

### RHM4900-1

## Quad, 40V<sub>IN</sub>, Silent Switcher $\mu$ Module Regulator with Configurable 3A Output Array

### General Description

The EVAL-RHM4900-1-AZ evaluation board features the [RHM4900-1](#), a quad output, high-performance, step-down Silent Switcher<sup>®</sup> power  $\mu$ Module<sup>®</sup> regulator in a thermally-enhanced 16mm  $\times$  11.9mm  $\times$  3.32mm, ball-grid array (BGA) package. The EVAL-RHM4900-1-AZ has a wide operating input voltage range of 5.4V to 40V. The output rails are configured for 5V, 3.3V, 1.5V, and 1.2V. They are resistor programmable from 0.8V to 8V. Each output can provide up to 3A, and phases can also be paralleled together to satisfy higher rail current requirements.

The RHM4900-1 is a complete multi-output, DC-to-DC, point-of-load (POL) regulator in a compact form factor, requiring only a few input and output capacitors and resistors to set the output voltages and operating frequency. Output voltage tracking is made available by the TRSS pins for supply rail sequencing. External clock synchronization is available through the SYNC pins.

The CLKOUT pins provide for the optional synchronization of additional phases. For reduced noise, spread-spectrum operation is available through the SYNC pin programming. The RHM4900-1 data sheet must be read in conjunction with this user guide for working on or modifying the EVAL-RHM4900-1-AZ.

### Features and Benefits

- Optional Local or Remote Output Sensing
- Optional Circuitry for Parallel Operation
- Input EMI Filter (VEMI)

### EVAL-RHM4900-1-AZ Files

| FILE                              | DESCRIPTION                    |
|-----------------------------------|--------------------------------|
| <a href="#">EVAL-RHM4900-1-AZ</a> | Evaluation board design files. |

[Ordering Information](#) appears at end of this user guide.

### Evaluation Board Photo

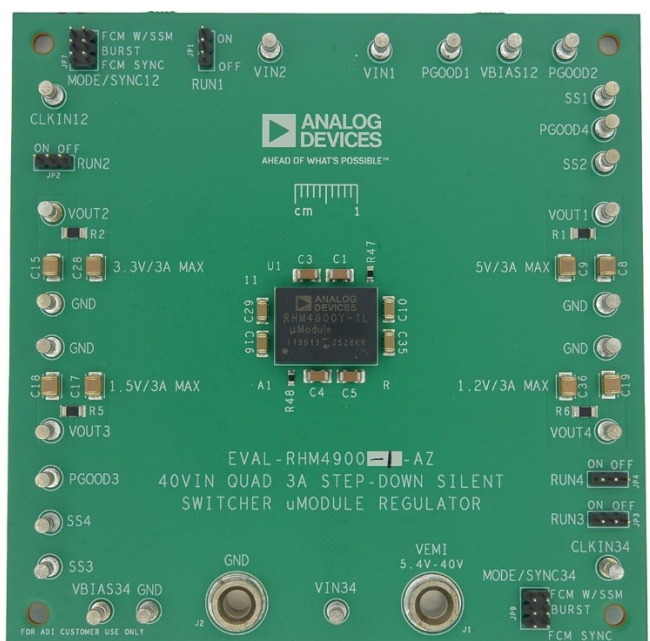


Figure 1. EVAL-RHM4900-1-AZ Evaluation Board (Part Marking is Either Ink Mark or Laser Mark)

## Performance Summary

Specifications are at  $T_A = 25^\circ\text{C}$ .

| PARAMETER                                   | CONDITIONS                                                                                                                                                              | MIN                                                   | TYP                    | MAX | UNITS            |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------------------------|-----|------------------|
| Input voltage range                         |                                                                                                                                                                         | 5.4                                                   |                        | 40  | V                |
| Output voltage $V_{OUT}$                    | $V_{OUT1}$<br>$V_{OUT2}$<br>$V_{OUT3}$<br>$V_{OUT4}$                                                                                                                    |                                                       | 5<br>3.3<br>1.5<br>1.2 |     | V<br>V<br>V<br>V |
| Maximum continuous output current per phase | Derating is necessary for certain operating conditions. Refer to the RHM4900-1 data sheet for more details.                                                             |                                                       | 3                      |     | A                |
| Default operating frequency                 | $V_{OUT1}$ , $V_{OUT2}$ , ( $R_T = 28\text{k}\Omega$ )<br>$V_{OUT3}$ , $V_{OUT4}$ , ( $R_T = 100\text{k}\Omega$ )                                                       |                                                       | 1.2<br>400             |     | MHz<br>kHz       |
| Efficiency                                  | $V_{IN} = 12\text{V}$<br>$V_{OUT} = 5\text{V}/3\text{A}$<br>$V_{OUT} = 3.3\text{V}/3\text{A}$<br>$V_{OUT} = 1.5\text{V}/3\text{A}$<br>$V_{OUT} = 1.2\text{V}/3\text{A}$ | See <a href="#">Figure 3a</a><br>93<br>91<br>84<br>82 |                        |     | %<br>%<br>%<br>% |

## Quick Start

### Required Equipment

- Power supply
- At least one electronic load.
- At least two digital multimeters (DMMs).

## Procedure

The EVAL-RHM4900-1-AZ evaluation board provides an easy way to evaluate the performance of the RHM4900-1. See [Figure 2](#) for test setup connections and use the following procedure.

1. With power off, place the jumpers in the following positions.

| JP1  | JP2  | JP3  | JP4  | JP7                                | JP9         |
|------|------|------|------|------------------------------------|-------------|
| RUN1 | RUN2 | RUN3 | RUN4 | MODE/SYNC12                        | MODE/SYNC34 |
| ON   | ON   | ON   | ON   | Forced continuous mode (FCM), SYNC | FCM, SYNC   |

2. Before connecting the input supply, loads, and meters, preset the input voltage supply to be between 5.4V to 40V. Preset the load currents to 0A.
3. With power off, connect the loads, input voltage supply, and meters, as shown in [Figure 2](#).
4. Turn on the input power supply. The output voltage meters for each phase should display the programmed output voltage  $\pm 2\%$ .

5. Once the proper output voltages are established, adjust the load currents for each phase within the 0A to 3A range. Observe each output's load regulation, efficiency, and other performances. Output voltage ripples for each output should be measured across the furthest output capacitor with a BNC cable and oscilloscope.
6. To observe increased light load efficiency, place the MODE/SYNC pin jumpers (JP7, JP9) in the BURST position. For spread-spectrum operation, place the jumpers in the FCM W/SSM position.
7. To synchronize the VOUT1 and VOUT2 rails to an external clock, connect a clock to CLKIN12 (E19) with MODE/SYNC12 (JP7) set to FCM, SYNC, and to synchronize VOUT3 and VOUT4 to an external clock, connect a clock to CLKIN34 (E20) with MODE/SYNC34 (JP9) set to FCM, SYNC. Set the clock voltage to 50% duty cycle with the clock low-level below 0.8V and clock high-level above 1.5V. Do not exceed 6V on these pins.
8. Optional: An input EMI filter is included on the evaluation board. To include this filter, connect the input supply positive terminal to VEMI. To exclude the input EMI filter, connect the input positive supply to VIN1, VIN2, or VIN34. The VIN1 is the input for the VOUT1 rail, VIN2 is the input for the VOUT2 rail, and VIN34 is the input for the VOUT3 and VOUT4 rails.

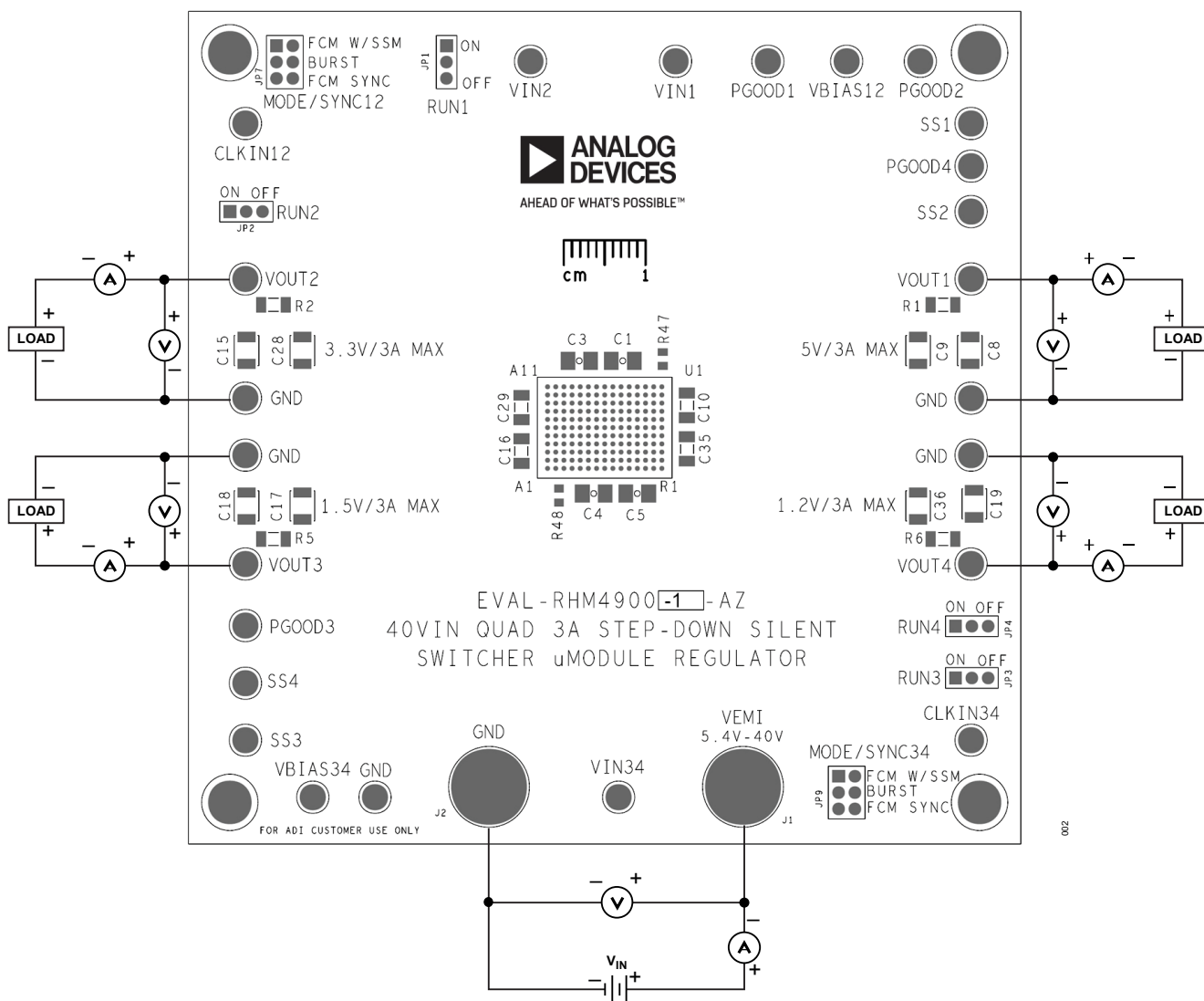


Figure 2. Test Setup of EVAL-RHM4900-1-AZ

## Typical Performance Characteristics

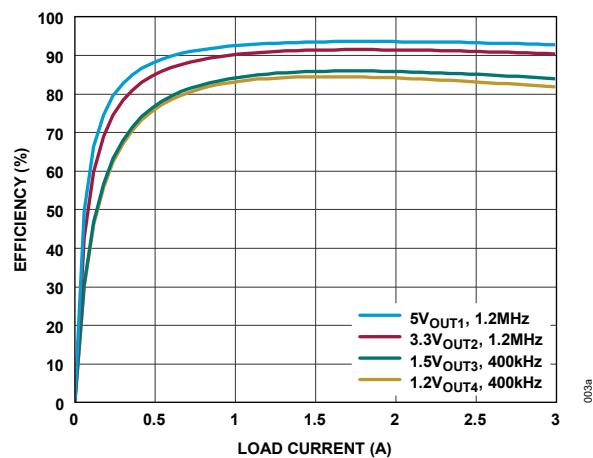
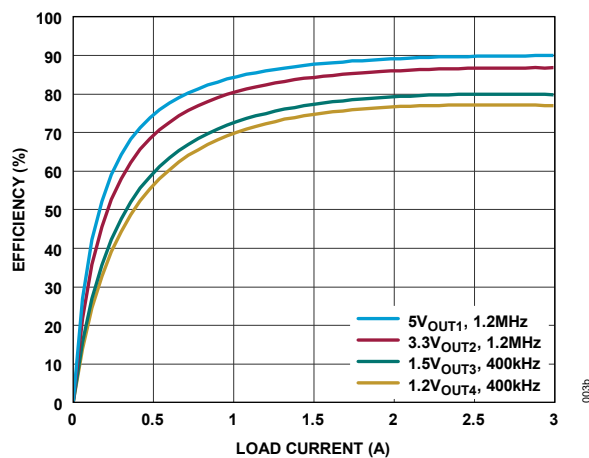
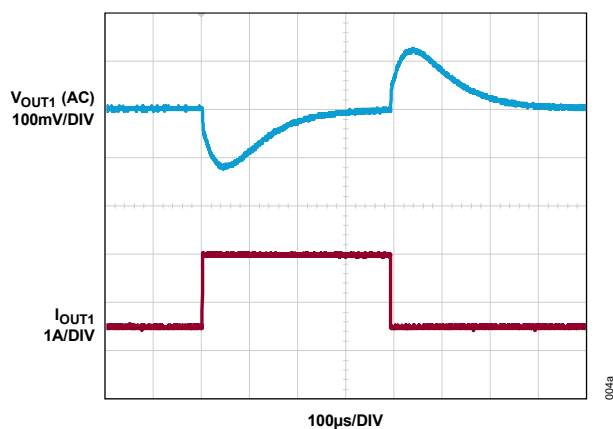
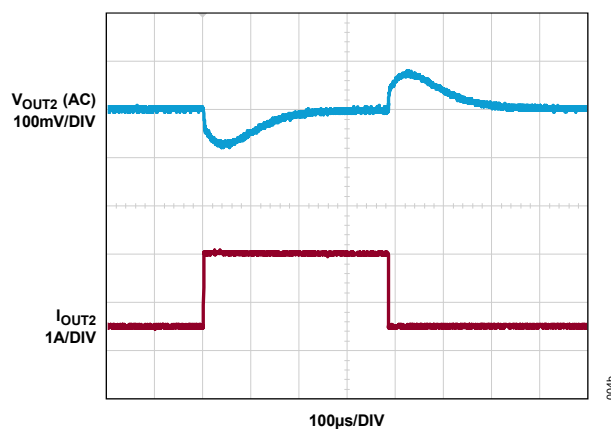
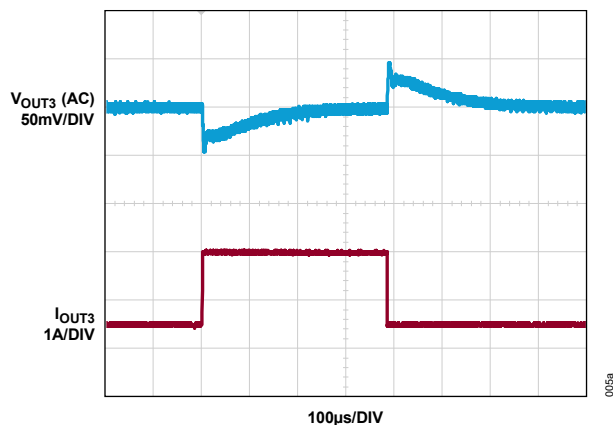
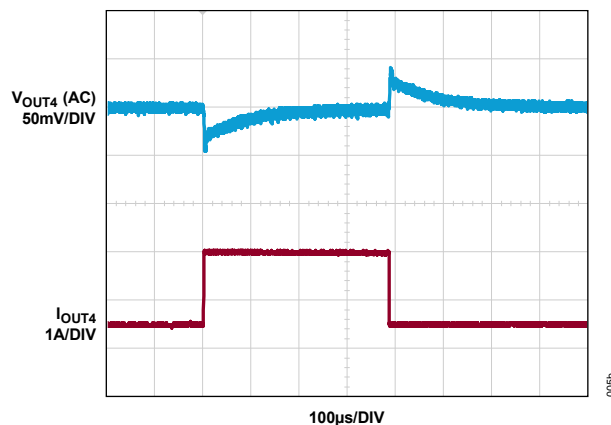
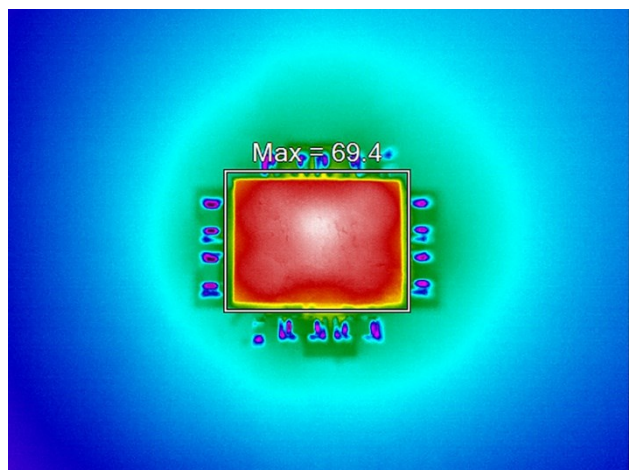
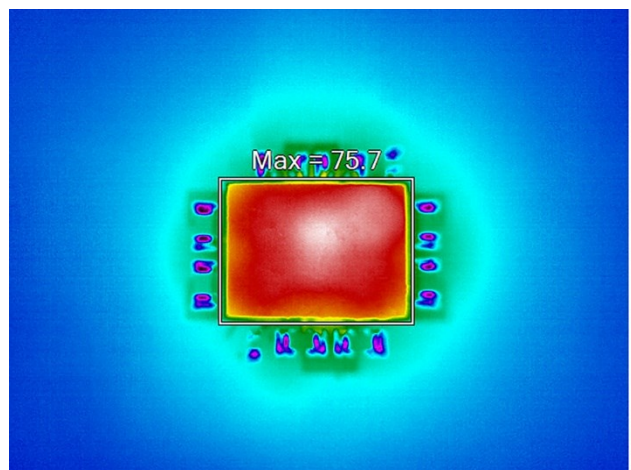
(a)  $12V_{IN}$ (b)  $24V_{IN}$ 

Figure 3. Efficiency in Forced Continuous Mode (FCM)

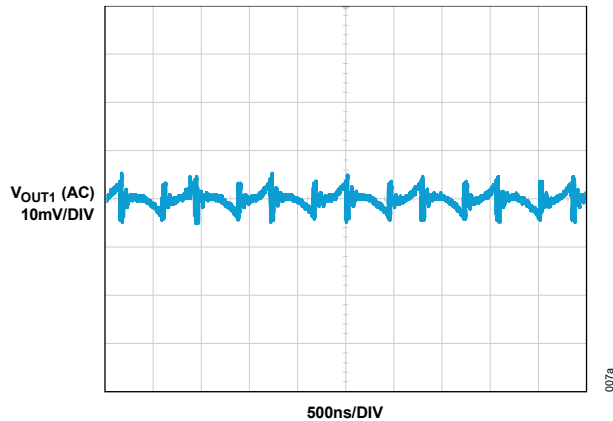
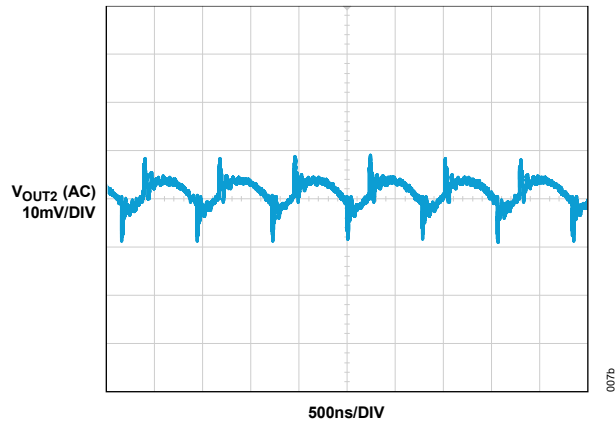
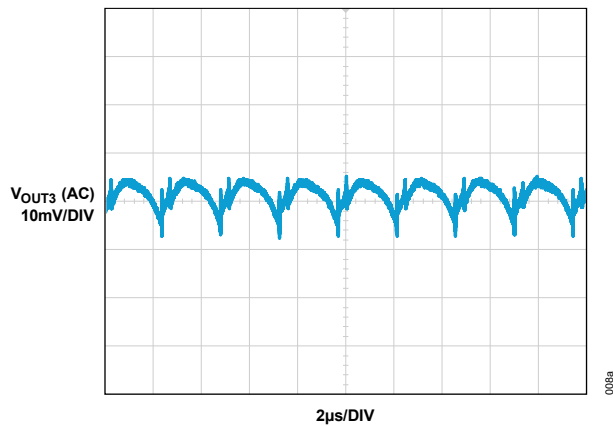
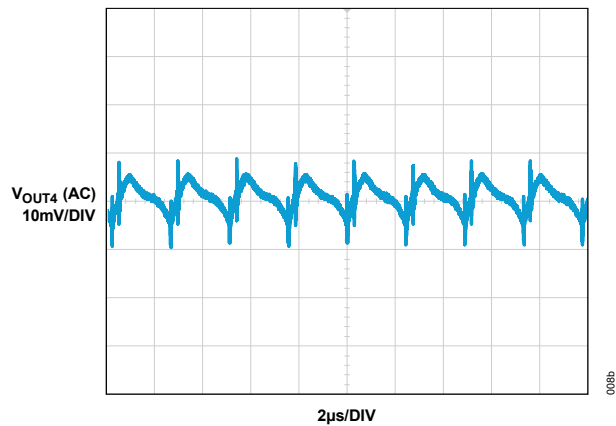
(a)  $V_{OUT1} = 5V$ (b)  $V_{OUT2} = 3.3V$ Figure 4.  $12V_{IN}$  Measured Transient Responses at 1.5A to 3A Load Step

(a)  $V_{OUT3} = 1.5V$ (b)  $V_{OUT4} = 1.2V$ Figure 5. 12V<sub>IN</sub> Measured Load Transient Responses at 1.5A to 3A Load Step(a)  $V_{IN} = 12V$ (b)  $V_{IN} = 24V$ 

| $V_{IN}$<br>(V) | AIRFLOW            | HEATSINK | AMBIENT<br>(°C) |
|-----------------|--------------------|----------|-----------------|
| 12              | Natural convection | None     | 25              |

| $V_{IN}$<br>(V) | AIRFLOW            | HEATSINK | AMBIENT<br>(°C) |
|-----------------|--------------------|----------|-----------------|
| 24              | Natural convection | None     | 25              |

Figure 6. Measured Thermal Captures with 3A Load on Each Output

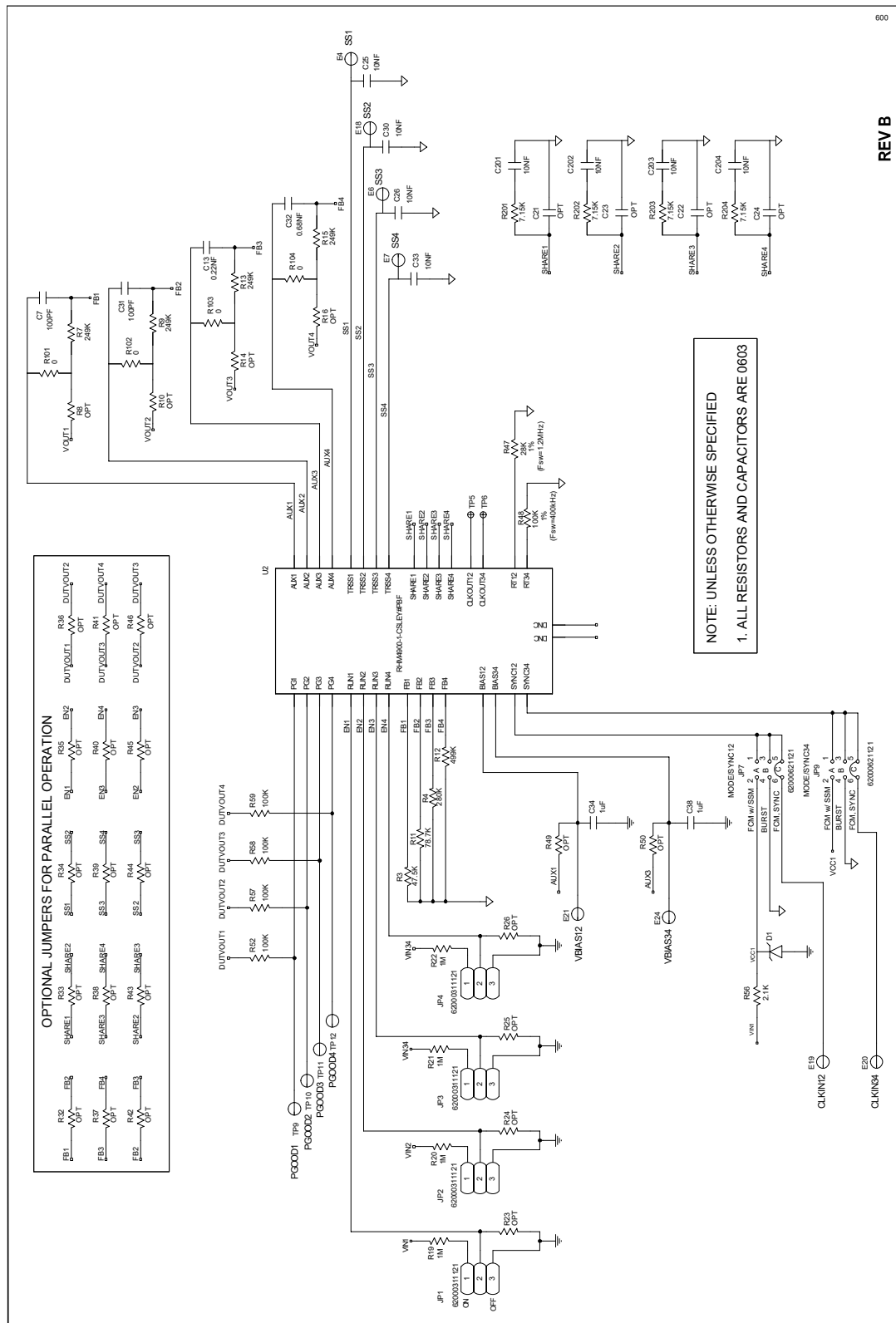
**(a)  $V_{OUT1} = 5V$** **(b)  $V_{OUT2} = 3.3V$** *Figure 7. 12V<sub>IN</sub> Measured Output Ripple at 3A Load***(a)  $V_{OUT3} = 1.5V$** **(b)  $V_{OUT4} = 1.2V$** *Figure 8. 12V<sub>IN</sub> Measured Output Ripple at 3A Load*

## EVAL-RHM4900-1-AZ Evaluation Board Bill of Materials

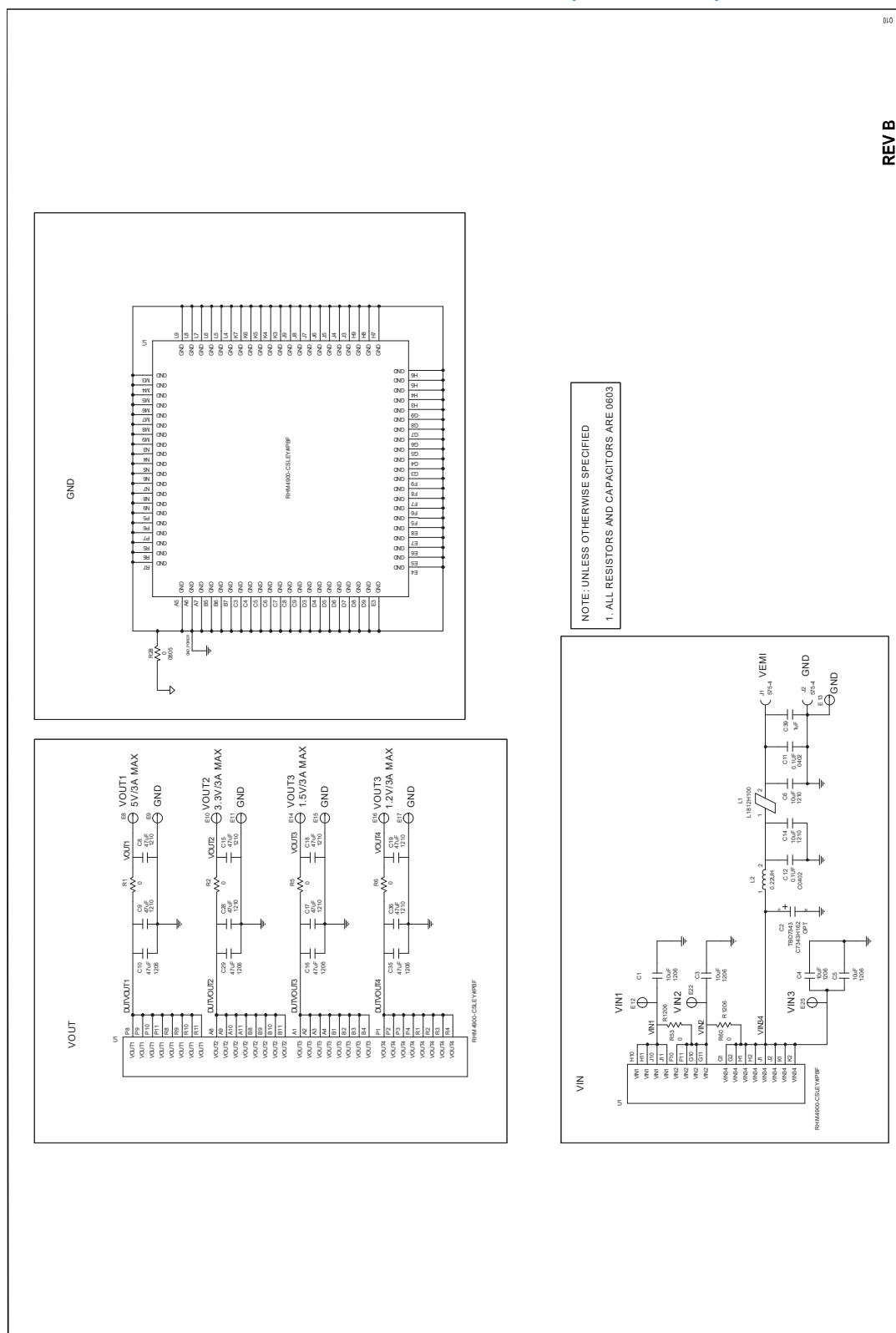
| ITEM                               | QTY | REFERENCE                         | PART DESCRIPTION                                                                     | MANUFACTURER/PART NUMBER        |
|------------------------------------|-----|-----------------------------------|--------------------------------------------------------------------------------------|---------------------------------|
| <b>REQUIRED CIRCUIT COMPONENTS</b> |     |                                   |                                                                                      |                                 |
| 1                                  | 4   | C1, C3-C5                         | CAP., CER, 10 $\mu$ F, 50V, 10%, X5R, 1206                                           | TDK, C3216X5R1H106K160AB        |
| 2                                  | 4   | C10, C16, C29, C35                | CAP., CER, 47 $\mu$ F, 6.3V, 20%, X5R, 1206                                          | MURATA, GRM31CR60J476ME19L      |
| 3                                  | 2   | C11, C12                          | CAP., CER, 0.1 $\mu$ F, 50V, 10%, X7R, 0402, AEC-Q200                                | MURATA, GCM155R71H104KE02D      |
| 4                                  | 1   | C13                               | CAP., CER, 0.22nF, 25V, 10%, X7R, 0603                                               | AVX CORPORATION, 06033C221KAT2A |
| 5                                  | 2   | C6, C14                           | CAP., CER, 10 $\mu$ F, 50V, 10%, X7R, 1210                                           | MURATA, GRM32ER71H106KA12L      |
| 6                                  | 8   | C8, C9, C15, C17 to C19, C28, C36 | CAP., CER, 47 $\mu$ F, 6.3V, 10%, X7R, 1210, AEC-Q200                                | MURATA, GCM32ER70J476KE19L      |
| 7                                  | 8   | C25, C26, C30, C33, C201 to C204  | CAP., CER, 10nF, 16V, 10%, X5R, 0603                                                 | AVX CORPORATION, 0603YD103KAT2A |
| 8                                  | 2   | C7, C31                           | CAP., CER, 100pF, 16V, X7R, 10%, 0603                                                | YAGEO, CC0603KRX7R7BB101        |
| 9                                  | 1   | C32                               | CAP., CER, 0.68nF, 25V, 5%, C0G, 0603                                                | AVX CORPORATION, 06033A681JAT2A |
| 10                                 | 3   | C34, C38, C39                     | CAP., CER, 1 $\mu$ F, 50V, 10%, X5R, 0603, AEC-Q200                                  | MURATA, GRT188R61H105KE13D      |
| 11                                 | 1   | D1                                | DIO., ZENER, 3.9V, 0.2W, SOD-323                                                     | DIODES INC., BZT52C3V9S-7-F     |
| 12                                 | 1   | L1                                | IND., FERRITE BEAD, 100 $\Omega$ AT 100MHz, 25%, 8A, 0.006 $\Omega$ , 1812, AEC-Q200 | WURTH ELEKTRONIK, 74279226101   |
| 13                                 | 1   | L2                                | IND., POWER SHIELDED, 0.22 $\mu$ H, 30%, 9.5A, 0.0073 $\Omega$ , 1616                | WURTH ELEKTRONIK, 744373240022  |
| 14                                 | 4   | R1, R2, R5, R6                    | RES., SMD, 0 $\Omega$ , 1%, 1/4W, 1206                                               | VISHAY, WSL1206000000ZEA9       |
| 15                                 | 4   | R7, R9, R13, R15                  | RES., SMD, 249k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                 | PANASONIC, ERJ-3EKF2493V        |
| 16                                 | 1   | R11                               | RES., SMD, 78.7k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                | PANASONIC, ERJ-3EKF7872V        |
| 17                                 | 1   | R12                               | RES., SMD, 499k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                 | VISHAY, CRCW0603499KFKEA        |
| 18                                 | 4   | R19-R22                           | RES., SMD, 1M $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                   | VISHAY, CRCW06031M00FKEA        |
| 19                                 | 1   | R28                               | RES., SMD, 0 $\Omega$ , JUMPER, 1/8W, 0805, AEC-Q200                                 | VISHAY, CRCW080500000Z0EA       |
| 20                                 | 1   | R3                                | RES., SMD, 47.5k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                | VISHAY, CRCW060347K5FKEA        |
| 21                                 | 1   | R4                                | RES., SMD, 280k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                 | VISHAY, CRCW0603280KFKEA        |
| 22                                 | 1   | R47                               | RES., SMD, 28k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                  | VISHAY, CRCW060328K0FKEA        |
| 23                                 | 5   | R48, R52, R57-R59                 | RES., SMD, 100k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                 | VISHAY, CRCW0603100KFKEA        |
| 24                                 | 2   | R53, R60                          | RES., SMD, 0, 5%, 1/4W, 1206, AEC-Q200                                               | VISHAY, CRCW120600000Z0EA       |
| 25                                 | 1   | R56                               | RES., SMD, 2.1k $\Omega$ , 1%, 1/10W, 0603, AEC-Q200                                 | PANASONIC, ERJ-3EKF2101V        |

| ITEM                                 | QTY | REFERENCE                                                                   | PART DESCRIPTION                                                                              | MANUFACTURER/PART NUMBER          |
|--------------------------------------|-----|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------|
| 26                                   | 4   | R101 to R104                                                                | RES., SMD, 0Ω, JUMPER, 1/10W, 0603, AEC-Q200                                                  | VISHAY, CRCW06030000Z0EA          |
| 27                                   | 4   | R201 to R204                                                                | RES., SMD, 7.15kΩ, 1%, 1/10W, 0603, AEC-Q200                                                  | PANASONIC, ERJ-3EKF7151V          |
| 28                                   | 1   | U1                                                                          | IC-ADI, QUAD 40V <sub>IN</sub> , 3A STEP-DOWN Silent Switcher $\mu$ Module REGULATOR, BGA-165 | ADI, RHM4900IY-1-CSL#PBF          |
| <b>OPTIONAL CIRCUIT COMPONENTS</b>   |     |                                                                             |                                                                                               |                                   |
| 1                                    | 0   | C2                                                                          | CAP., OPTION, 7343                                                                            |                                   |
| 2                                    | 0   | C21-C24                                                                     | CAP., OPTION, 0603                                                                            |                                   |
| 3                                    | 0   | R8, R10, R14, R16, R23 to R26, R32 to R35, R37 to R40, R42 to R45, R49, R50 | RES., OPTION, 0603                                                                            |                                   |
| 4                                    | 0   | R36, R41, R46                                                               | RES., OPTION, 2512                                                                            |                                   |
| <b>HARDWARE: FOR DEMO BOARD ONLY</b> |     |                                                                             |                                                                                               |                                   |
| 1                                    | 24  | E4, E6 to E22, E24, E25, TP9-TP12                                           | CONN-PCB, TEST POINT, TURRET, 0.094-INCH, MTG. HOLE                                           | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 2                                    | 2   | J1, J2                                                                      | CONN-PCB, BANANA JACK, FEMALE, NON-INSULATED, THT, SWAGE, 0.218-INCH LENGTH                   | KEYSTONE ELECTRONICS, 575-4       |
| 3                                    | 4   | JP1 to JP4                                                                  | CONN-PCB, 3-POS, MALE, HDR, SINGLE ROW, 2mm PITCH, 2.70mm                                     | WURTH ELEKTRONIK, 62000311121     |
| 4                                    | 2   | JP7, JP9                                                                    | CONN-PCB, 6-POS, MALE, HDR, DUAL ROW, 2mm PITCH, 2.70mm                                       | WURTH ELEKTRONIK, 62000621121     |
| 5                                    | 4   | MH1 to MH4                                                                  | STANDOFF, SELF-RETAINING SPACER, 12.7mm LENGTH                                                | WURTH ELEKTRONIK, 702931000       |
| 6                                    | 6   | XJP1 to XJP4, XJP7, XJP9                                                    | SHUNT, FEMALE, 2-POS, 2mm                                                                     | WURTH ELEKTRONIK, 60800213421     |

## EVAL-RHM4900-1-AZ Evaluation Board Schematic



## EVAL-RHM4900-1-AZ Evaluation Board Schematic (Continued)



## Ordering Information

| PART              | TYPE                                                                                                                                                |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| EVAL-RHM4900-1-AZ | Evaluation board featuring the RHM4900-1, a quad output, high-performance, step-down Silent Switcher® power µModule regulator for CSL applications. |

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION      | PAGES<br>CHANGED |
|--------------------|------------------|------------------|------------------|
| Rev. 0             | 07/26            | Initial release. | —                |

## Notes

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