EVQ7795-R-00A

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

DESCRIPTION

The EVQ7795-R-00A is an evaluation board designed to demonstrate the capabilities of the MPQ7795-AEC1, an automotive-grade, low-EMI, differential analog input, Class D audio amplifier with I^2C diagnostics. The MPQ7795 can drive a mono speaker in a bridge-tied load (BTL) configuration.

The MPQ7795 employs a BTL structure to deliver 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 AB amplifiers at high efficiency.

The selectable 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 MPQ7795 integrates the load diagnostic function that detects open load, short load, load short to GND, load short to PVDD. The diagnostic runs when the device is enabled, which helps to protect the load and the device.

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

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

The EVQ7795-R-00A is a fully assembled and tested evaluation board. The MPQ7795 is a fully integrated audio amplifier that reduces the solution size, and is available in a QFN-24 (4mmx4mm) package.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{EMI}	5 to 36	V

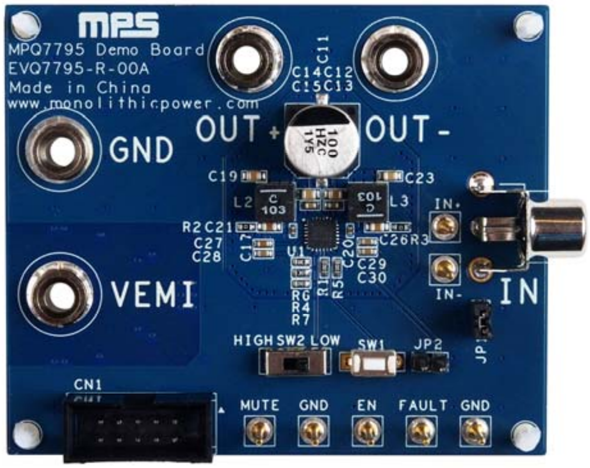
FEATURES

- 5V to 36V Operating Input Voltage (V_{IN}) Range
- ±5A Peak Current Output
- Differential Analog Input
- 42V Load Dump
- Low 0.02uA Standby Current
- Low 6.5mA Idle Current
- 330kHz, 384kHz, 470kHz, or 2.2MHz Selectable Switching Frequency (f_{SW})
- Delivers 24.5W into 4Ω Load with 14.4V Power VDD (PVDD)
- High Power Efficiency:
  - Up to 92.6% Efficiency for 8Ω Load
  - Up to 90.4% Efficiency for 4Ω Load
- 150mΩ power MOSFETs
- Start-Up/Shutdown Pop-Noise Reduction
- Selectable Voltage Gain
- Adjustable Power Limiter
- Open/Short Load Detection
- Output Short to PVDD/Ground Detection
- Over-Current Protection (OCP)
- Under-Voltage Protection (UVP)
- Thermal Shutdown
- Status Reporting via the I^2C Interface and Fault Output Pin (FAULT#)
- Low EMI Meets CISPR 25 Class 5 Specifications with Long Output Cable
- Communicates with Microcontroller Unit (MCU) via I^2C Interface
- Supports 2Ω to 16Ω Speakers
- Available in a QFN-24 (4mmx4mm) Package
- Available in AEC-Q100 Grade 1

APPLICATIONS

- Automotive Emergency Call (eCall) Systems
- Telematics Systems
- Audio Infotainment Systems
- Automotive Clusters

EVQ7795-R-00A EVALUATION BOARD

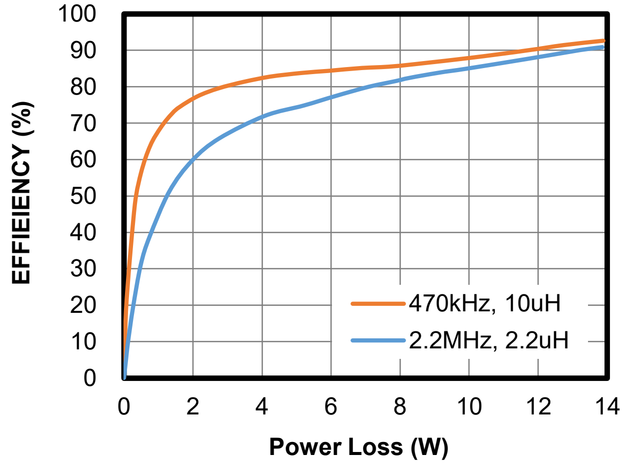


LxWxH (7.62cmx6.35cmx0.5cm)

Board Number	MPS IC Number
EVQ7795-R-00A	MPQ7795GRE-AEC1

Efficiency vs. Power Loss

V_{PVDD} = 14.4V, f_{SW} = 1kHz, 20dB gain,
C_{OUT} = 1μF, load = 8Ω + 66μH

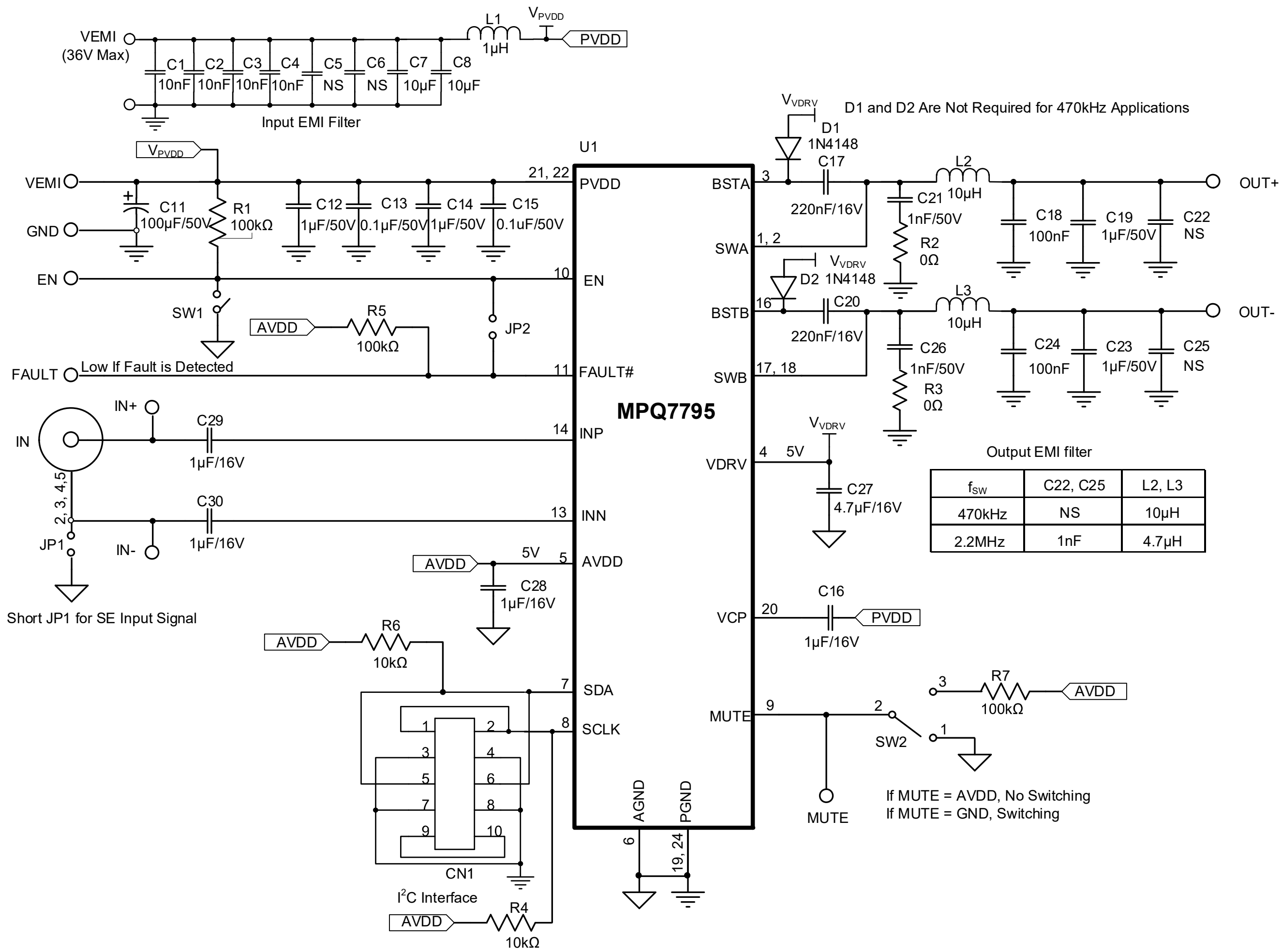


QUICK START GUIDE

The MPQ7795 is set for a 5V to 36V single-supply operating input voltage (V_{IN}) with single-ended signal inputs. To use different signal inputs, remove the jumpers from JP1. It is recommended to use a 4.7µF to 10µF VDRV capacitor (C_{VDRV}) for a stable VDRV voltage (V_{VDRV}), especially at extremely high or low temperatures.

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. The power, signal, and load impedance requirements are listed below:
   a. Power supply: 5V to 36V (typically 14.4V).
   b. Speaker: 4Ω to 8Ω (typically 8Ω).
4. Follow the steps below to set up the evaluation board for 14.4V operation:
   a. Preset the DC power supply to 14.4V.
   b. Connect the output terminals to:
      a) Positive (+): OUT+
      b) Negative (-): OUT-
   c. Connect the DC power supply terminals to:
      a) Positive (+): VEMI
      b) Negative (-): GND
   d. Connect the audio input signal source to:
      a) Positive (+): IN+
      b) Negative (-): IN-
5. 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.
6. Follow the steps below to adjust the gain, switching frequency (f_{SW}), and power limit:
   a. Turn on the DC power supply.
   b. Open the I^2C to fill in 6C PMBus Address.
   c. Set the desired gain, f_{SW}, and power limit for the application.
7. The MPQ7795'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 MUTE low.
8. For typical applications, remove the jumper (JP2).

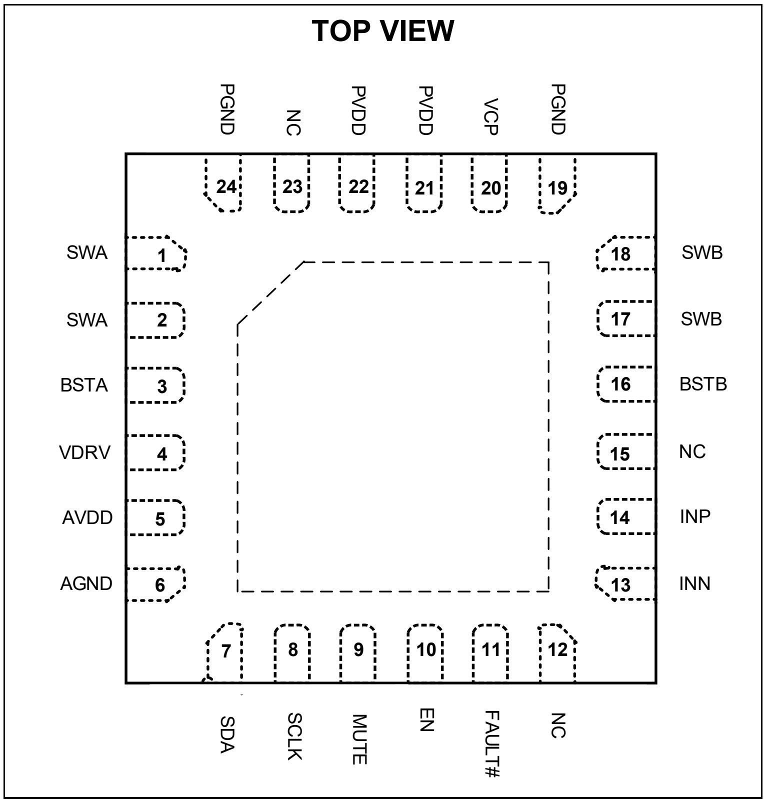
EVALUATION BOARD SCHEMATIC



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

Figure 1: Evaluation Board Schematic

PACKAGE REFERENCE



QFN-24 (4mmx4mm)

EVQ7795-R-00A BILL OF MATERIALS

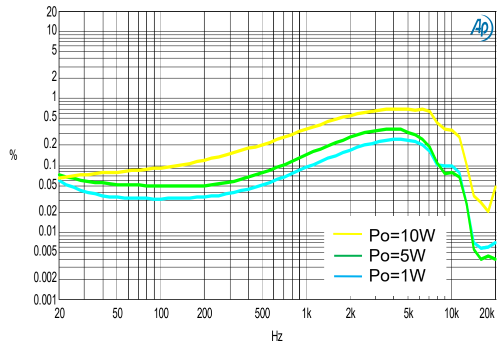
Qty	Des	Value	Description	Package	Manufacturer	Manufacturer P/N
1	C11	100µF	Electrolytic capacitor, 50V	SMD	Panasonic	EEHZC1H101P
5	C12, C14, C16, C19, C23	1µF	Ceramic capacitor, 50V, X7R	0805	Murata	GRM21BR71E105KA99L
4	C12, C14, C19, C23	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
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	On Semiconductor (Fairchild)	1N4148WS
1	L1	1µH	Inductor, 14.6m, 9.6A	SMD	Coilcraft	XEL4020-102MEB
2	L2, L3	10µH	Inductor, 40.9m, 3.6A	SMD	Coilcraft	XEL5050-103MEC
1	U1	MPQ7795	Class D Amplifier	QFN-24 (4mmx 4mm)	MPS	MPQ7795GRE-AEC1

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.

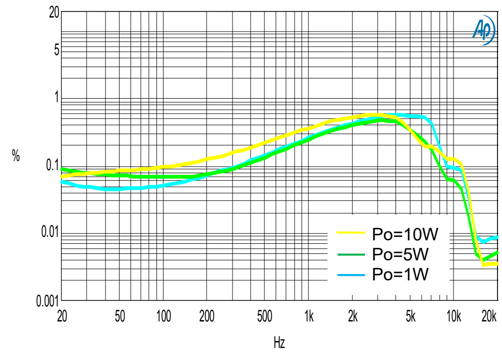
Total Harmonic Distortion + Noise (THD + N) vs. Input Signal Frequency

Load = 8Ω + 66µH



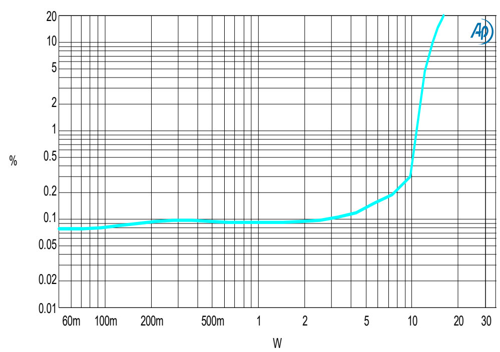
Total Harmonic Distortion + Noise (THD + N) vs. Input Signal Frequency

Load = 4Ω + 33µH



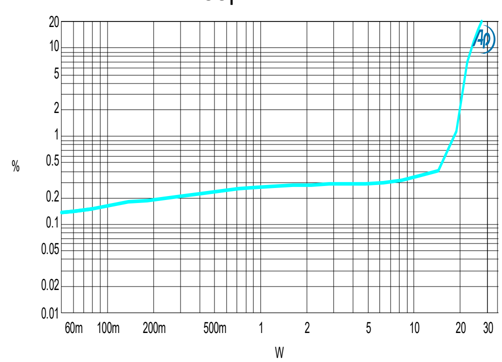
Total Harmonic Distortion + Noise (THD + N) vs. P_{OUT}

Load = 8Ω + 66µH



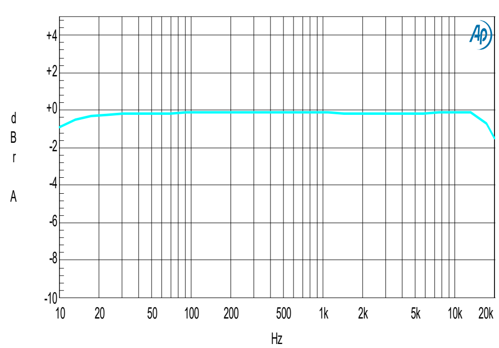
Total Harmonic Distortion + Noise (THD + N) vs. P_{OUT}

Load = 4Ω + 33µH



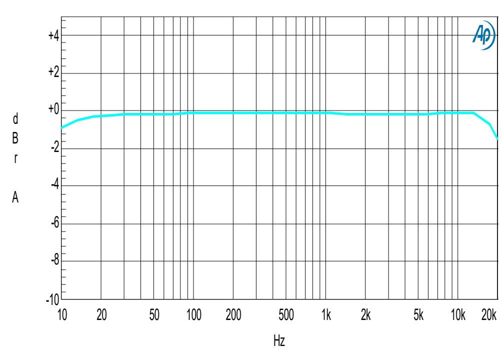
Input Signal Frequency Response

1W, load = 8Ω + 66µH



Input Signal Frequency Response

1W, load = 4Ω + 33µH

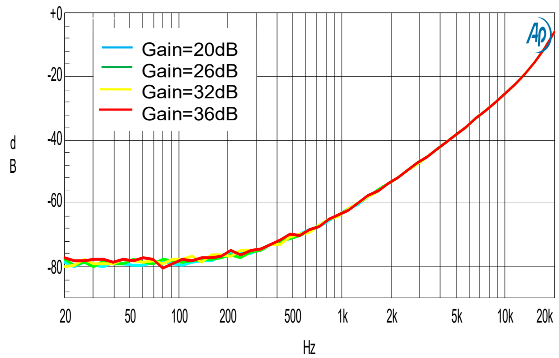


EVB TEST RESULTS *(continued)*

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.

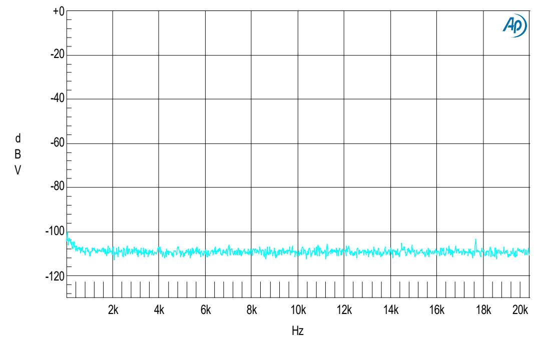
Power Supply Rejection Ratio

V_{AC_RIPPLE} = $1V_{PP}$



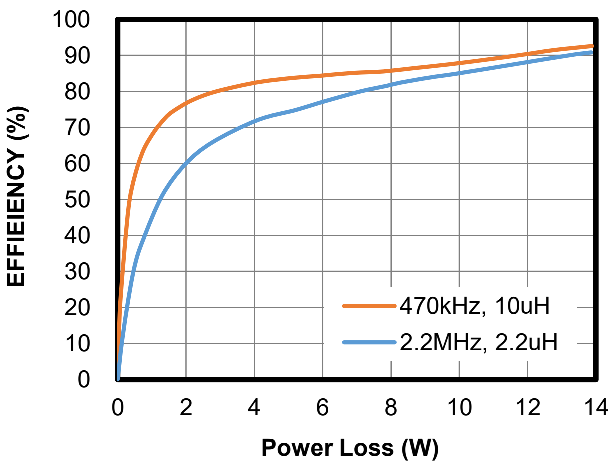
Fast Fourier Transform (FFT) Noise Floor

Load = 8Ω + 66µH



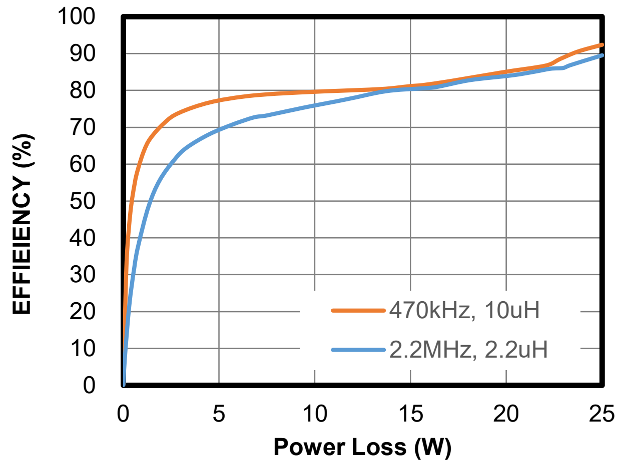
Efficiency vs. Power Loss

Load = 8Ω + 66µH (1) (2)



Efficiency vs. Power Loss

Load = 4Ω + 33µH (1) (2)



Notes:

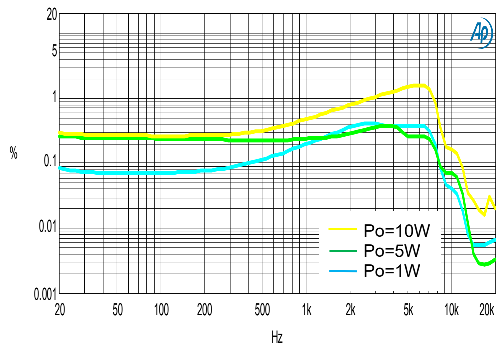
1) For 470kHz f_{SW}, inductor: XAL6060-103MEB, 10µH, DCR = 27mΩ.
2) For 2.2MHz f_{SW}, inductor: XAL4030-222MEB, 2.2µH, DCR = 35.2mΩ.

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.

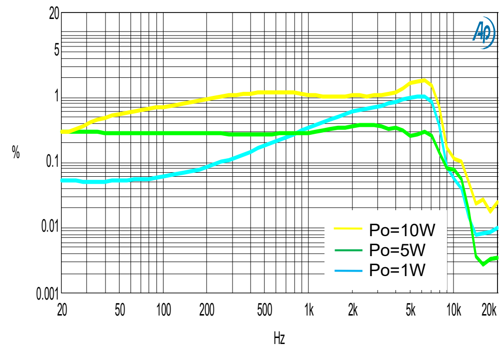
Total Harmonic Distortion + Noise (THD + N) vs. Input Signal Frequency

Load = 8Ω + 66µH



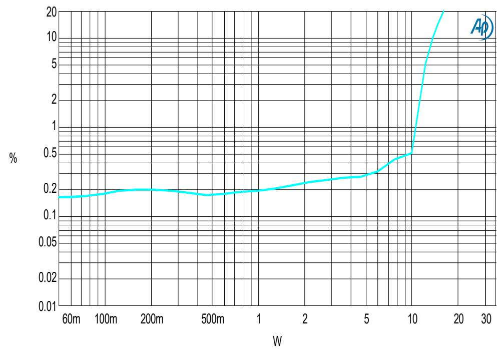
Total Harmonic Distortion + Noise (THD + N) vs. Input Signal Frequency

Load = 4Ω + 33µH



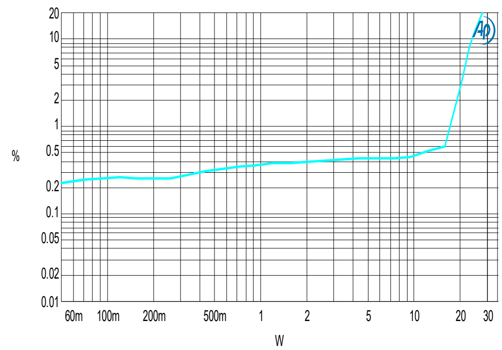
Total Harmonic Distortion + Noise (THD + N) vs. P_{OUT}

Load = 8Ω + 66µH



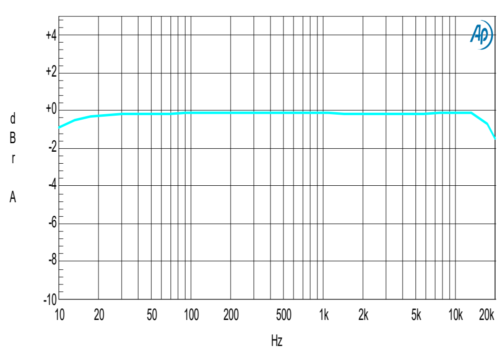
Total Harmonic Distortion + Noise (THD + N) vs. P_{OUT}

Load = 4Ω + 33µH



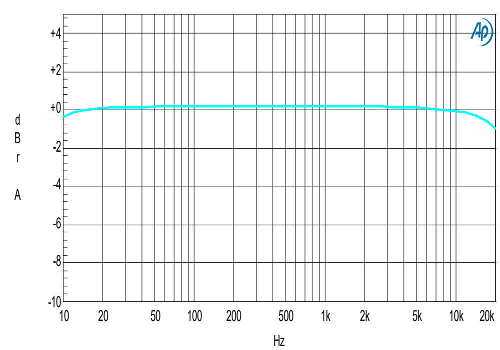
Input Signal Frequency Response

1W, load = 8Ω + 66µH



Input Signal Frequency Response

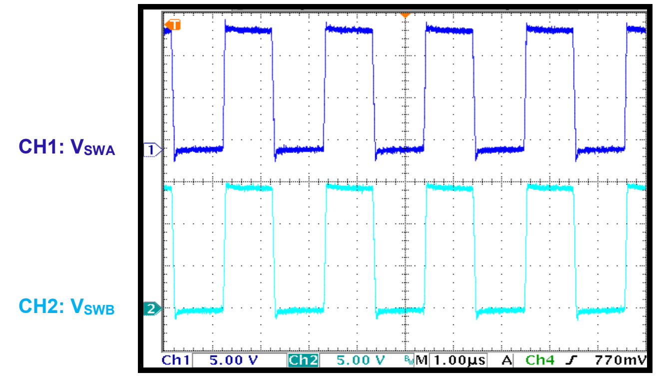
1W, load = 4Ω + 33µH



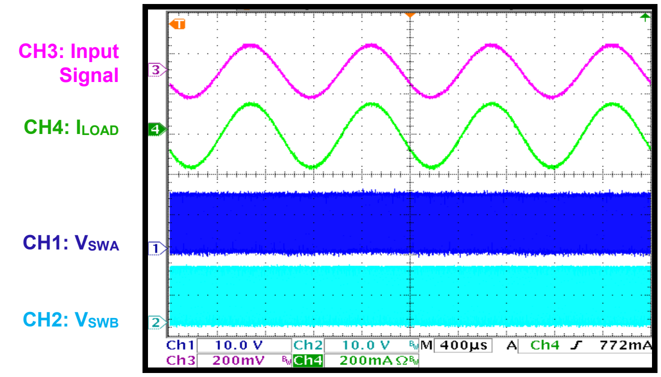
EVB TEST RESULTS *(continued)*

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.

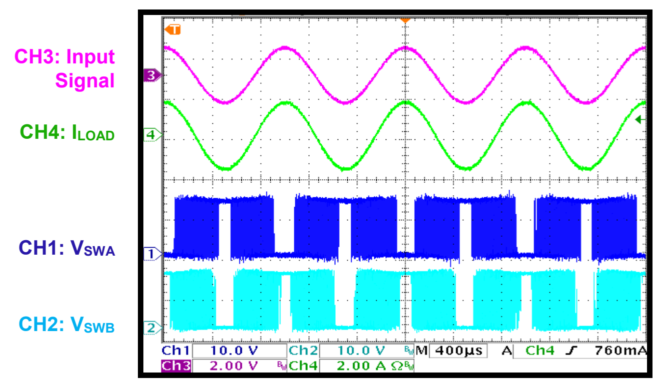
Steady State
Load = 8Ω + 66µH, no input signal



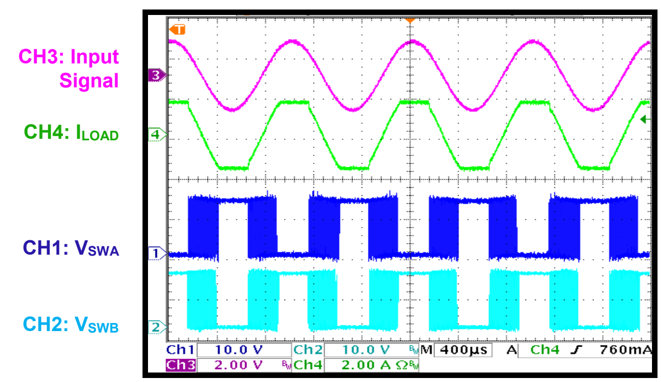
Steady State
Load = 8Ω + 66µH, THD + N = 0.1%,
P_{OUT} = 94.5mW



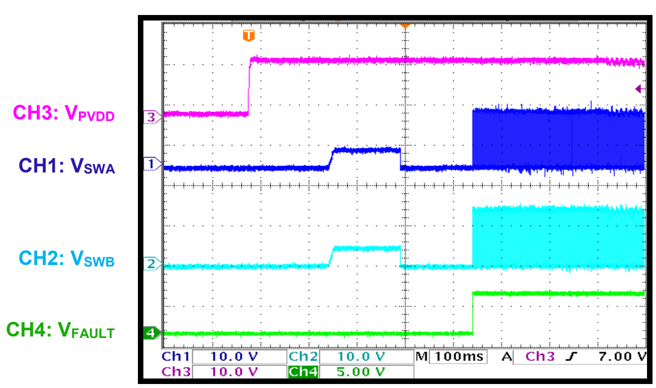
Steady State
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



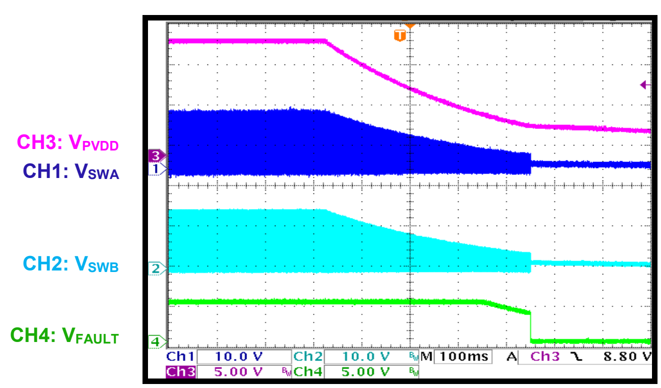
Steady State
Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



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



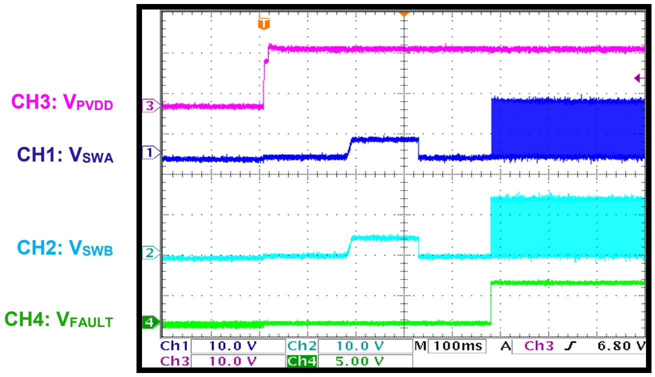
Shutdown through VIN
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



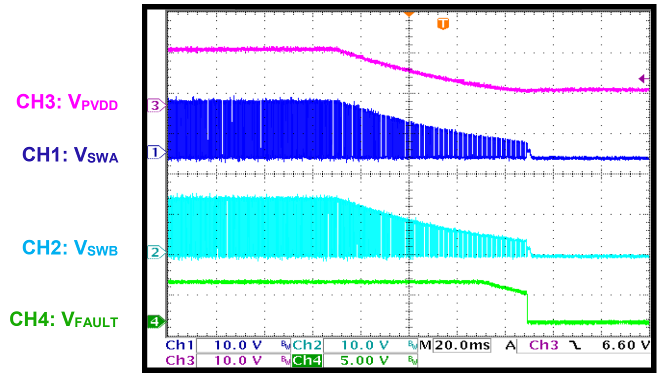
EVB TEST RESULTS *(continued)*

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.

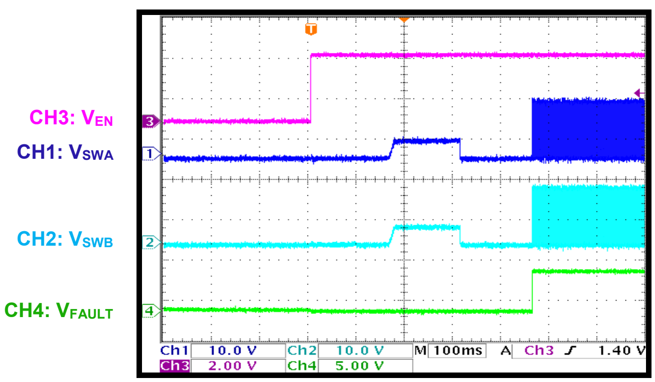
Start-Up through VIN
Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



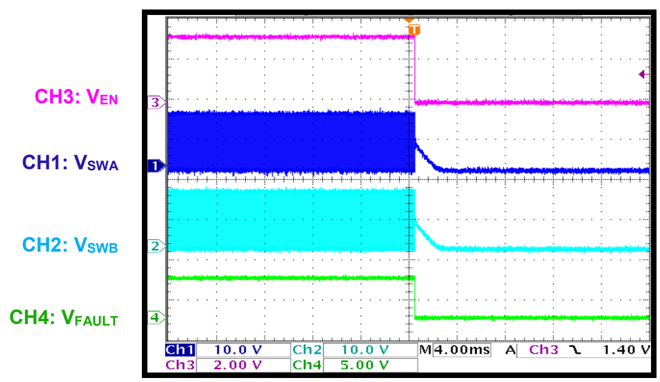
Shutdown through VIN
Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



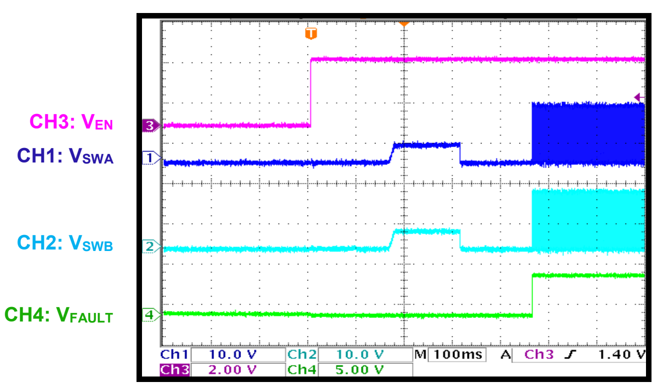
Start-Up through EN
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



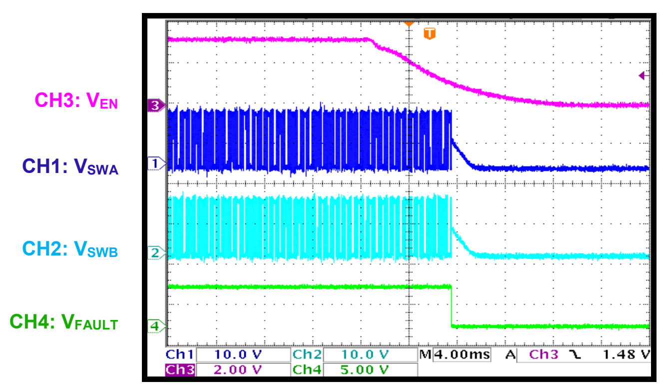
Shutdown through EN
Load = 8Ω + 66µH, THD + N = 1%,
P_{OUT} = 11.3W



Start-Up through EN
Load = 8Ω + 66µH, THD + N THD = 10%,
P_{OUT} = 13.6W



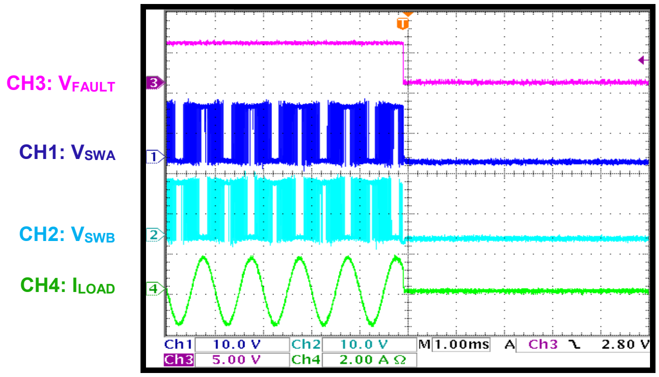
Shutdown through EN
Load = 8Ω + 66µH, THD + N = 10%,
P_{OUT} = 13.6W



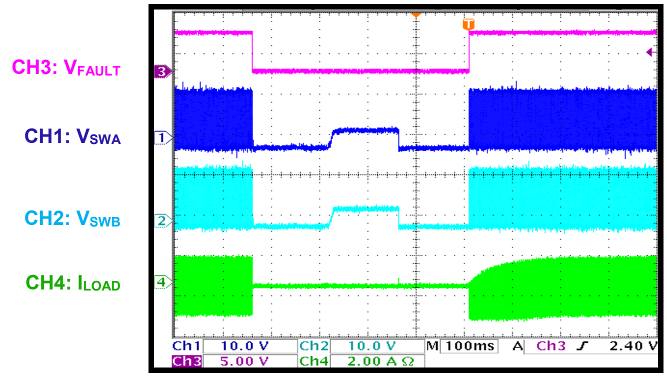
EVB TEST RESULTS *(continued)*

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.

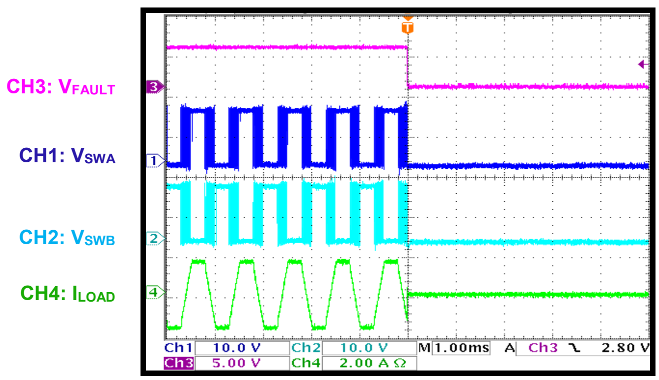
SCP Entry
OUT- short to GND, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



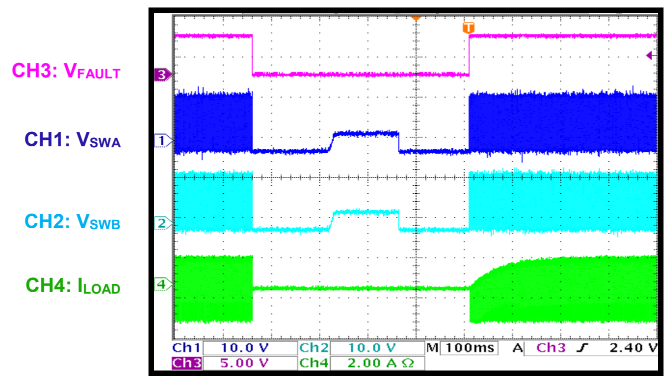
SCP Recovery
OUT- short to GND, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



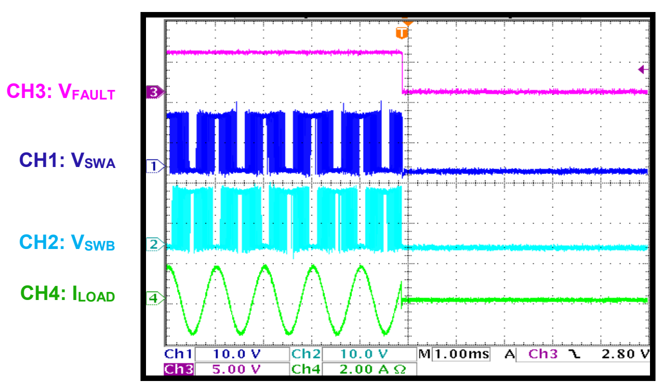
SCP Entry
OUT- short to GND, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



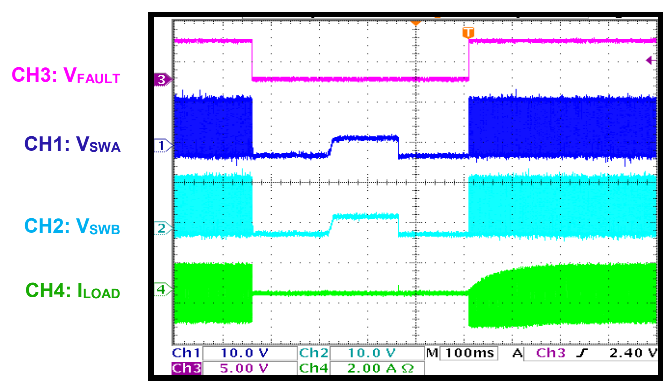
SCP Recovery
OUT- short to GND, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



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

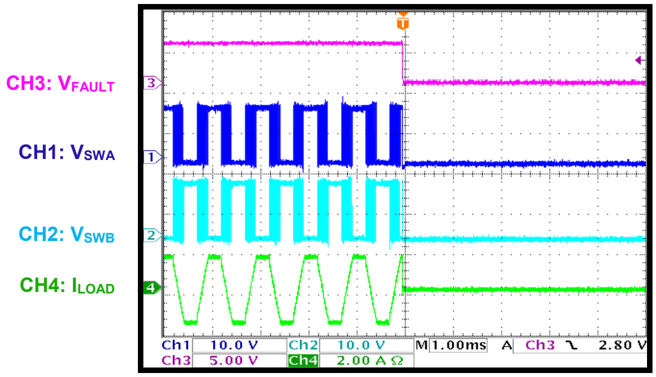


EVB TEST RESULTS *(continued)*

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.

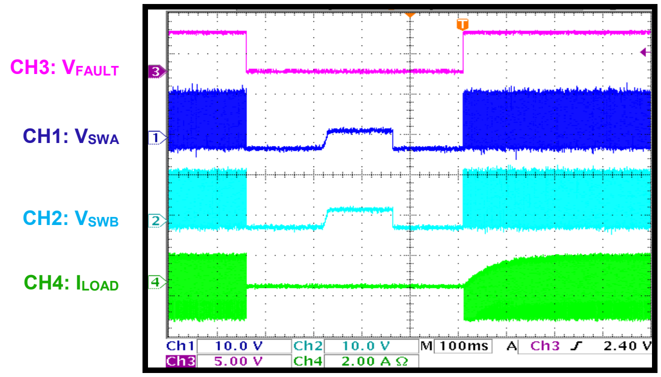
SCP Entry

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



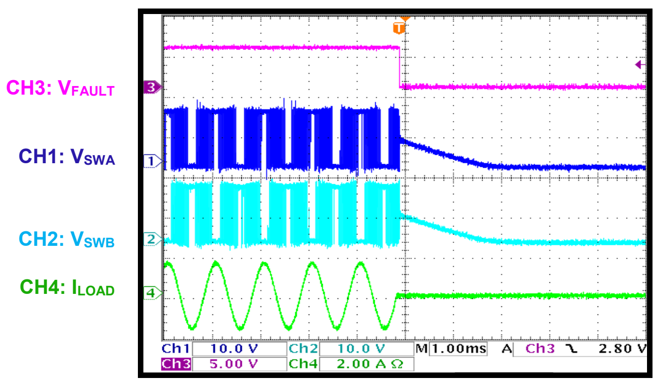
SCP Recovery

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



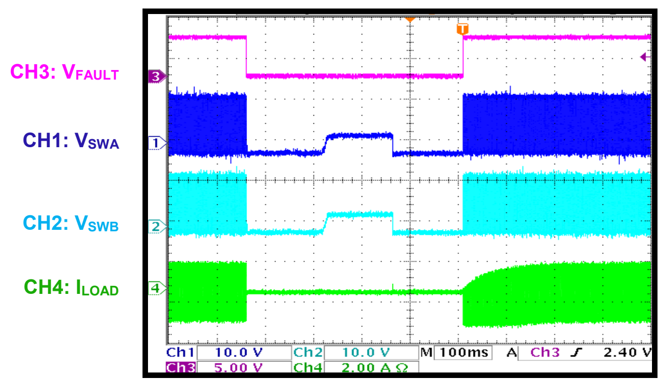
SCP Entry

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



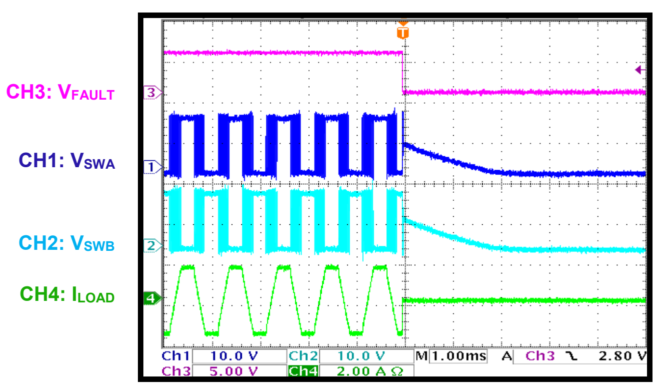
SCP Recovery

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



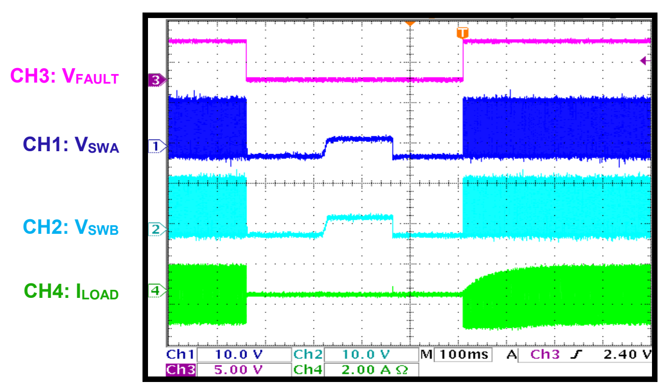
SCP Entry

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



SCP Recovery

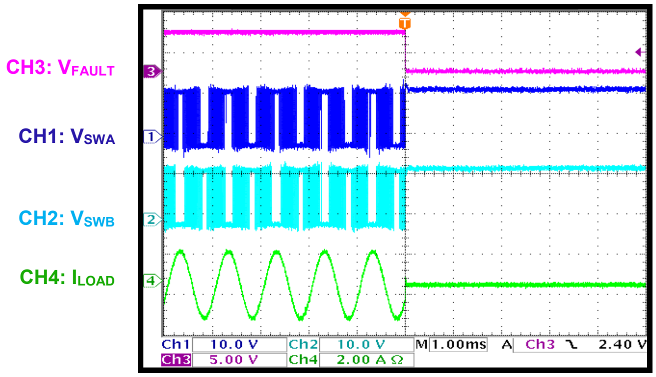
OUT+ short to OUT-, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



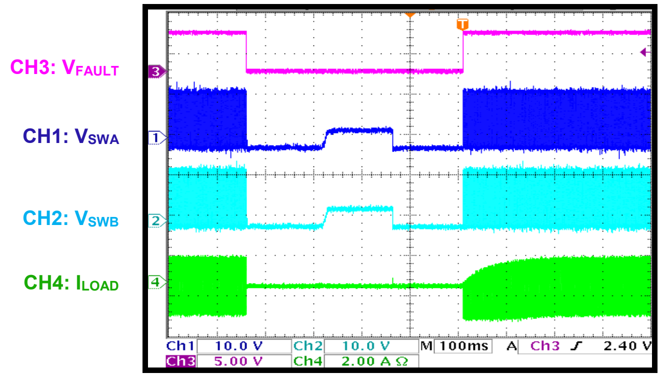
EVB TEST RESULTS *(continued)*

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.

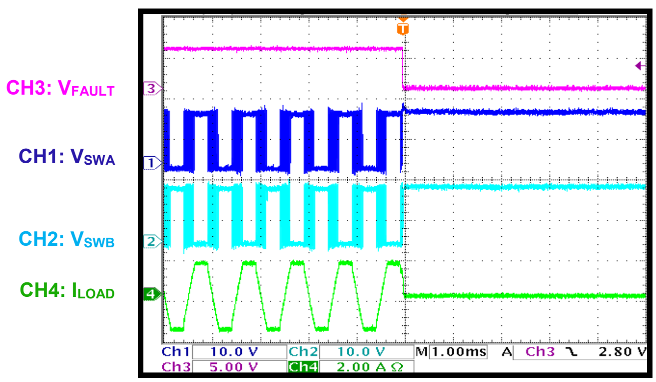
SCP Entry
OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



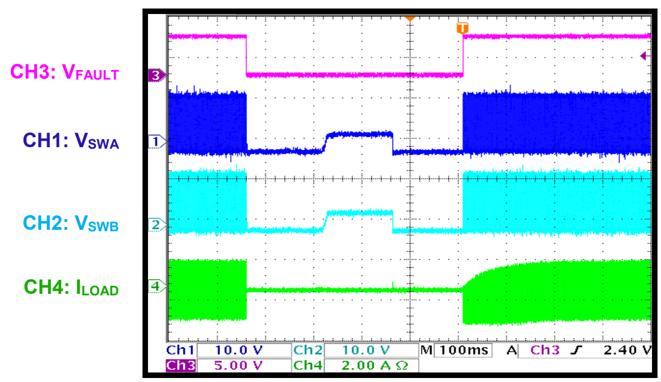
SCP Recovery
OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 1%, P_{OUT} = 11.3W



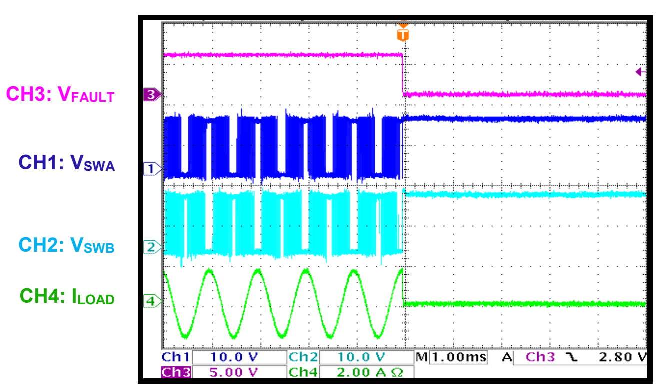
SCP Entry
OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



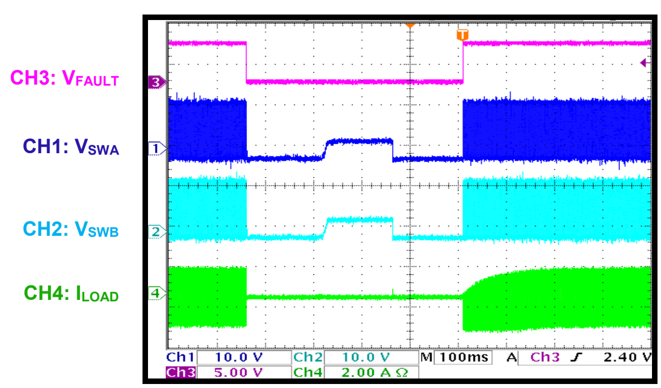
SCP Recovery
OUT+ short to PVDD, load = 8Ω + 66µH,
THD + N = 10%, P_{OUT} = 13.6W



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

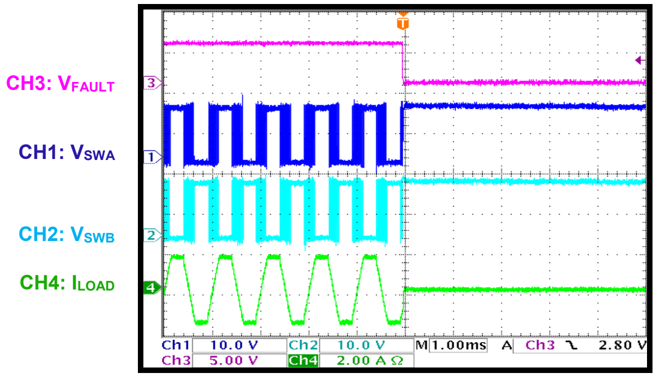


EVB TEST RESULTS *(continued)*

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.

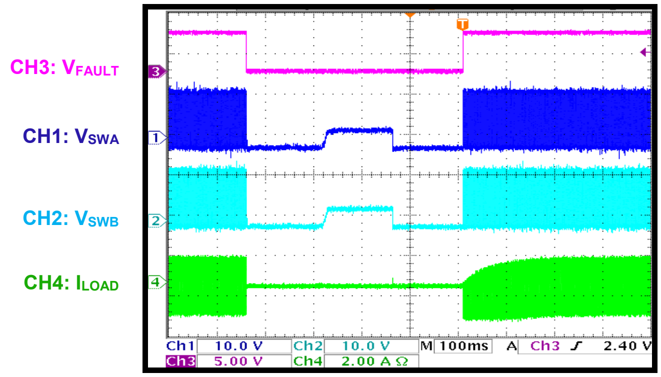
SCP Entry

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



PCB LAYOUT

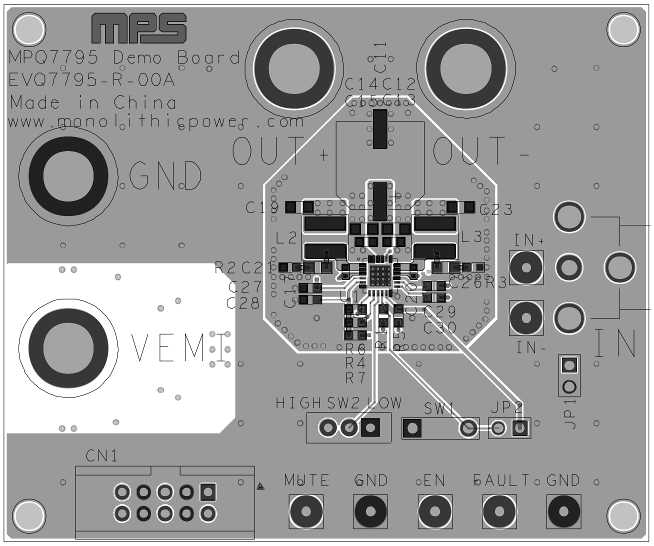


Figure 2: Top Silk and Top Layer

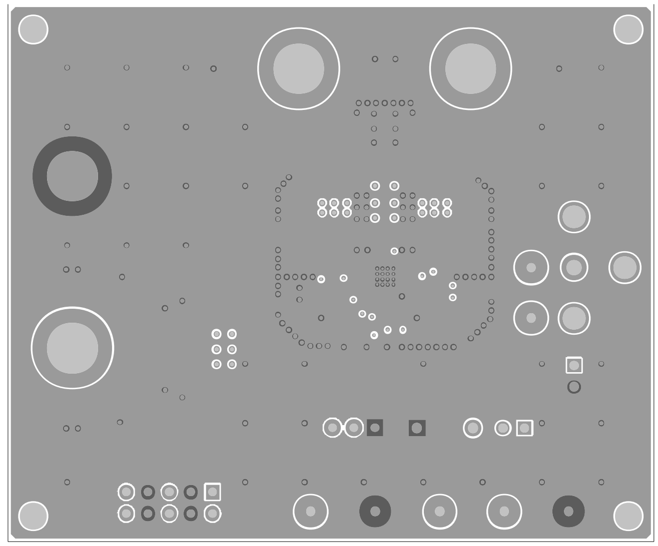


Figure 3: Mid-Layer 1

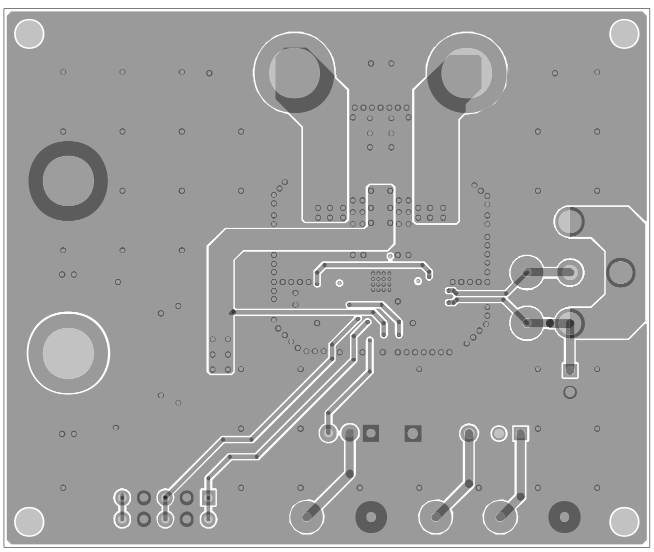


Figure 4: Mid-Layer 2

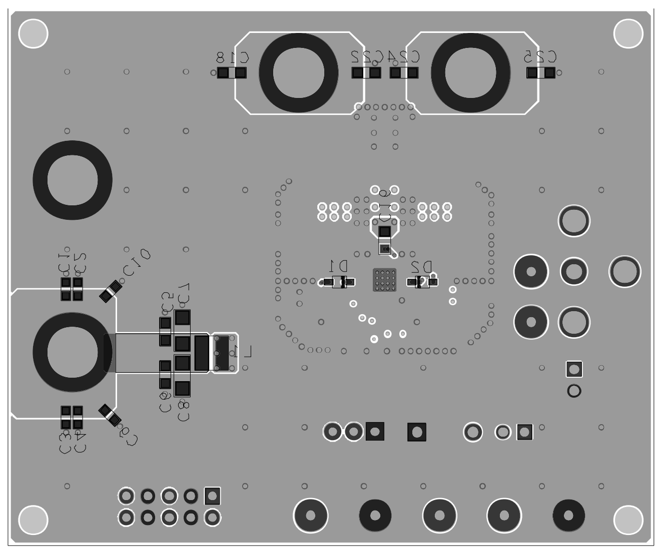


Figure 1: Bottom Layer and Bottom Silk

Revision History

Revision #	Revision Date	Description	Pages Updated
1.0	10/21/2021	Initial Release	-