



# PERMA Series Revision 2 Amplifiers

High Efficiency Life Safety  
Digital Power Amplifiers



Current  
Thinking



## **Introduction**

Voice Alarm (VA) systems are the quickest way to evacuate the public & staff from a building.

Following fire detection, automated messages control the flow of people in stairwells and corridors allowing an orderly evacuation without panic. These messages are supplemented by spoken messages from the fire service or management suite confirming the validity and need to leave the building.

This positive confirmation speeds evacuation and avoids the "false alarm" mentality reducing the risk of death from fire.

The PERMA series of amplifiers form a vital part of a VA system, and due to unique features they are suitable for all sizes and complexities of VA system.

## **Amplifier Overview**

Each PERMA amplifier contains two independent high efficiency power amplifiers, each with load monitoring (both AC and DC), earth fault monitoring, and tone fail monitoring, and a 24VDC battery supply input with onboard monitored battery charger.

Routing logic allows amplifier modules to operate independently, with each amplifier having a main and auxiliary input, which mix or, if the PTT contact is operated, the main overrides the auxiliary.

The routing logic also allows the amplifier to operate as an AB amplifier, where both channels receive the same signal (this also allows the outputs to be paralleled for higher power operation). In this case the slave output allows the priority audio signal to be routed directly to the slave connector, and faults and swap information cascade

Each amplifier's current fault status is displayed on the front panel along with an output bar graph and matrix access status. All indicators are in accordance with EN60849. The unit is supplied in a 2U 19" DIN standard rack mount chassis.

All sections of the amplifier and charger are constantly monitored for faults or abnormal operation. The load monitoring either checks the DC



resistance of the speaker lines, or checks the power absorbed by the speaker load and end of line units (EOLs) and compares this with the value set at installation. If the power draw deviates outside a pre defined window of 10% a fault is indicated on the unit and signalled to other equipment via the relevant fault outputs.

If the surveillance monitoring tone is not being received by the amplifier, the Tone Fail light shows for the relevant channel.

Should either leg of the speaker wiring short to system earth this will also light the Earth Fault LED, this system will also spot earth faults on the secondary of speaker transformers.

Mains power status is monitored, along with the internal fuses, standby batteries and battery charger to give a complete picture of the state of the amplifier.

The output from each module is presented on a three-way LVD compliant socket and is fully floating.

The standard output voltage is 100V, allowing two modules to be connected in parallel to give up to 400W at 100V line using the PERMA4 amplifier.

### **Standards Compliance**

The @udio Logistics PERMA series amplifiers complies with all the current Voice Alarm standards including BS5839 parts 1 & 8 and EN60849.

We are also monitoring the meetings of the EN54-16 committee to ensure we will comply when this is released.

Additionally the PERMA series comply with the EMC requirements of EN55103-1 and EN55103-2 as well as the LVD requirements of EN60065 and EN61000-3-2.



## Detailed technical description

The two audio signals enter the amplifier module through RJ45 type connectors, from which they pass through an input preamplifier, which debalances them and allows the audio level to be set with rear mount potentiometers.

The audio then passes to an analogue switch array, which gates the audio depending on the setting of the PTT access voltage.

### Amplifier Modules

The two amplifier modules are identical.

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The signal output from the matrix then passes through to the output stage, which consists of two identical PSCPWM half bridges, each driven with an error signal 180° out of phase with the other. This phase shift has the effect of doubling the effective sampling frequency of the modulators; this reduces the filtering requirement on the amplifier output, whilst lowering the switching losses in each of the bridges all of which increase the efficiency of the amplifier.

Each PSCPWM bridge has cycle by cycle current limiting, which reduces the power dissipation when the amplifier is driving a difficult load, or the output is short circuited, this limiting is fully automatic, and resets as soon as the fault is removed.

A protection circuit shuts down the output stage when the voltage rails in the amplifier fall below 22V or exceed 36Volts, or when a DC offset is present on the output rails (due to component failure).



The output of the transformer boosts the audio level to 100 Volt line level, and amplifiers channels can be connected in parallel to provide up to 400 Watts at 100 V line on a PERMA4 amplifier.

## **Power Supply**

Mains enters via the mains inlet, passes through the power switch, EMC filter and inrush suppression circuits and is transformed and rectified. A large low ESR capacitor bank provides a very smooth output, even under large current surges which is necessary for class D amplifiers which have a low PSVRR (Power Supply Voltage Ripple Rejection) compared to class AB amplifiers.

Two separate filtered 15 Amp fused outputs connect to the two amplifier modules (one feed per amplifier channel).

Another feed passes, via the aux. on LED (this shows that the aux. power is available on the rear connector) through a 3 Amp fuse to the aux. power connector this is used to power.

A 27.6 Volt variable impedance regulator with a 3 amp current limit is also driven from the supply, allowing the connection of external vent regulated sealed lead acid (VRSLA) batteries via a 25 Amp fuse. This charger is switched off for 10mS every time the mains AC waveform passes through zero, to enable the charge in the batteries to be determined.

The battery chargers in several amplifiers can be paralleled for large capacity batteries, however the amplifiers must be driven from the same mains phase for the monitoring to work.

Batteries for the amplifier must be connected in series, as the battery monitoring circuit cannot detect faulty cells in paralleled battery banks.

Normally the amplifier would be connected to two series 12V nominal batteries, however for higher capacities it may be necessary to series four 6V nominal batteries. The battery monitoring circuit cannot detect faulty cells in paralleled battery banks

The power supply is fully monitored for battery health and fuse integrity.



## **Fault Monitoring**

The PERMA Series amplifiers contain two methods of load monitoring, depending on the setting of the DIP Switches on the rear of each amplifier module, AC monitoring and DC monitoring.

### **AC Line Monitoring:**

To monitor the amplifier and loudspeaker system, two parameters are measured, the output voltage and current. These signals then pass through fourth order band pass filters @ 22.05 kHz, the rectified log of these ac signals is then taken, and the signals are summed. This gives a voltage, which represents the true load power ( $I \cdot V$ ) at 22.05 KHz. This value is passed to a detector, which compares the measured power value with that set at commissioning, generating load HI or LO faults if necessary. The monitoring tone is injected into the incoming audio input from the previous device in the chain, allowing the full audio path to be monitored. The detector also indicates the absence of the monitoring tone and signals this to the tone fail LED.

The detector circuit also tracks small changes in impedance over time to prevent faults being detected due to cable impedance changing with temperature or ageing of speaker transformers.

Because the monitoring tone is crystal controlled, and the detect circuit is so accurate, it is possible to accurately determine load faults without false faults being generated. This allows most speaker circuits to be cabled as spurs provided each spur's wattage exceeds 25 Watts or has an end of line unit fitted.

### **DC Line monitoring:**

Because of the wide specification of high capacitance cables such as MICC we have equipped the PERMA series amplifiers with DC line monitoring, this requires that each speaker be fitted with a DC blocking capacitor (typically 2.2uF 400V non polar on a 6W ceiling speaker), which are available from most speaker manufacturers. The amplifier looks for a 9K end of line load, and this allows the speaker circuits to be operated as spurs, typical supplied end of line resistors are 2 number 18K 1W power



resistors, however you can also use up to 6 spurs, each fitted with a 56K  $\frac{1}{4}$  W resistors.

### **Earth Fault Monitoring:**

A detector circuit connected to the output transformer monitors the current flowing through the load, any imbalance in this normally floating output must be due to a short or low impedance leak to system earth generating an earth fault and lighting the EARTH LED on the front panel.

The load high, load low, earth fault and tone fail outputs for each amplifier are brought out separately on the Fault port.

A common fault output is also provided which is triggered by any fault on the amplifier.



## Front Panel Indication



## Module Indication

Both amplifier modules are identical in operation, and the operation of the A module will be described only:

- Peak: This LED lights when the output voltage on the 100V line terminals exceeds 90V.
- Signal: This LED lights when the output voltage on the 100V line terminals exceeds 4V.
- Priority: This LED lights when a priority PTT voltage is present on the Priority audio input for this module.
- Page: This LED lights when a page PTT voltage is present on the Page audio input for this module, or INPUT OPTION switch 3 is set to ON (Access Page Port)
- On: This LED lights when the module has all supply rails available
- Protect: This LED lights when the module has detected an internal fault, including over temperature, oscillator failure, over current (output shorted) or under voltage. When the amplifier is turned on this led will illuminate for approximately 3 seconds as the module stabilises.
- Load: This LED lights when a load fault has been detected, depending on the settings of the load monitor dip switch for this module (see later)
- Swap: This LED lights when a priority is operated on the module and either a tone fail or protect condition exists, signalling that a reserve amplifier is required in automatic Hot Swap systems.

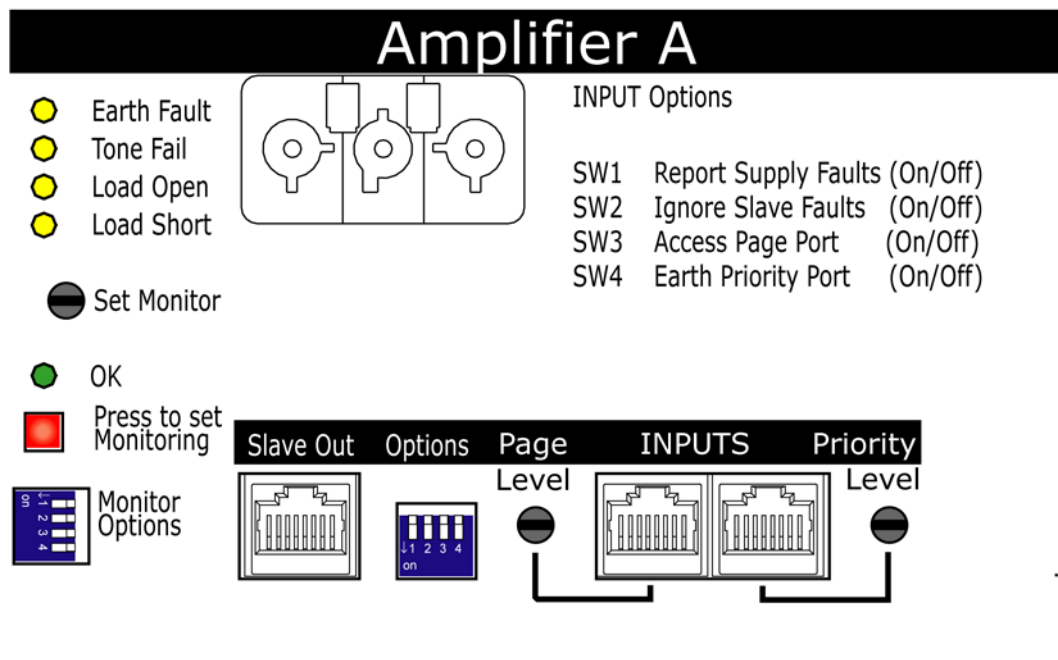


## Supply Indications

- Mains: This LED lights when AC mains is present to the amplifier
- Battery: This LED lights when the DC reserve battery supply is present.
- Fuse: This LED lights when either the mains or battery fuses have failed (or these supplies have been removed).
- PSU Fault: This LED signifies that a supply rail to the amplifier modules has failed or the battery charger has failed.
- OK: This blue LED is illuminated if the amplifier is free of monitored faults.

## Rear Panel Indication and Settings

Both amplifier modules are identical in operation, and the operation of the A module will be described only.



Each module has 2 sets of DIP Switches (monitor options Vertically to the left, and Input Options horizontally toward the middle of the module), 5 LEDs associated with the monitoring section (as well as a set pot and push switch). First we shall describe the audio inputs and outputs, and associated input switch options; followed by the monitoring section.



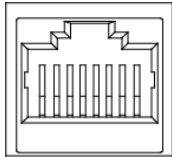
## Connections

### Audio Inputs

Normally the amplifier will be housed in a rack with the control equipment, when connection is simply by using a LSF (low smoke & fume) CAT5 patch lead.

The PERMA amplifiers have 2 audio inputs per amplifier Module, Main & Priority.

However if the amplifier is remote from the rack recommended cabling for the field Amplifiers is 1 number 1.5mm<sup>2</sup> four core FP200 type soft skin cable for runs up-to 1KM, alternatively 1 number 4 core 1.5mm<sup>2</sup> MICC type cable can also be used, up-to a maximum distance of 200M



Audio input Connection Details

1	+24V DC
2	GND*
3	PTT
4	NC
5	NC
6	NC
7	Audio +Phase
8	Audio -Phase

**\*see text below for Priority port**

### Signal Descriptions

Pins 2 & 3, provide a two-way handshake between the amplifier and control equipment, the amplifier monitors the voltage on the line, and normally presents 2V if the amplifier is healthy. Pin 1 provides a power supply for microphones or message stores on simple systems.

Pin 2 on the priority port can be earth lifted to remove hum loops in larger systems, when lifted the pin is referenced to earth with a 1N EMC capacitor and a 10K pull down resistor- this option should be disabled by setting INPUT OPTION switch 4 ON when using microphones or message stores powered from this input.



Audio comes from the control equipment via pins 7 & 8, this audio pair also indicates the operational status of the control equipment by applying an 8V phantom voltage to the lines to indicate integrity of field wiring.

### **Operation**

The Control equipment raises the PTT line voltage to 5V to indicate that it wishes to use the audio input for priority paging. This sense voltage can be used to trigger external devices such as volume over ride relays or activating page only areas.

The page input can be set to permanently access the amplifier for music inputs by selecting INPUT OPTION switch 3 to ON

If the control equipment fails to see the 2V on the PTT line, and the output monitor option is set, the Control equipment will signal a fault and places an entry into its' fault log.

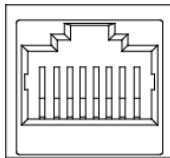
Power supply faults can be signalled back to the control equipment by selecting INPUT OPTION switch 1 to ON



## SLAVE Port

The slave port has two main functions, the primary function is to cascade amplifier priority inputs for multiple amplifiers serving a zone, or where you have the priority port supplying VA programme material, and the page port used for multi-zone PA applications.

The secondary function of the Slave port is to provide audio out and handshaking for the hot swap amplifier controller, allowing automatic substitution of a serving amplifier in fault.



### Slave Port Connection Details

1	+24V DC
2	GND
3	PTT OUT
4	SWAP
5	Fault in
6	NC
7	Priority Audio +Phase
8	Priority Audio -Phase

## Operation

When the priority signal is detected by the priority input of this module, the slave PTT out acts in sympathy, accessing the priority input of the next amplifier in the chain, similarly the fault in line expects to be held low by the cascaded amplifier unless INPUT OPTION switch 2 is set to ON, in which case slave faults are ignored.

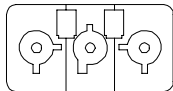
When the amplifier module detects a fault which has stopped it operating it will open circuit the SWAP line, and light the front panel SWAP LED signalling to a hot swap controller it wants substitution.



## 100V Line Output Connections

The recommended cabling for the field speakers with no restoration is 1 number 1.5mm<sup>2</sup> two core FP200 type soft skin cable for runs up-to 500M, or 1 number 2.5mm<sup>2</sup> two core FP200 type soft skin cable for runs up-to 1KM, alternatively 1 number 2 core 1.5mm<sup>2</sup> MICC type cable can also be used, up-to a maximum distance of 200M

The cabling for the field speakers with three wire volume restoration is 1 number 1.5mm<sup>2</sup> four core FP200 type soft skin cable for runs up-to 500M, or 1 number 2.5mm<sup>2</sup> four core FP200 type soft skin cable for runs up-to 1KM, alternatively 1 number four core 1.5mm<sup>2</sup> MICC type cable can also be used, up-to a maximum distance of 200M



100V Line Output Connections

- |   |                           |
|---|---------------------------|
| 1 | 100V line output          |
| 2 | Electrical Earth (screen) |
| 3 | 0V return                 |

### Signal Descriptions

Pins 1 and 3 are high voltage terminals, which are designed to connect to 100V line speaker distribution circuits.

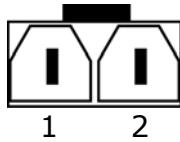
### Operation

In normal mains powered operation, the amplifier provides a voltage proportional to the audio present at the selected input. The output is fully protected against short circuits and earth faults.



## Battery Connection

The recommended cabling for the batteries are two number 4mm CSA LSF cables within a rack, we recommend fusing the batteries separately for each amplifier with a 20A HRC cartridge type fuse. The feeds to several amplifiers should always be run separately to ensure the best audio separation between amplifier channels.



Battery Connection Details

1	GND
2	+27V6 maintained connection to battery

## Signal Descriptions

Pins 1 & 2, are high current (49A) terminals which are designed to connect to SLA batteries.

## Operation

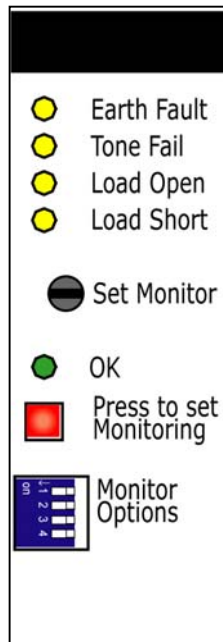
In normal mains powered operation, the amplifier provides a charging voltage of 27V6 at 3A from a variable impedance charging circuit to maintain valve regulated sealed lead acid batteries (VRSLA). Multiple amplifiers can be connected to the same batteries as long as the amplifiers are driven from the same mains phase.

Batteries must be connected in series; the battery monitoring circuit cannot detect faulty cells in parallel battery packs.



## Load Monitoring

Each amplifier module has independent load monitoring, selectable as AC or DC mode depending on application and the settings of the monitor option DIP Switches:



- 1: DC Short Monitor
- 2: AC Open Monitor
- 3: Earth Fault Monitor
- 4: Tone Fail (AC Short)

DC SHORT Circuit Monitor (option 1), setting this switch to On will report a fault (light the Load Short LED) whenever the DC resistance of the 100V line speaker terminals falls below 5K ohms.

AC Open Circuit Monitor (option 2), setting this switch to On will light the Load Open LED when the set monitoring tone is 10% above the level set on the "Set Monitor" Pot.

Earth Fault Monitor (option 3), setting this switch to On will light the earth fault LED when either leg of the 100V line circuit is less than 20K to earth (AC or DC leakage)

Tone Fail Monitor (option 4), setting this switch to On will light the TONE Fail LED when the 22KHz pilot tone level drops 10% below the level set on the "Set Monitor" pot

## Setting the Load Monitoring

### DC Load Monitoring:

Ensure all speakers have DC blocking capacitors fitted, and the end of line 9K resistor (2 off 18K in parallel or 6 off 56K in parallel) is fitted on the circuit end, then set switch 1 and 3 to on (2 and 4 off)- set up is automatic if the EOL resistor is missing, or the line is shorted (or <5K DC resistance) the relevant LED will light

### AC Load Monitoring:

Ensure the AC end of line device is fitted for complete EOL detection; otherwise the monitoring will detect a change of 10% only. Set options 2,3 and 4 to on (1 off).

Set up- Press the set monitor push button in (this reduces the detection window to 1%) and turn the set monitor pot until the Tone fail and load open LEDs go out (the OK LED should light), the push button can now be released, opening the window to 10%. The LEDs on the rear light on any momentary fault, however using a digital filter in the amplifier the fault has to exist for 5 seconds before the fault is transmitted to the front panel and any controller reducing false indications

### Stand by Amplifier Monitoring:

This checks the amplifier is amplifying the monitor tone when used as a Hot Standby amplifier; Set switch 4 on, (1,2 and 3 off) and turn the "Set Monitor" pot until the tone fail LED goes out.



## Amplifier Performance Specification

Output power	200W RMS (PERMA 4) 100W RMS (PERMA 2)
Frequency Response	50Hz to 25kHz -3dB +0dB
THD	better than 0.1%, 1kHz
SINAD	better than -80dB
Regulation	better than 1dB
Output voltage	100V line (50 & 70.7V available to special order)
Operational mode	Bi phase PSCPWM
Efficiency	>92% PERMA2 >86% PERMA4
Protection	Over voltage, under voltage, DC offset, short circuit, thermal and safe operating area
Standby current	150mA with fault lights lit and full load monitoring per module
Full load current	11A (PERMA4) 6A (PERMA 2) @27V

## Monitoring

Detection frequency	22.05kHz
Detection type	AC Window comparator system DC Resistive Bridge option (10K open circuit 5K Short Circuit)
AC Window	10%
Sensitivity	-40dB to -10dB, user adjustable

## Power supply & charger

AC input	230 VAC +/- 20%
DC input	22 to 34 VDC
Charging voltage	27.6 VDC
Charging current	3A
Monitoring	Short circuit and battery high impedance
Aux supply	1A
Fault Port	Isolated faults for signalling to other equipment

## Dimensions

Width	433mm
Height	88mm
Depth	300mm
Weight	14Kgs