

## Sup/IRBuck™

### USER GUIDE FOR IRDC3710-QFN EVALUATION BOARD

#### DESCRIPTION

The IR3710M is a single phase sync-buck PWM controller IC optimized for efficiency in high performance portable electronics. The switching modulator uses constant ON-time control. Constant ON-time with diode emulation provides the highest light load efficiency required for all applications.

Key features offered by the IR3710M include: programmable switching frequency, soft start, forced continuous conduction mode (FCCM) operation at light load and over current protection.

Additional features include pre-bias startup, very precise 0.5V reference, over/under voltage fault protection, power good output, and enable input with voltage monitoring capability. The gate drive is designed to operate up to 7.5V to enhance over all system efficiency.

This user guide contains the schematic and bill of materials for the IRDC3710-QFN evaluation board. The guide describes operation and use of the evaluation board itself. Detailed specifications and application information for IR3710M is available in the IR3710M data sheet.

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#### BOARD FEATURES

- $V_{in} = +12V$  Typical ( 8-19V input Voltage range. Pls. see note below)
- $PV_{cc} = +5.0V$
- $V_{cc} = +3.3V$
- $V_{out} = +1.1V @ 0- 20A$
- $F_s = 300kHz @ 20A$
- $L = 0.5\mu H$
- $C_{in} = 2x10\mu F$  (ceramic 1210) +  $1x330\mu F$  (electrolytic)
- $C_{out} = 2x10\mu F$  (ceramic 1206) +  $3x330\mu F$  (SP Cap)

Note: At low input line an additional 10 $\mu F$  ceramic capacitor is recommended at input to handle higher ripple current)

**CONNECTIONS and OPERATING INSTRUCTIONS**

A regulated +12V input supply should be connected to VIN+ and Vin-. A maximum 20A load should be connected to VOUT+ and VOUT-. The connection diagram is shown in Fig. 1 and inputs and outputs of the board are listed in Table I.

IRDC3710-QFN has three input connectors, one for gate drive supply (PVcc), one for biasing (Vcc) and the third one as input voltage (Vin). Separate supplies should be applied to these inputs. PVcc input should be a well regulated 4.5V-5.5V supply and it would be connected to +5V and GROUND and Vcc input should be a well regulated 3.0V-3.6V supply and it would be connected to +3.3V and GROUND. An external signal can be provided as Enable signal to turn on or turn off the converter if desired. This signal is not required to power up the Evaluation board as EN pin is connected to a voltage divider from Vin. The absolute maximum voltage of Enable signal is +3.9V.

The evaluation board is configured for use with 2x10uF (ceramic 1206) + 3x330uF (SP) capacitors. However, the design can be modified for an all ceramic output cap configuration by adding the inductor DCR sensing circuit as show in the schematic.

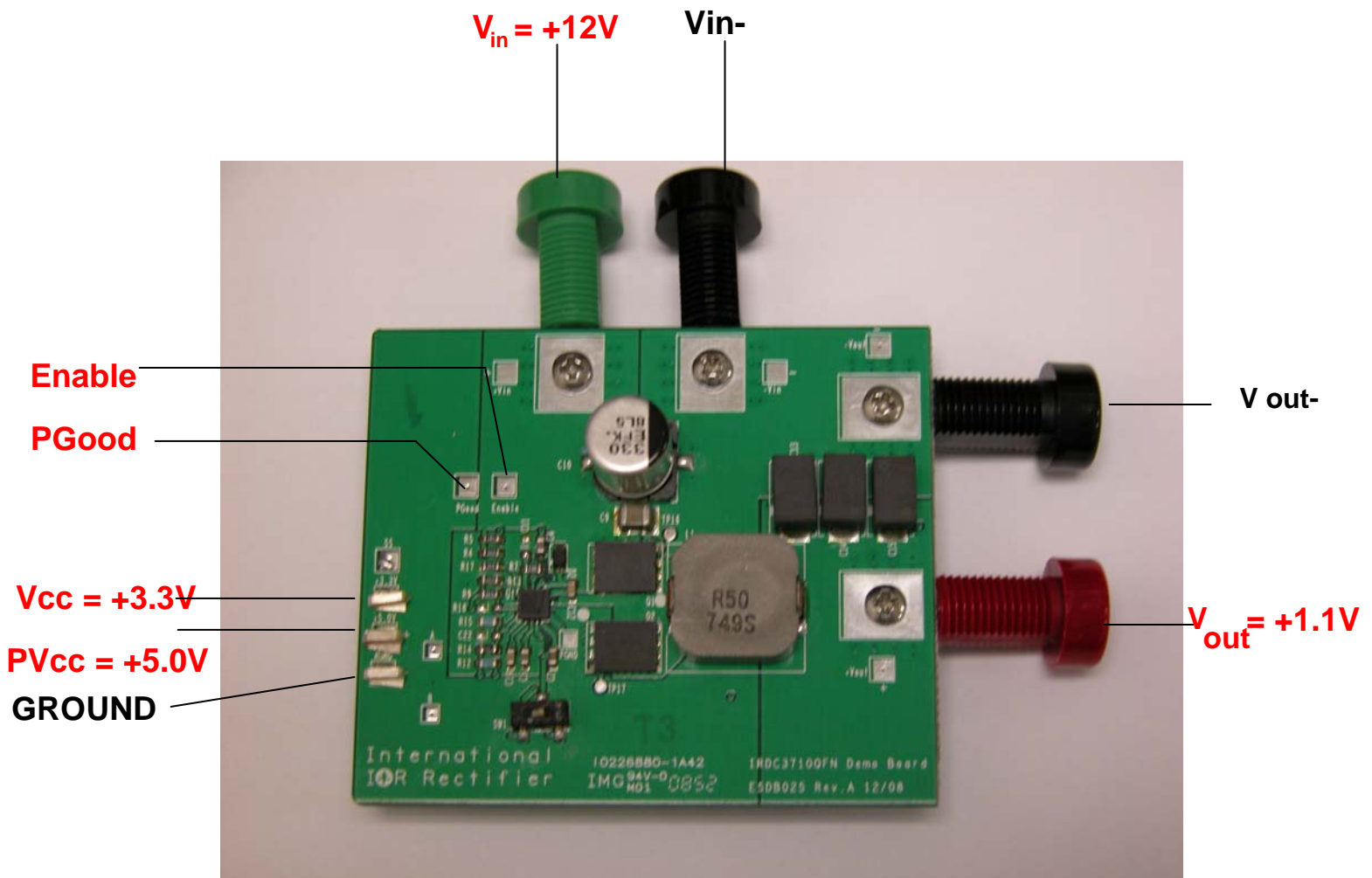
**Table 1: Connections**

| Connection | Signal Name                   |
|------------|-------------------------------|
| VIN+       | VIN (+12V)                    |
| VIN-       | Ground of VIN                 |
| +5V        | PVcc input (+5.0V)            |
| +3.3V      | Vcc input (+3.3V)             |
| GROUND     | Ground for PVcc and Vcc input |
| VOUT+      | V <sub>out</sub> (+1.1V)      |
| VOUT+      | Ground of V <sub>out</sub>    |
| Enable     | Enable input                  |

**LAYOUT**

The PCB is a 4-layer board. All layers are 2 Oz. copper. The IR3710M and other components are mounted on the top and bottom side of the board.

Power supply decoupling capacitors, the Bootstrap capacitor and feedback components are located close to IR3710M. The feedback resistors are connected to the output voltage at the point of regulation and are located close to IR3710M. To improve efficiency, the circuit board is designed to minimize the length of the on-board power ground current path.



**Figure 1: Connection diagram of IRDC3710-QFN evaluation board**

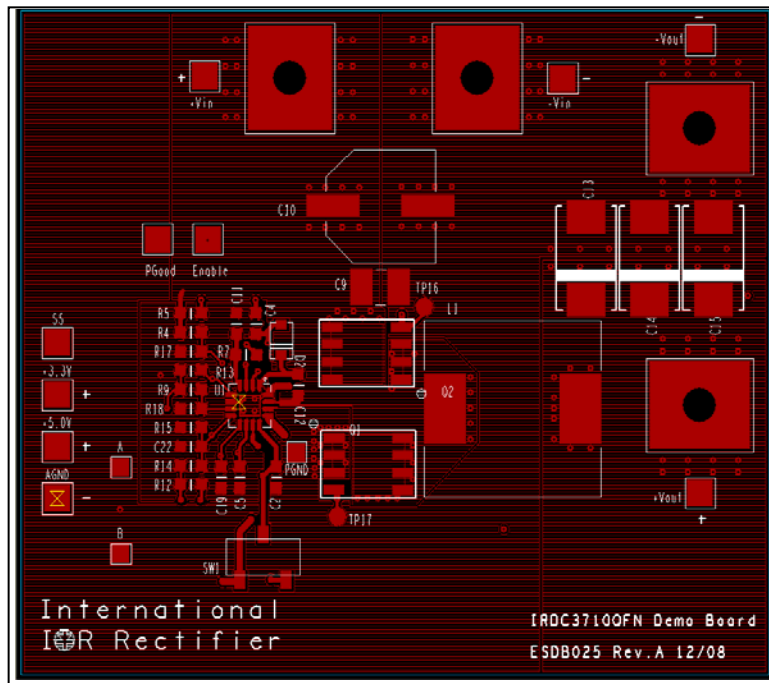


Figure 2: PCB layout, top layer

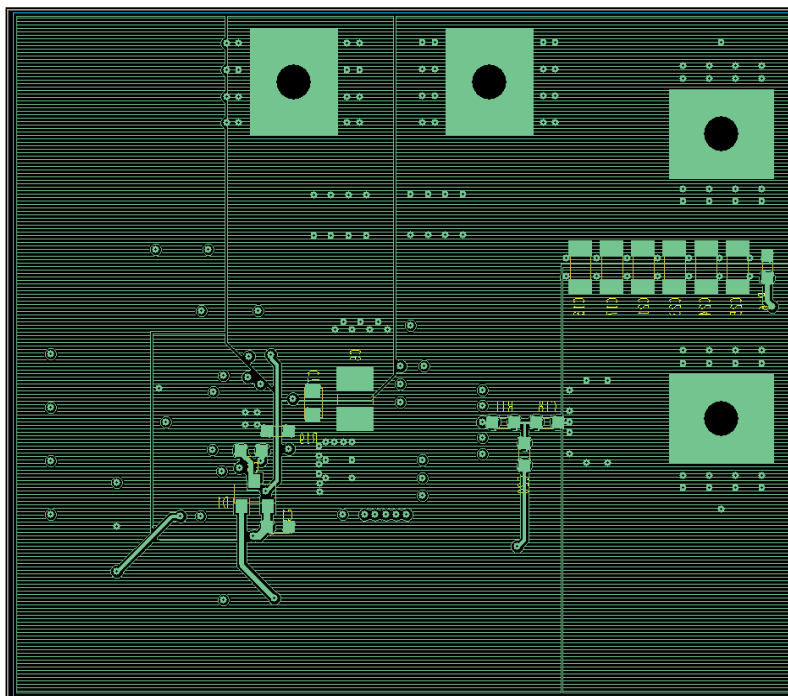
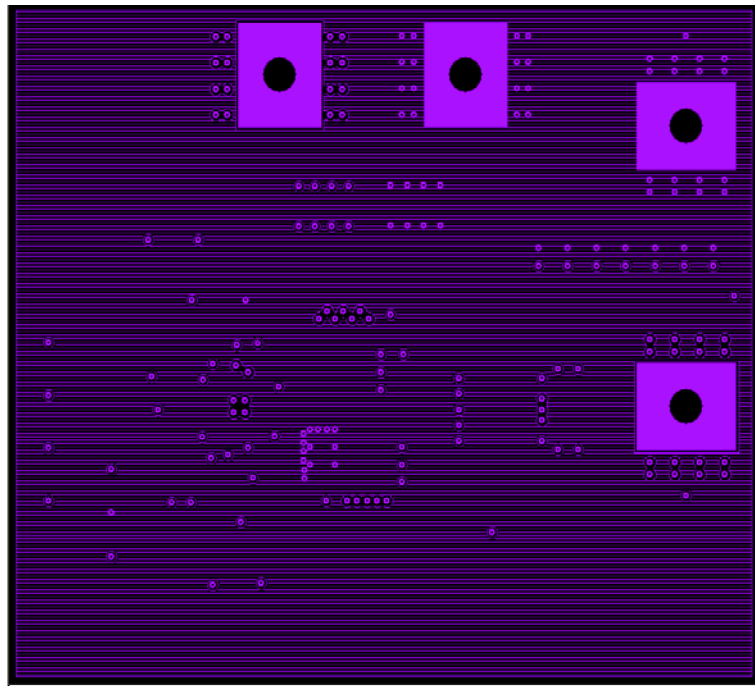
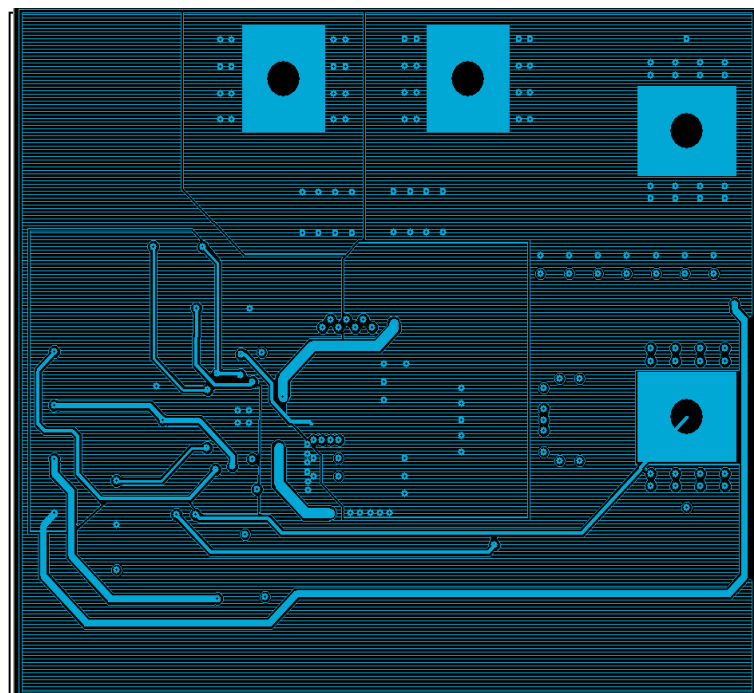


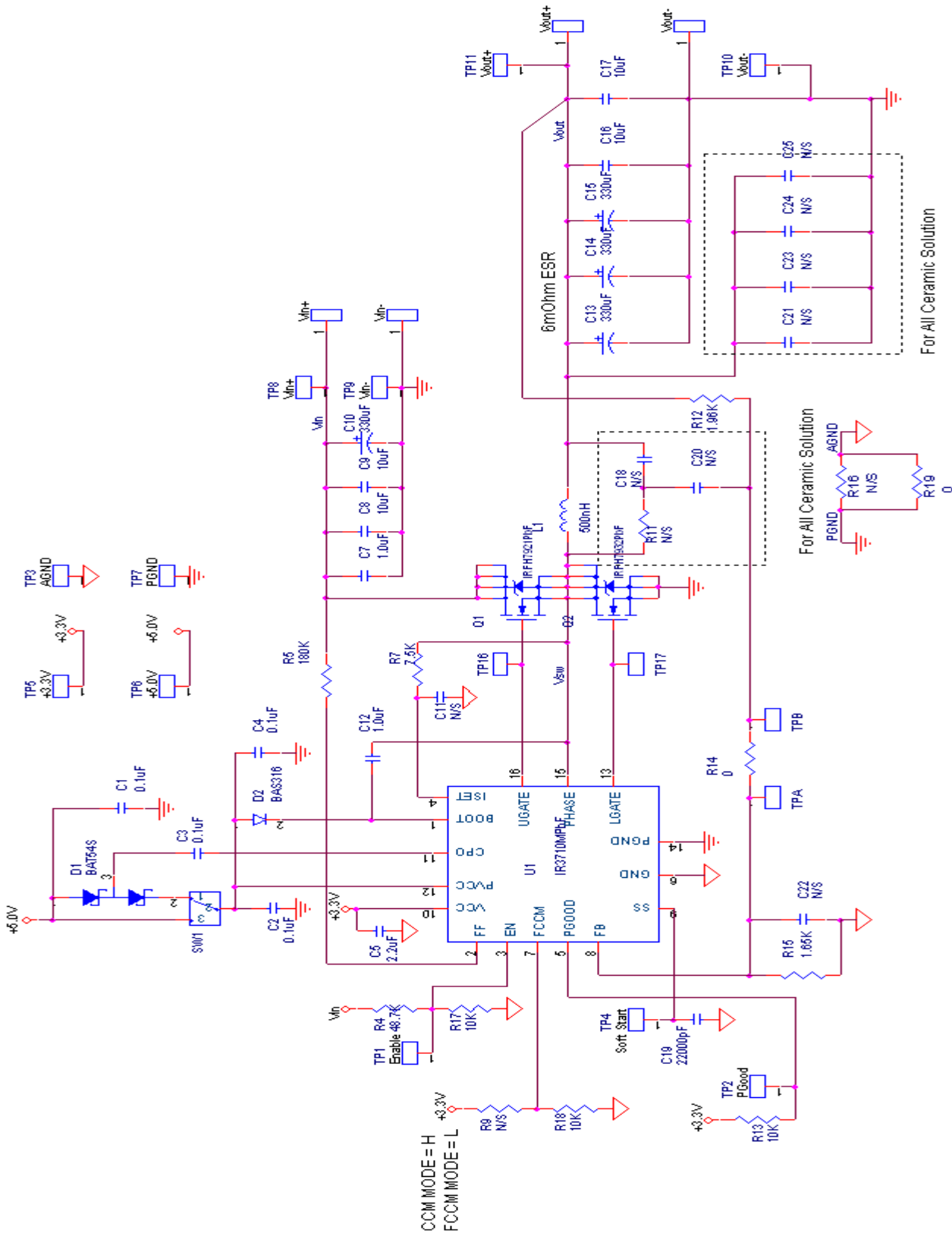
Figure 3: PCB layout, bottom layer



**Figure 4: Board layout, mid-layer I**



**Figure 5: Board layout, mid-layer II**



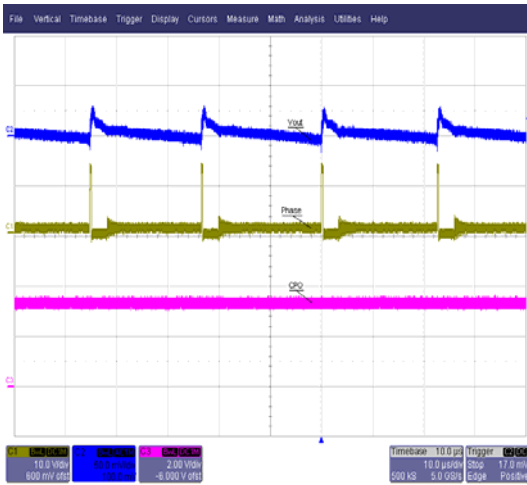
**Figure 6: Schematic of the IRDC3710-QFN Evaluation board**

**Bill of Materials**

| <u>Item Number</u> | <u>Quantity</u> | <u>Part Reference</u> | <u>Value</u>   | <u>Description</u>                    | <u>Manufacturer1</u>             | <u>Manufacturer Part Number</u> |
|--------------------|-----------------|-----------------------|----------------|---------------------------------------|----------------------------------|---------------------------------|
| 1                  | 4               | C1 C2 C3 C4           | 0.1uF          | Ceramic,25V,0603,X7R,10%              | Murata Electronics North America | GRM188R61E105KA12D              |
| 2                  | 1               | C5                    | 2.2uF          | Ceramic, 6.3V, 0603, X7R, 10%         | Murata Electronics North America | GRM185R60J225KE26D              |
| 3                  | 1               | C7                    | 1.0uF          | Ceramic, 25V, 0805, X5R, 10%          | Taiyo Yuden                      | TMK212BJ105KG-T                 |
| 4                  | 2               | C8 C9                 | 10uF           | Ceramic,25V,1210,X5R,10%              | Taiyo-Yuden                      | TMK325BJ106MN-T                 |
| 5                  | 1               | C10                   | 330uF          | SMD Electrolytic, 25V, F-size,20%     | Panasonic                        | EEE-FK1E331P                    |
| 6                  | 1               | C12                   | 1.0uF          | Ceramic,25V,0603,X5R,10%              | Murata Electronics North America | GRM188R61E105KA12D              |
| 7                  | 3               | C13 C14 C15           | 330uF          | SP-Cap,Dcase,4V,20%                   | Panasonic                        | EEFUE0G331XE                    |
| 8                  | 2               | C16 C17               | 10uF           | Ceramic,6.3V,1206,X5R,20%             | Murata Electronics North America | GRM21BCB0G106ME19F              |
|                    |                 | C11,C18,C20,C22       |                | N/S                                   |                                  |                                 |
|                    |                 | C21,23,C24,C25        |                | N/S                                   |                                  |                                 |
| 9                  | 1               | C19                   | 22000pF        | Ceramic,50V,0603,X7R,10%              | TDK Corporation                  | C1608X7R1H223K                  |
| 10                 | 1               | D1                    | BAT54S         | Diode,40V,BAT54S,SOT-23               | Diodes, Inc.                     | BAT54S                          |
| 11                 | 1               | D2                    | BAS316         | Diode 75V , 0.25A, SOD323             | NXP                              | BAS316                          |
| 12                 | 1               | L1                    | 500nH          | SMT-Inductor, 0.8mOhm,12.1x13.4mm,20% | Toko                             | FDUE1245-R50M                   |
| 13                 | 1               | Q1                    | IRFH7921PbF    | Mosfet 30V 8.5mOhm PQFN               | International Rectifier          | IRFH7921PbF                     |
| 14                 | 1               | Q2                    | IRFH7932PbF    | Mosfet 30V 3.3mOhm PQFN               | International Rectifier          | IRFH7932PbF                     |
| 15                 | 4               | R13 R17 R18           | 10K            | Thick-film,0603,1/10W,1%              | Vishay/Dale                      | CRCW060310K0FKEA                |
|                    |                 | R4                    | 48.7K          | Thick-film,0603,1/10W,1%              | Rohm                             | MCR03EZPFX4872                  |
| 16                 | 1               | R5                    | 180K           | Thick-film,0603,1/10W,1%              | Rohm                             | MCR03EZPFX1803                  |
| 17                 | 1               | R7                    | 7.5K           | Thick-film,0603,1/10 W,1%             | Rohm                             | MCR03EZPFX7501                  |
| 18                 | 1               | R12                   | 1.96K          | Thick-film,0603,1/10W,1%              | Rohm                             | MCR03EZPFX1961                  |
| 19                 | 3               | R14 R19               | 0              | Thick-film,0603,1/10 W,5%             | Vishay/Dale                      | CRCW06030000Z0EA                |
|                    |                 | R9,R11,R16            | N/S            |                                       |                                  |                                 |
| 20                 | 1               | R15                   | 1.65K          | Thick-film,0603,1/10W,1%              | Panasonic - ECG                  | ERJ-3EKF1651V                   |
| 21                 | 1               | SW1                   | Switch, 2-Pos. | Switch, DIP, 2-Pos., SPDT             | Copal Electronics Inc            | CJS-1200TB                      |
| 22                 | 1               | U1                    | IR3710MPbF     | IR3710, Controller,PQFN,3x3mm         | International Rectifier          | IR3710MPbF                      |

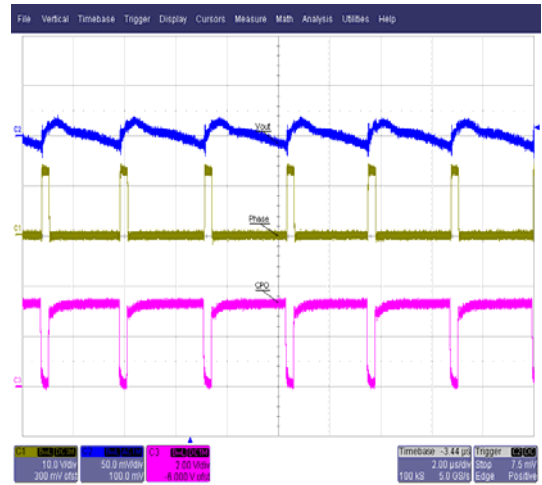
## TYPICAL OPERATING WAVEFORMS

$V_{in}=12V$ ,  $PV_{cc}=5.0V$ ,  $V_{cc}=3.3V$ ,  $V_o=1.1V$ ,  $I_o=0-20A$ , , Room Temperature, No Air Flow



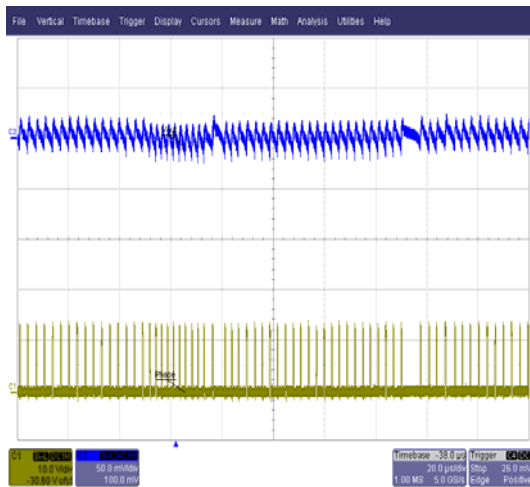
Ch1-Phase Voltage(10V/Div) Ch2-Vout(50mV/div)  
Ch3-CPO(2V/Div) Time: 10uS/Div

**Figure 7: Charge Pump Off at  $I_{out} = 0.5A$**

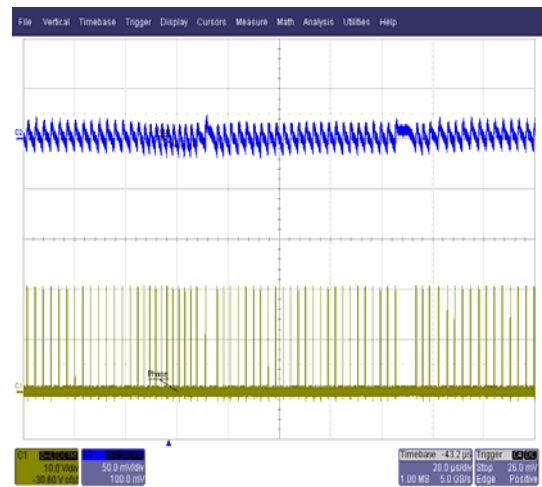


Ch1-Phase Voltage(10V/Div) Ch2-Vout(50mV/div)  
Ch3-CPO(2V/Div) Time: 2uS/Div

**Figure 8: Charge Pump On at  $I_{out} = 5A$**



Ch1-Phase Voltage (10V/Div) Ch2-Vout(50mV/Div)  
**Figure 9: Load Step (5A to 15A) Transient at 12Vin**

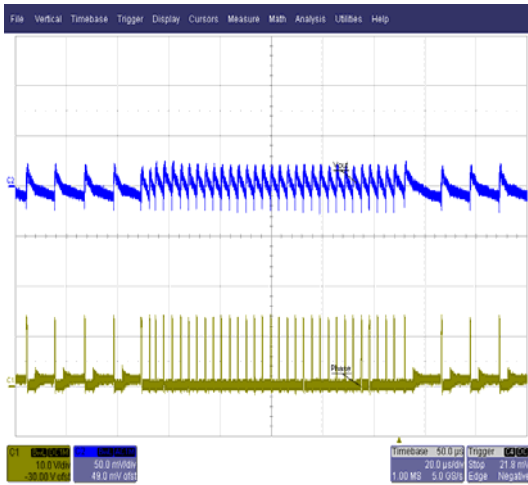


Ch1-Phase Voltage (10V/Div) Ch2-Vout(50mV/Div)  
**Figure 10: Load Step (5A to 15A) Transient at 19Vin**

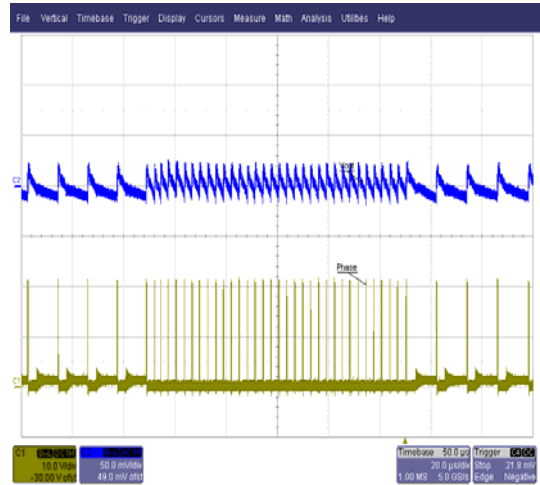


## TYPICAL OPERATING WAVEFORMS

$V_{in}=12V$ ,  $PV_{cc}=5.0V$ ,  $V_{cc}=3.3V$ ,  $V_o=1.1V$ ,  $I_o=0-20A$ , Room Temperature, No Air Flow



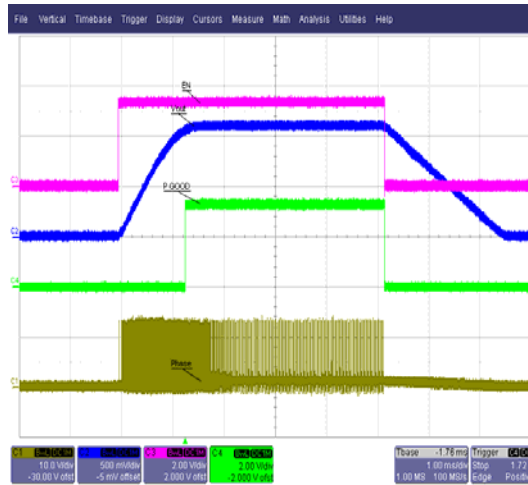
Ch1-Phase Voltage (10V/Div)      Ch2-Vout(50mV/Div)



Ch1-Phase Voltage (10V/Div)      Ch2-Vout(50mV/Div)

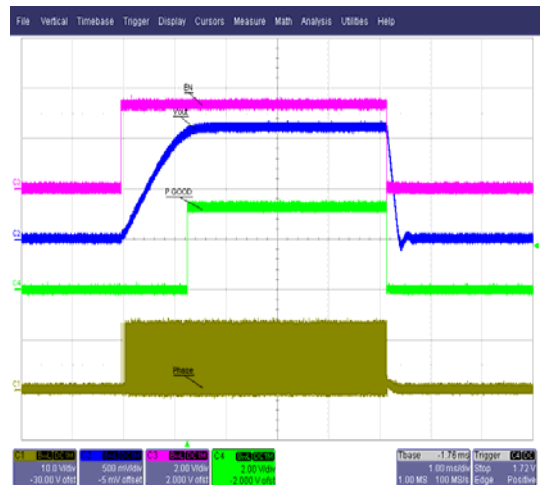
**Figure 11: DCM/CCM transition from 1.0A to 5A at 12Vin**

**Figure 12: DCM/CCM transition from 1.0A to 5A at 19Vin**



Ch1-Phase Voltage (10V/Div)      Ch2-Vout(500mV/Div)  
Ch3-EN(2V/Div)                      Ch4-PGood(2V/Div)

**Figure 13: Startup/Shutdown 12Vin at 0.5A**

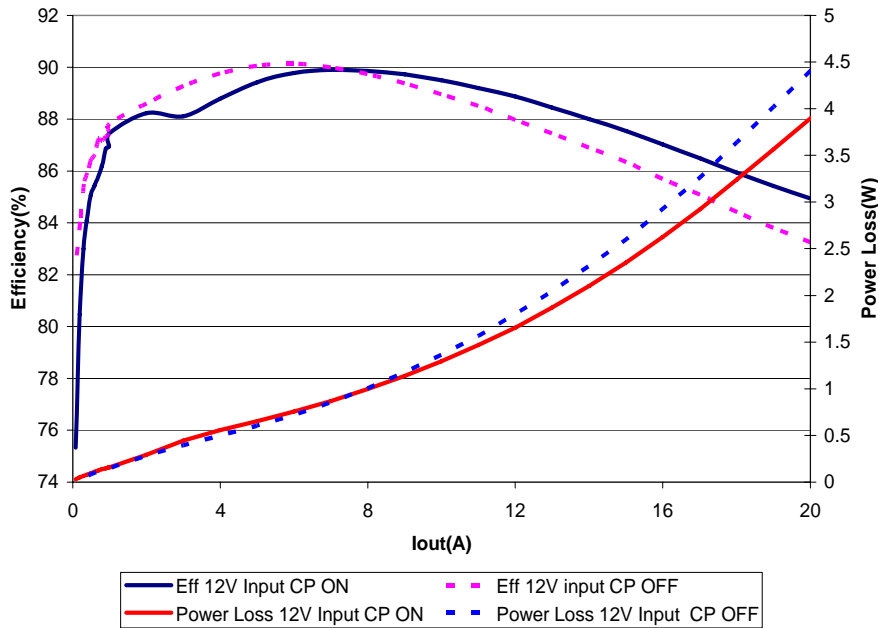


Ch1-Phase Voltage (10V/Div)      Ch2-Vout(500mV/Div)  
Ch3-EN(2V/Div)                      Ch4-PGood(2V/Div)

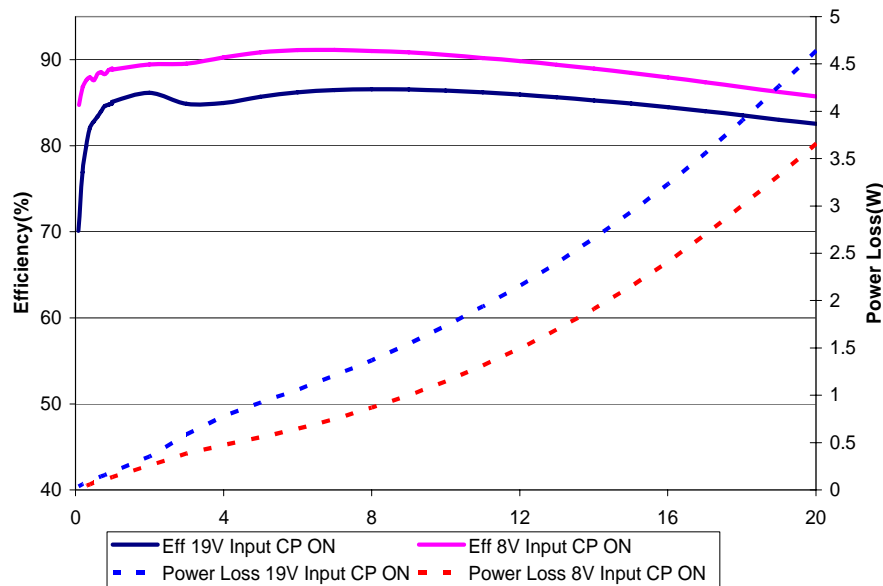
**Figure 14: Startup/Shutdown 12Vin at 5.0A**

**TYPICAL OPERATING WAVEFORMS**

Vin=12V, PVcc=5.0V, Vcc=3.3V, Vo=1.1V, Io=0- 20A, , Room Temperature, No Air Flow



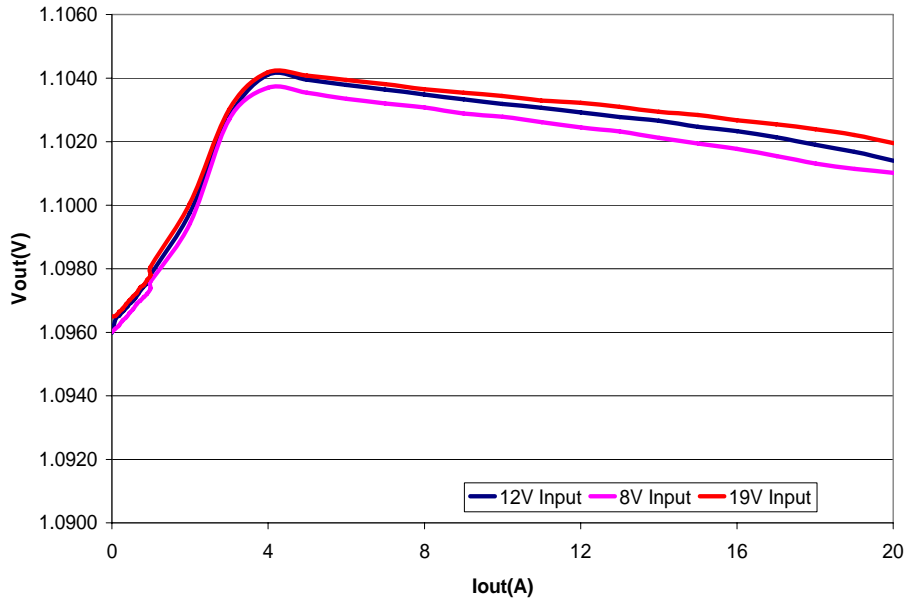
**Figure 15: Typical Efficiency and Power Loss at Vin=12V**



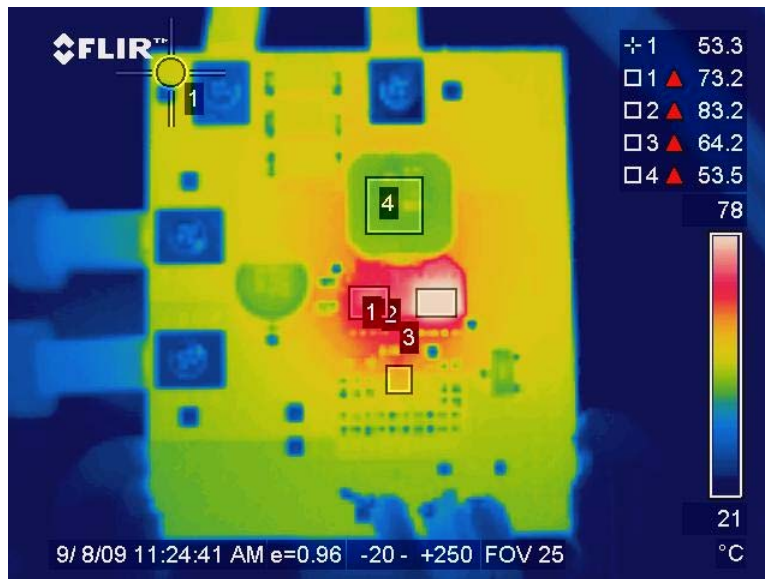
**Figure 16: Typical Efficiency and Power Loss at Vin=8V and 19V**

**TYPICAL OPERATING WAVEFORMS**

Vin=12V, PVcc=5.0V, Vcc=3.3V, Vo=1.1V, Io=0- 20A, , Room Temperature, No Air Flow



**Figure 17: Typical Output Voltage Regulation**

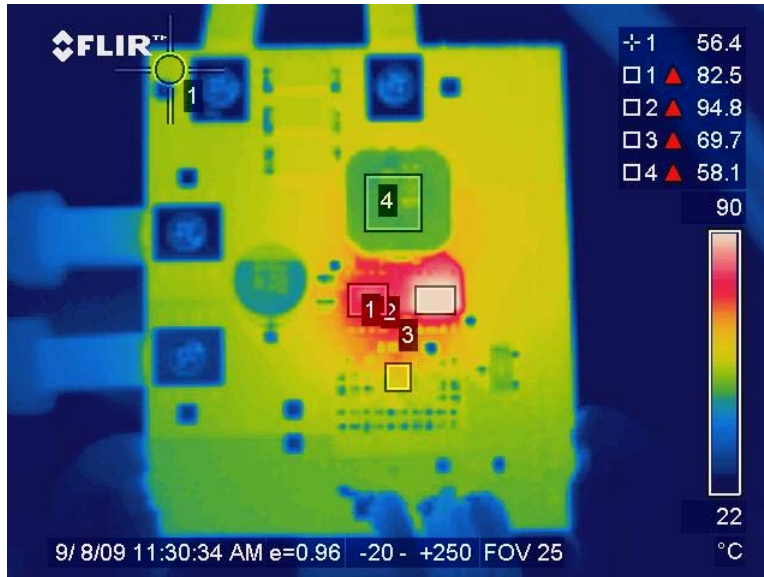


Q1: 73.2°C, Q2:83.2°C, IC-64.2°C, Inductor: 53.5°C, PCB: 53.3°C

**Figure 18: Thermal Image @12Vin, 20A, With CP On**

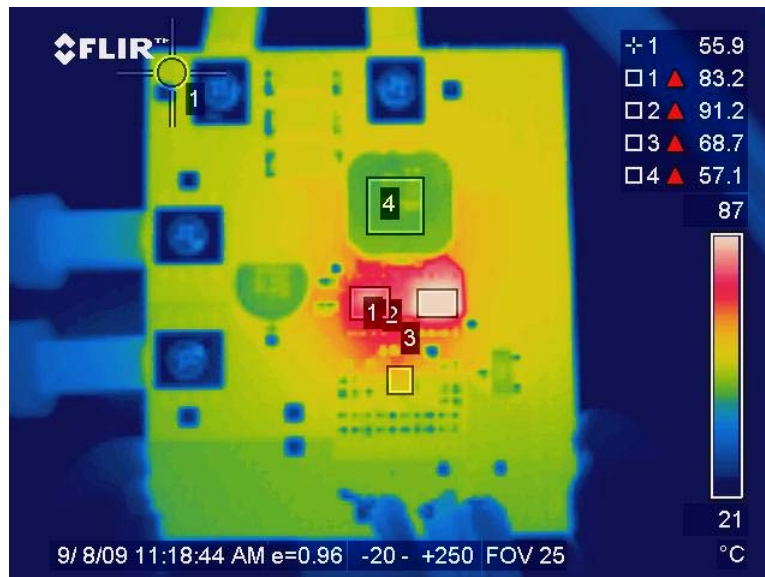
**TYPICAL OPERATING WAVEFORMS**

Vin=12V, PVcc=5.0V, Vcc=3.3V, Vo=1.1V, Io=0- 20A, , Room Temperature, No Air Flow



Q1: 82.5°C, Q2:94.8°C, IC-69.7°C, Inductor: 58.1°C, PCB: 56.4°C

**Figure 19: Thermal Image @19Vin, 20A, With CP On**

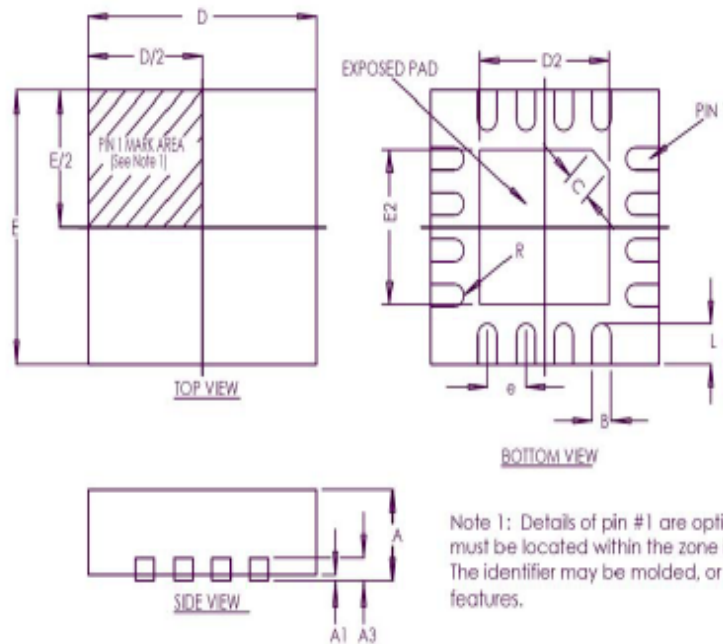


Q1:83.2°C,Q2:91.2°C, IC-68.7°C, Inductor: 57.1°C, PCB: 55.9°C

**Figure 20: Thermal Image @12Vin, 20A, With CP Off**

# PACKAGE INFORMATION

## 3X3 MLP LEAD FREE PACKAGE AND LAYOUT INFORMATION



Note 1: Details of pin #1 are optional, but must be located within the zone indicated. The identifier may be molded, or marked features.

| SYMBOL | 16-PIN 3x3 (unit: MM) |      |      |
|--------|-----------------------|------|------|
| DESIGN | MIN                   | NOM  | MAX  |
| A      | 0.80                  | 0.85 | 0.90 |
| A1     | 0.00                  | 0.02 | 0.05 |
| A3     | 0.20 REF              |      |      |
| B      | 0.20                  | 0.25 | 0.30 |
| D      | 3.00 BSC              |      |      |
| D2     | 1.6                   | 1.70 | 1.8  |
| E      | 3.00 BSC              |      |      |
| E2     | 1.6                   | 1.70 | 1.8  |
| e      | 0.50 TYP              |      |      |
| L      | 0.30                  | 0.40 | 0.50 |
| R      | 0.125                 | ---  | ---  |
| C      | 0.35 TYP              |      |      |

Data and specifications subject to change without notice.  
 This product has been designed and qualified for the Consumer market.  
 Qualification Standards can be found on IR's Web site.