DB359 Demo Board Performance Data and Infrastructure for Xilinx Versal Power Delivery

www.infineon.com/power-versal

V1.0

May 13, 2019

Portfolio:
Infineon Power Solutions for Xilinx Versal™

Part Number	Feature Description	Proven Solutions & Application Benefits
IR35215MTRPBF *Controlled document upon request*	Dual-loop digital multi-phase buck controller	Vcore at high current and current transient designs; 8+0, 4+4 loop design options; PMBus/I2C
→ TDA21472 *Controlled document upon request*	OptiMOS 5 high current (70A) and high efficiency power stage in 5x6x0.9mm^3 PQFN	Output current capability > 70A; Integrated current and temperature sense, reporting and protection; Boot refresh; HS short protection; Excellent efficiency; up to 1.5MHz
IRPS5401	5-output PMIC, 4 DC-DC (2A, 4A, 8A, PWM for external powerstage) + 1 LDO (0.5A, tracking option), 5W to 50W	Compact design for multiple rails; Integrated sequencer; Integrated FETs; Use with ext. power stage optional; Digital compensation; PMBus/I2C
→ TDA21240 → TDA21242	OptiMOS 5 Power-Stages 25A and 40A in 4mm x 4mm package; high efficiency	FPGA/SoC; best solution for size and efficiency in the market
IR38060, IR38062, IR38063, IR38064	Integrated FET regulators for 6A to 35A	Vcore and SERDES for Xilinx; Excellent thermal performance; PMBus/I2C with integrated sequencer, Fault mgmt., Telemetry
IR3897, IR3898	Integrated FET regulators for 4A and 6A	DDR3/DDR4 tracking +/-4A and +/-6A VTT
IR3883	Integrated FET regulator for 3A	Xilinx VCCIO voltages; low cost
IR3887, IR3889	New 30A High efficiency integrated FET regulators – releasing June 2019	Excellent performance; Efficiency > 90% at load and over temperature
IFX1763	Low Noise LDO	2.5V for Xilinx ZYNQ Ultrascale+ RFSoC
IFX54441	Low Noise LDO	1.8V SERDES for Xilinx ZYNQ Ultrascale+ MPSoC
IR3823	Low Noise analog DC/DC regulator	1.2V SERDES for Xilinx ZYNQ Ultrascale+ FPGAs

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Demo Board:
DB359 Board (Load Socket and Decoupling)

❑ 2-phase to 8-phase Vcore high transient board for Xilinx Versal™ (10 layers)

❑ Supports Power Macros for Xilinx Versal VC1902 Power Macro Solutions (others in progress)

Capacitors used for test:
10x 560uF
50x 47uF

16x 470uF

Phase inductors for test:
5x 100nH/120nH

35x 47uF

130x 10uF

8x 120nH

4x 470uF + 14x 47uF

26x 47uF

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Demo Board:
DB359 Test Setup: 2 Loops (5-Phases + 2 Phases)

Intel Voltage Regulator Transient Test Tool

Test Conditions:

VID=0.7V

Loop 1:

Iout: 120A…165A

Transient steps: 30A…90A at 200A/us

Loop 2:

Iout: 25A

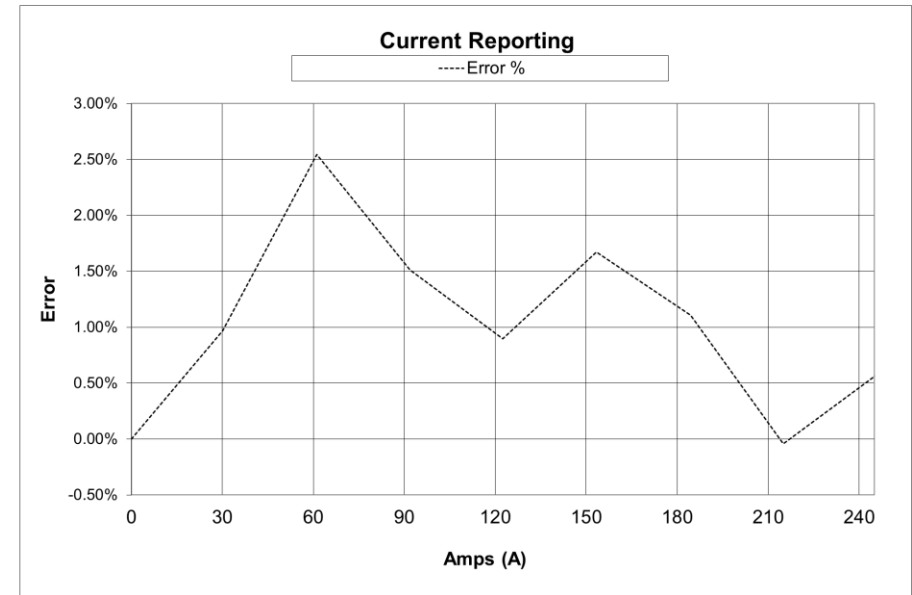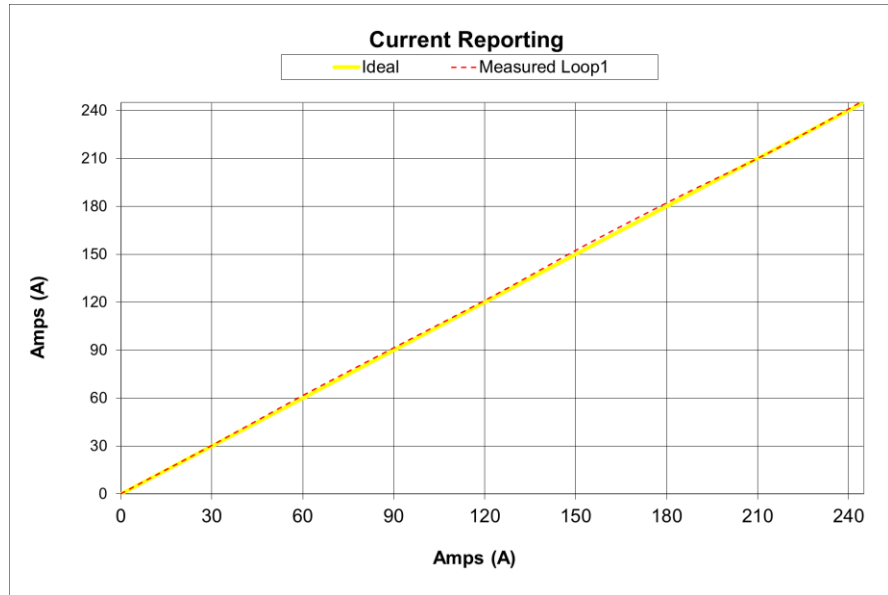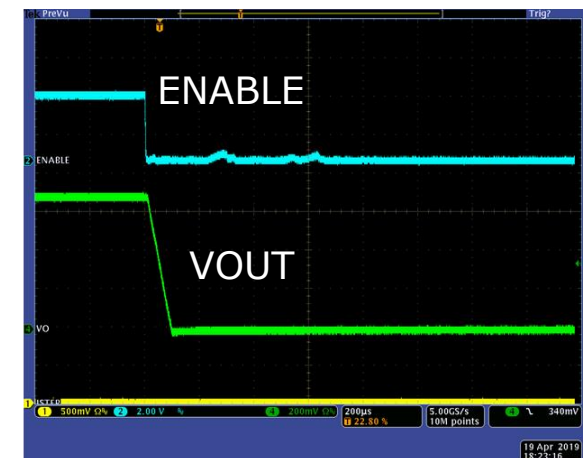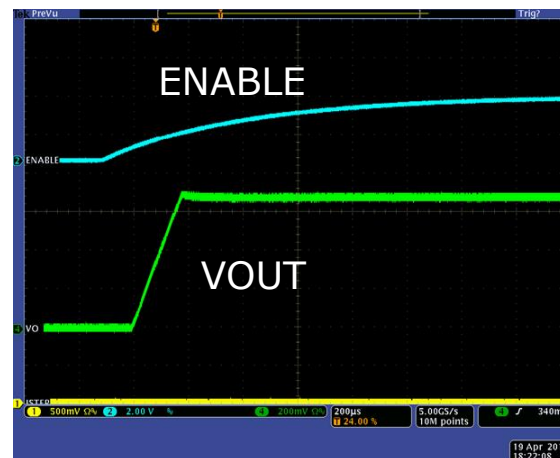Transient step: 35A at 200A/us

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DB359 Loop 1, 5-Phase Performance Results

Current reporting accuracy:

Startup/Shutdown:

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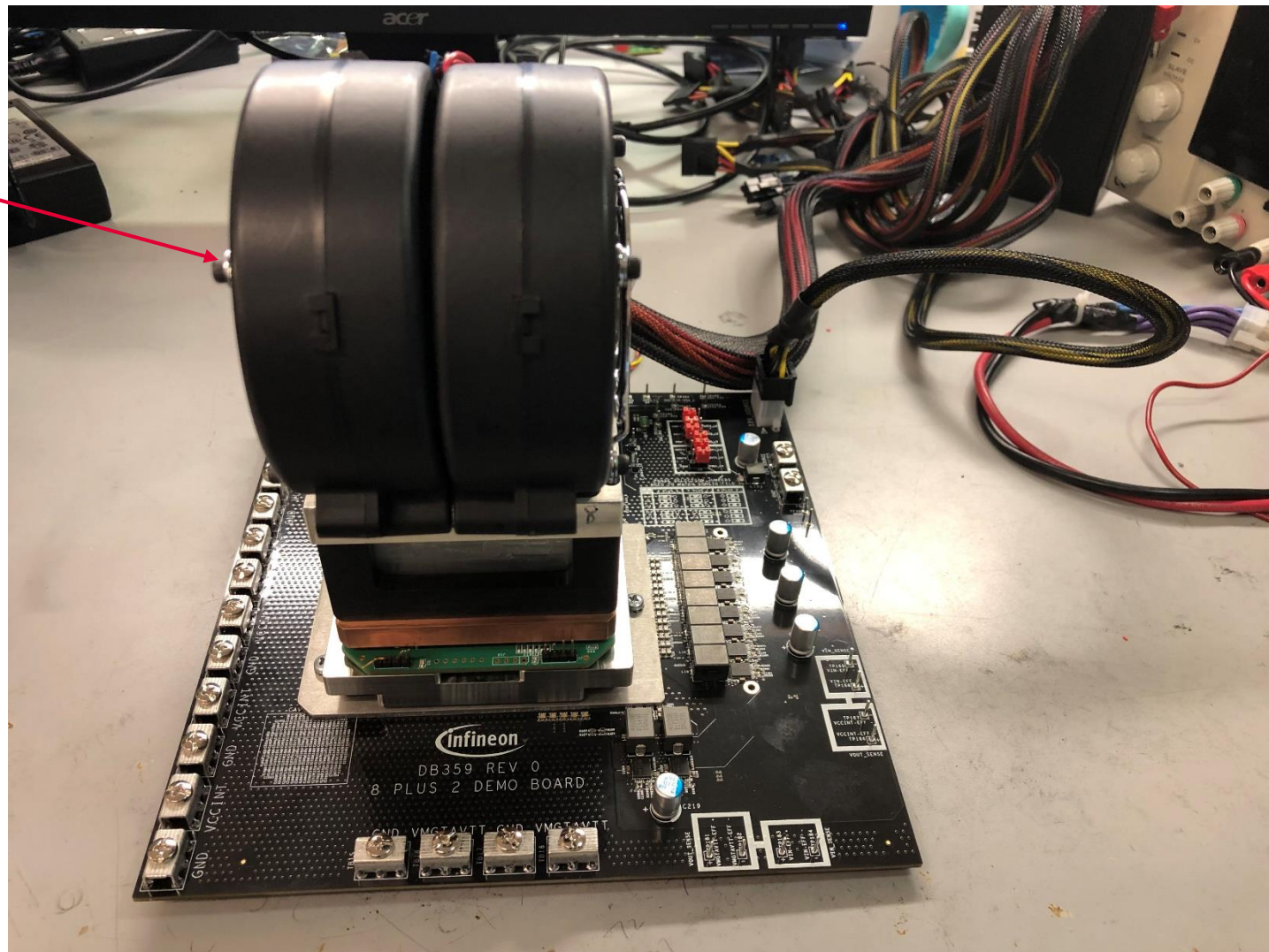
Demo Board:
DB359 Loop 1, 5-Phase Performance Results

Transient step 90A-150A at 200A/us:

1kHz repetition rate

10kHz repetition rate

Transient step 60A-150A at 200A/us:

8.7kHz repetition rate

Decoupling:
10x 560uF/3mΩ POSCAP
50x 47uF/0805
260x 10uF/0402 (cavity)
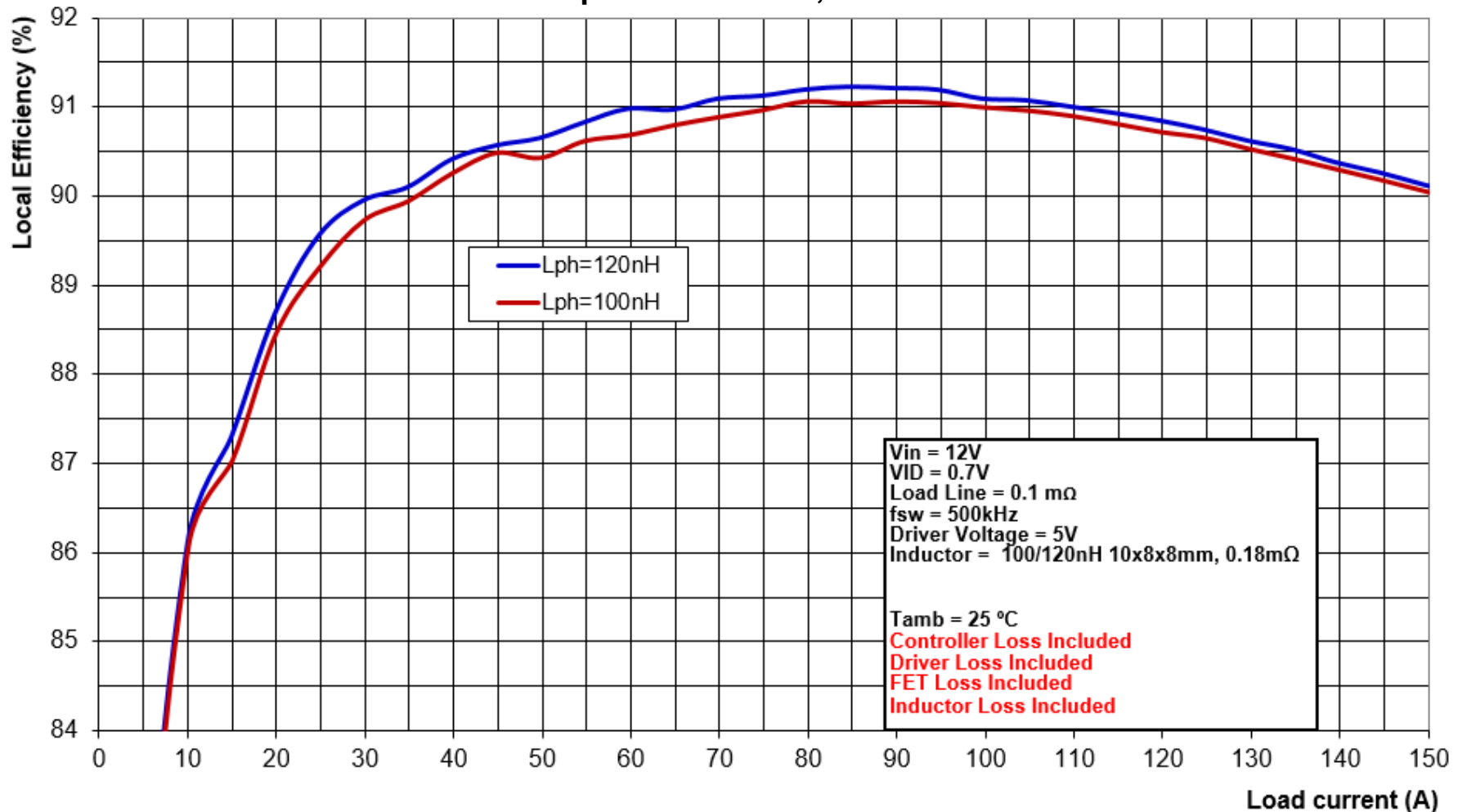
DB359 Loop 1, 5-Phase Performance Results

› Efficiency

**DB359 Rev 0, 5 Phases, TDA21472, 0.1 mΩ LL, Output voltage 0.7V, 100nH/120nH phase inductors, TDC=150A**

Legend: Lph=120nH, Lph=100nH

Vin = 12V
VID = 0.7V
Load Line = 0.1 mΩ
fsw = 500kHz
Driver Voltage = 5V
Inductor = 100/120nH 10x8x8mm, 0.18mΩ

Tamb = 25 ºC
Controller Loss Included
Driver Loss Included
FET Loss Included
Inductor Loss Included

The board has been tested up to 240A output current with only 5 phases enabled.
The power loss at 240A is 26W.

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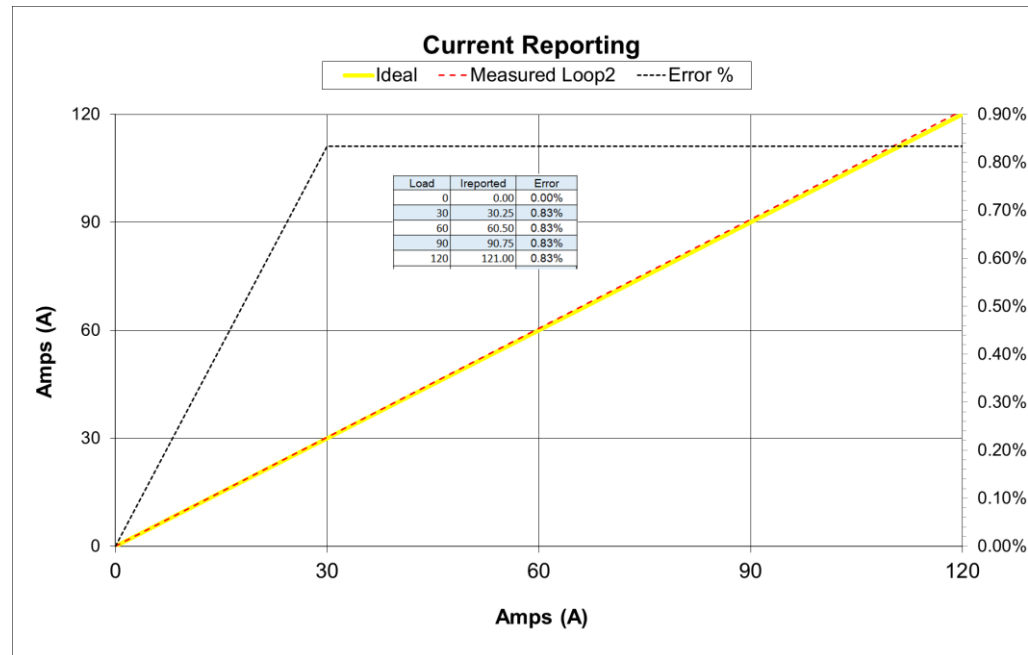
7

DB359 Loop 1, 5-Phase Performance Results

› Operating conditions:

  – 5 Phases, TDA21472

  – LL=0.1mΩ

  – V_{out}=0.7V

  – f_{sw}=500kHz

  – I_{out}=150A

  – L_{ph}=100nH

  – T_a=25°C

  – No heatsink

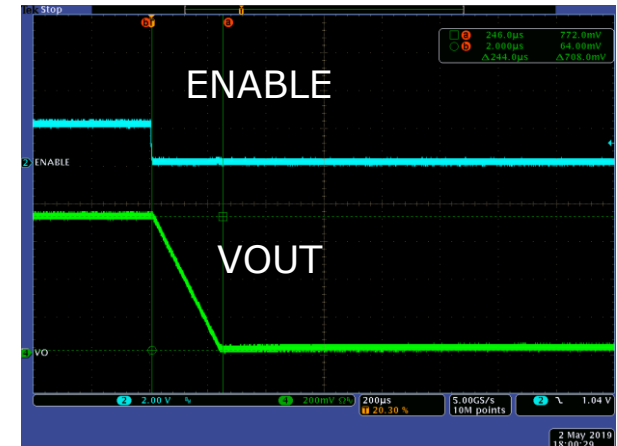› Thermal data taken after 10 min soaking at 150A load current
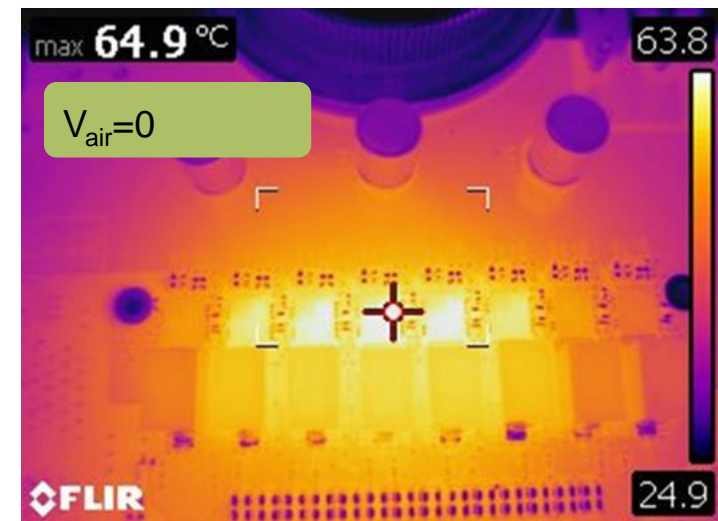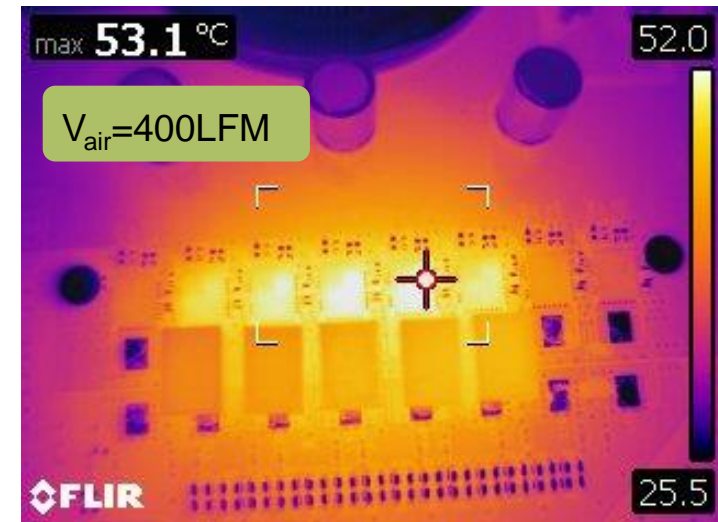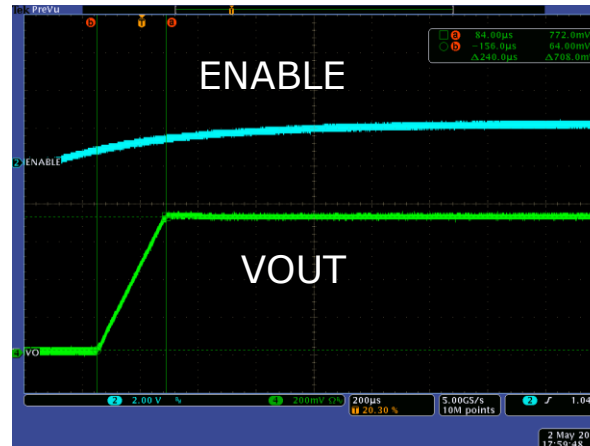
Demo Board:
DB359 Loop 2, 2-Phase Performance Results

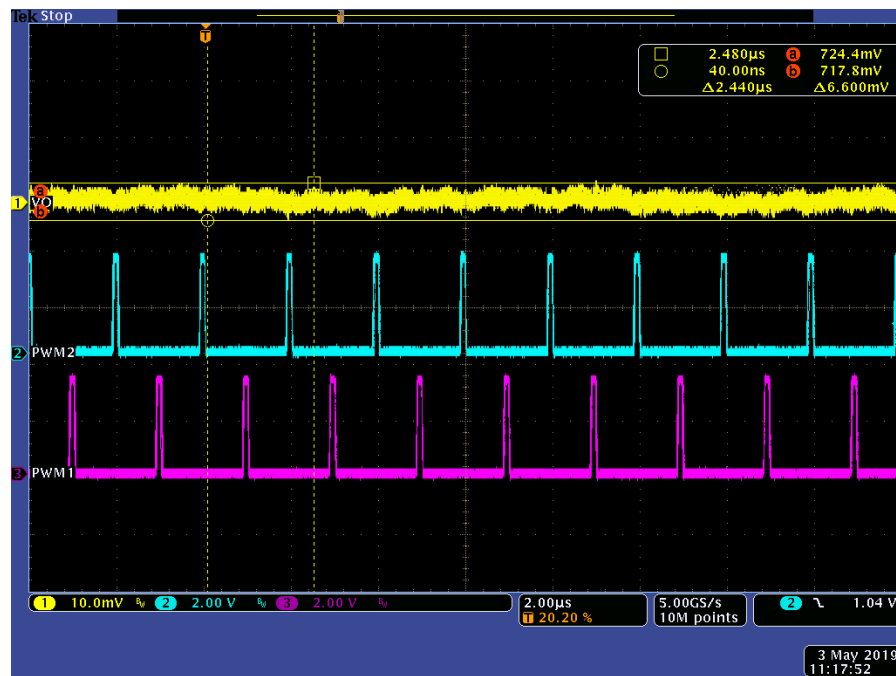Current reporting accuracy:

Startup/Shutdown:

 Infineon Proprietary
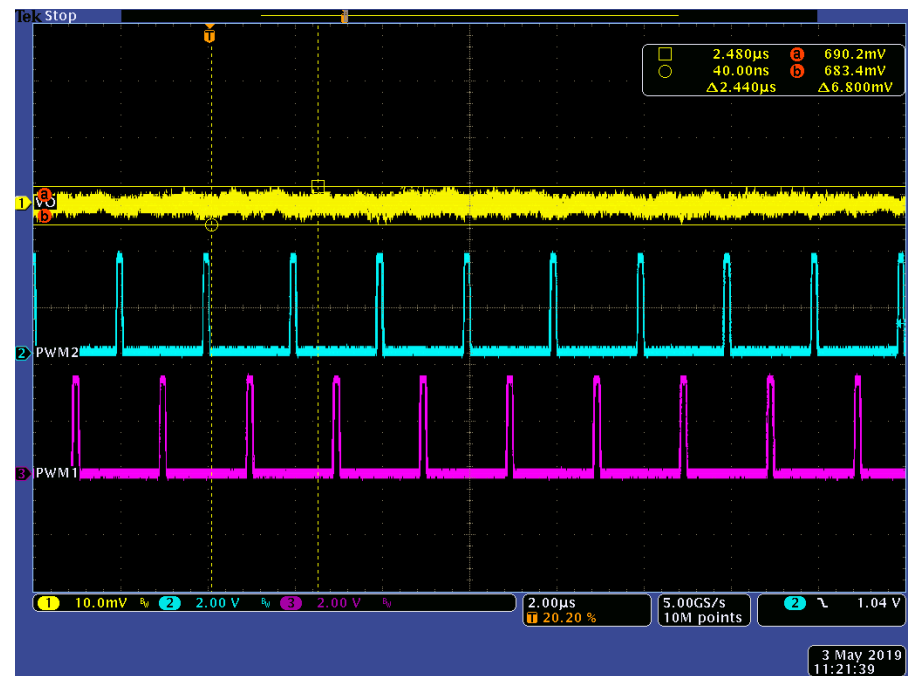
DB359 Loop 2, 2-Phase Performance Results

› Steady State Ripple

No Load

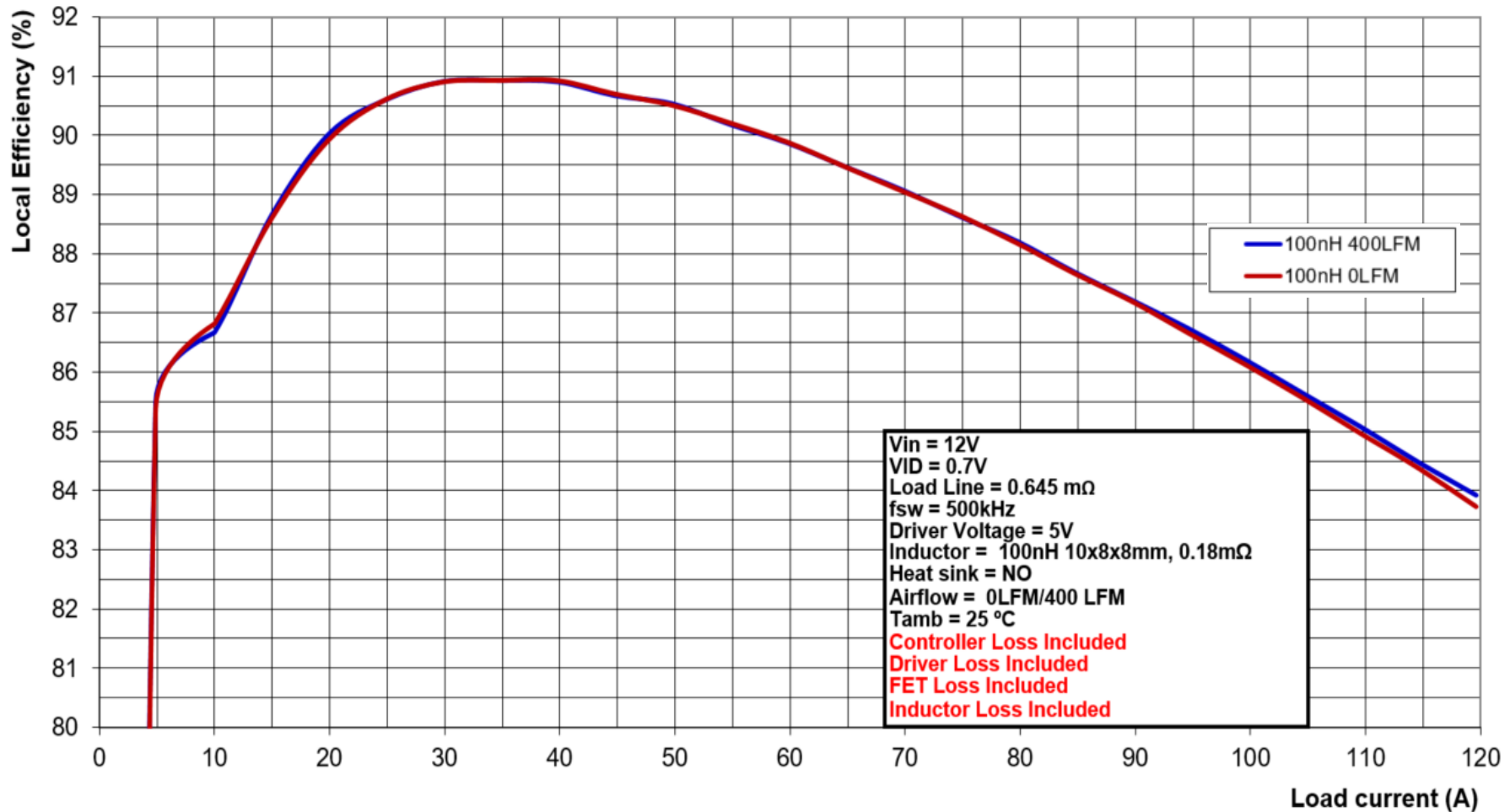60A Load Current

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Demo Board:
DB359 Loop 2, 2-Phase Performance Results

› Efficiency

DB359 Rev 0, 2 Phases, TDA21472, 0.645 mΩ LL Output voltage 0.7V, 100nH phase inductor, TDC=60A

Legend:
- 100nH 400LFM
- 100nH 0LFM

Vin = 12V
VID = 0.7V
Load Line = 0.645 mΩ
fsw = 500kHz
Driver Voltage = 5V
Inductor = 100nH 10x8x8mm, 0.18mΩ
Heat sink = NO
Airflow = 0LFM/400 LFM
Tamb = 25 ºC
Controller Loss Included
Driver Loss Included
FET Loss Included
Inductor Loss Included

The board has been tested up to 120A output current with 2 phases enabled. The power loss at 120A is 15.3W.

Demo Board:
DB359 Loop 2, 2-Phase Performance Results

› Operating conditions:

  – 2 Phases, TDA21472

  – $LL=0.645m\Omega$

  – $V_{out}=0.7V$

  – $f_{sw}=500kHz$

  – $I_{out}=60A$

  – $L_{ph}=100nH$

  – $T_a=25°C$

  – No heatsink

› Thermal data taken after 10 min soaking at 60A load current

$V_{air}=400LFM$

$V_{air}=0$

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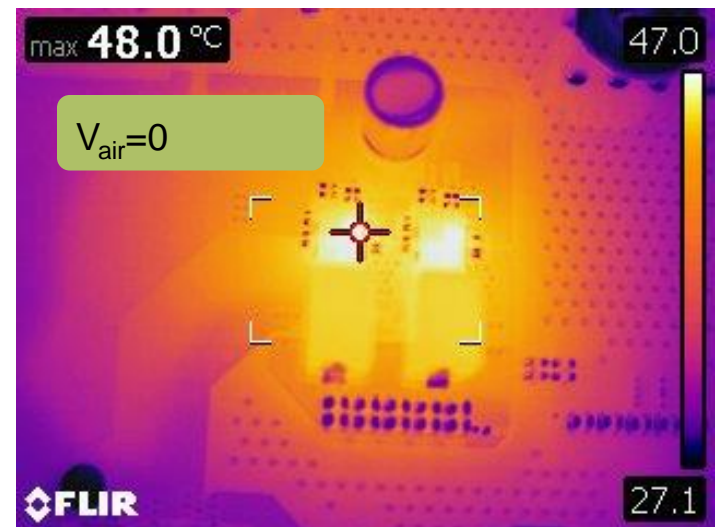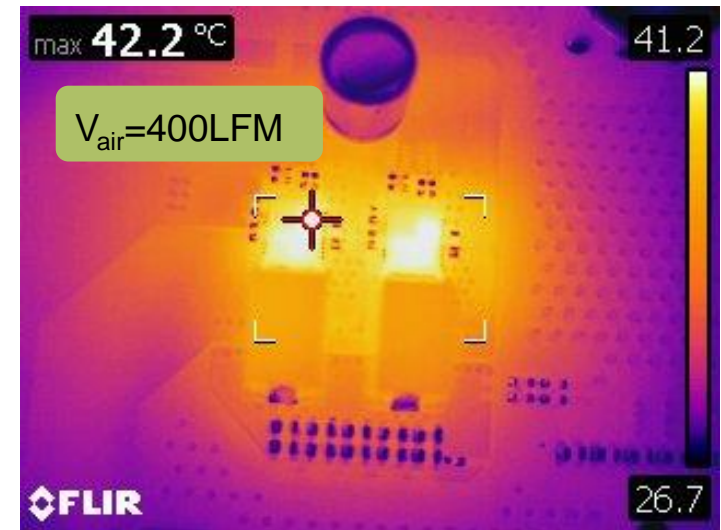
Multiphase:
Multiphase Controllers & Power Stages

Reasons to use MultiPhase solutions:

› Output current exceeds range for a single phase solution

› High efficiency over wide load range

› Better transient response

› Smaller decoupling solution (L, C)

› Less EMI due to smaller switched current

PowerStages on
Infineon Website:

Key features
- Small 5x6x0.9mm^3 overmolded PQFN package, 0.45mm pitch
- Highly accurate current reporting
- Programmable constant current limit OCSET
- Fast switching technology for improved performance at higher frequency, better peak efficiency
- Input voltage range 4.25V to 16V
- Output voltage range from 0.25V up to 5.5V
- Output current capability up to 70A
- Operation up to 1.5MHz
- Optimized for 5V drive

Key benefits
- Peak efficiency >95%
- 2.5mA I_{CC}, with low I_Q (<200µA) disable PS4 (deep sleep mode) capability

Target applications
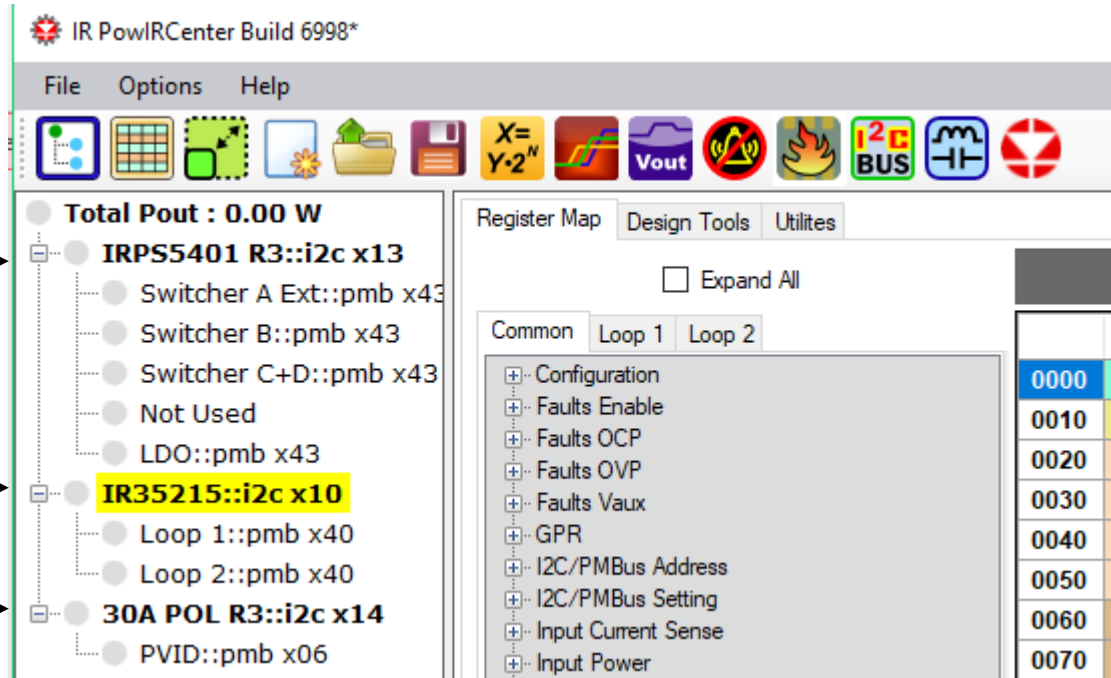- **Server** and storage
- **Telecom**
- Datacom

Multiphase:
Multiphase Controller IR35215

› Seemless integration with POL and PMIC devices into the same GUI

› 5-output PMIC configured for 2 single phase switcher rails, a dual phase rail and an LDO rail
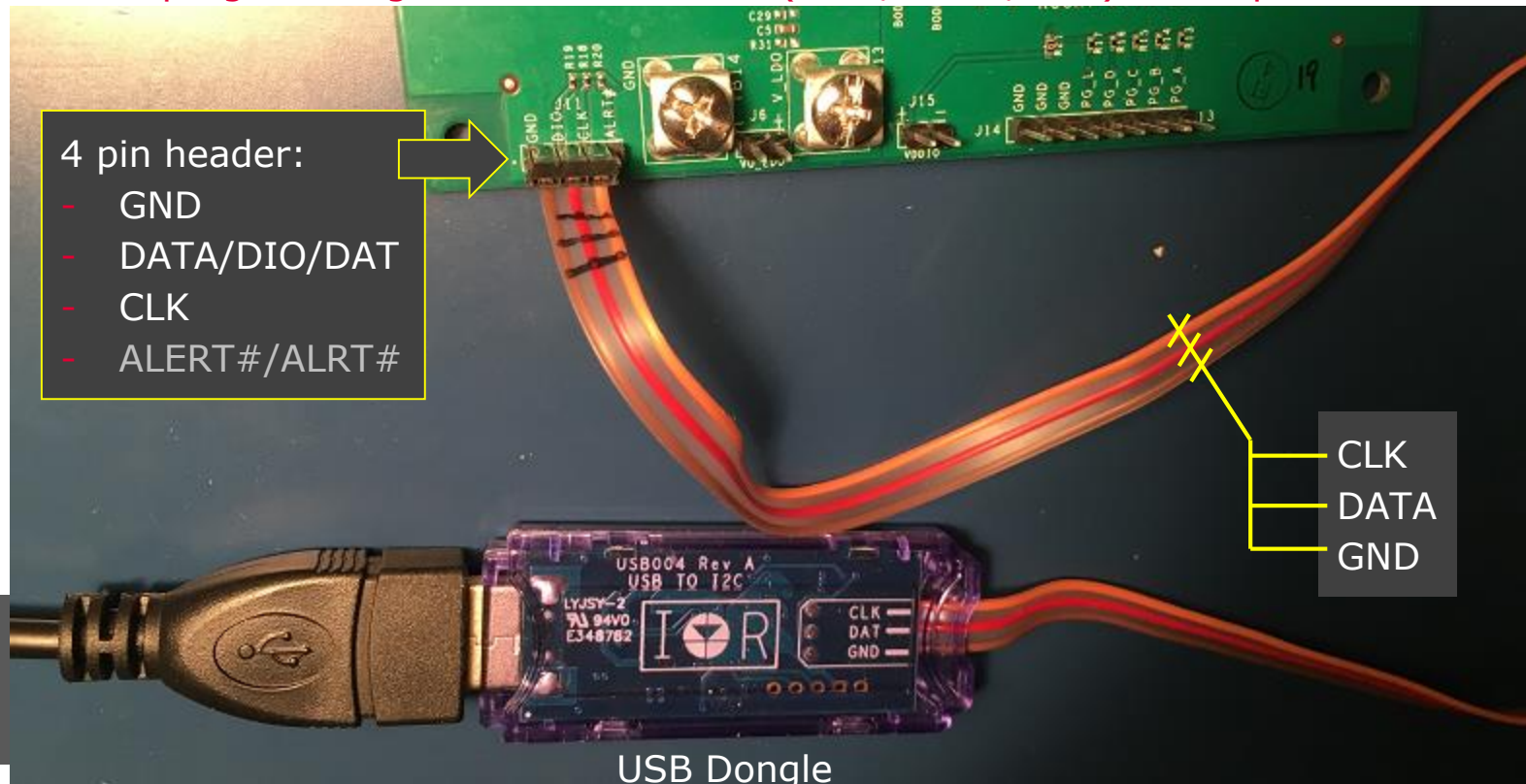
› 2-output multiphase controller

› 1-phase 30A POL

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Multiphase:
I2C and PMBUS Communication

USB Dongle005 connects

PC and application board

For communication and programming via I2C three wires (GND, DATA, CLK) are required.

4 pin header:
- GND
- DATA/DIO/DAT
- CLK
- ALERT#/ALRT#

CLK
DATA
GND

Connected to programming USB port

USB Dongle

Install header on pcb: 4 positions, breakaway connector 2.54mm (0.1") pitch

e.g. Digikey S1011E-04-ND or S1011E-36-ND (36 pins, break off 4 pins)

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Multiphase:
IR35215 Features

› Established controller solution for Intel CPU regulation

› 8/4 phase dual loop controller (2 loops configurable from 1..4+0..4, 5+0..3, 6+0..2, 7+0/1, 8+0)

  › Active voltage positioning (load-line)

  › 5mV VID resolution

  › Voltage mode with active current balancing (active current sharing)

  › Nonlinear transient support (adaptive transient algorithm)

  › Digital compensation (no external compensation components)

  › SVID and I2C/PMBUS

  › Autophasing (phase shedding)

  › Telemetry on voltage, current, power, temperature, fault protection and reporting

  › 5mm x 5mm 40-pin QFN-package

  › Digital pin-strapping to select an entire configuration from many

  › Programmable I/O pins to support additional reporting and enable functions

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Multiphase:
PowIRCenter, IR35215 Device Addresses

(1% tolerance)

If i2c_use_addr_offset=0 then Address Offset =0 else Address Offset =f(R_PROG)

Addr. Offset	R_{PROG} [kΩ]
+0	0.845
+1	1.30
+2	1.78
+3	2.32
+4	2.87
+5	3.48
+6	4.12
+7	4.75
+8	5.49
+9	6.19
+10	6.98
+11	7.87
+12	8.87
+13	10.00
+14	11.00
+15	12.10

I2C Address = I2C NVM address + Address Offset

PMBUS Address = PMBUS NVM address + Address Offset

GUI:

I2C/PMBus Address
  I2C NVM address
  PMBUS NVM address
  I2C/PMBUS address offset Enable

The I2C and PMBus device addresses reset to 0x10 and 0x40. They can also be loaded from the OTP. If this bit is set, the value in latched_prog is added to the device address. This allows multiple devices on the same I2C bus to have unique device addresses. 1 = nvm_plus_ext_resistor. 0 =

i2c_use_addr_offset
x58 [12:12]   0   ⇕   x00
Not added

Read   Write

R_{PROG}

PROG

10nF

GND

Internal

Note: The offset for PMBUS and I2C bus is always identical.

Multiphase: IR35215 Multiple Image Files and Segment Selection by PROG Pin Resistor

Example 1:

A .MIC file with 11 configuration sections was written into NVM. PROG_MAX has been set to the value of 11. The PROG resistor of 5.49 kΩ selects configuration section 9 to be loaded and used.

No further .MIC file can be programmed.

A subsequent programming of a new configuration writes into section 12 which is then being used. Another 15 sections remain free for possible single configuration writes.

(1% tolerance)

Config Offset	.MIC file	R_{PROG} value [kΩ]	Single MTP write
+0	1	0.845	1
+1	2	1.3	2
+2	3	1.78	3
+3	4	2.32	4
+4	5	2.87	5
+5	6	3.48	6
+6	7	4.12	7
+7	8	4.75	8
+8	9	5.49	9
+9	10	6.19	10
+10	11	6.98	11
+11	12	7.87	12
+12	13	8.87	13
+13	14	10	14
+14	15	11	15
+15			16
+16			17
+17			18
+…			…
+26			27

15 sections

Example 2:

The first write into NVM was a single configuration

No .MIC file can be programmed anymore.

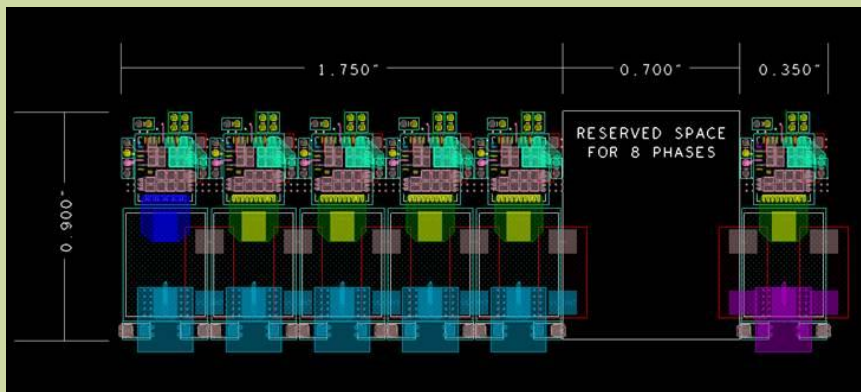26 more single configuration writes remain available.

In general:

- *If prog_max is smaller than the number of programmed segments, the last segment will be used.*
- *If prog_max is bigger than the number of programmed segments and*
  - ○ *R_{PROG} points to a valid segment, this segment will be used.*
  - ○ *R_{PROG} points to an unprogrammed segment, the part does not start.*

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Summary:
One Software Interface

› PowIRCenter GUI for all PMBUS devices

› Reporting status of

  – Interface to board

  – PMBUS/I2C addresses

  – Vin

  – Vout

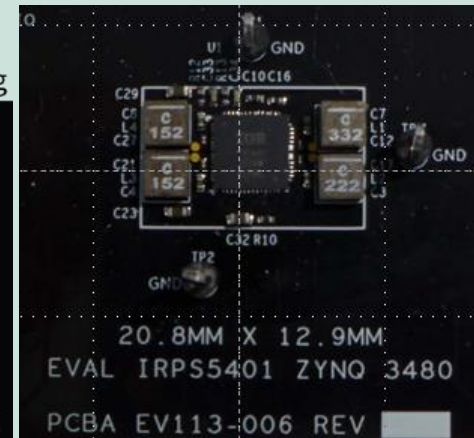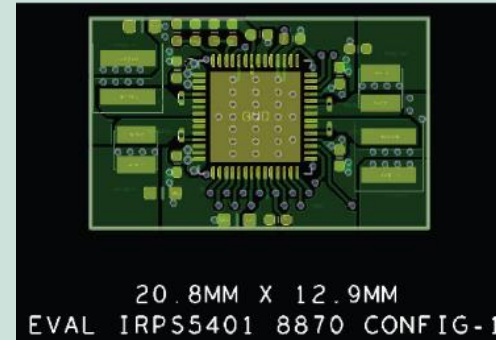 – Iin

  – Iout

  – Temperature

  – Status of each rail
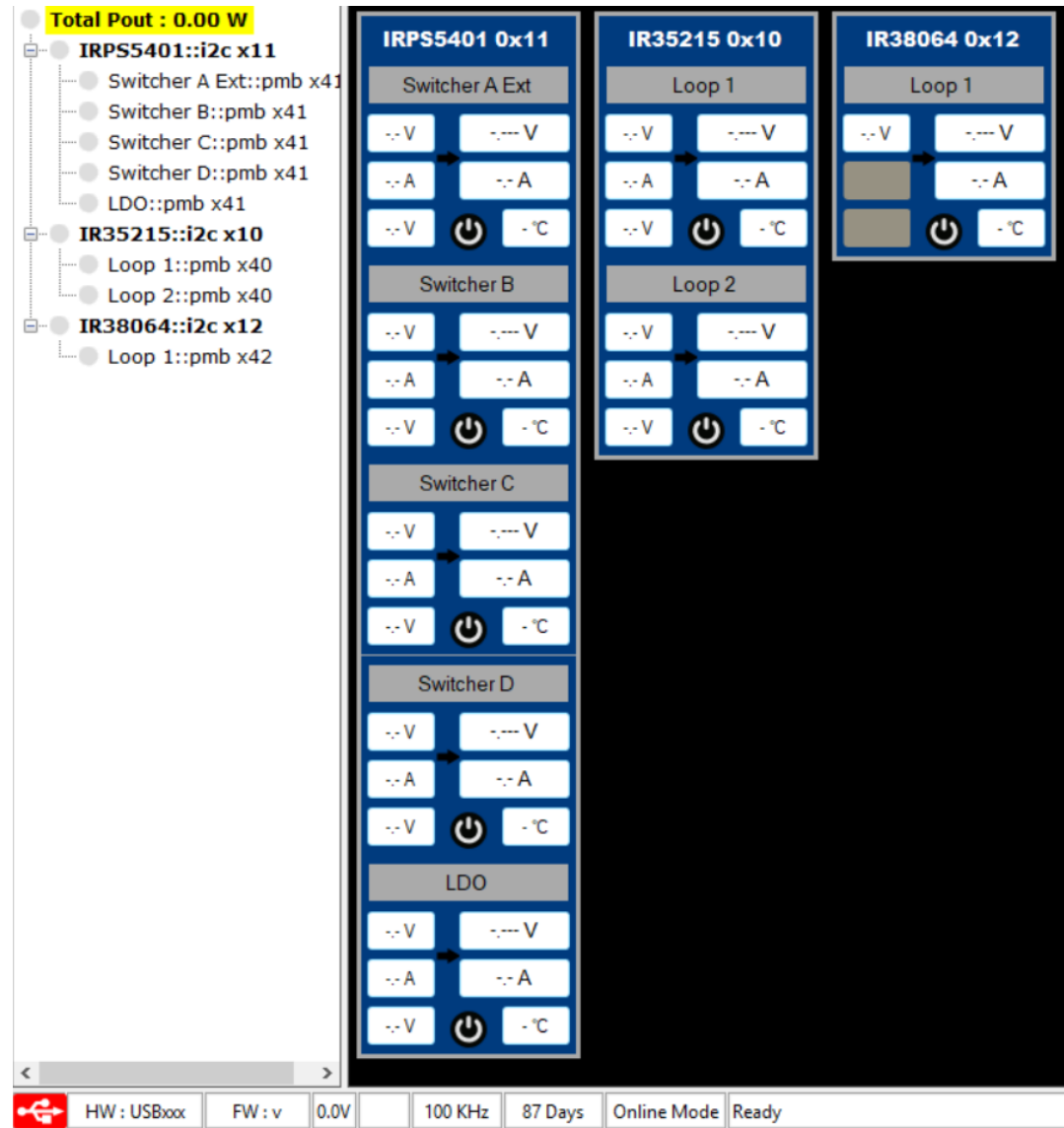
Summary: Enormous Flexibility to Support Any Power Requirement on XILINX VERSAL™

IRPS5401 - 20.8mm x 12.9mm
5 outputs with L's, Cout's
with integrated power sequencing

20.8MM X 12.9MM
EVAL IRPS5401 8870 CONFIG-1

20.8MM X 12.9MM
EVAL IRPS5401 ZYNQ 3480
PCBA EV113-006 REV

- Scalability for the Vcore rails from 2-phase to 8-phase to cover from **40A to 300+A** @ >90% Efficiency at Load and Temperature

- Additional output for DDR3/DDR4 voltages

- Preset Vcore voltages for Versal

- Integrated power sequencing

- PMBus telemetry and margining

- Ready to go PID designs for load transients and power macros for various Versal power use cases

- Proven design using Infineon's Power Validation Board – DB359

- High integration PMICs for compact design for Versal smaller current rails – 5 outputs

- Each PMIC stores up to 15 **simultaneous** designs

- Integrated power sequencing (also to external VR)

- Hardware sequencing with external regulators possible

- Capable for **5W to 50W voltage rail combinations**

- PMBus telemetry, margining, tracking LDO

- Proven on many Xilinx reference designs

- Ready to go Versal designs and power macros

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Summary:
More Information www.infineon.com/power-versal

http://www.infineon.com/xilinx

Please choose a subcategory
+ Expand all subcategories

+ Xilinx Zynq UltraScale+ RFSoC – New!
+ Xilinx Zynq Ultrascale+, Embedded Vision, Zu07EV - New!
› Xilinx Zynq UltraScale+ MPSoC, UltraZED-EG, Zu03
› All of Infineon's Zynq UltraScale+ MPSoC Power Macros
› Xilinx Zynq7
+ Xilinx Ultra Scale Kintex 10W Power Design - New!

+ Xilinx Ultra Scale Kintex 45W Power Design
› Xilinx Artix 7
› Xilinx Spartan6
+ Xilinx Kintex UltraScale+ (coming soon)
+ Xilinx Virtex UltraScale+ (coming soon)
+ Xilinx Spartan 7 (coming soon)

Videos

› How to power up a state-of-the-art SoC
› Infineon power for Xilinx ZCU-111 Zynq UltraScale+ RFSoC
› Infineon power for Avnet UltraZED-EV Zu07EV evaluation platform
› Infineon power for Xilinx ZCU-104 Zu07EV evaluation platform
› Infineon power macros and reference designs for Xilinx Zynq UltraScale+ MPSoC and RFSoC

e.g.:
https://www.youtube.com/watch?v=ovRTIxLXDFk

› Application examples

Infineon - Xilinx Solution Selector

Family	Power Range	FPGA Power	Voltage Range
☐ Virtex	▬▬▬	☐ Core	▬▬▬
☐ Kintex	1 - 99 Watts	☐ Platform	0.1 - 5.0 Volt
☐ Zynq Plus		☐ Serdes	

Part Number Total Matched: 238	Xilinx Family	FPGA Power	Volt Rail	Power (W)	Voltage (V)	Features
IR36021 + IR3553	Virtex	CORE	VCCINT0V95	45	0.95	Digital Multi-phase Controller and
IR36021 + IR3553	Virtex	CORE	VCCINT_IO0V95	45	0.95	Digital Multi-phase Controller and
IR36021 + IR3553	Virtex	CORE	VCCBRAM0V95	45	0.95	Digital Multi-phase Controller and
IR3899	Virtex	PLATFORM	VCCAUX1V8	45	1.80	9A Analog SupIRBuck Regulator

Part of your life. Part of tomorrow.