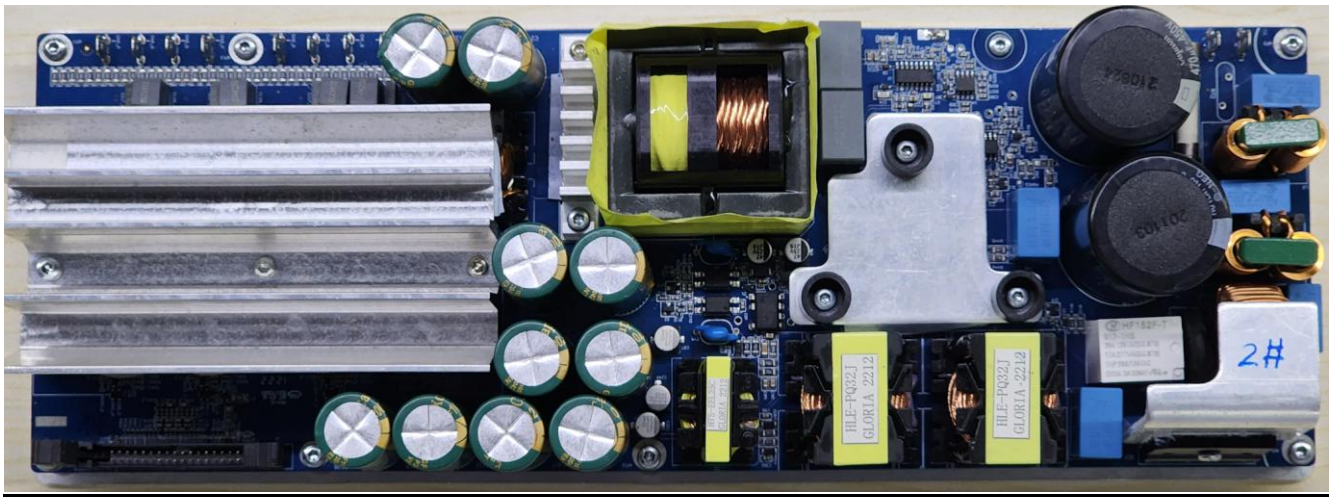
Peerless

LCPF2000
Datasheet



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0.1	2024.1.31	First release based on EVT samples	Engineering
0.2	2025.1.31	PV samples	Engineering

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1.Overview

1.1 Purpose

This document provides the technical specifications and description of use of the LCPF2000 power supply and audio amplifier module.

1.2 Features and Description

1.2.1 Description

The LCPF2000 module is a discrete class D amplifier with an integrated universal mains power supply with PFC pre-regulator and LLC main supply.

The amplifier is designed to be integrated onto a plate type amplifier module, as typically used in loudspeaker or subwoofer systems, or into rack mounted amplifiers.

The LCPF2000 module has a ribbon cable header for the DSP/MCU interface and is designed with DSP integration in mind, for example some thermal protection is expected to be done in the DSP using limiters. Additionally, voltage and current monitoring is provided for load characterization and advanced DSP control over the acoustic system.

The built-in auxiliary power supply provides up to 25 W of power to supply a typical professional DSP front end.

1.2.2 Features

- 2000 W total rated audio output power with +/- 80 V (160 V) rail
- Universal Mains Regulated Power Supply with Interleaved 2-Phase PFC
- Four independent discrete class D amplifier channels with flexible channel configuration (Shall be DSP Controlled to < 2000W total)
  - 1400 W BTL + 1400 W into 8 Ω
  - 1500+ W BTL + 1500+ W into 6 Ω
  - 1500+ W BTL into 6 Ω + 2x 700 W SE into 4 Ω
  - 4 x 700 W SE channels into 4 Ω
- Auxiliary power supply to power-up external Input / Controller DSP FE "Front End"
- Controller provides up to 25 W total on +/-15 V (main) and a +3.3 V (standby) power outputs, and additional 15V always on output, is not switched in standby mode.
- ErP and Energy Star compliant standby consumption of <0.3 W (where 3.3 V is an always on output and +/-15 V are power switched outputs) simplifies DSP front-end low power standby circuit design
- >80% total system efficiency at 50% output power
- Multiple readouts (current, voltage, temperatures, fault)
- I2C Interface for advanced monitoring.
- Verified for Safety and EMC compliance

1.3 Applications

Medium and larger sized touring loudspeakers, medium and larger PA loudspeakers, larger fixed installation loudspeakers (conference facilities, bars, etc.), larger studio monitors and home subwoofers, other self-powered loudspeakers. Bass, guitar and keyboard amplifiers and mid-power rack amplifiers.

1.4 Module Size and Mounting

Size (LWH, metric): 346 x 136 x 64 mm
Size (LWH, approximate imperial to the nearest ⅛"): 13 5/8" x 5 23/64" x 2 33/64"

Subject to system verification, additional space around the amplifier module should be left for cooling (100 mm) and safety clearance (10 mm).

There are six mounting holes (see Figure 1: LCPF2000 Mechanical Drawing) and they should all be used when mounting the amplifier module. They have an M3 thread and the screw can protrude 6 mm into the metal plate. The torque setting should be 0.58 ±0.05Nm.

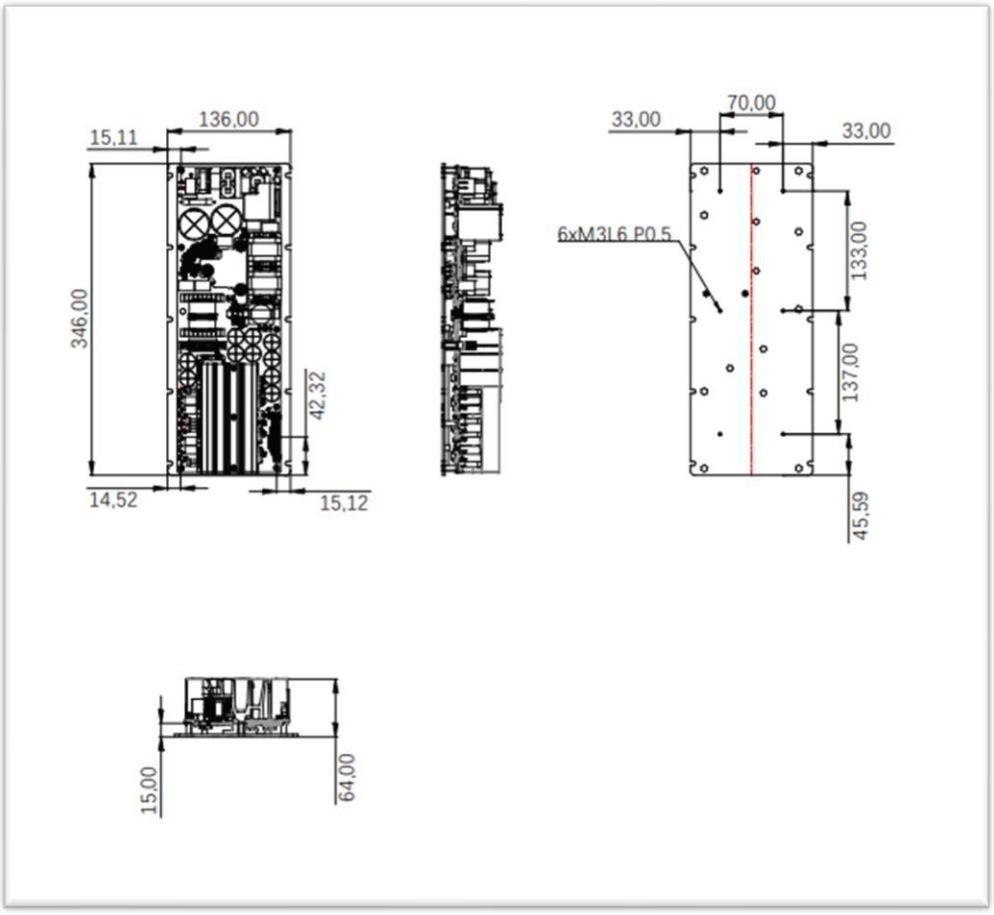


Figure 1: LCPF2000 Mechanical Drawing

• 1.5 Block Diagram

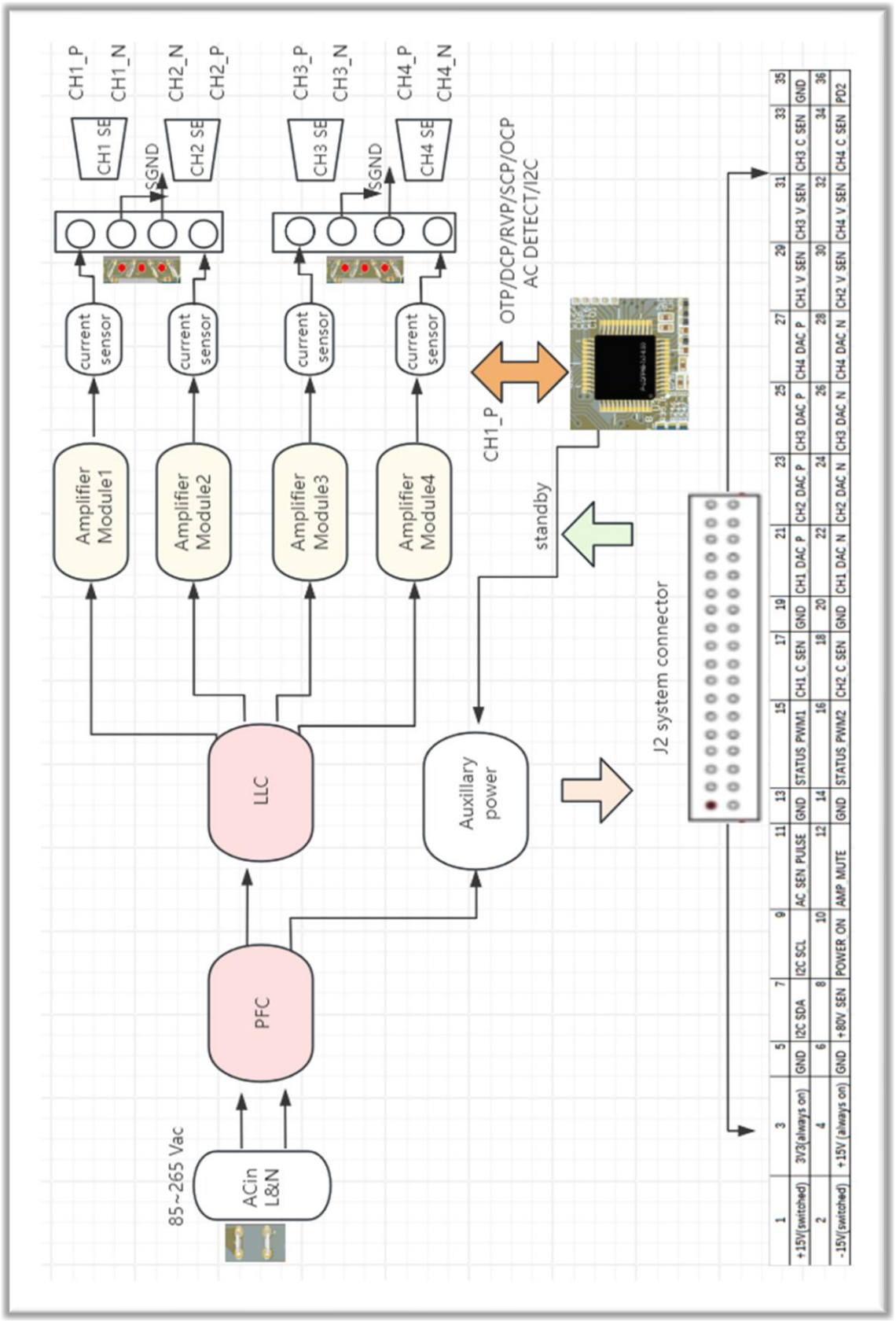


Figure 2: LCPF2000 Block Diagram Connectivity

2. Connectivity

2.1 Connector Locations

the connector is shown on the picture below and is also clearly marked on the PCB.

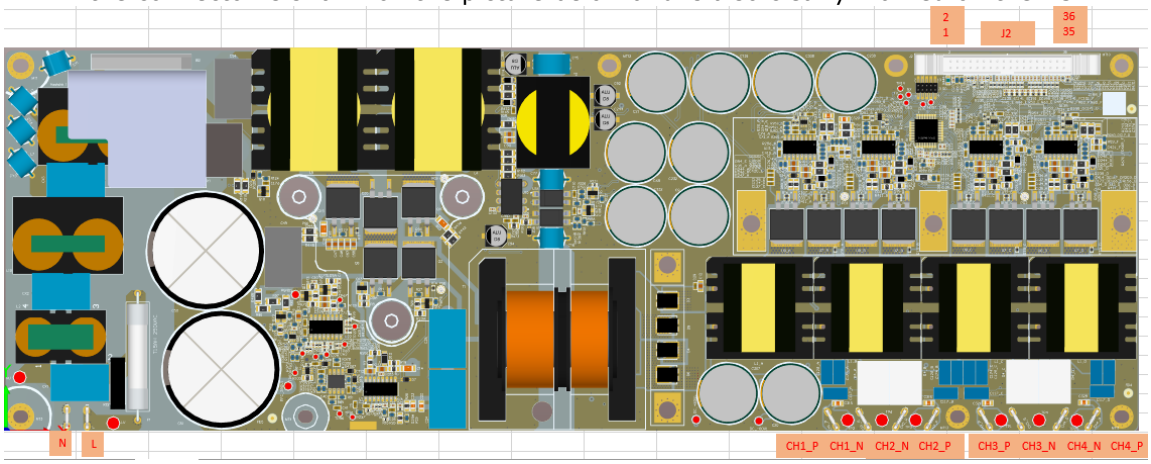
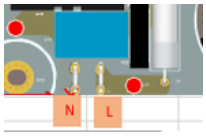


Figure 3: LCPF2000 Connector Overview

2.2 AC Mains Connector:



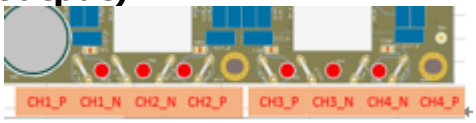
Connector Type: CHAPIAN 2P P-187-C JINJIA K*1, CHAPIAN 2P P-205-C JINJIA K*1

Mating connector: connector 187 lock thickness 0.8, connector 205 lock thickness 0.8

Pin	Function	Description	Type
L	Line	AC Line	AC mains input
N	Neutral	AC Neutral	AC mains input

Table 1: AC Mains Connector

2.3 Speaker Connector (CH1 output, CH2 output ,CH3 output, CH4 output)



Connector Type: CHAPIAN 2P P-187-C JINJIA K*2, CHAPIAN 2P P-205-C JINJIA K*2

Mating connector: connector 187 lock thickness 0.8, connector 205 lock thickness 0.8

Pin	Function	Description	Type
CH1_P	Ch1+	CH1_P	Speaker output
CH1_N	Ch1-	CH1_N	Ground
CH2_N	Ch2-	CH2_N	Ground
CH2_P	Ch2+	CH2_P	Speaker output
CH3_P	Ch3+	CH3_P	Speaker output
CH3_N	Ch3-	CH3_N	Ground
CH4_N	Ch4-	CH4_N	Ground
CH4_P	Ch4+	CH4_P	Speaker output

Table 2: Speaker Connector

In BTL mode, use pins CH1_P and CH2_P. CH3_P and CH4_P.

2.4 J2: System Connector

Connector Type: IDC connector, 36-Pin, pitch = 2.0 mm
Mating connector: IDC cable, 36-Pin, pitch = 2.0 mm

Pin	Function	Description	Type
1	+15V(switched)	Power supply +15 V, 750 mA max	Power
2	-15V(switched)	Power supply -15 V, 500 mA max	Power
3	3V3(always on)	Power supply +3.3 V, 500 mA max	Power
4	+15V (always on)	Power supply +15V , 1000 mA max	Power
5	GND	Power Ground (same as signal ground)	Ground
6	GND	Power Ground (same as signal ground)	Ground
7	I2C SDA	I2C series date	-
8	+80V_SEN	Power rail real detect on +80v output	Analog output
9	I2C SCL	I2C series clock	
10	POWER_ON	High (3.3 to 5 V) enables the SMPS. Low (0 to 0.7 V) disables the SMPS.	Logic input
11	AC_SEN_PULSE	Pulse train (0 and +3.3 V) correlated to 2x AC mains frequency; missing pulse detects loss of AC mains for system safe shutdown.	Logic output
12	AMP_MUTE	High (3.3 to 5 V) is unmuted. Low (0 to 0.7 V) is muted.	Logic input
13	GND	Signal Ground (same as power ground)	Ground
14	GND	Signal Ground (same as power ground)	Ground
15	STATUS_PWM1	DC level that indicates the amplifier status 0V Normal Operation 0.5V OTP – AMP FET 1V OTP – LLC Transformer 1.5V OTP – Output Filter 2V DCP 2.5V RVP 3V AMP Fault – Short or HW Failure	Analog output
16	STATUS_PWM2	DC level that indicates the Temperature Status 0V Highest temp measured is <=20degC 1V Max reading is 33% of limit value 2V Max reading is 66% of limit value 3V Max reading is 100% of limit value	Analog output
17	CH1_C_SEN	CH2 current monitoring output, 0-3 V	Analog output
18	CH2_C_SEN	CH1 current monitoring output, 0-3 V	Analog output
19	GND	Signal Ground (same as power ground)	Ground
20	GND	Signal Ground (same as power ground)	Ground
21	CH1_DAC_P	CH1 Analog non-inverting input	Audio input
22	CH1_DAC_N	CH1 Analog inverting input	Audio input
23	CH2_DAC_P	CH2 Analog non-inverting input	Audio input
24	CH2_DAC_N	CH2 Analog inverting input	Audio input
25	CH3_DAC_P	CH3 Analog non-inverting input	Audio input
26	CH3_DAC_N	CH3 Analog inverting input	Audio input
27	CH4_DAC_P	CH4 Analog non-inverting input	Audio input
28	CH4_DAC_N	CH4 Analog inverting input	Audio input
29	CH1 V SENSE	CH1 amplifier output voltage sense, 2.2 V p-p	Analog output
30	CH2 V SENSE	CH2 amplifier output voltage sense, 2.2 V p-p	Analog output
31	CH3 V SENSE	CH3 amplifier output voltage sense, 2.2 V p-p	Analog output
32	CH4 V SENSE	CH4 amplifier output voltage sense, 2.2 V p-p	Analog output
33	CH3 C SENSE	CH3 current sensing output, 0-3V	Analog output
34	CH4 C SENSE	CH4 current sensing output, 0-3V	Analog output
35	GND	GND	Ground
36	Mode	I2C Mode	Logic Input

Table 3: System Connector

3.Protection Features

3.1 Under-voltage protection (UVP)

The amplifier module has a built-in under-voltage protection. It monitors whether the line voltage drops below the specified low operational AC voltage range, typically the main supply will shut down below 85 Vac, however the standby SMPS may continue to operate with a line voltage as low as 60 Vac. In this intermediate case the system may see an amplifier fault condition.

3.2 Amplifier DC Protection (DCP)

The amplifier module has a built-in dc detection circuit. If a dc-voltage is detected at the one of the amplifier outputs, the MCU will power off the main power. The threshold is set to trigger with a 10Hz full scale output square wave.

3.3 Over-current Protection (OCP)

The amplifier module features over-current protection to protect the power MOSFETs during abnormal load conditions. The controller detects an over-current condition during either the high-side or low-side turn-on of the class D MOSFET. As soon as either the high-side or low-side current sensing block detects an overcurrent, then the amplifier is shut down for 100-500ms and restarted. The response time is ~10uS and the threshold is 35-45A.

3.3 Over-current Regulation (OCR)

The amplifier module features over-current regulation with a I2C configurable threshold up to 28A, response time is <1ms, the output voltage will be reduced to control the peak current below the set value. Note that this "current clipping" is not a limiter and will result in distortion or clipping of the output signal to the set current level.

3.4 Thermal Protection (OTP)

The amplifier module has a built-in thermal protection to prevent the module from suffering thermal runaway. If the primary transformer is >100 ºC and the primary MOSFET >120 ºC, the built- in thermal protection circuit switches off the power supply rails, after some cooling the unit can restart. The cool down time depends on the ambient temperature and attached heatsinking. The thresholds and detailed sensor readings are configurable over I2C, with the reset values as the recommended setpoints for most installations.

3.5 Electrostatic discharge (ESD)

Whilst the amplifier module is well protected against ESD, appropriate ESD handling precautions should still be taken. The warranty does not cover ESD damaged to products due to improper handling.

4. Specifications

4.1 Environmental Conditions

Parameter	Test Conditions	Min	Typical	Max	Unit
Weight			2268		g
Storage temperature		-20		+60	ºC
Storage humidity	(40 ºC, non-condensing)			90	% RH
Operating temperature				+45	ºC
Operating humidity	(non-condensing)			90	% RH
Operating altitude				2000	m

Table 5: Environmental Conditions

4.2 Mechanical Stress Testing

Parameter	Test Conditions	Quantity
Shake test (unpacked)	Random vibration with total spectral content 3.78 Grms	4 hours per axis on 3 axes
Shock test (unpacked)	60 cm onto a hard surface	1 shock on each of 3 axes
Drop test (packed)	60 cm onto a hard surface	2 drops on flat sides, 2 on edges and 2 on corners

Table 6: Mechanical Stress Testing

4.3 Environmental Stress Testing

Parameter	Test Conditions	Time
Reliability aging	1/8 rated power on all channels with 9dB crest factor IEC noise, 8 Ω Load BTL	12 days
Power test	1/8 rated power on all channels with 9dB crest factor IEC noise, 8 Ω Load BTL	100 hours
Power cycling test	EIA noise on all channels, 8 Ω load, 2 mins/cycle	1000 cycles
Thermal profile test	25ºC, 1/8 rated power on all channels with 9dB crest factor IEC noise, 8Ω load BTL	180 min
Temperature test	23 ºC to 0 ºC in 30 min, 0 ºC for 4 hours, 0 ºC to +45 ºC in hour, 45 ºC for 4 hours, 45 ºC to 23 ºC in 30 mins. 33% rated power on all channels with 9dB crest factor IEC noise, 8 Ω load BTL	1 cycle
High temperature /humidity test	45 ºC and 90% RH for 4 hours with 30 min ramp up and down time to ambient conditions. 33% rated power on all channels with 9dB crest factor IEC noise, 8 Ω load BTL	5 hours

Table 7: Environmental Stress Testing

4.4 AC Mains Supply Specification

Electrical Characteristics @ 25℃ (unless otherwise specified)

Parameter	Test Conditions	Min	Typical	Max	Unit
Function voltage range	47Hz – 63 Hz	85		265	V_{ACrms}
Performance voltage range	47Hz – 63 Hz	100		250	V_{ACrms}
Mains frequency		47		63	Hz
Switching frequency (LLC) at rated power			60		kHz
Standby power consumption	STBY pin is low, 230Vac		0.3	0.35	W
Idle power consumption			24	26	W
In-rush current		15		45	A
On-board hardwired fuse			15		A
Power supply discharge time	No load		1.2	1.5	min
Rated thermal power mounted to a Plate（250w*2 BTL 8 Ohms）	360 x 360 x 4 mm AL plate, vertical		500		W
System efficiency @2x4 Ω at 200w*2 BTL	120 Vac 240 Vac		71 72		%
System efficiency @2x6 Ω at （1000w*2 BTL）	120 Vac 240 Vac		82 84		%
System efficiency @2x8 Ω at 200W*2 BTL	120 Vac 240 Vac		77 78		%
System efficiency @2x8 Ω at 1000W*2 BTL	120 Vac 240 Vac		84 86		%
Power factor (200w*2 BTL)@120Vac			0.985		
Power factor (200w*2 BTL)@240Vac			0.925		
Main transformer thermal shutdown			100		℃
Amplifier thermal shutdown			120		℃

Table 8: AC Mains Parameters

4.5 Rated Audio Power vs Load Impedance and Configuration

Amplifier module was mounted to an 4mm thick AL plate.

Configuration	Load	Power (1%)	V (peak)	V (RMS)
SE	3	833	70.7	50
SE	4	689	74.2	52.5
SE	6	459	74.6	52.75
SE	8	351	74.9	53
BTL	6	1600**	141	100
BTL	8	1400	149	105
* Shall be DSP-limited to less than rated value within 100 ms * Shall be DSP-controlled less than 2000w total **peak current limit may be exceeded above this power level				

Table 9: Audio Power vs. Load and Configuration

4.6 Thermal Power Dissipation

Mains Voltage	Output @8ohm vs. Max Power	Thermal Power Dissipation
120 Vac	0%	24 W
	12.5%	80 W
	33%	160 W
230 Vac	0%	25 W
	12.5%	80 W
	33%	140 W

Table 10: Thermal Power Dissipation

4.7 System efficiency & Power loss(BTL)

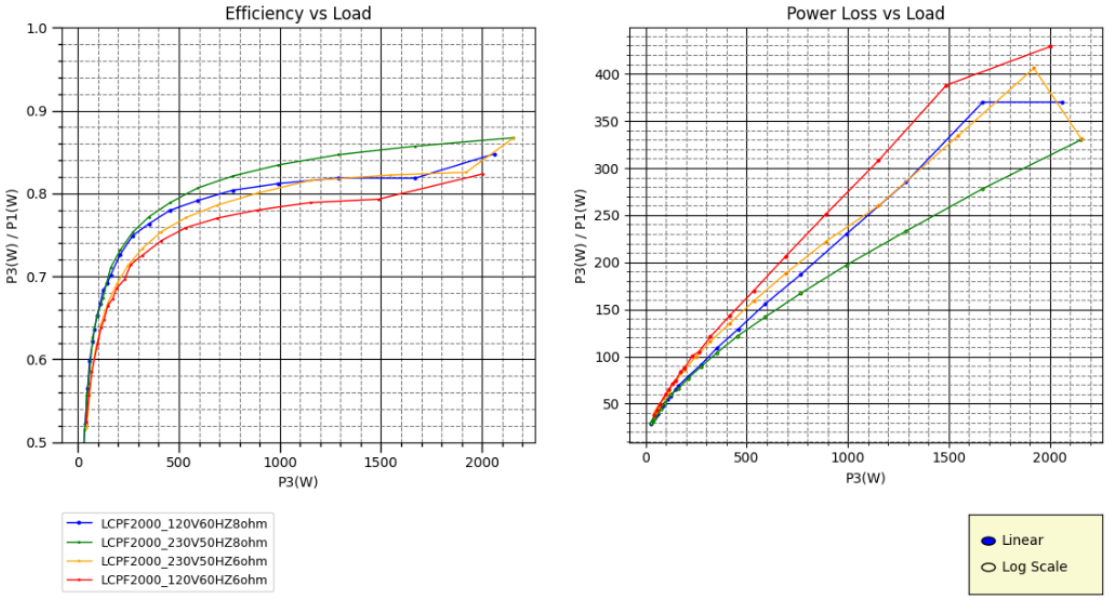


Figure 4: LCPF2000 efficiency and power loss @ 6ohm & 8ohm dummy load (total max power:2000W)

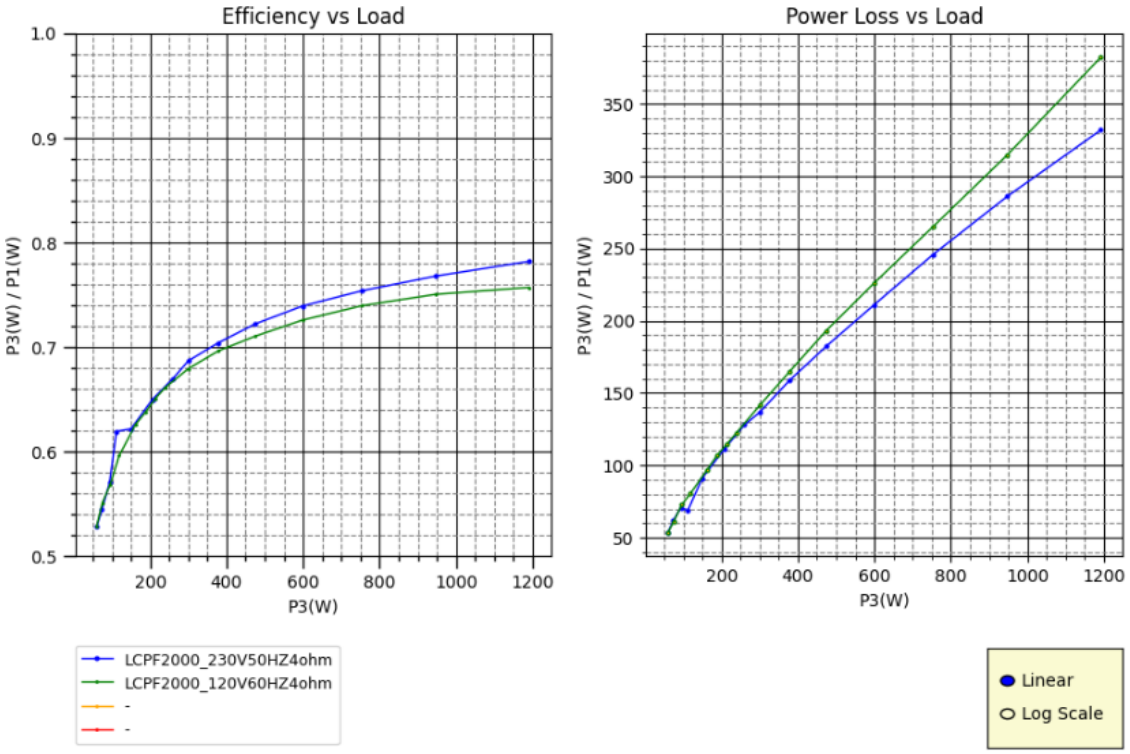


Figure 5: LCPF2000 efficiency and power loss @4ohm dummy load (total max power:1200W)

4.8 Audio Performance

Room Temperature = 25 ºC, f = 1 kHz, RL = 8 Ω, 240 V/50 Hz AC mains supply, test set = Audio Precision (unless otherwise specified)

Parameter	Test Conditions	Min	Typical	Max	Unit
Rated total power for all channels	THD+N <1%, duration 1 s	1800	2000		W
Long term thermally limited total power	THD+N <1%, continuous		500		W
Peak power, single channel (BTL), 1khz,	Duration 1 ms		2600		W
Rated power, single channel (BTL)	THD+N <1%, duration 1s		1200		W
Peak power, single channel (SE)	Duration 1 ms		800		W
Rated power, single channel (SE)	THD+N <1%, duration 1 s,		600		W
Maximum output voltage			149		Vp
Maximum output current	Output inductor and OCP limited			28	Ap
Power bandwidth			>30		kHz
THD+N	Power output 10 W		0.001	0.002	%
Self-generated output noise, SE	20 – 20k Hz, unweighted		38	50	uV
	20 – 20k Hz, A-weighted		27	45	uV
Channel separation	SE at 10 W	60			dB
	BTL at 10 W	65			dB
Dynamic range	Unweighted		125		dB
	A-weighted		128		dB
Voltage gain	BTL mode		30		dB
	SE mode		24		dB
Input sensitivity	Power output 1000 W @ 8ohm		2.95		V
Common-mode rejection ratio			60		dB
Frequency response	Fin 20 – 20k Hz		±1		dB
Input impedance signal line			4.8		kΩ
Input level limit	Fin 20 – 20k Hz			10	Vp
Output impedance (SE)			20		mΩ
Damping factor (SE)			200		-
Amplifier PWM frequency		340		375	kHz

Table 11: General Audio Parameters

4.9 Auxiliary Power Supply Specification

Electrical Characteristics @ 25℃ (unless otherwise specified)

Parameter	Test Conditions	Min	Typical	Max	Unit
+15V(switched)	Module On	14.5	15	15.5	V
-15V(switched)	Module On	-14.2	-15	-15.5	V
+15V (always on)	Module On	+14.5	+15	+15.5	
+15 V rail full load current rating	Module On			750	mA
- 15 V rail full load current rating	Module On			500	mA
+15V (always on)	Module On			1000	mA
Ripple and Noise on +15V(switched)	Full load			300	mVpp
Ripple and Noise on -15V(switched)	Full load			332	mVpp
Ripple and Noise on +15V (always on)	Full load			372	mVpp
+3.3 V rail（always on）	Module On	3.10	3.30	3.40	V
+3.3 V rail full load current rating	Module On			500	mA
Ripple and noise on +3.3 V rail	Full load			42 mV	mVpp
Maximum total output power external	Combination of +/-15 V and 3 .3V outputs available			25	W

Table 12: Auxiliary Power Supply Parameters

• 4.10 Audio Precision Detailed Measurement Report Graphs

4.10.1 Frequency Response

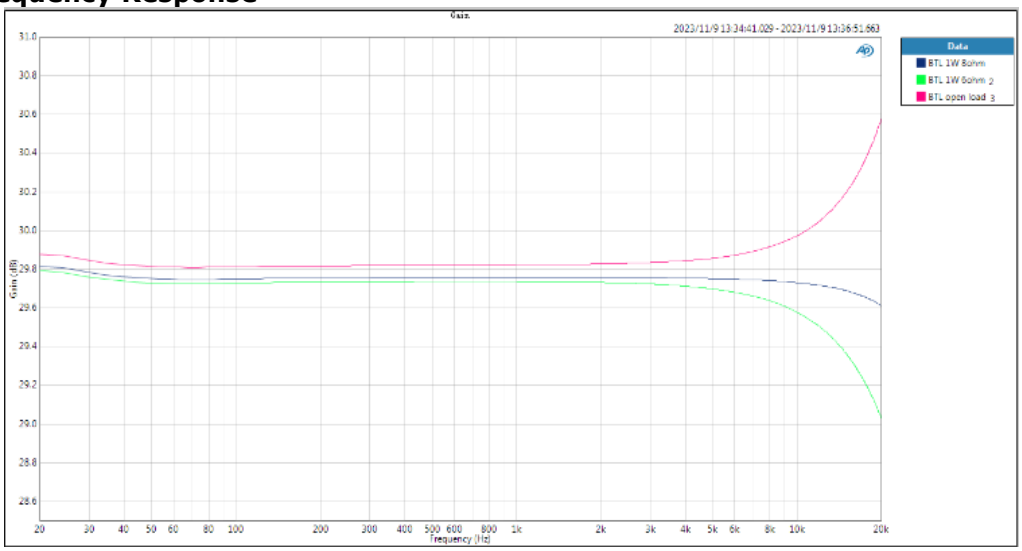


Figure 6: Frequency response 8 Ω (blue), 6 Ω (green), open load (purple)

4.10.2 Total Harmonic Distortion + Noise

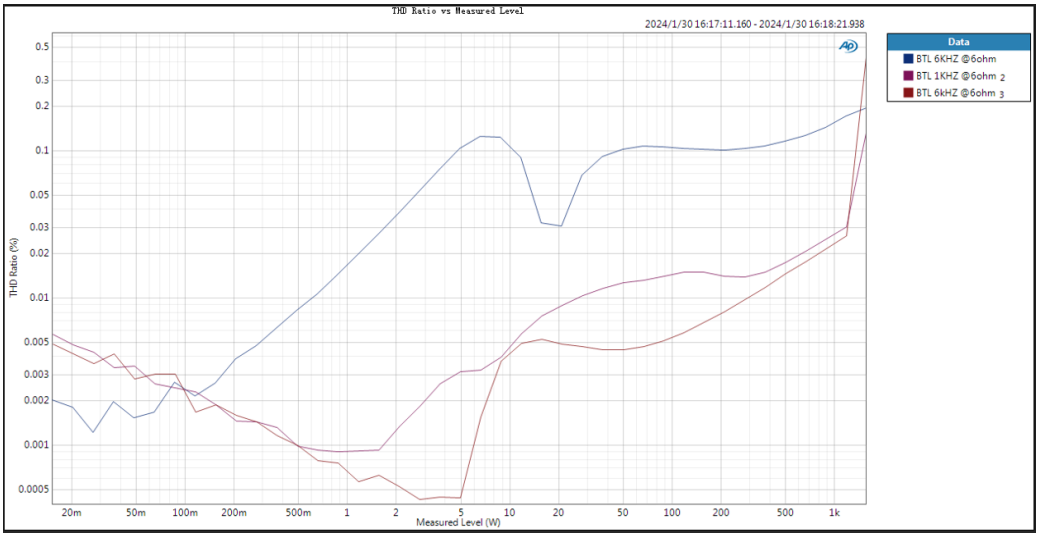


Figure 7: THD + Noise (6 Ω load),100 Hz,1 kHz and 6.67 kHz

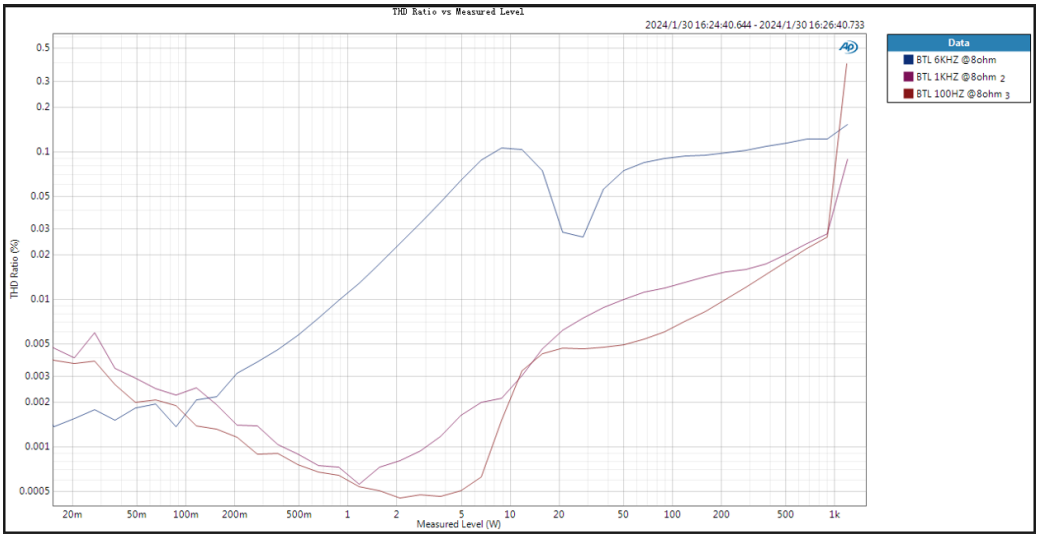


Figure 8: THD + Noise (8 Ω load),100Hz,1 kHz, 6.67 kHz

4.10.3 Idle Noise Spectrum

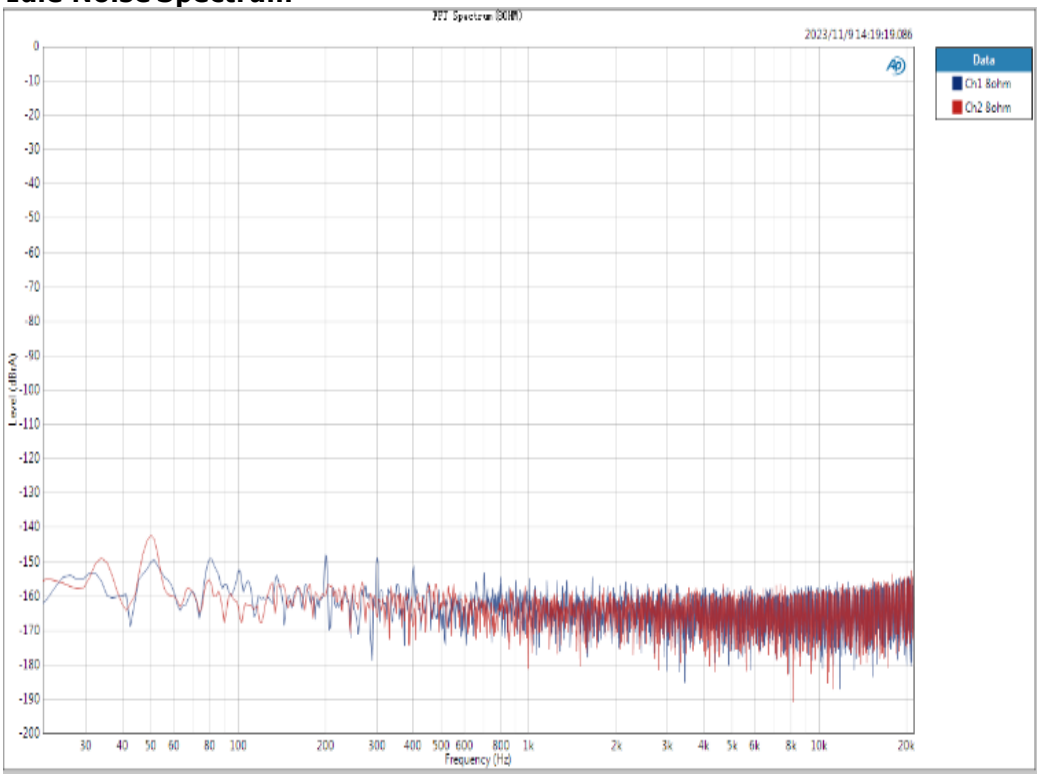


Figure 9: FFT idle noise (0 dB = rated power), CH1 (Red), CH2 (Blue)

4.10.5 Intermodulation Distortion (TIM)

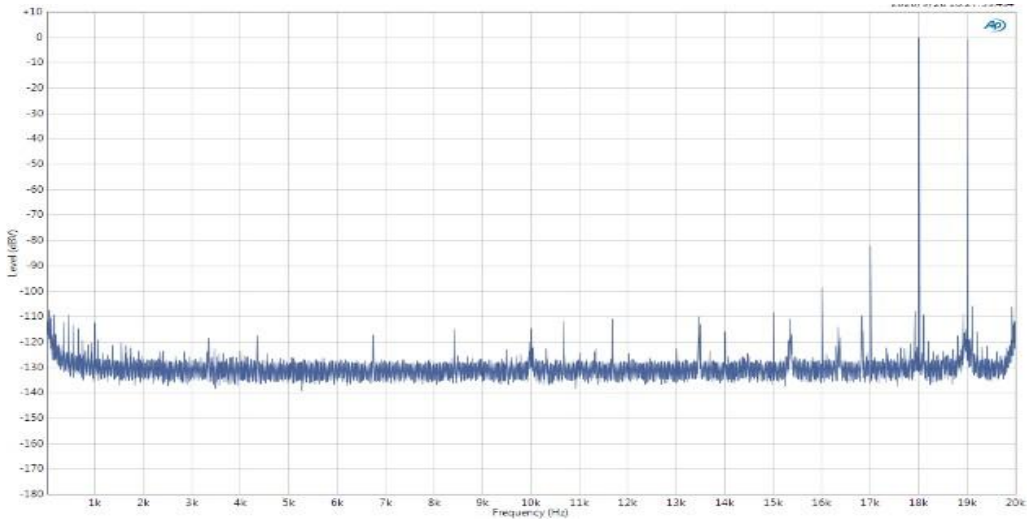


Figure 11: Dual tone intermodulation spectrum

4.10.6 Crosstalk (BTL)

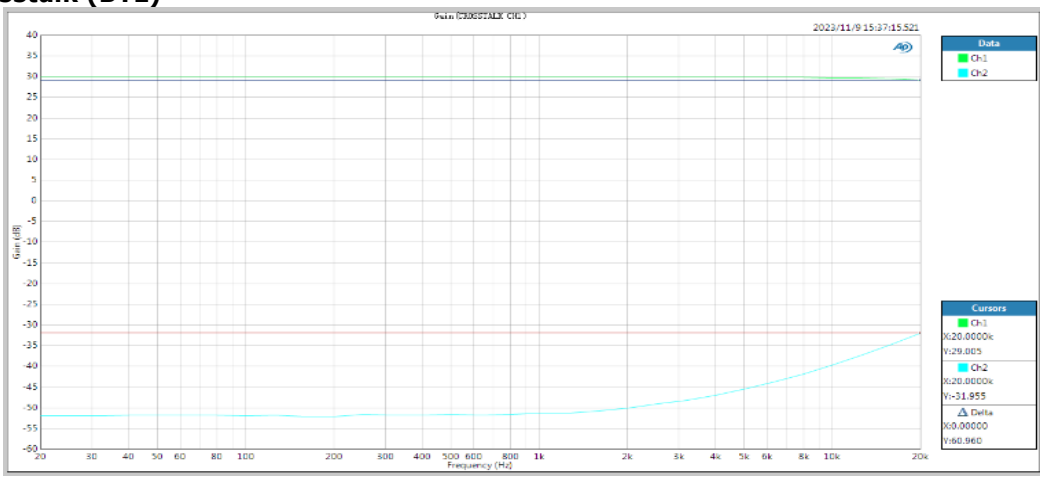


Figure 12 CROSSTALK BTL

4.10.7 Crosstalk (SE)

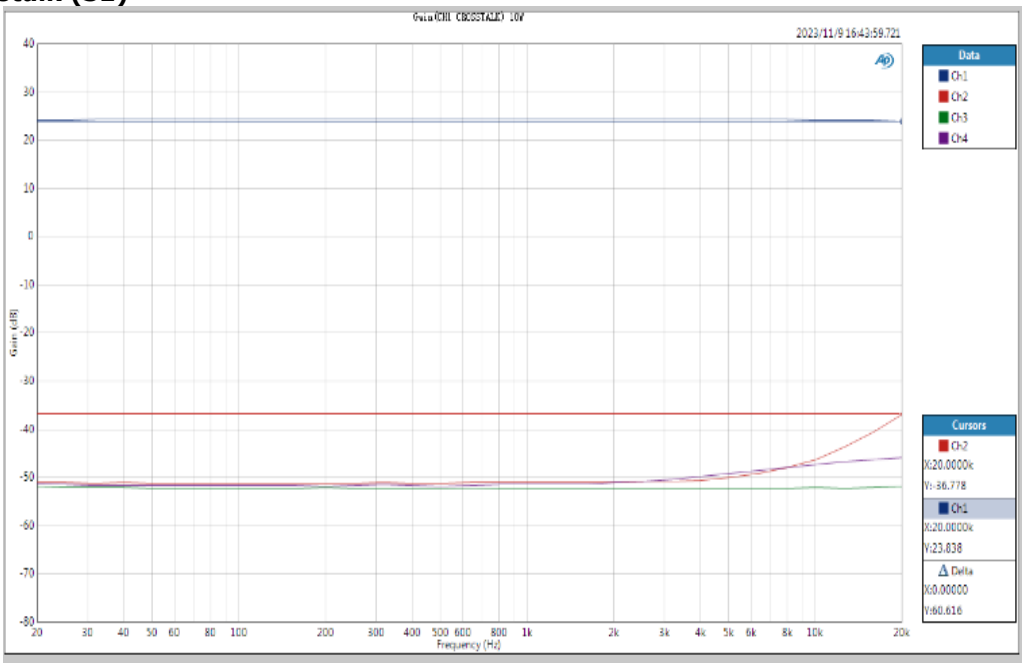


Figure 13 CROSSTALK SE

5 Control and Read Out Pin Specification

5.1 Control Pin Descriptions

5.1.1 Power On / STBY (Pin 10)

Power consumption is minimized as the +/-80 V and +15/-15 V supply rails are switched off. The PFC function is also disabled to further reduce power. Providing a switched +/-15V simplifies system design, as typically this would need to be managed and implemented in the DSP. The only active power rail is the 3.3 V standby output (maximum 6W at 2000 mA is available). It is expected that the MCU detects the presence or not of a signal and puts the amplifier module into standby as needed using this pin.

Logic: High = Active, Low = Disabled.

5.1.2 AMP MUTE (Pin 12)

The amplifier output is disabled when the amplifier module is muted. There is approximately a 200 ms switch-on mute when this control pin is changed from low-to-high to prevent startup popping noises and allow power supply rails to stabilize. Conversely, when this control pin is changed from high-to-low, muting is near instantaneous to quickly mute the speaker outputs.

Logic: High = Active, Low = Disabled.

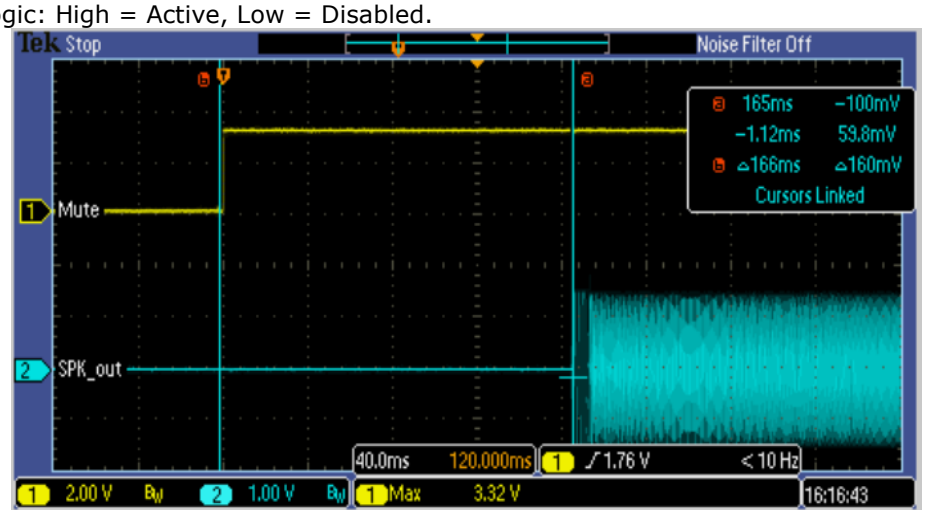


Figure 14: Mute Release timing

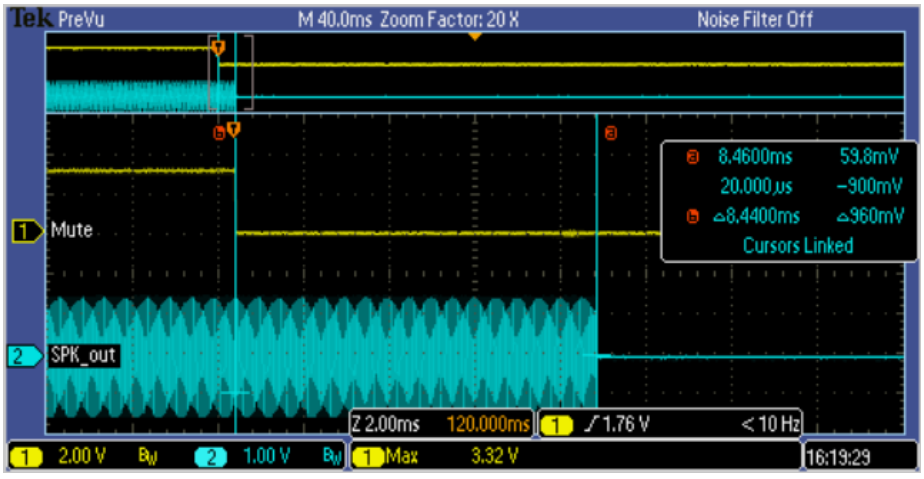


Figure 15: Mute Active Timing

5.2 5.2 Read Out Pin Descriptions

5.2.1 Power Rail Volt (Pin 8)

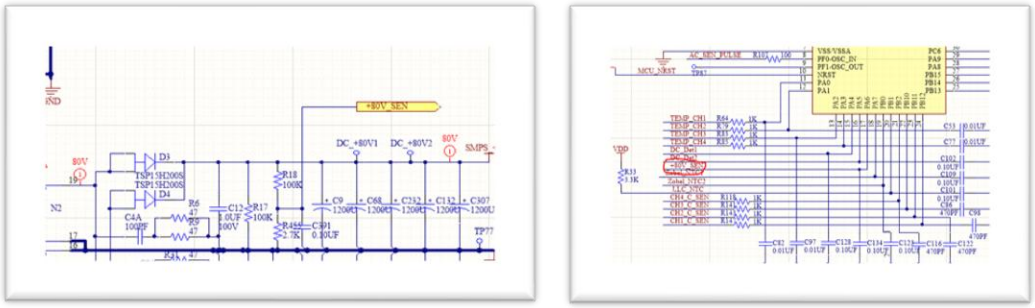


Figure 16 : Power Rail Voltage Detection Circuit

This is a resistance divider to MCU for monitoring the voltage of the amplifier power rail (positive side only). We can read the real voltage to detect the system is overloaded or there is excessive rail drop caused by low mains voltage or SMPS overload.

Recommended DSP Rail Voltage Drop Limiter Thresholds

1) Mild Overload 15-20% drop or 1.9 - 2.0 V, start to limit output signal.
2) Severe Overload, 20-30% drop , 1.6 – 1.9 V aggressive output limiting
3) Shutdown, > 40% drop, < 1.4V, it is recommended to shut down or mute.

This is not required if the DSP is tuned to prevent overload of the SMPS. However, it can be useful in case of low mains voltage operation, where SMPS is derated or when the load are connected by the user to prevent shutdown in case of overload.

Note that the amplifier also has an internal rail voltage UVP limiter, that will intervene at <65V to reduce gain up to 10db by 60V and shut down below 55V.

5.2.2 Protection Status 1 (Pin 15)

This has been changed to a DC level that indicates the amplifier status.

0V	Normal Operation
0.5V	OTP – AMP FET
1V	OTP – LLC Transformer
1.5V	OTP – Output Filter
2V	DCP
2.5V	RVP
3V	AMP Fault – Short or HW Failure

5.2.3 Thermal Status 2 (Pin 16)

This has been changed to a DC level that indicates the overall amplifier temperature relative to the limit values. The amplifier monitors each channels FET as well as the SMPS transformer and output filter temperature, each of these parts have different limit values, thus this reading is scaled relative to the maximum limits of the location closest to the limits.

0V	All sensors are <=20degC
1V	Max reading is 33% of limit
2V	Max reading is 66% of limit
3V	Max reading is 100% of limit

For example, if the AMP FET is closest to the limit and the limit is 100 deg C, a status indication of 2V would be 66 degrees.

5.1.1 AC Sense (Pin 11)

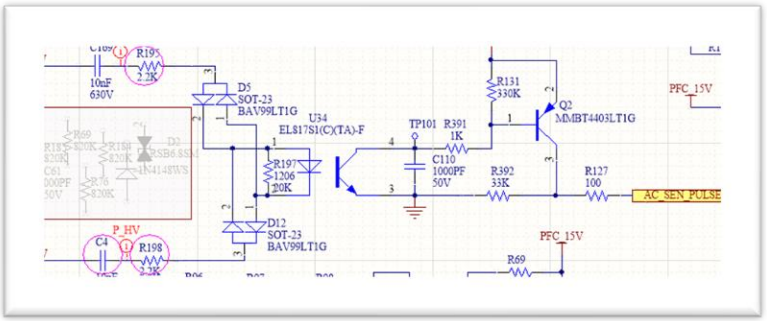


Figure 18 : AC Line Detection Circuit

This is a logic output pin for monitoring the AC mains status. It is a pulse train (0 - 3.3 V) correlated to twice the AC mains frequency; a missing pulse indicates a loss of AC mains so that the system can be safely shutdown. Together with a timer, this signal can be used by the system MCU; if no pulse is detected for at least 3 mains cycle periods, the MCU can assume that AC power has been disconnected and power off the Main power immediately

5.1.2 I2C Mode 2 (Pin 36)

Pull Down PD2 to set I2C address to default 0x56, Pull Up PS2 to 3.3V to set I2C address to 0x58

I2C Address	Register Name	R/W	RST Value	Description
0	Power	R/W	0	0 - standby, 1 - on
1	Mute	R/W	0	0 - mute, 1 - on
2	OTP AMP Threshold	R/W	120	up to 125 deg C
3	OTP LLC Threshold	R/W	110	up to 110 deg C
4	OTP RC Threshold	R/W	90	up to 120 deg C
5	RVP Minimum Allowed Before Compression	R/W	66	valid range form 55-70 V to start HW compression, recommended range is 68 = -15% to 65 = -20% note that below 55V the amplifier will immediately enter standby
6	OCP Regulation Threshold	R/W	25	up to 28A
7	OTP/RVP/FLT Flag	R/W	0	0 - is no protection, cleared on un_mute command, or write 0 to clear, bitmap for example both RVP and Fault ch1 for example = 0x18 0b 0000 000x - OTP AMP 0b 0000 00x0 - OTP LLC 0b 0000 0x00 - OTP RC 0b 0000 x000 - RVP 0b xxxx 0000 - AMP Fault, xxxx = ch 4, 3, 2, 1
8	OCR/RVP/DCP Flag	R/W	0	0 - is no protection, cleared on un_mute command, write 0 to clear, bitmap for example both OCP ch1 and OCP ch2 = 0x03 Compression OCR or RVP - 0000 xxxx = ch 4, 3, 2, 1 DCP - 00xx 0000 = ch3-4, ch 1-2
9	No Mains Auto Mute	R/W	50	0 - disabled, or other value in "ms"
10	AMP Rail Voltage Minimum	R/W	n/a	Minimum Value Measured, write 80 to clear / reset
11	AMP Rail Voltage	R	n/a	Real Time Rail Voltage Read Out
12	AMP FET ch1 Temp	R	n/a	FET copper tab temperature
13	AMP FET ch2 Temp	R	n/a	FET copper tab temperature
14	AMP FET ch3 Temp	R	n/a	FET copper tab temperature
15	AMP FET ch4 Temp	R	n/a	FET copper tab temperature
16	AMP RC ch1&2 Temp	R	n/a	Output filter RC damping network temperature, HF limited
17	AMP RC ch3&4 Temp	R	n/a	Output filter RC damping network temperature, HF limited
18	LLC TX Temp	R	n/a	Temperature inside SMPS transformer, safety limit is 110 deg C
19	Board Temp	R	n/a	Measured on PCBA near connector, local ambient reference
20	T of Max %	R	n/a	Scaled peak temperature relative to limit where 20 deg C = 0
21	AC Mains Time Out	R	n/a	0 = stable AC mains, 1 = no AC mains
22	AMP Current ch1	R	n/a	1s TC RMS RC filtered current, 0-255 = 0 -25.5A, 0.1A / value
23	AMP Current ch2	R	n/a	1s TC RMS RC filtered current, 0-255 = 0 -25.5A, 0.1A / value
24	AMP Current ch3	R	n/a	1s TC RMS RC filtered current, 0-255 = 0 -25.5A, 0.1A / value
25	AMP Current ch4	R	n/a	1s TC RMS RC filtered current, 0-255 = 0 -25.5A, 0.1A / value
26	AMP Current Total Short	R	n/a	1s TC RMS RC filtered current correlates to FET die temp, 0-255 = 0-51A, 0.2A / value
27	AMP Current Total Long	R	n/a	100s TC RMS RC filtered current correlates to VC or Thermal
28	Reset	W	0	Write one to reset the device to default settings
29	Status1 PWM	R	n/a	Status 1 PWM duty cycle
30	I2C Address	R/W	86	valid range is standard 7 bit 0-127
31	n/a	n/a	n/a	n/a
32	SW Major Ver	R	n/a	Software Major version
33	SW Minor Ver	R	n/a	Software Minor Version
34	HW Major Ver	R	n/a	Hardware Major Version
35	HW Minor Ver	R	n/a	Hardware Minor Version

5.1.3 C-SENSE

This is an analog output pin which uses an isolated hall current sensor to provide amplifier current monitoring. It has a voltage-to-current sensitivity of 45 mV/A and a maximum range of 0 - 3 V, to represent the -25 A to +25 A output current range, with a DC offset of 1.65V. When connected to a DSP, it is recommended to AC couple the signal to remove the DC offset. How this is done will depend on the ADC input used. The signal is low pass filtered with a 20 kHz RC to reduce noise and the output impedance is approximately 1 kΩ. An example output is shown in Figure 20.

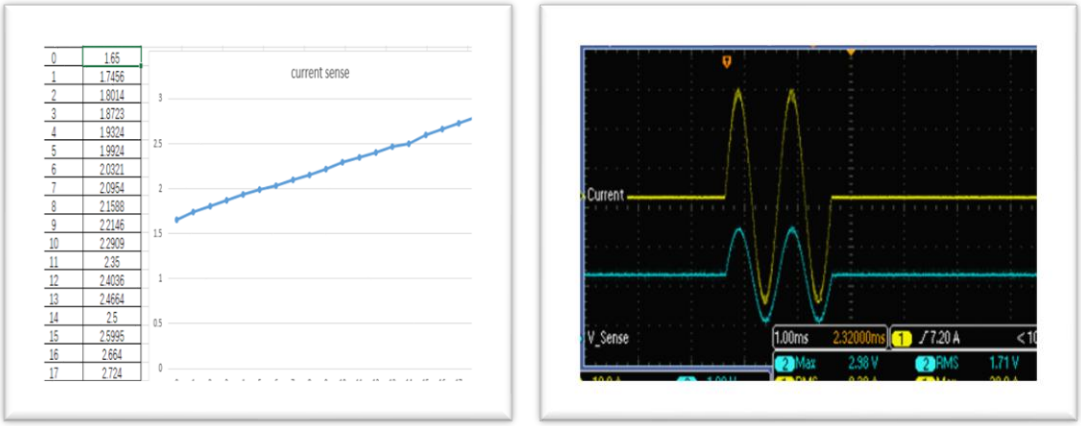


Figure 21: C-sense output voltage vs AMP load current

5.1.4 V-SENSE

This is an analog output pin presents the amplifier power level to an external device with a 1/26 voltage divider. Note therefore that if a low impedance ADC is used to sample this signal it may require buffering otherwise it will have a reduced amplitude. The maximum output voltage corresponding to the 80 V rail is 3.07V peak.

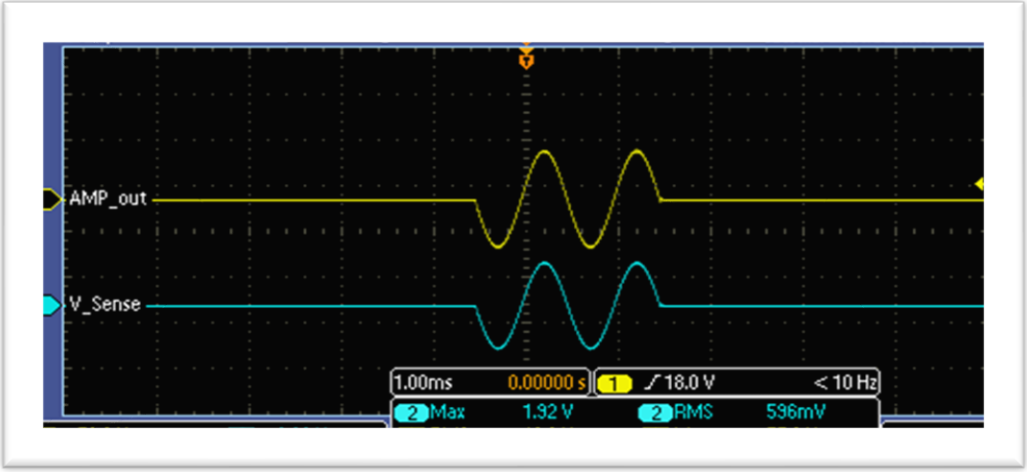


Figure 22: V-sense voltage vs AMP output voltage.

6 Thermal Requirements

At full power, the LCPF can be operated within the range -10 to +45 º

From 45 – 55 ºC, the amplifier can operate, but, depending on system de-rating or intervention of DSP, thermal management may be needed.

It is recommended that the amplifier is mounted to a 4 mm thick aluminum plate with minimum dimensions of 360x360 mm. However, temperature profiling and testing within the system will be needed to verify operation as the thermal environment of each system is different. The plate should be clean and flat, and thermal transfer paste should be used to aid heat dissipation.

Subject to system verification, additional space around the amplifier module should be left for cooling (100 mm) and safety clearance (10 mm).

High frequency thermal limitations:

The output filter damping network has a limited power dissipation at high frequencies and must be considered in the system. The SE output voltage of the amplifier should be limited over 1-2 second time window to the following:

5khz = <50 Vrms (practically limited by rail voltage)
10khz = <25 Vrms
20khz = <12 Vrms

Ideally this can be guaranteed by using a side chain shelf filter with above response to trigger a slow RMS limiter in the DSP.

Temperature is also monitored by the MCU and the amp can protect against damage from resistors provided the OTP threshold is configured properly for the system. These readouts are available in I2C address 16 & 17.

7 Safety

This amplifier module operates at mains voltages and generates high voltages. Hazardous voltages are presented on accessible parts. It must not be possible to touch these parts when the amplifier module installed into equipment. Never touch any part of the amplifier module while it is connected to the mains. Power up via an isolated current-limited supply when testing. Be aware of high voltages when testing.

Attention: Observe precautions for handling electrostatic sensitive devices. This module uses semiconductors that can be damaged by electrostatic discharge. Damage due to inappropriate handling is not covered by the warrantee.

Never expose this apparatus to liquids or moisture.

This product has no user-serviceable parts. Do not disassemble.

8 Application Notes

8.1 Amplifier input driver

Suggested output stage to drive amplifier module input:

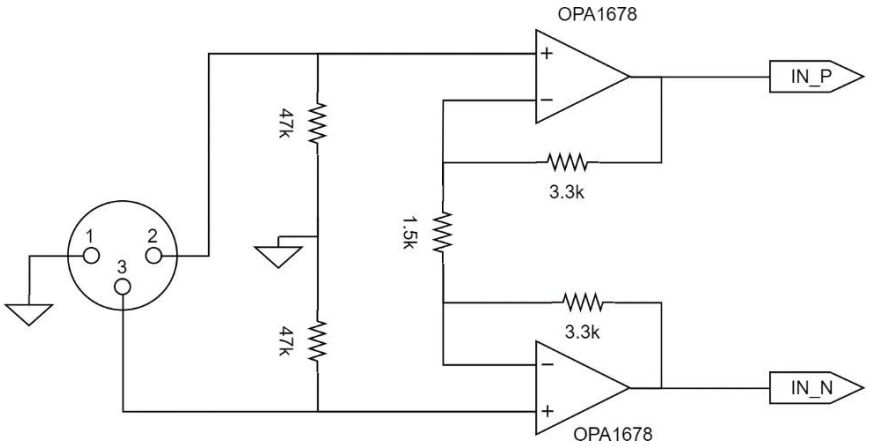


Figure 23: Suggest source board output stage.

8.2 Avoiding EMC and Ground Loops Issues

Ways to minimize the issues with EMC include, but are not limited, to:

- Connect all metal plate mounting holes to the chassis using low impedance spacers.
- Keep speaker cables close to each other, and, ideally, twist them together or even add grounded shielding to the cable (use a capacitor to connect the shielding to the speaker chassis).
- Route cables close to the equipment chassis where possible.
- Do not route cables across the amplifier module. Always route cables directly away from the module.
- Do not cable tie mains, audio input and speaker output cables together.
- Decouple external wires and MCU audio GND to the chassis at the input terminals.
- For longer speaker cables, suggest adding the ferrite core wound the cable wire.

9 Demo Board Guide

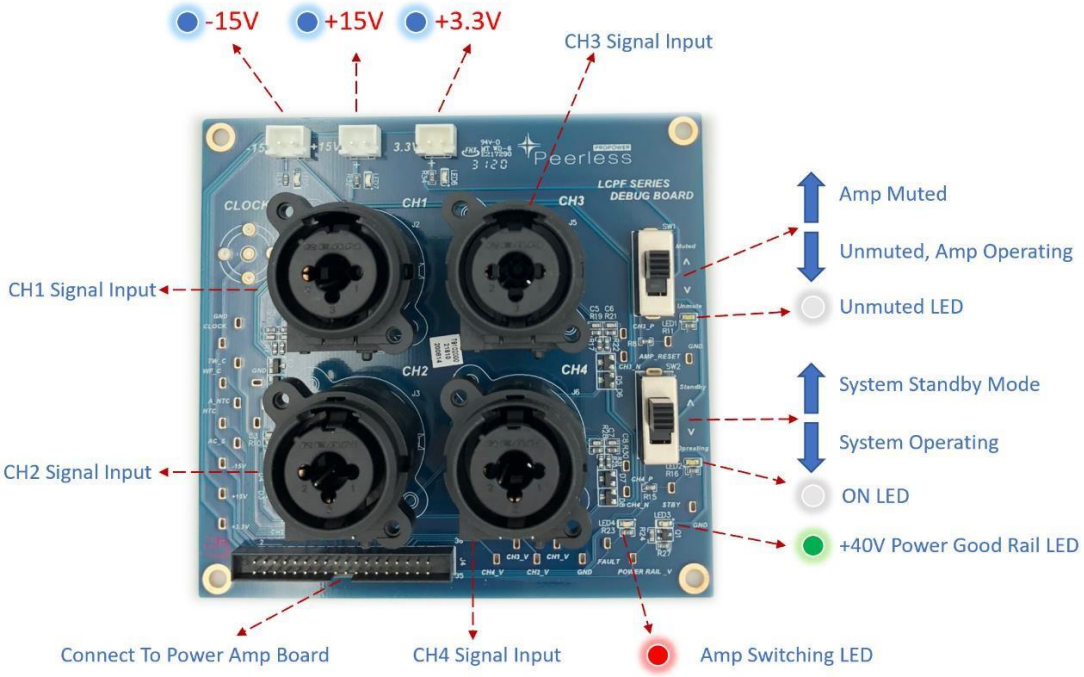


Figure 24: Demo board connectors, LEDs and switches.

Power on Sequence:

1. AC power OFF
2. Reset the switches as shows on the picture, connect to power amplifier board
3. AC power ON: +3.3 V LED lights up
4. Set switch to "Operating": white LED lights up
5. +/-15 V LEDs light up
6. +80 V power rail LED lights up
7. Set switch to "Unmuted": white LED lights up
8. Amp switching LED lights up: amplifier is operational

10 List of abbreviations

SE: Single-ended amplifier
BTL: Bridge-tied-load amplifier
PFC: Power Factor Correction pre-regulation
LLC: Inductor-Inductor-Capacitor power supply
MCU: Micro-Controller Unit
EMC: Electro-magnetic compatibility
GND: Power and signal ground
NTC: Temperature sensor with a negative temperature coefficient

11 Compliance Standards

11.1 System Compliance Notes

EMI and Safety verification, and formal testing of the final product should be carried out to secure compliance of the final product and to achieve formal regulatory approval. The module is provided pre-tested to meet the above requirements in a mock-up system however this cannot exactly represent the end use. The system integrator will need to work with Peerless to ensure the amplifier in the product application can pass the regulatory requirements.

EMC will require special attention and collaboration with the system integrator, note that for Class A "professional" products, it may be possible to pass conducted and radiated emission without any system-level shielding of the amplifier module. However, Class B "consumer" products will likely require an EMI shielded enclosure such as a steel case, perforated steel cage, or "aluminum tub" type of enclosure for the amplifier module. Shielding and EMC require attention to how the amplifier module is used in the system application, cable lengths, and proximity of other internal wiring to the amplifier and power supply components. System design should be reviewed with Peerless engineering before design completion.

11.2 Safety Compliance

Pre-testing to the standards listed below has been completed within Peerless' own testing labs. Official certification must be done at the system level.

11.2.1 Core standards

Safety tested according to the following core standards:

- EN 60065:2002 + A1:2006 + A11:2008 + A2:2010 + A12:2011
- EN 62368-1:2014
- CSA C22.2 NO.62368-1-14:2014
- UL 62368:2014

11.2.2 Country regulations

Evaluated against and complies with the regulations of the following countries:

- 60065 AR, AT, AU, BE, BY, CA, CH, CN, CZ, DE, DK, ES, EU, FI, FR, GB, GR, HU, IE, IT, JP, KR, MY, NL, NO, NZ, PL, PT, RO, SE, SG, SI, SK, UA, US
- 62368-1 CA, DK, FI, DE, IE, IT, NO, SE, GB, US, CENELEC common modifications

11.3 Electro-Magnetic Compliance

11.3.1 ESD Precautions

- The product (the system into which this amplifier module will be installed) shall pass the ESD discharge test by ±4 kV contact discharge and ±8 kV air discharge.

11.3.2 EMI Compliance

- EN 55032:2012 with EN 55032:2012 AC 2013
- EN 61000-3-2:2014
- EN 61000-3-3:2013
- FCC part 15 subpart B

11.3.3 Immunity

- EN 55103-2:2009
- EN 55035:2017

11.4 Environmental

- EN 50564 (ErP)
- RoHS 2.0

12 Warrantee

Unless there is a separate purchase/project contract containing negotiated warranty terms, the warranty terms below apply.

TYM warrants that the Products produced by TYM or TYM's subcontractor are free from defects in material, functionality and workmanship. In every case TYM stays liable for the fulfilment of the duties resulting from this Agreement. The warranty is valid for twelve (12) months from the delivery date of such Products ("Warranty Period"). Customer may make any warranty claim in writing within ten (10) days after Customer becomes or ought to aware of the defect and before the expiration of the Warranty Period.

If any defect occurs, Customer shall immediately notify TYM and provide TYM with a detailed description in component level of defect of the Products and the results of already performed analysis in regard to the defect Products. In case of the defect is confirmed by TYM and attributable to TYM and within the Warranty Period, TYM may at its own discretion: (i) replace the defective Products with non-defective Products; (ii) repair; (iii) accept the return of the defective Products for a full refund if such Products cannot be repaired or replaced with non-defective Products; or (iv) reimburse Customer for the reasonable costs incurred in connection with the reasonable corrective action agreed by both Parties.

TYM's warranty shall not apply to the extent arising out of: (i) modifications to the Products that were not authorized by Customer; or (ii) compliance with design(s), requirement(s), instruction(s), or use of part(s) or materials provided by Customer; (iii) the modification of components made by Customer or any third party not authorized by TYM; or (iv) any misuse, neglect, accident, or improper installation or testing by Customer. In any event, TYM shall not be liable for any defects which are caused by or attributable to Customer.

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