12V; Vout = 2.5V; Fsw = 600kHz

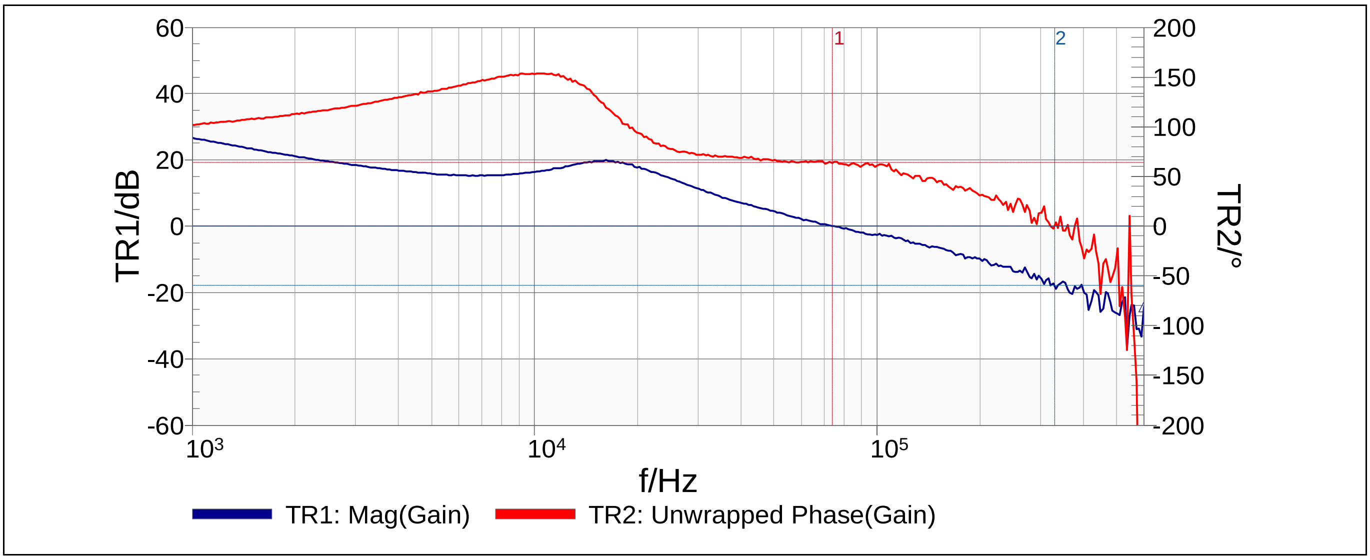

Figure 77 **Bode plot of IR3892 2.5V (SERDES) with 0A load**

Fo = 74.1 kHz
Phase Margin = 64.1 Degrees
Gain Margin = -18.0 dB

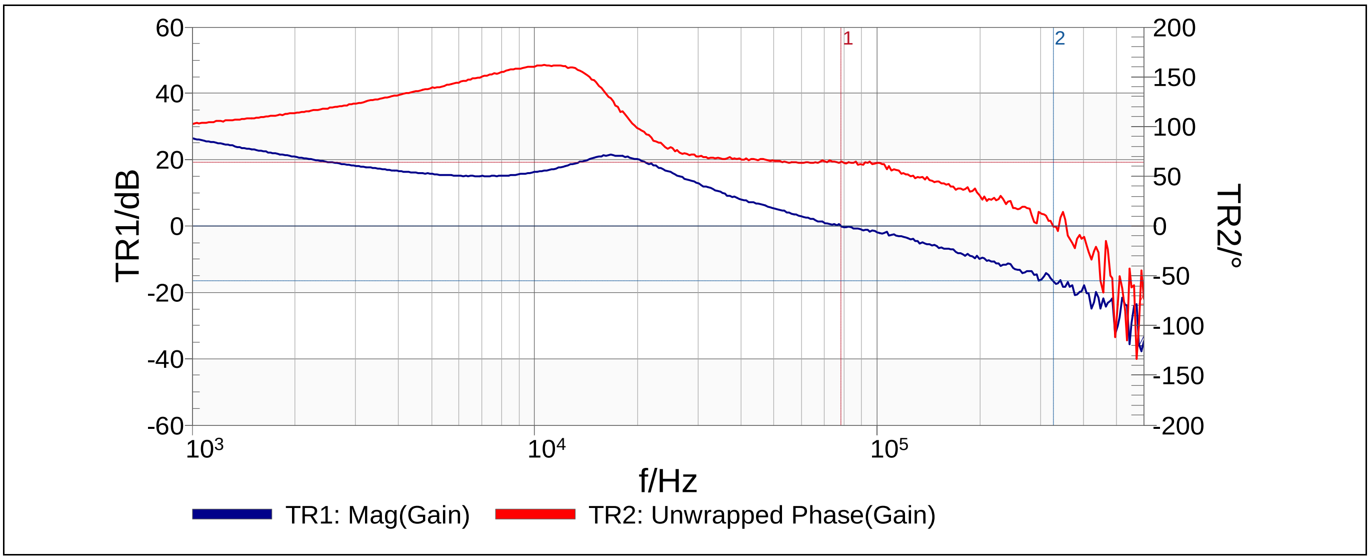

Figure 78 **Bode plot of IR3892 2.5V (SERDES) with 6A load**

Fo = 78.4 kHz
Phase Margin = 64.5 Degrees
Gain Margin = -16.6 dB

12.5 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 2.5V, Fsw = 600kHz

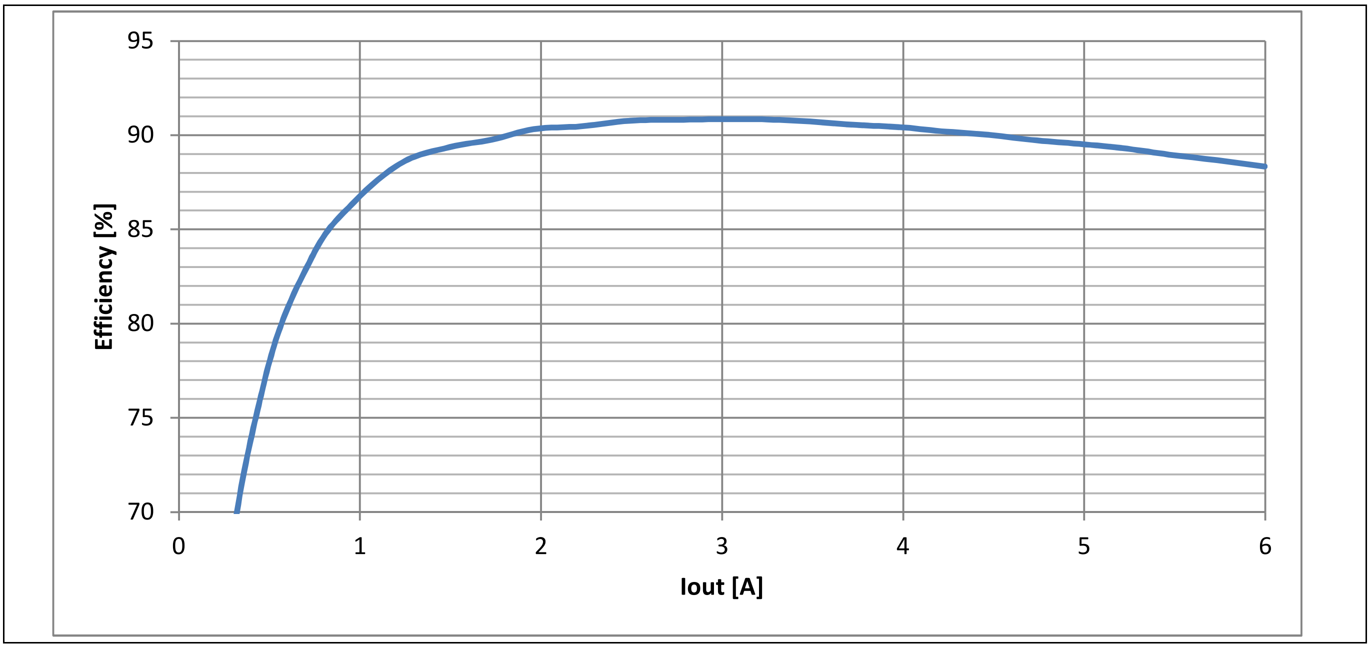

Figure 79 **Efficiency of the IR3892 regulating 2.5V @ 6A from a 12V input**

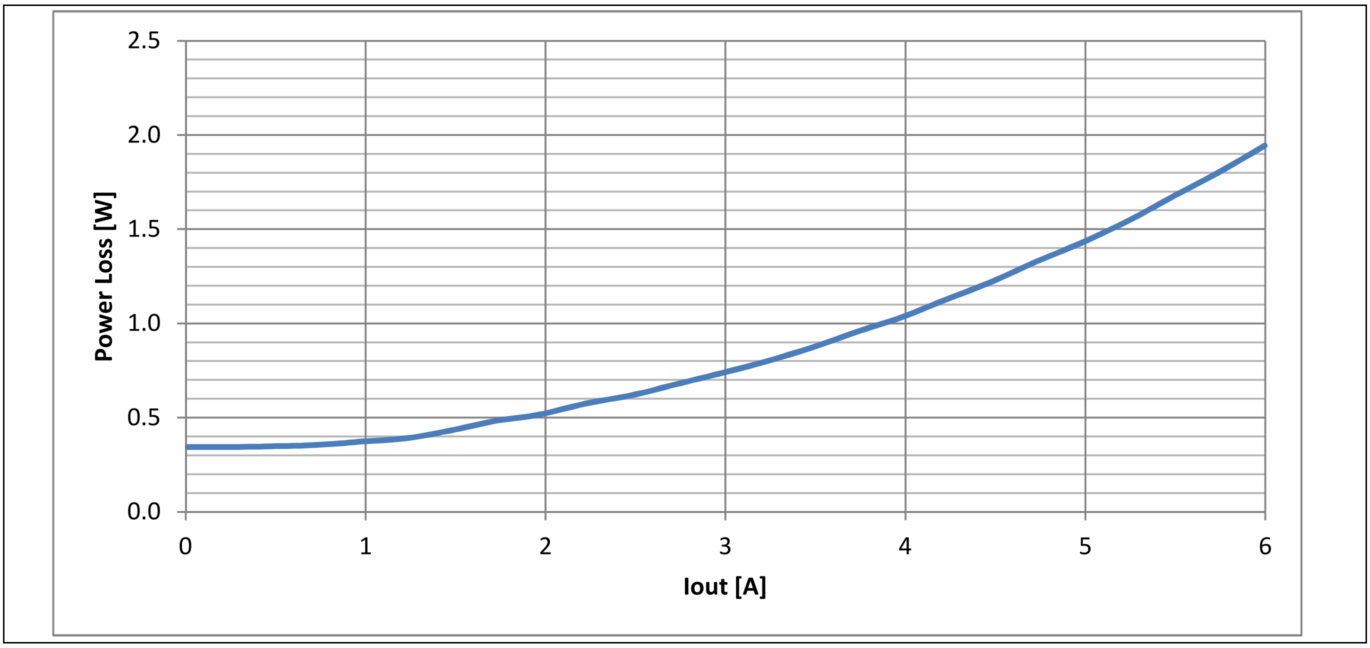

Figure 80 **IR3892 power loss while regulating 2.5V @ 6A from a 12V input**

12.6 Typical Waveforms for 3.3V Rail

PVin = Vin = 12V; Vout = 3.3V; Fsw = 600kHz

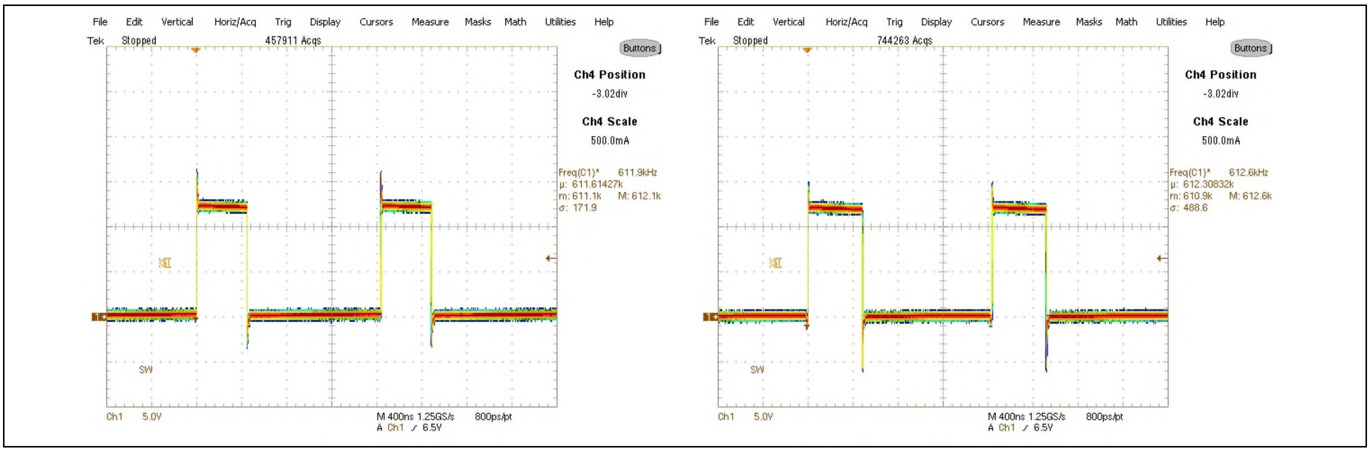

Figure 81 **IR3892 3.3V (SERDES) switch node: 0A (left) and 6A (right)**

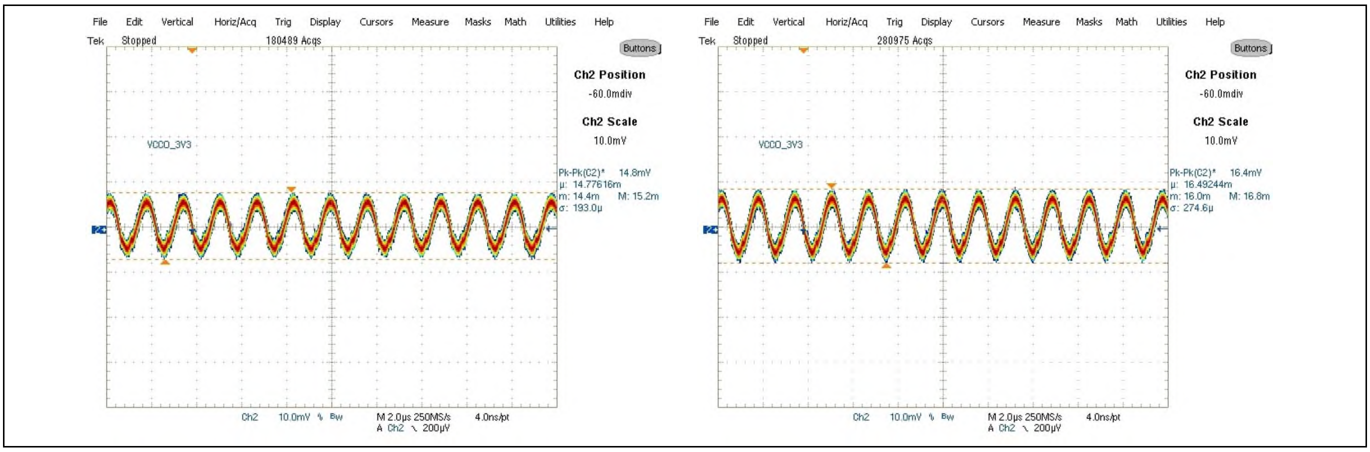

Figure 82 **IR3892 3.3V (SERDES) output ripple@ C36: 0A (left) and 6A (right)**

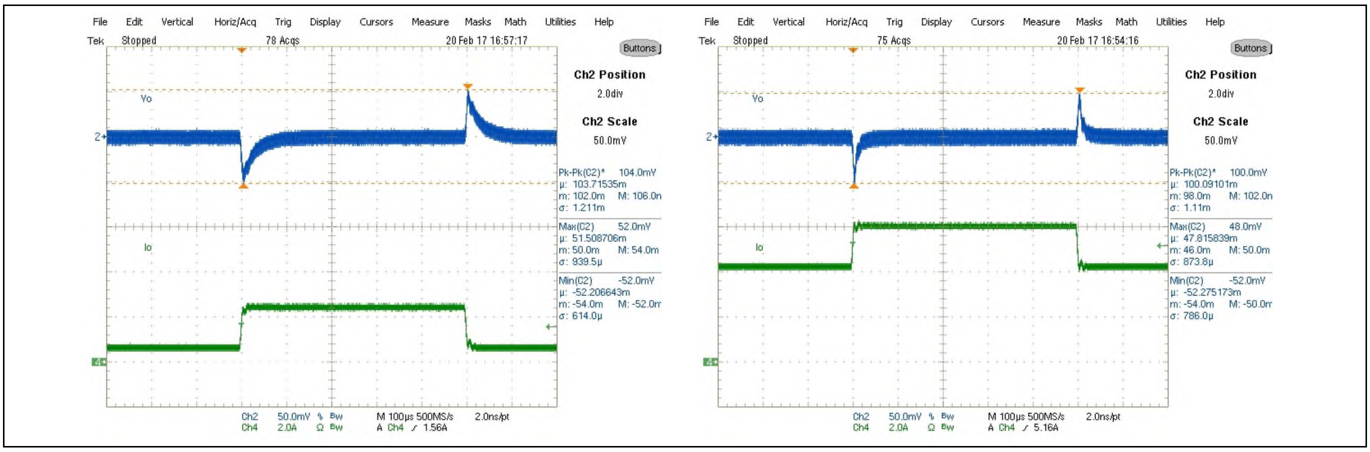

Figure 83 **IR3892 3.3V (VCCO) transient response @ C36: 0.6A-2.4A @ 2.5A/uS (left) and 4.2A-6A @ 2.5A/uS (right)**

12.7 Bode Plot [3.3V]

PVin = Vin = 12V; Vout = 3.3V; Fsw = 600kHz

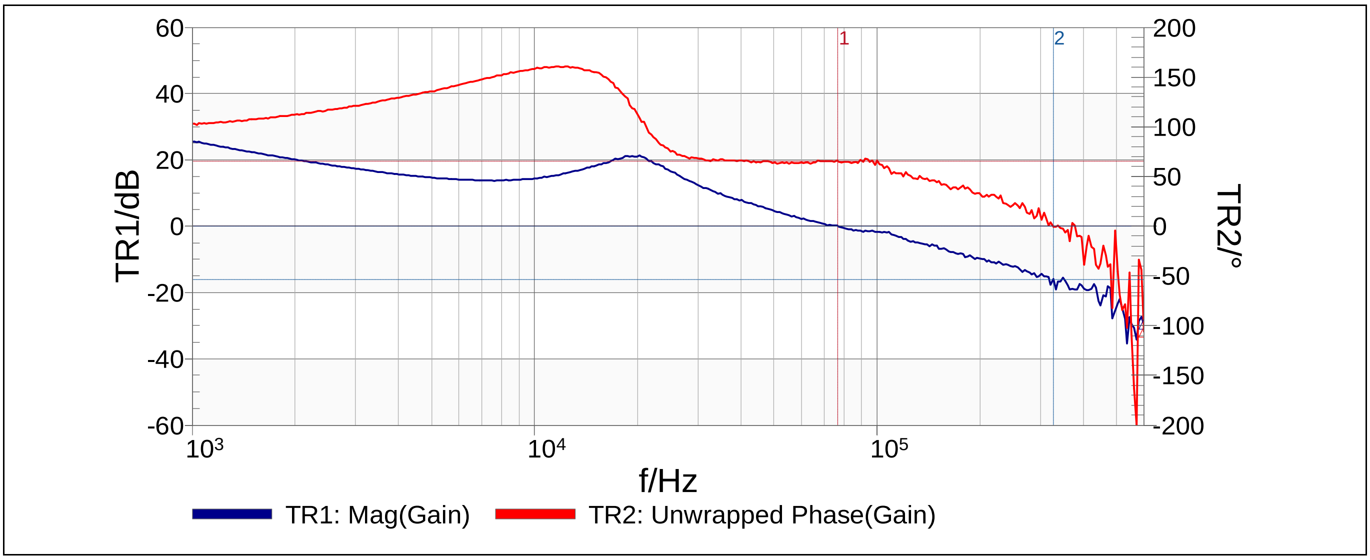

Figure 84 **Bode plot of IR3892 3.3V (VCCO) with 0A load**

Fo = 76.7 kHz
Phase Margin = 65.5 Degrees
Gain Margin = -16.2 dB

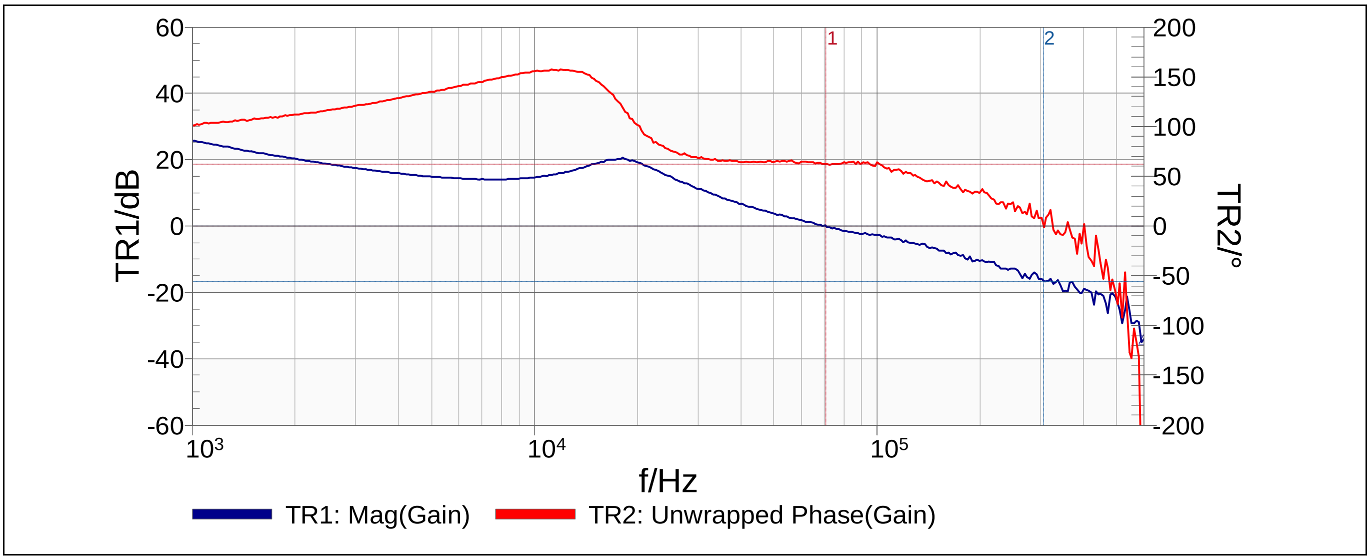

Figure 85 **Bode plot of IR3892 3.3V (VCCO) with 6A load**

Fo = 70.8 kHz
Phase Margin = 62.1 Degrees
Gain Margin = -16.7 dB

12.8 Efficiency and Power Loss

PVin = Vin = 12V, Vout = 3.3V, Fsw = 600kHz

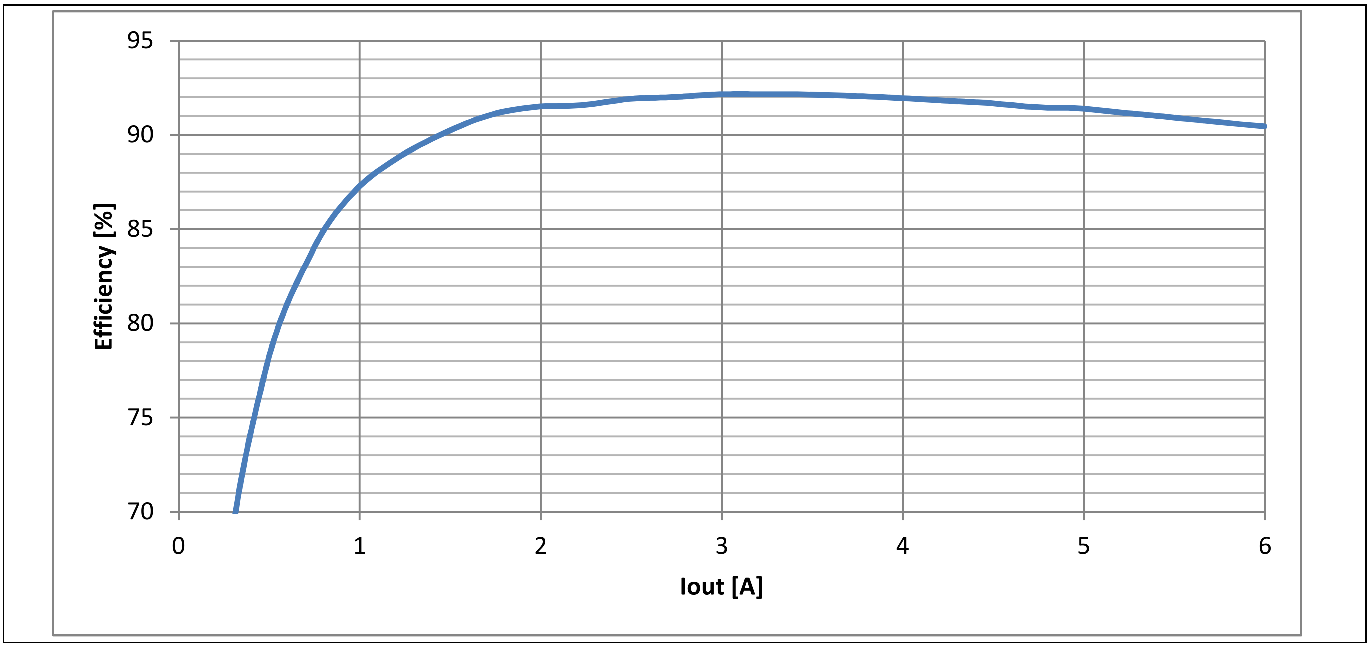

Figure 86 **Efficiency of the IR3892 regulating 3.3V @ 6A from a 12V input**

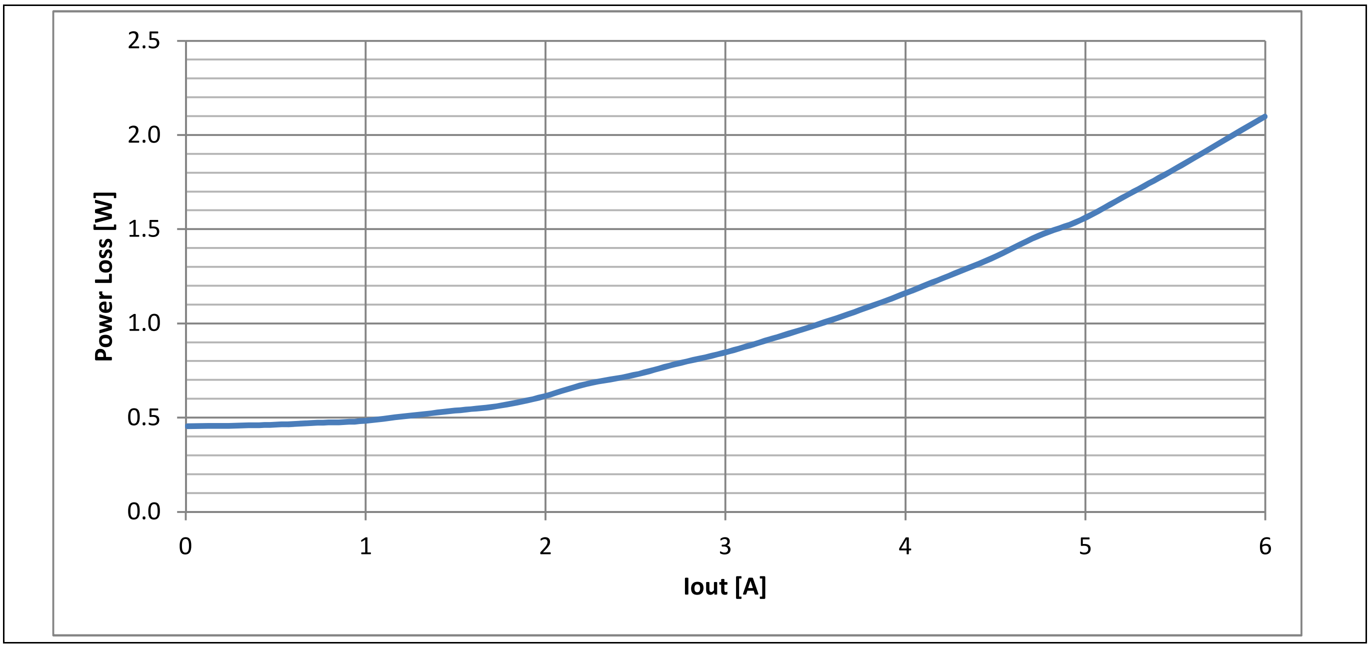

Figure 87 **IR3892 power loss while regulating 3.3V @ 6A from a 12V input**

12.9 Thermal Image

PVin = Vin = 12V, Vout = 2.5V and 3.3V, Fsw = 600kHz, Iout = 6A and 6A

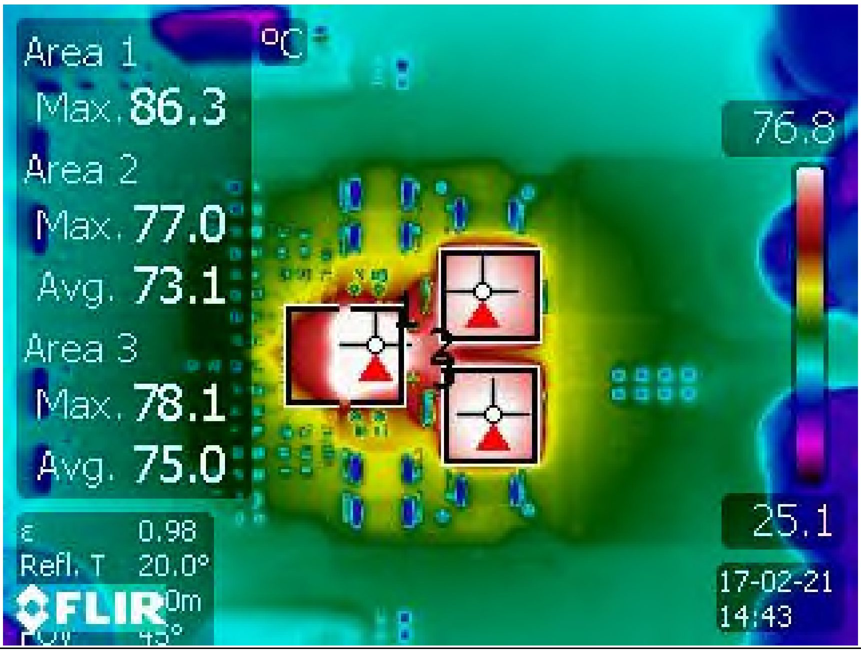

Figure 88 **Thermal image of IR3892 running 2.5V @ 6A and 3.3V @ 6A from 12V Input**

IR3892	86.3°C
Inductor [2.5V]	77.0 °C
Inductor [3.3V]	78.1 °C
Ambient Temperature	28 °C

13 Websites and More Information

- Infineon's Xilinx Solutions

  [www.infineon.com/xilinx]
- Manhattan IR38060 Datasheet

  [www.infineon.com/IR38060]
- SupIRBuck IR3892 Datasheet

  [www.infineon.com/IR3892]
- PowIR Center Web Site

  [www.infineon.com/cms/en/product/promopages/power-center-software/]
- PMBus Documents

  [www.pmbus.org/Specifications/CurrentSpecifications]
- I2C Documents

  [www.nxp.com/documents/user_manual/UM10204.pdf]

Revision History

Major changes since the last revision

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