EVQ7795A-R-00A

2.2MHz, Low-EMI, 24.5W, Mono BTL Class-D Audio Amplifier Evaluation Board, AEC-Q100 Qualified

DESCRIPTION

The EVQ7795A-R-00A evaluation board is designed to demonstrate the capabilities of the MPQ7795A-AEC1, a low-EMI, differential analog input, Class-D audio amplifier with I^2C diagnostics. The MPQ7795A can drive a mono speaker in a bridge-tied load (BTL) configuration.

The MPQ7795A employs a BTL structure to deliver up to 24.5W of power to 4Ω speakers with a 14.4V power supply. MPS's Class-D audio amplifiers exhibit the high fidelity of Class-A and Class-B amplifiers at higher efficiencies.

The switching frequency (f_{SW}) can be set to 330kHz, 384kHz, 470kHz, or 2.2MHz, and can achieve >90% efficiency at both 470kHz and 2.2MHz.

The MPQ7795A integrates load diagnostic functionality to detect open load, short load, load short to GND, and load short to PVDD conditions.

The diagnostic runs anytime the device is enabled, and helps protect both the load and the device.

Full protection features include over-current protection (OCP), under-voltage protection (UVP), thermal shutdown, and adjustable power limiting.

The adjustable power limit (P_{LIMIT}) sets the output peak-to-peak voltage limit (V_{PP_LIMIT}) by limiting the duty cycle to a fixed maximum value. V_{PP_LIMIT} can be considered the virtual voltage rail. The power supply input (PVDD) voltage (V_{PVDD}) is greater than V_{PP_LIMIT}.

The EVQ7795A-R-00A is a fully assembled and tested evaluation board. The MPQ7795A is a fully integrated audio amplifier that reduces total solution size. It is available in a QFN-24 (4mmx4mm) package, and is AEC-Q100 qualified.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		5V to 36V
Current limit		5A
Peak efficiency	8Ω load, f_{SW} = 470kHz, total harmonic distortion + noise (THD + N) = 10%	92.6%
Switching frequency (f_{SW})	Default configuration	470kHz

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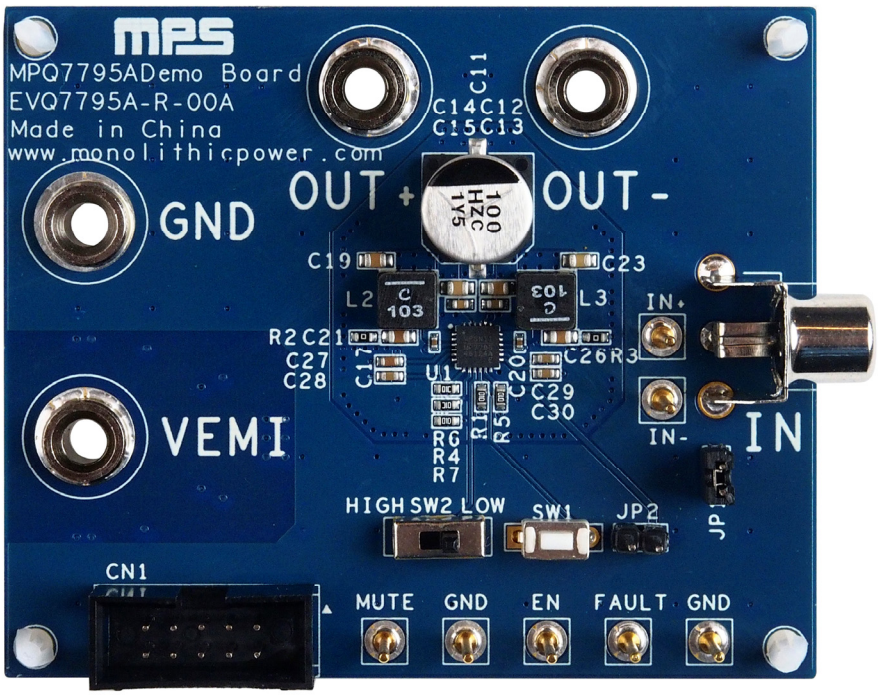
EVQ7795A-R-00A EVALUATION BOARD



LxWxH (7.6cmx6.3cmx1.8cm)

Board Number	MPS IC Number
EVQ7795A-R-00A	MPQ7795AGRE-AEC1

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QUICK START GUIDE

The EVQ7795A-R-00A evaluation board is easy to set up and use to evaluate the performance of the MPQ7795A. The MPQ7795A features a 5V to 36V single-supply operating input voltage (V_{IN}) with single-ended signal inputs. To use differential signal inputs, remove the jumpers from JP1. For a stable VDRV voltage (V_{VDRV}), it is recommended to use a 4.7µF to 10µF VDRV capacitor (C_{VDRV}), especially at extremely high or low temperatures. For proper measurement equipment set-up, refer to Figure 1 on page 4 and follow the steps below:

1. Connect the power supply terminals to:
   a. Positive (+): VEMI
   b. Negative (-): GND
2. Connect the load terminals to:
   a. Positive (+): OUT+
   b. Negative (-): OUT-
3. Set the power supply to be between 5V and 36B (typically 14.4V).
4. Set the speaker to be between 4Ω to 8Ω (typically 8Ω).
5. To set up the evaluation board for 14.4V operation, follow the steps below:
   a. Preset the DC power supply to 14.4V.
   b. Connect the output terminals to:
      i. Positive (+): OUT+
      ii. Negative (-): OUT-
   c. Connect the DC power supply terminals to:
      i. Positive (+): VEMI
      ii. Negative (-): GND
   d. Connect the audio input signal sources to:
      i. Positive (+): IN+
      ii. Negative (-): IN-
6. Press the switch (SW1) to disable the evaluation board; release SW1 to enable it. SW1 is enabled by default. Once SW1 is enabled, the power supply can be turned on and off.
7. To adjust the gain, switching frequency (f_{SW}), and power limit (P_{LIMIT}), follow the steps below:
   a. Turn on the DC power supply.
   b. Enter the 6C PMBus address via the I^2C.
   c. Set the desired gain, f_{SW}, and P_{LIMIT} for the application.
8. The MPQ7795A's f_{SW} is 470kHz by default. If 2.2MHz is required during start-up, follow the steps below:
   a. Pull the MUTE pin high, then turn on the DC power supply.
   b. Set f_{SW} to 2.2MHz via the I^2C.
   c. Pull the MUTE pin low.
9. For typical applications, remove the jumper (JP2).

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Figure 1 shows the measurement equipment set-up.

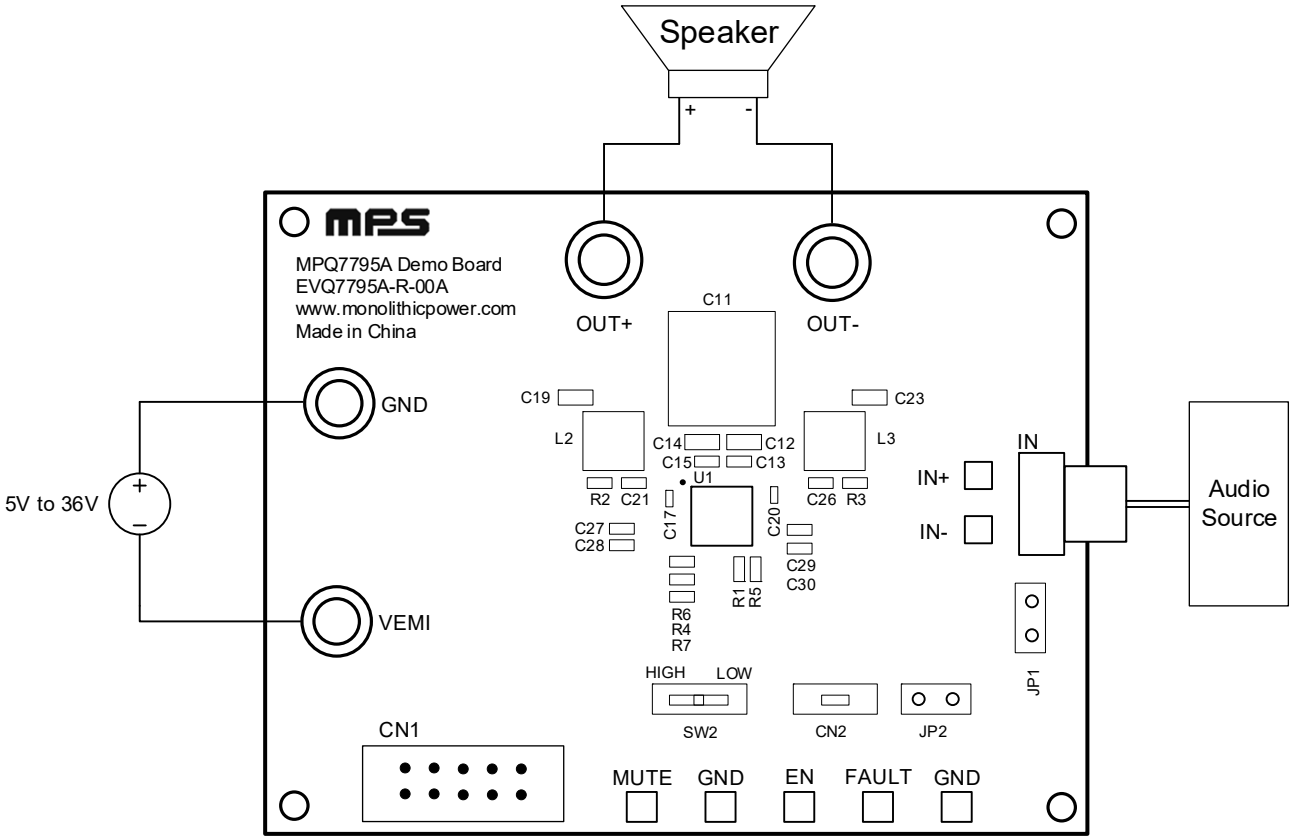

Figure 1: Measurement Equipment Set-Up

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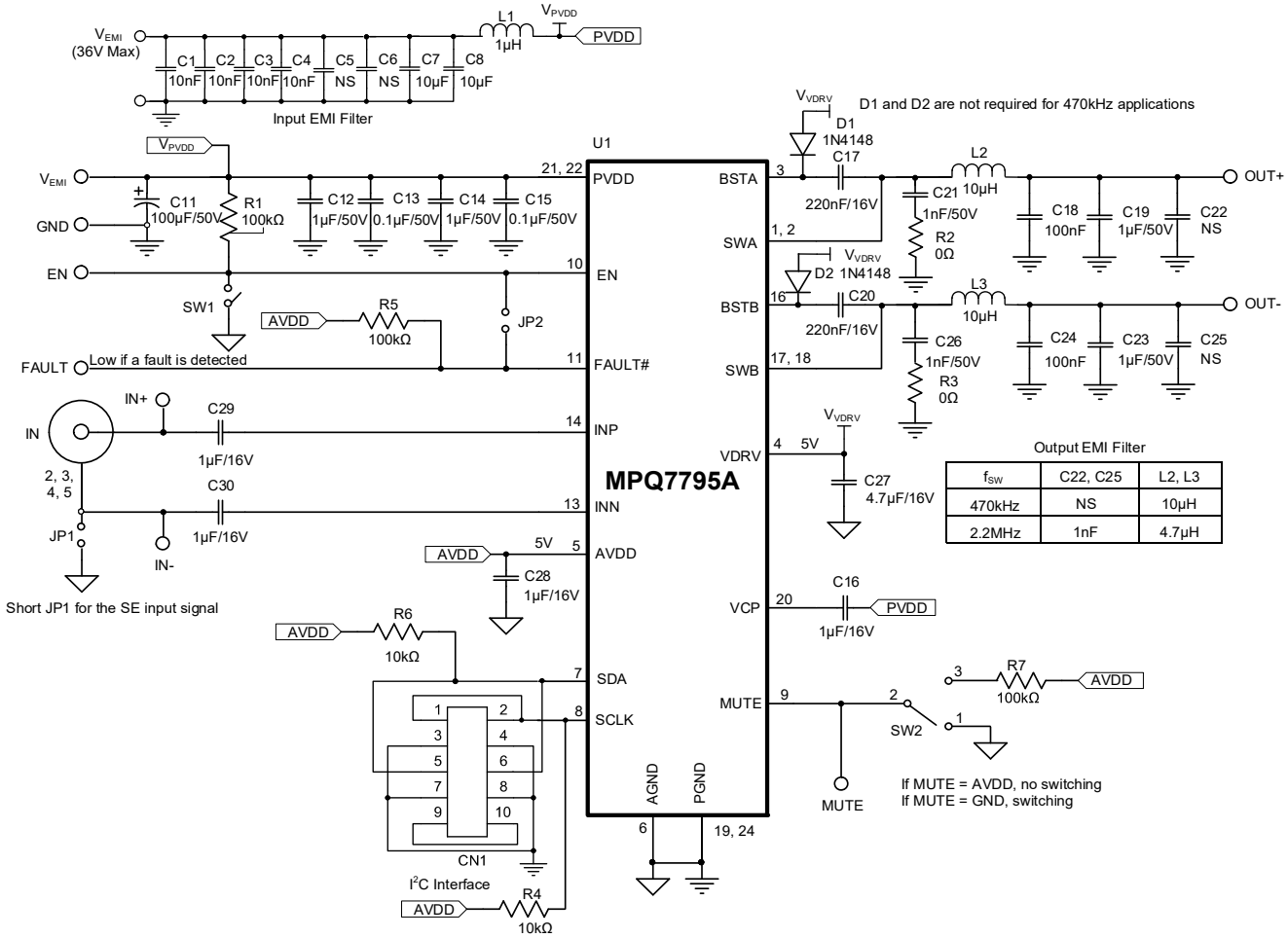
EVALUATION BOARD SCHEMATIC



Output EMI Filter

f_{SW}	C22, C25	L2, L3
470kHz	NS	10µH
2.2MHz	1nF	4.7µH

Figure 2: Evaluation Board Schematic

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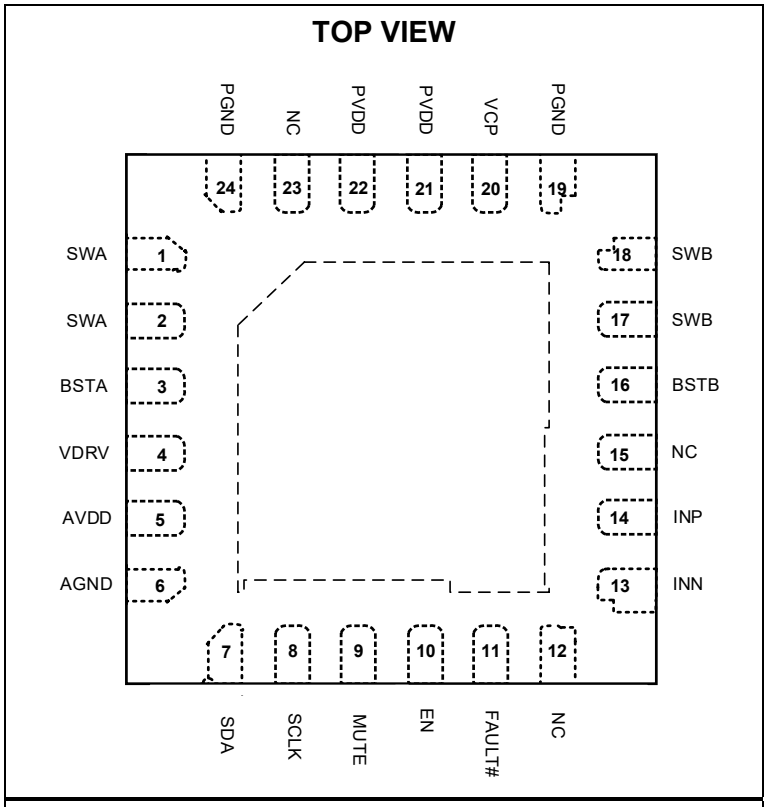
PACKAGE REFERENCE



QFN-24 (4mmx4mm)

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EVQ7795A-R-00A BILL OF MATERIALS

Qty	Des	Value	Description	Package	Manufacturer	Manufacturer PN
1	C11	100µF	Electrolytic capacitor, 50V	SMD	Panasonic	EEHZC1H101P
5	C12, C14, C16, C19, C23	1µF	Ceramic capacitor, 50V, X7R	0805	Murata	GRM21BR71E105KA99L
4	C12, C14, C19, C23	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
1	C16	1µF	Ceramic capacitor, 16V, X7R	0805	Murata	GRM21BR71C105KA01L
4	C9, C10, C13, C15	100nF	Ceramic capacitor, 50V, X7R	0603	TDK	GRM188R71H104KA93D
2	C21, C26	1nF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H102K
1	C27	4.7µF	Ceramic capacitor, 25V, X5R	0603	Murata	GRM188R61E475KE11D
3	C28, C29, C30	1µF	Film resistor, 1%	0603	Murata	GRM188R71C105KA12D
2	C18, C24	100nF	Ceramic capacitor, 50V, X7R	0805	Samsung	CL21B104KBCNNNC
0	C22, C25	NS				
2	C17, C20	220nF	Ceramic capacitor, 16V, X7R	0402	Murata	GRM155R71C224KA12D
4	C1, C2, C3, C4	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103JA01D
0	C5, C6	NS				
2	C7, C8	10µF	Ceramic capacitor, 50V, X7R	1206	Murata	GRM31CR61H106KA12L
2	R2, R3	0Ω	Film resistor, 5%	0603	Yageo	RC0603JR-070RL
3	R1, R5, R7	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
2	R4, R6	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	D1, D2	75V	Diode, 0.15A	SOD323	Fairchild	1N4148WS
1	L1	1µH	Inductor, 14.6mΩ, 9.6A	SMD	Coilcraft	XEL4020-102MEB
2	L2, L3	10µH	Inductor, 40.9mΩ, 3.6A	SMD	Coilcraft	XEL5050-103MEC
1	U1	MPQ7795A-AEC1	2.2MHz, 24.5W, low-EMI, differential analog input, Class-D audio amplifier with I^2C diagnostics, AEC-Q100 qualified	QFN-24 (4mmx 4mm)	MPS	MPQ7795AGRE-AEC1

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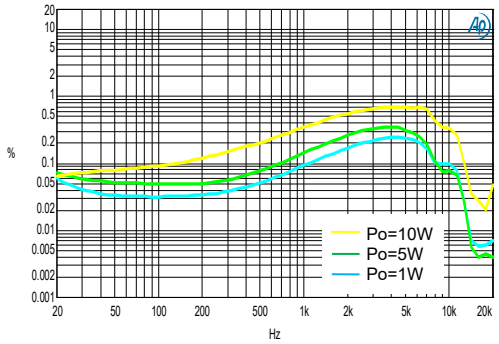
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10μH, C_{OUT} = 1μF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

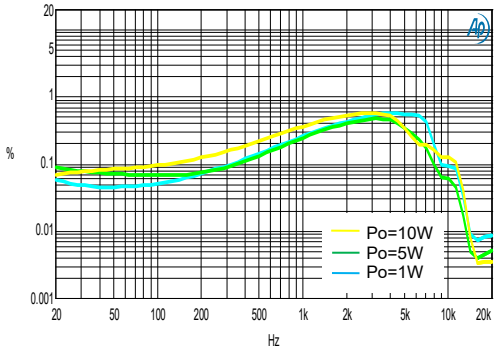
Total Harmonic Distortion + Noise (THD + N) vs. Input Signal Frequency

Load = 8Ω + 66μH



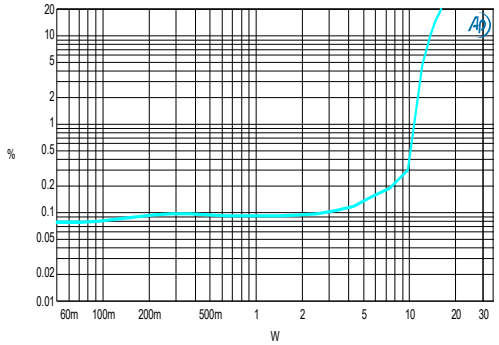
THD + N vs. Input Signal Frequency

Load = 4Ω + 33μH



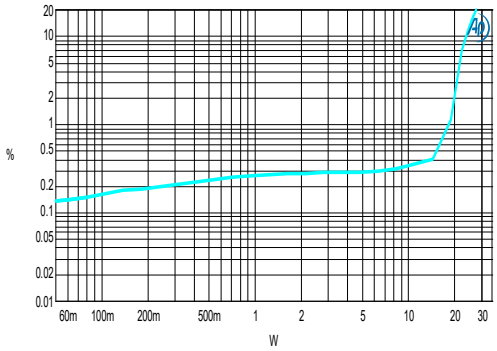
THD + N vs. Output Power

Load = 8Ω + 66μH



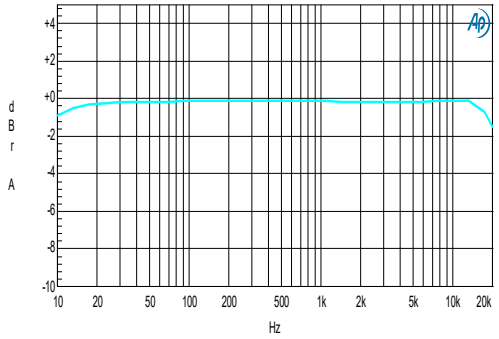
THD + N vs. Output Power

Load = 4Ω + 33μH



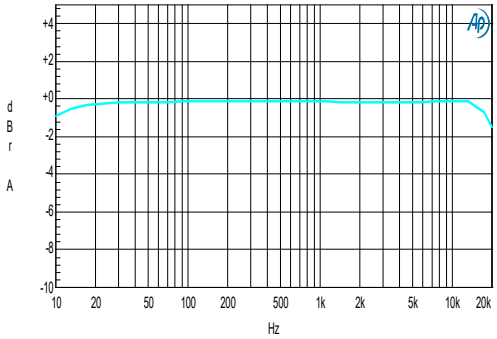
Input Signal Frequency Response

1W, load = 8Ω + 66μH



Input Signal Frequency Response

1W, load = 4Ω + 33μH



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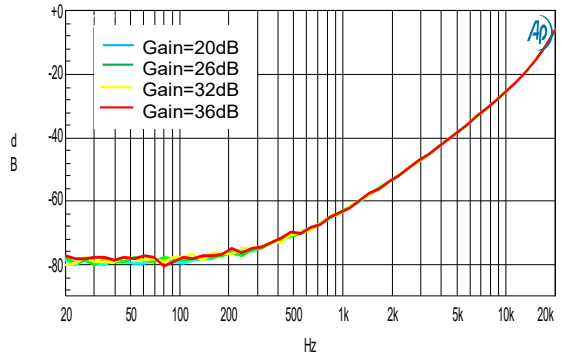
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10μH, C_{OUT} = 1μF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

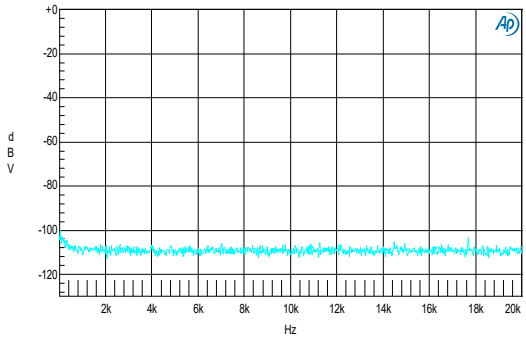
Power Supply Rejection Ratio

V_{AC_RIPPLE} = 1V_{PP}



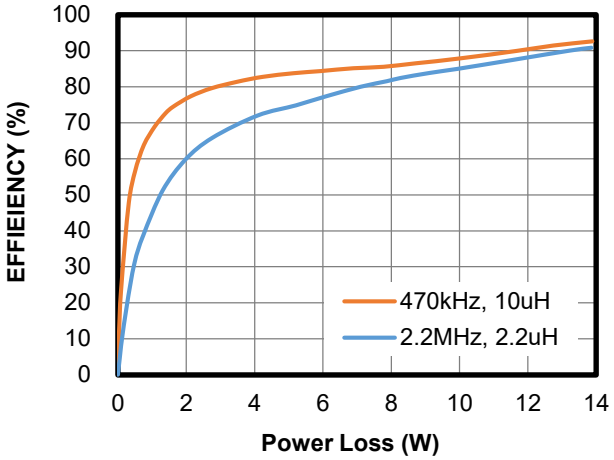
Fast Fourier Transform (FFT) Noise Floor

Load = 8Ω + 66μH



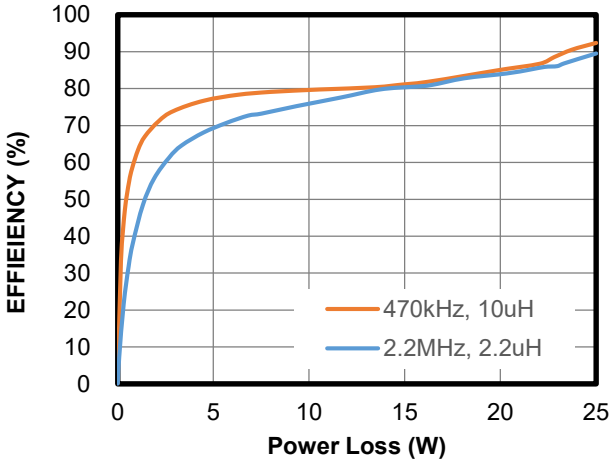
Efficiency vs. Power Loss

Load = 8Ω + 66μH (1) (2)



Efficiency vs. Power Loss

Load = 4Ω + 33μH (1) (2)



Notes:

1) When f_{SW} = 470kHz, inductor: XAL6060-103MEB, 10μH, DCR = 27mΩ.
2) When f_{SW} = 2.2MHz, inductor: XAL4030-222MEB, 2.2μH, DCR = 35.2mΩ.

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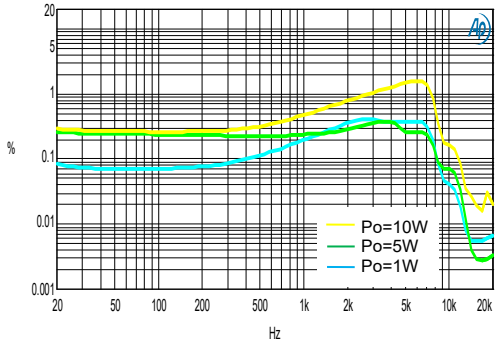
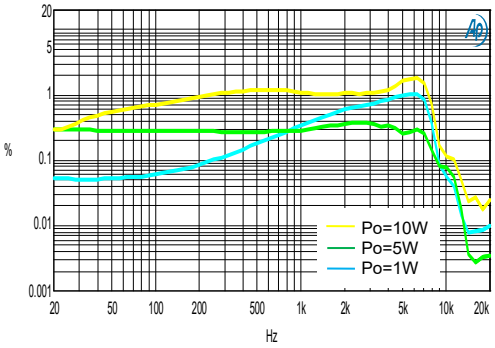
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 2.2MHz, L_{OUT} = 4.7μH, C_{OUT} = 1μF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

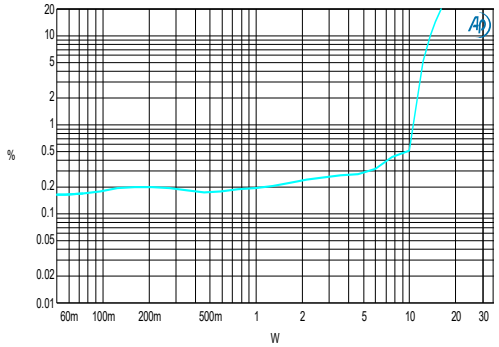
THD + N vs. Input Signal Frequency
Load = 8Ω + 66μH



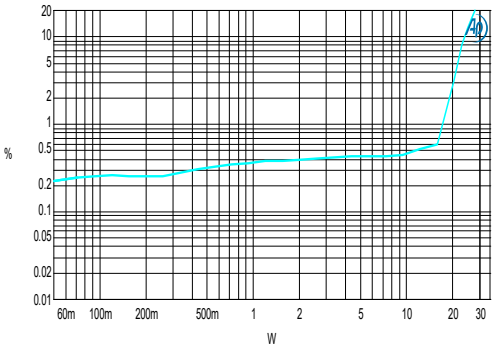
THD + N vs. Input Signal Frequency
Load = 4Ω + 33μH



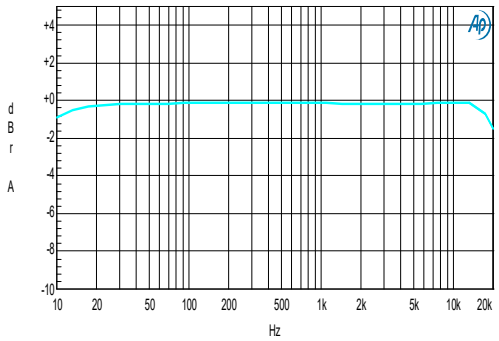
THD + N vs. Output Power
Load = 8Ω + 66μH



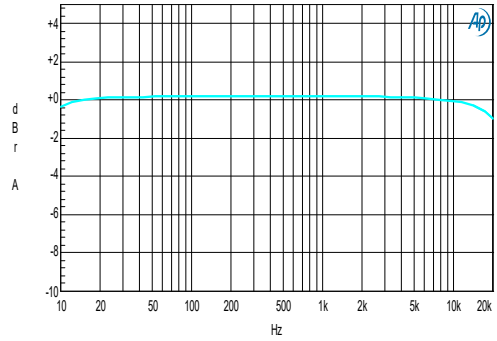
THD + N vs. Output Power
Load = 4Ω + 33μH



Input Signal Frequency Response
1W, load = 8Ω + 66μH



Input Signal Frequency Response
1W, load = 4Ω + 33μH



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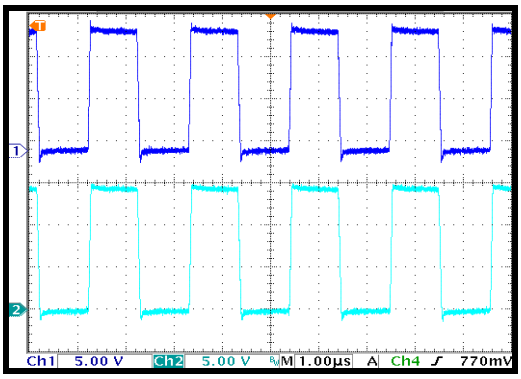
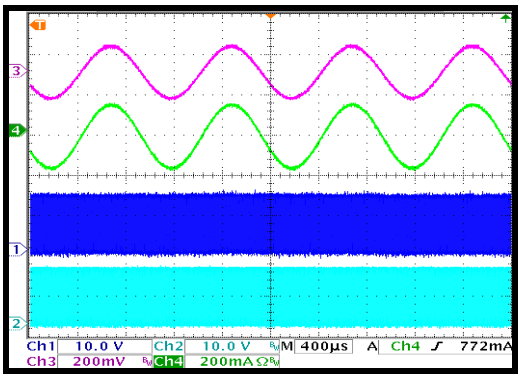
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10µH, C_{OUT} = 1µF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

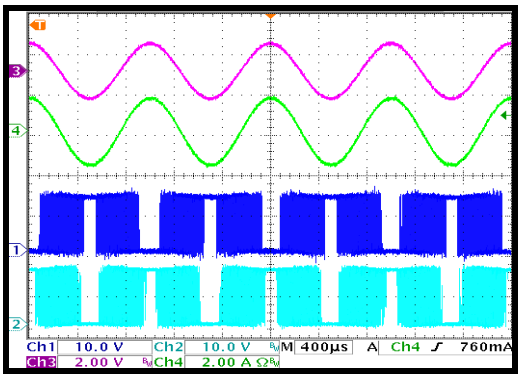
Steady State
Load = 8Ω + 66µH, no input signal



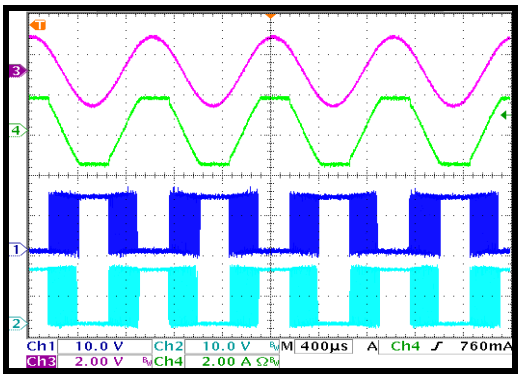
Steady State
Load = 8Ω + 66µH, THD + N = 0.1%,
output power (P_{OUT}) = 94.5mW



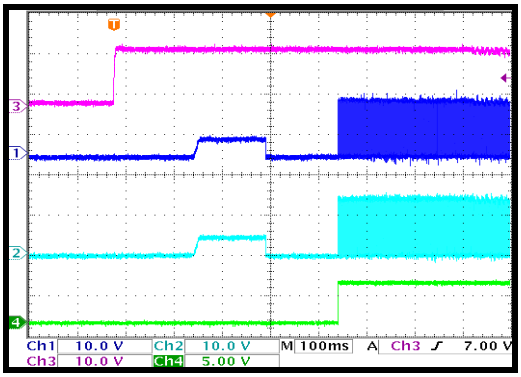
Steady State
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



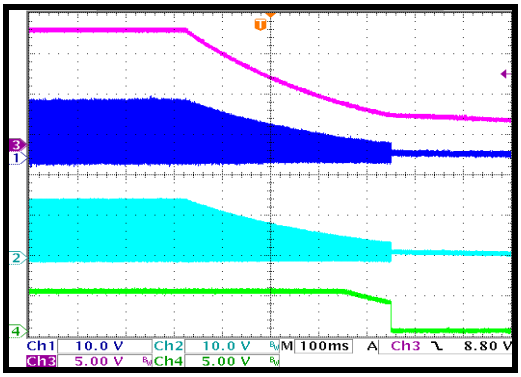
Steady State
Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



Start-Up through VIN
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



Shutdown through VIN
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



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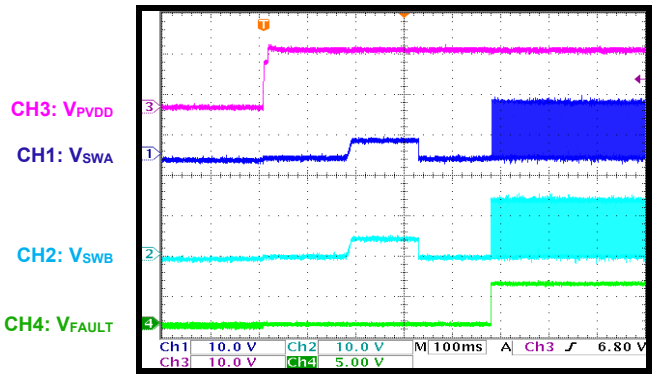
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10µH, C_{OUT} = 1µF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

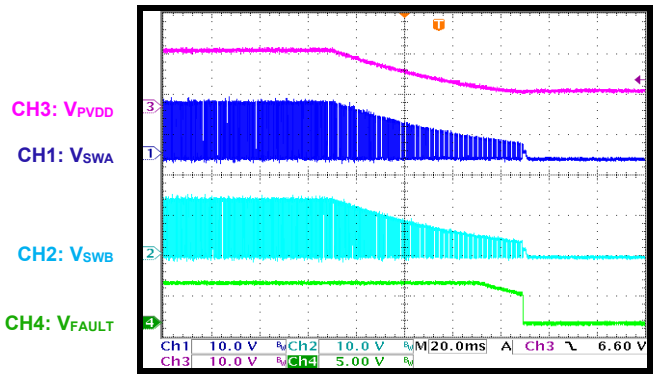
Start-Up through VIN

Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



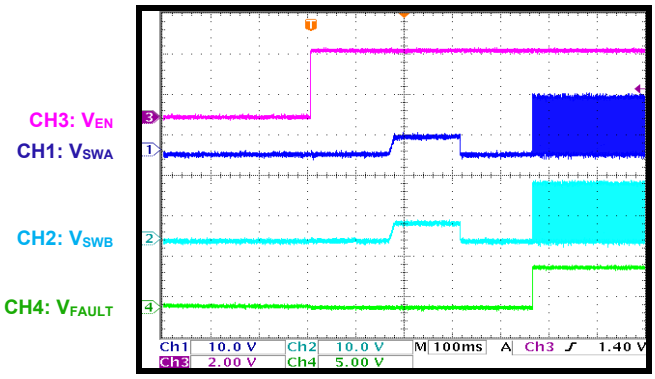
Shutdown through VIN

Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



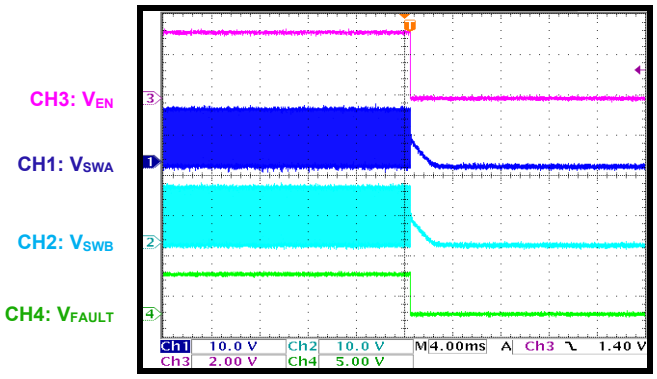
Start-Up through EN

Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



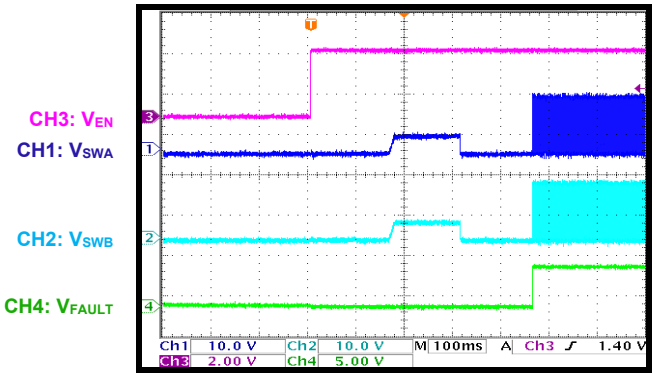
Shutdown through EN

Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



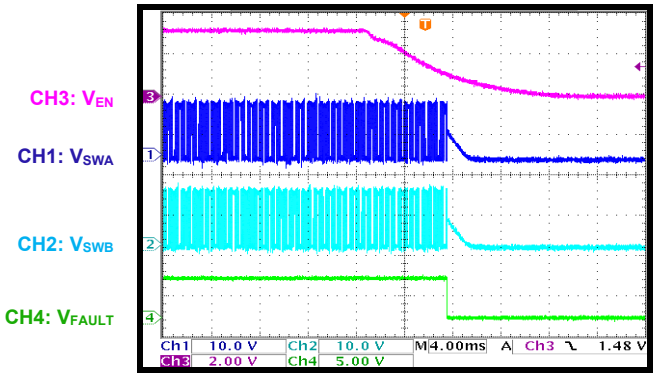
Start-Up through EN

Load = 8Ω + 66µH, THD + N THD = 10%,
P_{OUT} = 13.6W



Shutdown through EN

Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



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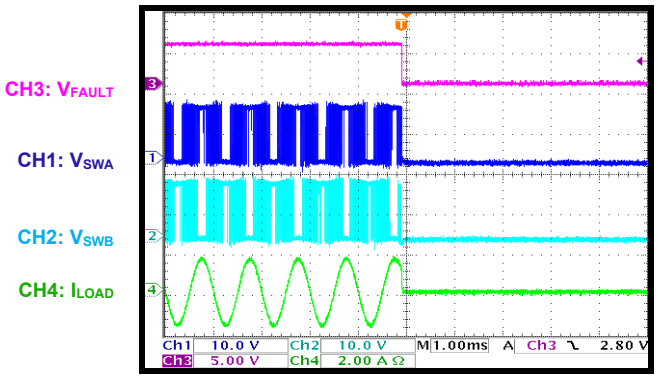
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10μH, C_{OUT} = 1μF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

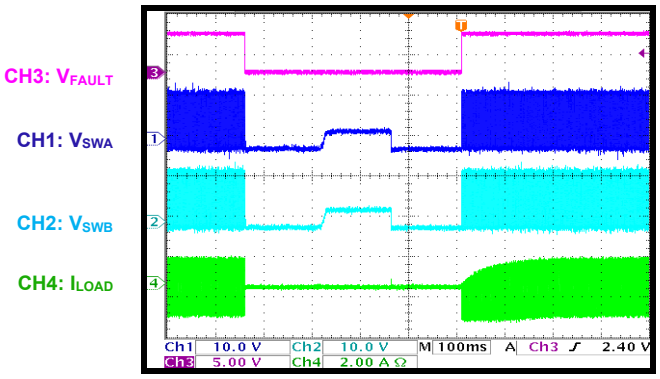
SCP Entry

OUT- short to GND, load = 8Ω + 66μH,
THD + N = 1%, P_{OUT} = 11.3W



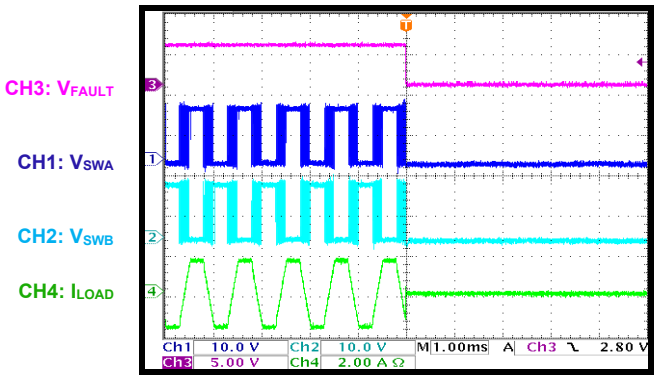
SCP Recovery

OUT- short to GND, load = 8Ω + 66μH,
THD + N = 1%, P_{OUT} = 11.3W



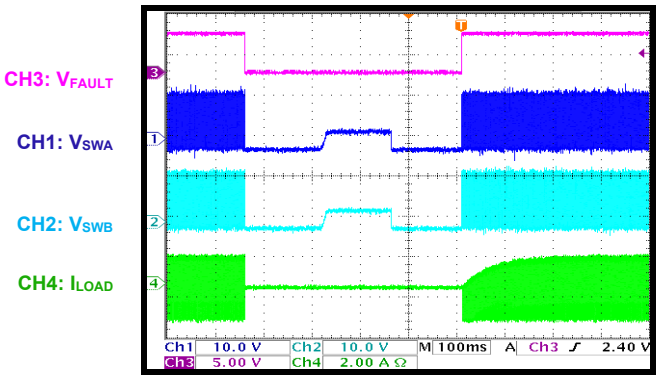
SCP Entry

OUT- short to GND, load = 8Ω + 66μH,
THD + N = 10%, P_{OUT} = 13.6W



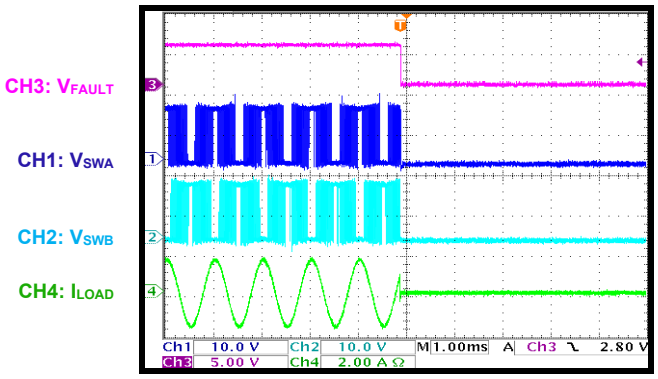
SCP Recovery

OUT- short to GND, load = 8Ω + 66μH,
THD + N = 10%, P_{OUT} = 13.6W



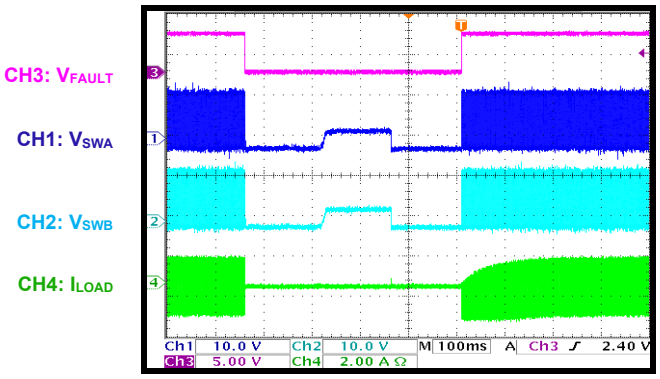
SCP Entry

OUT+ short to GND load = 8Ω + 66μH,
THD + N = 1%, P_{OUT} = 11.3W



SCP Recovery

OUT+ short to GND, load = 8Ω + 66μH,
THD + N = 1%, P_{OUT} = 11.3W



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EVB TEST RESULTS *(continued)*

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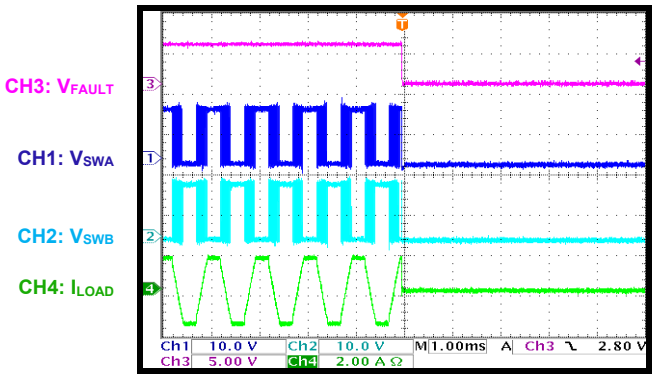
SCP Entry

OUT+ short to GND, load = 8Ω + 66μH,
THD + N = 10%, P_{OUT} = 13.6W



SCP Recovery

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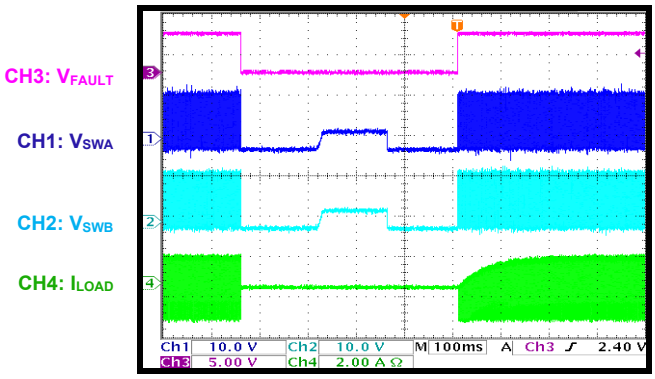
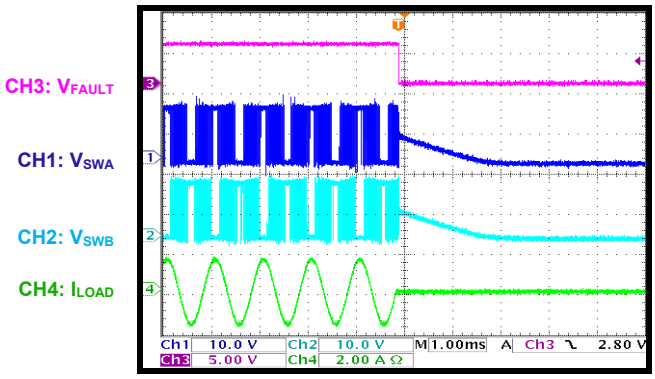
THD + N = 10%, P_{OUT} = 13.6W



SCP Entry

OUT+ short to OUT-, load = 8Ω + 66μH,
THD + N = 1%, P_{OUT} = 11.3W



SCP Recovery

OUT+ short to OUT, load = 8Ω + 66μH,
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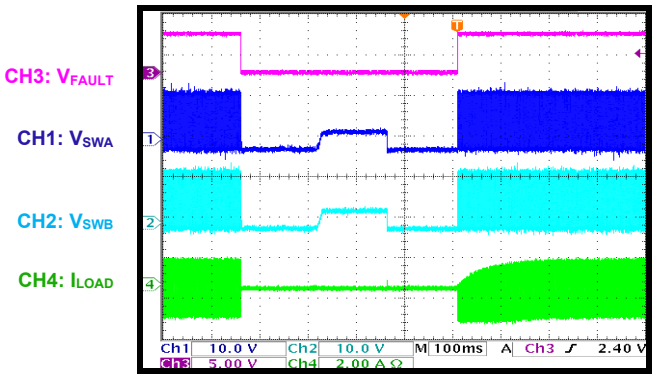
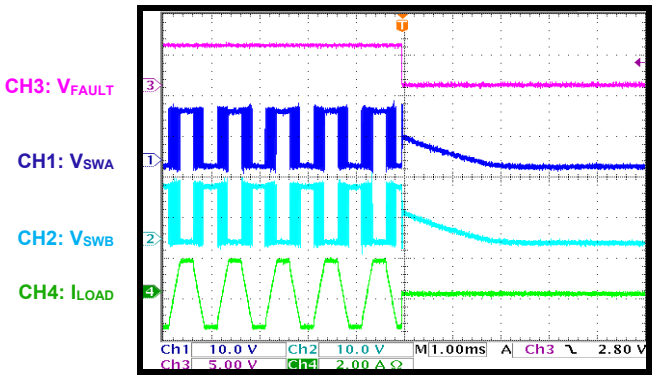


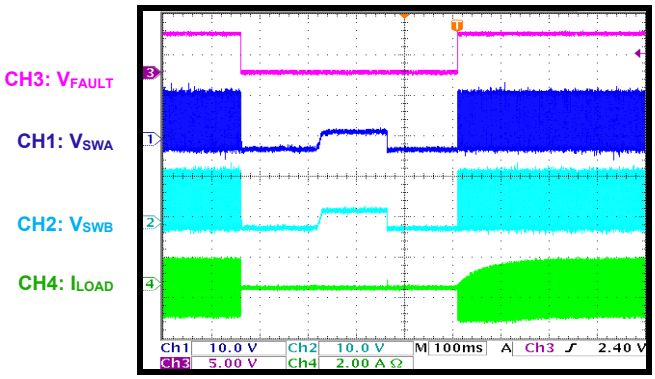
SCP Entry

OUT+ short to OUT-, load = 8Ω + 66μH,
THD + N = 10%, P_{OUT} = 13.6W



SCP Recovery

OUT+ short to OUT-, load = 8Ω + 66μH,
THD + N = 10%, P_{OUT} = 13.6W



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EVB TEST RESULTS *(continued)*

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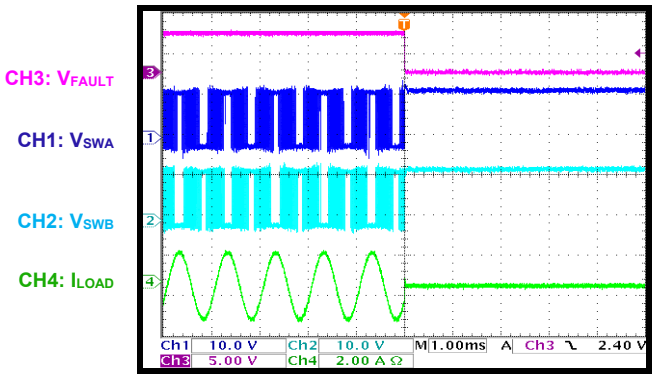
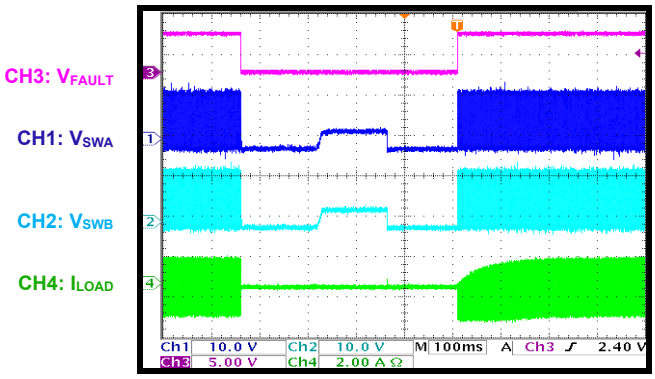
SCP Entry

OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



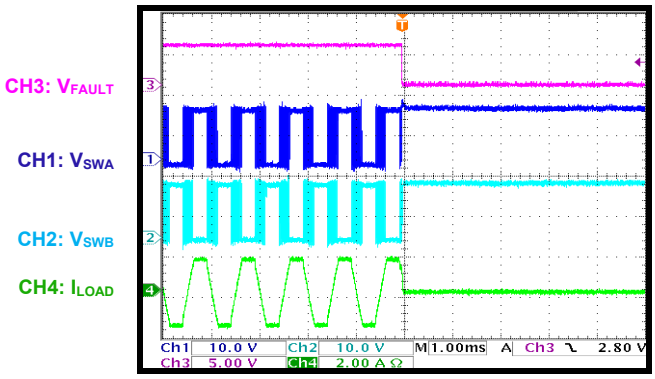
SCP Recovery

OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



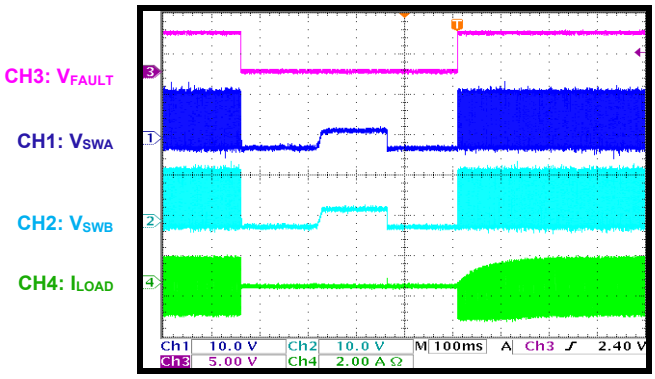
SCP Entry

OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



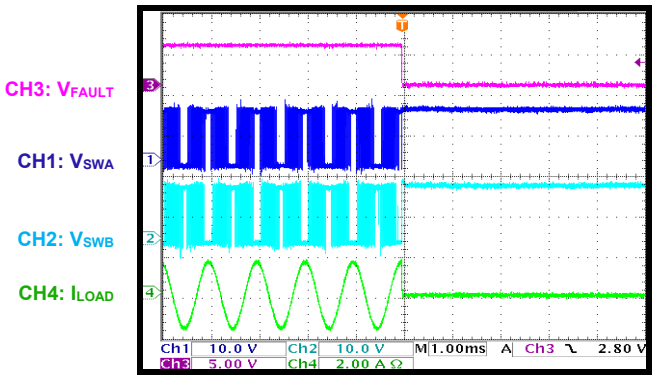
SCP Recovery

OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



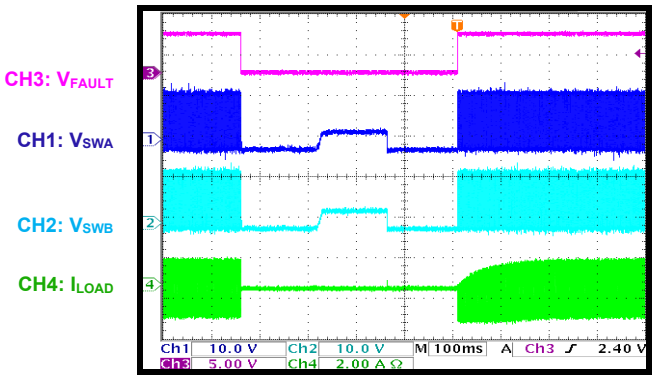
SCP Entry

OUT- short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



SCP Recovery

OUT- short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



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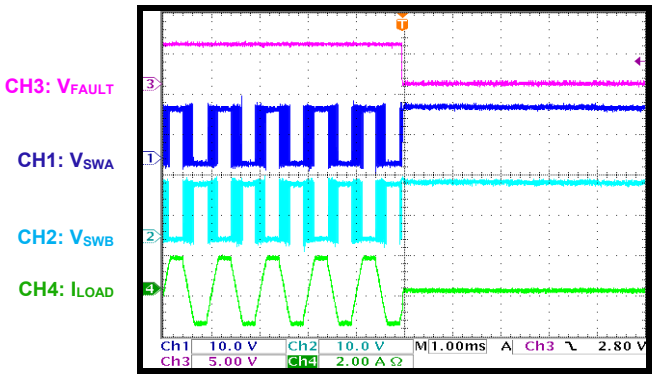
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{PVDD} = 14.4V, f_{SW} = 470kHz, L_{OUT} = 10µH, C_{OUT} = 1µF, f_{IN} = 1kHz, gain = 20dB, T_A = 25°C, unless otherwise noted.

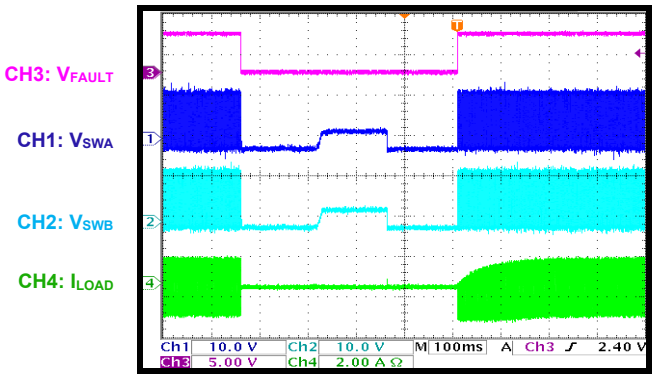
SCP Entry

OUT- short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



SCP Recovery

OUT- short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



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PCB LAYOUT

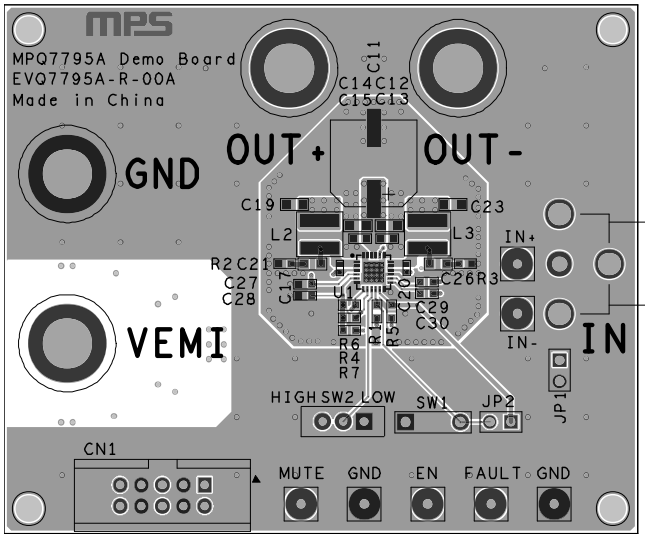

Figure 3: Top Silk and Top Layer

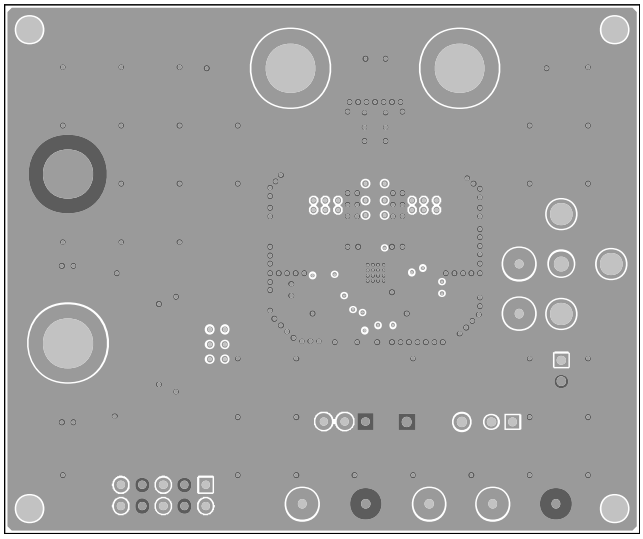

Figure 4: Mid-Layer 1

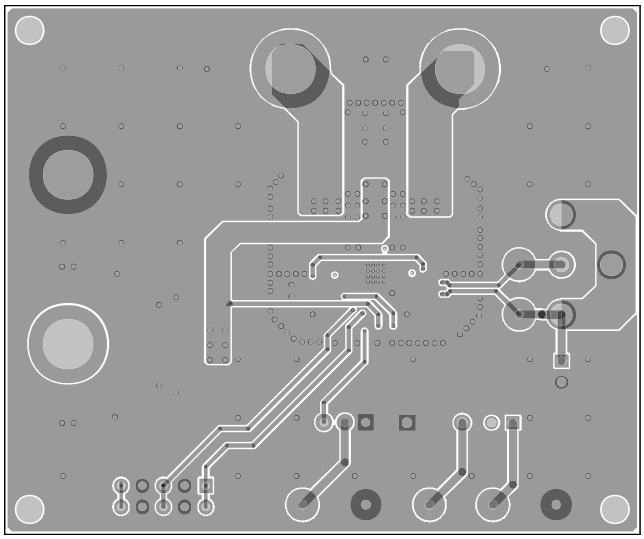

Figure 5: Mid-Layer 2

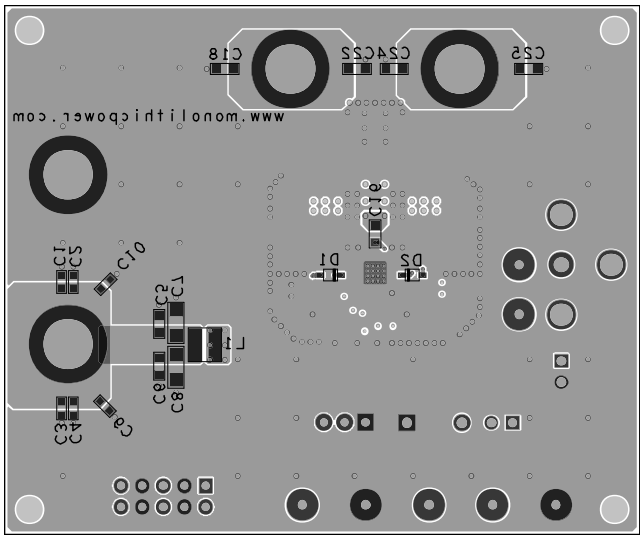

Figure 6: Bottom Layer and Bottom Silk

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REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	10/11/2024	Initial Release	-

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