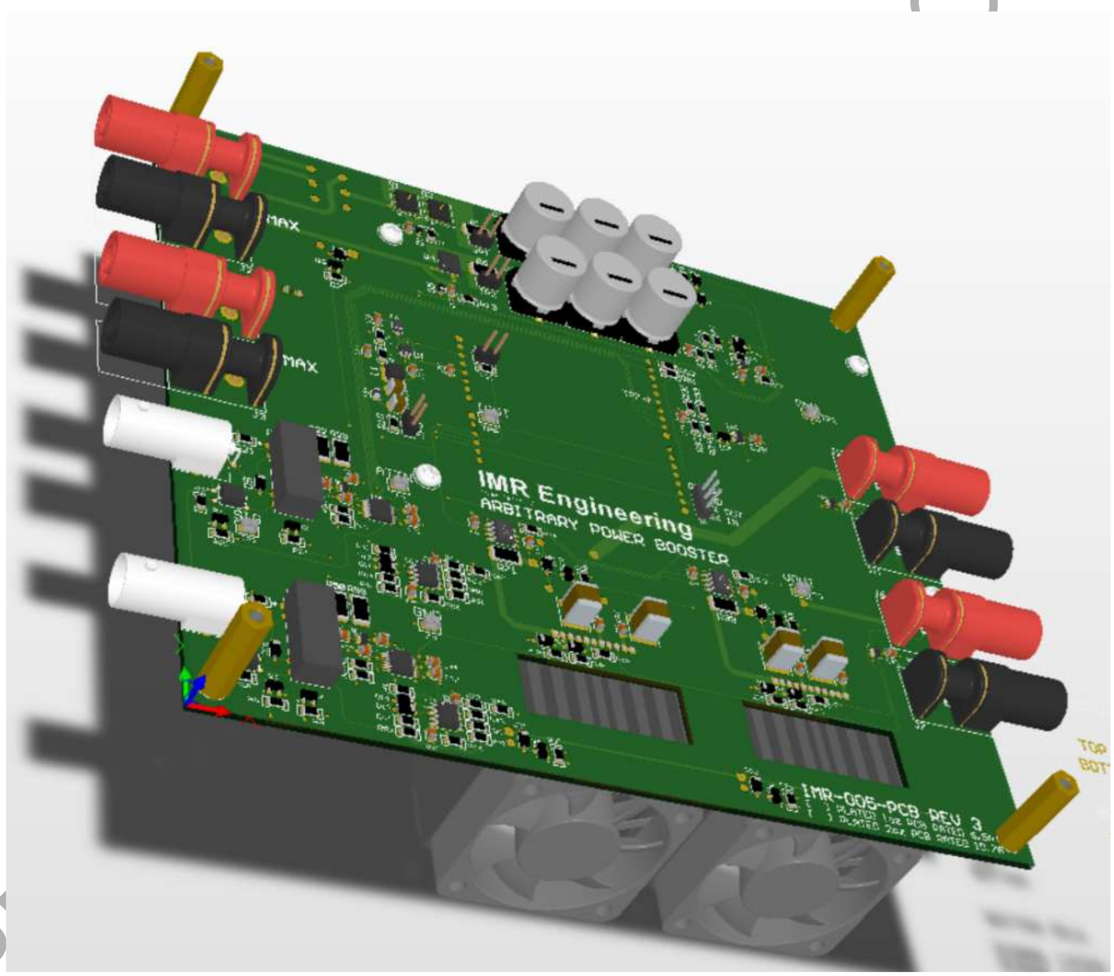
ARBITRARY POWER BOOSTER

IMR Engineering, LLC

Ideas Made Real



USER MANUAL AND TECHNICAL SPECIFICATION

Principal Engineer: Hab Collector
http://imrengineering.com

Table of Contents

DOCUMENT REVISION HISTORY		
DATE	**DESCRIPTION**	**EDIT BY**
2025-05-29	Initial draft - Preliminary	HSC
2025-05-30	Minor formatting. Thermal image clarification. Some additional verbiage for clarity.	HSC

1. INTRODUCTION:

1.1 THE PROBLEM:

Your embedded device is part of a much larger system, a system that does not live in isolation, and neither does its power source. It receives power from a parent platform: a drone, a vehicle, modular device, or trailer. While you may have scoped the rails for ripple and noise, what you are really up against is something much harder to simulate and, in fact, more impactful on your embedded DUT.

The power it receives is corrupted; not by the high-frequency harmonic noise you already know how to filter out, but by a deeper, more erratic class of disturbance: harmonic brownouts, surge events, and at times regenerative effects from inductive kickback or back-fed energy. These conditions aren't artifacts. They are systemic and the *reason* your device does not operate optimally. This supply rail issue manifests itself in multiple ways:

- Unwanted reset conditions
- Incorrect ADC or DAC measurements or conversions
- Destroyed components or components operating outside specification
- Improper charging or failure to charge
- Etc.

Though it works perfectly on the bench, it fails in-system. The truth is, your benchtop power supply, clean uninterrupted power, is anything but real world. It's clean, linear, obedient nature in such use-cases only masks the problem. As an engineer it is always your problem to solve, and so you are left with a simple but painful truth: the only place to test and debug these conditions is in the system, in the field, and in person. It cannot be debugged and tested remotely. Or can it?

1.2 THE WHAT IF:

Imagine sending your device a: sensor node, data collector, motor controller, or custom SoC board to a client site, a co-developer, or even a third-party integrator. Not waiting for them to integrate, test, and describe what happens under load. From your computer. In your lab. You replicate the exact issue the system imposes on the DUT. And what if you could scale that – not just a single supply rail or source signal, but multiple, and multiple DUT.

Imagine every prototype being powered by a small, intelligent, software-controlled power source that mimics system source issues exactly as they are, on your bench, in your lab, in real time, with real debug and test. Imagine a company standard for supply rail disturbances every embedded device must pass.

Not a luxury - a competitive edge.

1.3 THE SOLUTION:

The *Arbitrary Power Booster (APB) from IMR Engineering* is a precision, high-current, microcontroller-controlled voltage source designed to solve exactly this problem. It acts as a downstream power amplifier, taking in a programmable waveform from an Arbitrary Waveform Generator (AWG) and amplifying that signal into a high-current output — all while regulating the voltage and enforcing programmable current limits in real-time. Why an AWG? Because we are not trying to reinvent the wheel, but solve a real problem in a real way. The AWG is already on your desk. AWGs have the ability to accept and output raw data oscilloscope captures, complex math functions, or scripted sequences. The *Arbitrary Power Booster does the rest.*

At its core, the Arb Power Booster enables remote, scriptable, and repeatable testing with real load conditions. Its firmware integrates a closed-loop feedback system that monitors output current and enforces soft limits via a firmware-defined PID response. From an engineering perspective, it is a drop-in test solution for hardware developers. From a business perspective, it is a scalable tool for remote debugging, client demos, and iterative remote design. Work done anywhere from everywhere - in this digital age. That is not our future, that is today. That is how we work. The *Arb Power Booster* adds to that world. I trust you will find it a helpful tool. Ideas Made Real.

2. AT A GLANCE:

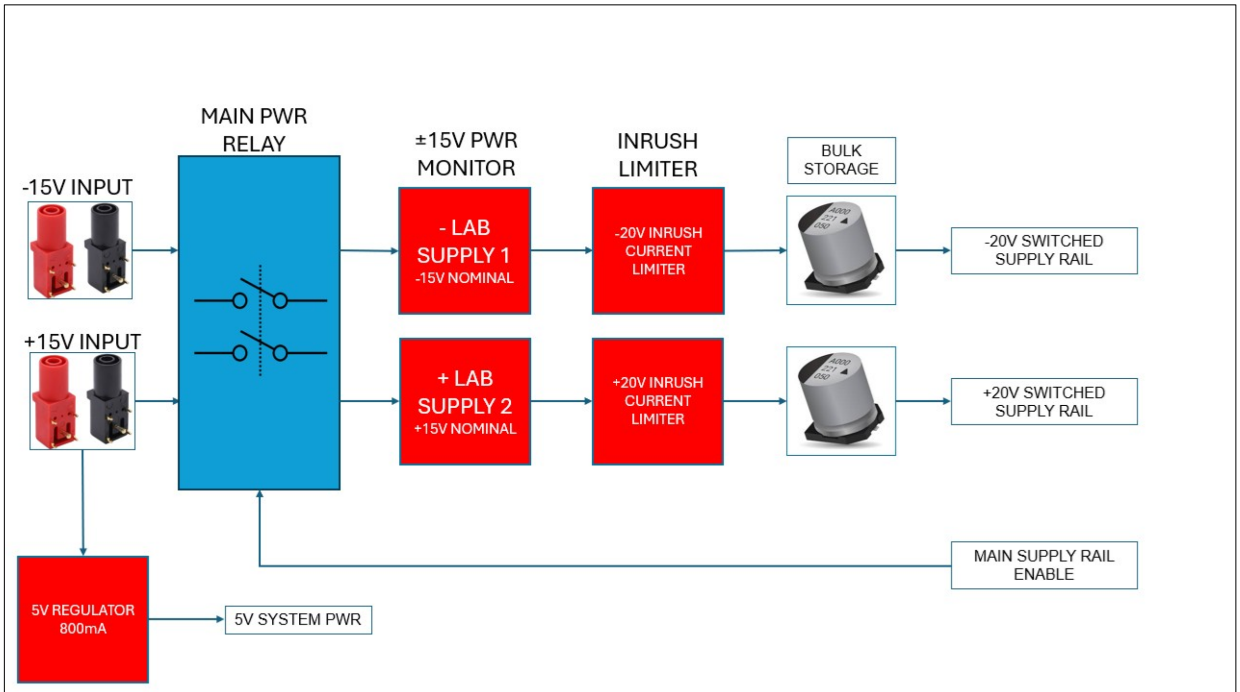
2.1 FEATURES:

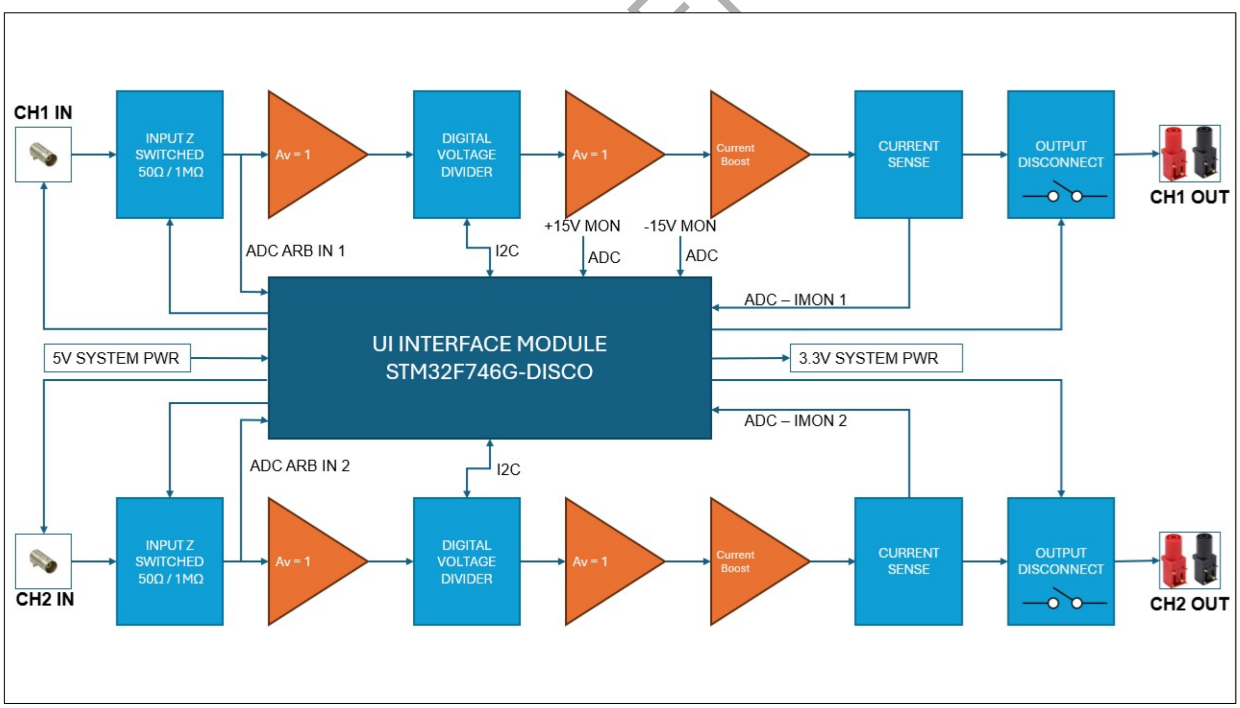
- Real Time True RMS measure on current and voltage
- PID constant current limit
- Selectable 1MΩ or 50Ω input impedance
- 109.2mm Color LCD Display with 16b color depth
- 480x242 Pixel with Touch LCD HMI
- SSR Fault tolerant Input isolation and protection
- Fault supply rail disconnect
- Device Inrush current limiter
- Over temperature shutdown indicators
- Smart Fan cooling
- uSD user parameter storage
- ARM Cortex M7 200MHz
- Dual independent channel control
- Over Temperature shutdown
- Over Temperature LED indication

2.2 APPLICATIONS:

- Augmented Test Equipment
- Remote source simulation
- Supply rail hardening
- Debug Test Develop and Deploy from anywhere

2.3 SIMPLIFIED BLOCK DIAGRAM





3. MODES OF OPERATION:

The Arb Power Booster has a simple, and intuitive 4 screen interface.

- Splash Screen

- Main Screen
- Configuration Screen
- Set Limits Screen

3.1 SPLASH SCREEN:

Prompted by POR (Power On Reset) the device is operational with the display of the introduction / splash screen. Following the introduction screen a test of the system parameters to include:

- System ±Supply Rails
- System 3.3V tolerance
- Junction Temperature

is conducted and the Main Screen is launched.

3.2 MAIN SCREEN:

READINGS:

The main screen shows measurement and control for both channels. Output current in RMS, min, and max instantaneous current. If enabled, The set current limit (Iset) and if active, Constant Current (CC) indicator (next to the set current limit). Lastly, the supplied signal in volts RMS. NOTE if the current limit is enabled and the device is in Constant Current mode both the CC indicator and the RMS voltage will flash. The RMS voltage when in CC mode will reflect the actual output value feed to the load and not the input.

CONTROL:

Input Impedance:

The far-left button controls the input impedance. It will read either 1MΩ or 50Ω depending on what it is currently set to. It is a toggle action. This load is the input impedance to the AWG output.

Set:

The middle control. This selection will launch the set limits screen

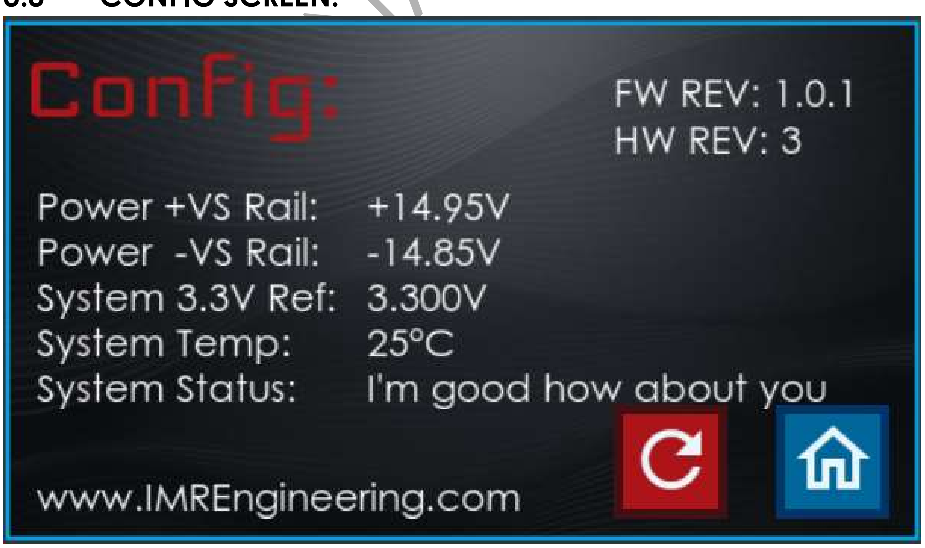
On:

This is the output on / off control. Note the button only reads "ON". The background color gives context. When the output is disabled (switched off) it will appear as the channel 1 indicator pictured above. When the output is enabled (switched on) it will appear as the channel 2 indicator. Fan on / off control is firmware driven – on when power dissipated by the output amplifier is greater than 3.5W and truns off 30s following the reduction of this value.

Gear:

The gear is the system status indicator. If green (as shown) it indicates all system parameters are within the specified tolerances. If highlighted by a red box then one or more system parameters are outside the specified tolerances and a system status correction is given. Selecting this control will launch the configuration screen.

3.3 CONFIG SCREEN:



Reset:

This is the red “re-do” button. Selection will cause a device reset – it is disabled in the present revision of firmware – future use TBD.

Home:

Return to the Main Screen

3.4 SET LIMITS SCREEN:

Current Limit:

The current limit is set by selecting the desired Amps, tenths of amps, hundredths of amps, or thousands of amps control. On selection each measure can be incremented up or down via the up / down controls. Note the current limit can not be changed unless Enable Limit is selected.

Enable Limit

Check box, when checked CC mode is enabled via PID control to the current limit

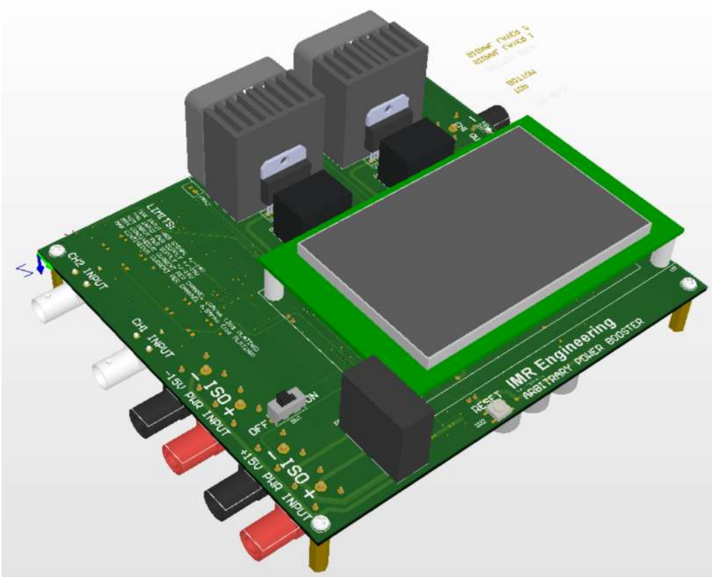
Reset Min Max

Reset the present min and max and return to the Main Screen

Home

Return to Main Screen

3.5 PHYSICAL CONTROLS:



- ON / OFF slide control
- RESET (POR) momentary push tactile

4. TECHNICAL SPECIFICATIONS:

4.1 MEASURES

ABSOLUTE MAX RATINGS					
PARAMETER	CONDITION	Min	Typ	Max	UNIT
ENVIRONMENTAL					
Operating Temperature		-20		30	°C
Storage Temperature		-40		85	°C
Relative Humidity	Non-condensing			97	%
SUPPLY RAIL INPUTS					
+VS Supply rail	As measured at the APB	14.5	15.0	15.5	V
-VS Supply rail		-15.5	-15.0	-14.5	V
INPUT					
Input		0		14.3	V

OPERATIONAL SPECIFICATIONS					
PARAMETER	CONDITION	Min	Typ	Max	UNIT
ENVIRONMENTAL					
Temperature		-20		30	°C
Relative Humidity	Non-condensing	0		95	%
PHYSICAL DIMENSIONS					
Length			160.0		mm
Width	Does not include connectors		180.0		mm
Height	Lowest to highest measure		62.0		mm
INPUT					
Impedance	1% of 1MΩ or 50Ω				Ω
Voltage Range		-14		14	V
Voltage Measure	Measured as % Vrms	-1.0		+1.0	%
OUTPUT					
Gain	[1]Non unity gain during CC mode		1	1	V/V
Peak Current	[2]Not max power			10	A
Continuous Current	[2]Not max power			8	A
Peak Power	Max peak time 5s at Ambient 25°C			60	W
Continuous	Ambient 25°C			25	W
Current Measure	Measured as % Vrms	-1.0		+1.0	%
POWER CONSUMPTION					
Load on -VS supply rail	[3]No output loading			-10	mA
Load on +VS supply rail	[3]No output loading			330	mA
Switch in OFF position				45	μA
FREQUENCY AND SAMPLE RATE					
Input frequency range		0		7.812	KHz
Sample Rate ±VS, Vin, Output Amps			64.00		μs
Sample Rate 3.3V & Temperature			71.11		μs
CONSTANT CURRENT MODE					
Time to 95% convergence CC				310	ms
Time to CC mode deactivated	Removal of fault load			200	ms

NOTES:

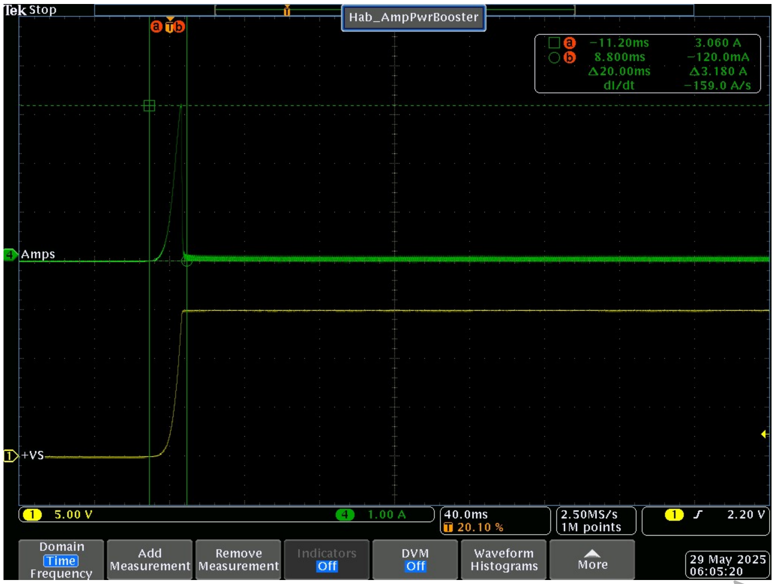
[1]In constant current mode the gain is adjusted in steps via 256 steps from unity to with the first non unity gain decreasing occurring at 0.9961V/V and the last at incremental step at 0.0039V/V

[2]Output power is limited by the ability to dissipate heat to keep the output amplifiers junction temperature below 160°C. The amplifier's dissipated power can be approximated by the equation: (Vs nominal – Output Voltage) x Output Current

[3]±VS nominal supply. Output to both channels switched on. Both fans are on. Input impedance both channels set to 50Ω. There is no output load.

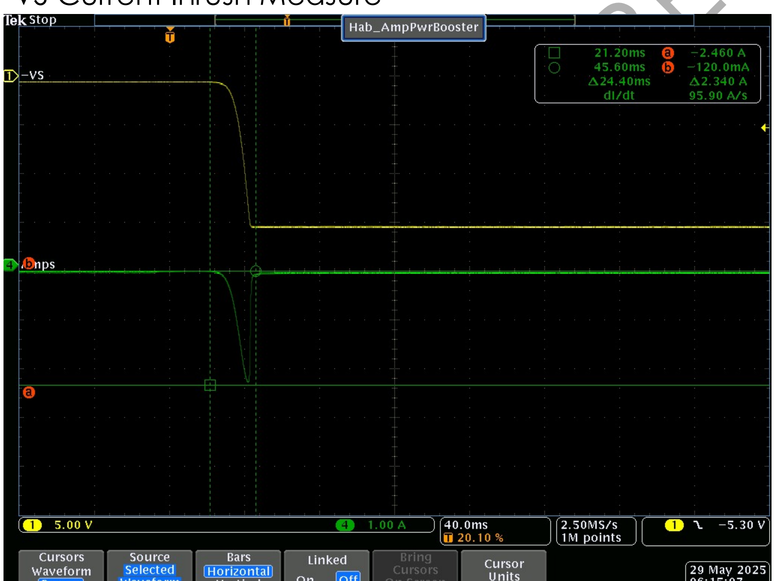
4.2 ±VS CURRENT INRUSH MEASURE

+VS Current Inrush Measure



- As measured at POR (Power On Reset)
- NO OUTPUT LOAD

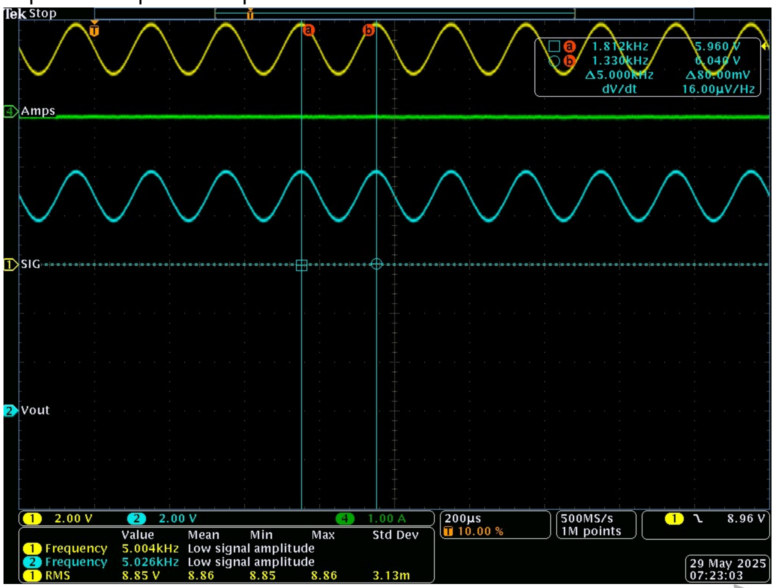
-VS Current Inrush Measure



- As measured at POR (Power On Reset)
- NO OUTPUT LOAD

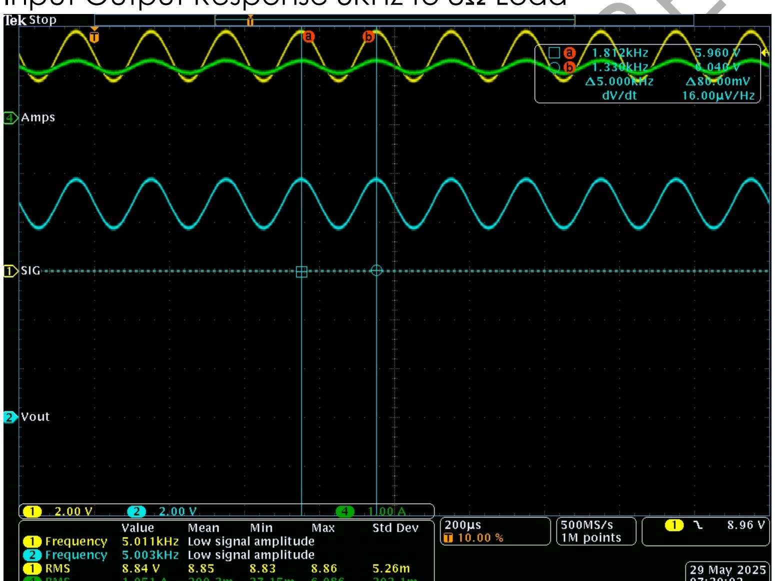
4.3 INPUT TO OUTPUT 5KHz LOADED AND UNLOADED

Input Output Response 5KHz No Load



- No measurable change in phase or frequency input to output
- Vin as measured by ARB = 8.93 (0.90% accuracy)

Input Output Response 5KHz to 8Ω Load



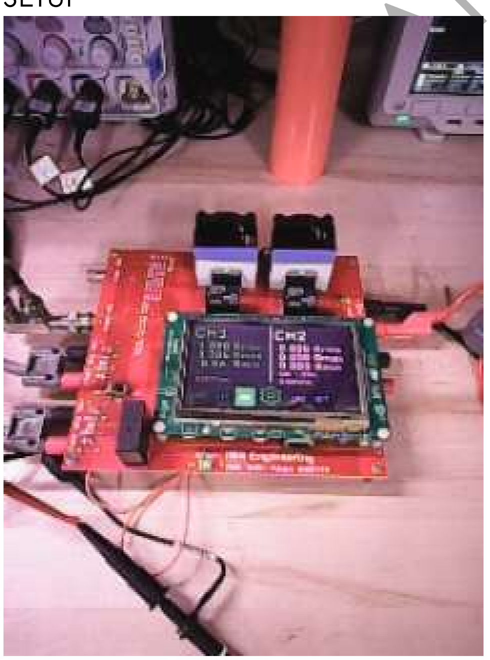
- No measurable change in phase or frequency input to output
- Vin as measured by ARB = 8.92Vrms (0.90% accuracy)
- Iout as measured by ARB = 1.061Irms (0.95% accuracy)
- Power To Load = 9.29W

4.4 Constant Current Mode Enable and Disable

- CC Mode Limit set to 500mA
- Vin 8V
- Vout adjusted based on CC PID to match limit set point of 500mA
- Enable:
  - From a running load of 250mA a fault load of 1A is applied
  - CC mode activates in 236ms (to 95%)
- Disable:
  - From 500mA CC the fault load is reduced to 250mA
  - CC mode disable (150ms)

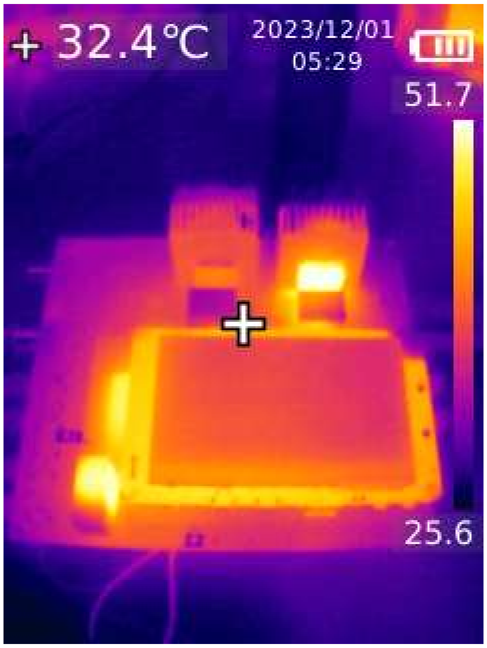
4.5 THERMAL PERFORMANCE

SETUP



- Connected to 8Ω 100W resistor load not shown

THERMAL IMAGE CHANNEL 1



- On Time = 20min
- Output Current = 1.061Arms
- Output Voltage = 8.92Vrms
- PCB PLATED TO 1Oz
- Thermal camera not calibrated, temperature information is incorrect (not nearly that hot), but the image is useful in that you can see heat not being transferred to the heat sink – nothing here was hot to touch.

5. ACKNOWLEDGEMENT

To the keeper of me, my beloved wife, I share everything with you. You are my strength in weakness, clarity in uncertainty and applause in victory. I accomplish nothing without your support, nor is anything of worth unless I can share it with you. I love you.

To my daughter Christina, we have had our challenges. In part, and in this, I hope one day in you the understanding of what I have been trying to say. Love is what you do. You are exceptional in so many ways; add to your gifts hard work and the world is yours.

To my daughter Faith, the Humanitarian, it is clear that you belong to the goodness of this world. You must remember that true greatness is only realized through service and that there are many ways to serve. Therein will be your pursuit – run to catch it. I hope I have shown you how to run.

To my daughter Trinity, the scientist, there is a clarity in the way you speak and think, in your questions and answers. You are to add to the scientific collective. Of the three, you are most like me. Don't be afraid, nor ashamed of whom you are; accept it, and work hard to be.

To God Almighty, it is you that have made me, and not me myself – thank you for the many blessings, may I be a better servant and steward.