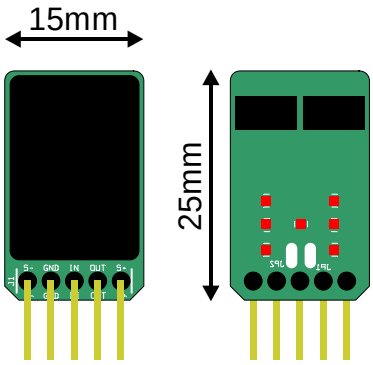
Hypex Electronics BV
Kattegat 8
9723 JP Groningen, The Netherlands
+31 50 526 4993
sales@hypex.nl
www.hypex.nl

HxR12

High-Performance Voltage Regulators



Introduction

The HPR12/HNR12 are high performance voltage regulators targeted at performance-critical audio applications. Key performance parameters exceed that of industry-standard integrated circuits by several orders of magnitude. Kelvin sense connections provide point-of-load (local) regulation without requiring physical proximity.

Highlights

- ✓ Ultra-low noise
- ✓ Wide bandwidth
- ✓ Excellent ripple rejection

Features

- ✓ Low, load-independent output impedance
- ✓ Kelvin sense connections
- ✓ Size and pin compatible with TO-220 style regulators

Applications

- ✓ Preamplifiers and buffers
- ✓ RIAA input stages
- ✓ Playback head amplifiers
- ✓ Performance upgrade for existing products

Theory of operation

The HxR12 series pass regulators are externally compensated transconductance amplifiers. The load decoupling capacitor thereby doubles as compensation capacitor.
In a traditional emitter-output regulator, a constant-gain amplifier is placed around an emitter follower whose output impedance is low and scales inversely with load current. The dominant pole is set inside the voltage amplifier with any load capacitance adding an unwanted pole, reducing phase margin. As output impedance becomes highly current-dependent, so does phase margin.
This contrasts with a transconductance regulator where the error voltage controls the output current. Dominant-pole compensation is effected by the decoupling capacitor across the load. Stability requires a minimum load capacitance and increasing it improves phase margin further. Output impedance works out as the inverse of transconductance which in turn is given by the transconductance of the difference amplifier and the Hfe of the pass device, all of which are nearly constant with load. The advantage of linear output impedance plays out most directly in power supply sensitive audio applications, where a non-linear response from the power supply adds distortion.
Because of the extreme bandwidth of the HxR12 regulators, care should be taken to take the sense connections directly at the decoupling capacitor.

Contents

1 Safety precautions

Warning: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.

1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this apparatus near water.
6. Protect the power cord from being walked on or pinched, particularly at plugs, convenience receptacles, and the point where they exit from the application.
7. Only use attachments/accessories specified or approved by the manufacturer.
8. Unplug this apparatus during lightning storms or when unused for long periods of time.
9. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally or has been dropped.
10. Don't run any cables across the top or the bottom of the module. Apply fixtures to cables to ensure that this is not compromised.
11. Observe a minimum clearance of 6mm with all possible conducting parts (housing etc.).
12. Natural convection should not be impeded by covering the module (apart from the end applications housing).
13. This product is to be used with designated Hypex amplifier modules only.
14. Before using this product, ensure all cables are correctly connected and the power cables are not damaged. If you detect any damage, do not use the product.
15. Changes or modifications not expressly approved by Hypex Electronics will void compliance and therefore the user's authority to operate the equipment.
16. Service or modifications by any person or persons other than by Hypex Electronics authorized personnel voids the warranty.

2 The HxR range

The HxR range is a high-end and low noise replacement for the LM7812 and LM7912 linear voltage regulators. The HPR12 can be used to replace an LM7812, the HNR12 is designed to replace an LM7912.

3 Electrical Specifications

3.1 General Performance Data

V_I=18V, I_O=10mA, T_{amb} =25ºC, unless otherwise noted

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Input Voltage		V_{IN}	15	18	25	V	1)
Thermal dissipation		T_{DISP}		0,5	0,75	W	1) 2)
Output Voltage		V_{OUT}	11.5	12	12.5	V	
Output Impedance	Tj =25ºC	Z_{OUT}	-	50	70	mΩ	
Ripple Rejection	Tj =25ºC	PSRR	105	110	-	dB	
Output Noise Voltage	MBW=10Hz to 20kHz	V_N	-	290	400	nV	
Dropout Voltage		V_D	-	-	3	V	
Quiescent Current	Tj =25ºC	I_Q	-	14	20	mA	
Output Current Range		I_{OUT}	0	-	100	mA	
Short-Circuit Current		I_{SC}	-	500	-	mA	
Optimum Load Capacitance Range		C_L	2.2	-	∞	µF	

Note 1: Recommended operating conditions

Note 2: Please design your application in such a manner that the power dissipation of the HxR will not exceed the given values. The thermal dissipation can be calculated using the following formula: $(V_{IN} - V_{OUT}) * I_{IN}$

3.2 Absolute maximum ratings

Correct operation at these limits is not guaranteed. Operation beyond these limits may result in irreversible damage

Parameter	Conditions	Symbol	Max	Unit	Note
Input Voltage		V_{IN}	60	V	
Output Current		I_{OUT}	600	mA	
Power Dissipation		P_{DISP}	1	W	
Operating Temperature	Maximum junction temperature	T_{junc}	125	ºC	

4 Environmental Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Ambient Temperature	Storage		-25	-	70	ºC	
	Operation	T_{amb}	0	-	50	ºC	
Thermal resistance		$R_{\theta JA}$		105		ºC/W	
Humidity	Max 85 percent relative humidity, non-condensing.						

5 Connector Pinouts

5.1 HPR12 pinout

Pin	Direction	Function	Remarks
J1.1	Sense	SG	Ground Sense input
J1.2	Input	IN	Unregulated input
J1.3	-	GND	Ground connection
J1.4	Output	OUT	Regulated Output
J1.5	Sense	SO	Output Sense input

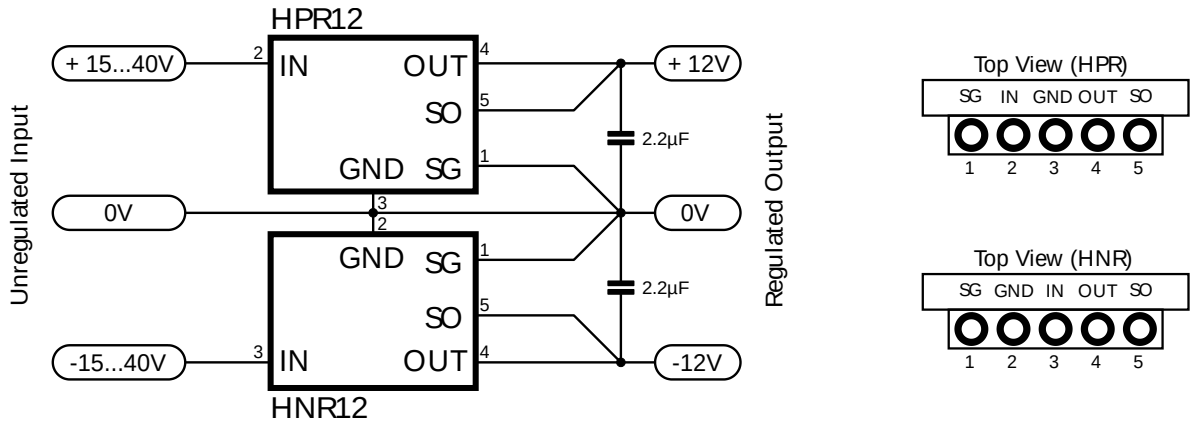
Footprint type equivalent: Fischer Elektronik SL 3.25.36G or Wurth Elektronik 61300511021

5.2 HNR12 pinout

Pin	Direction	Function	Remarks
J1.1	Sense	SG	Ground Sense input
J1.2	-	GND	Ground connection
J1.3	Input	IN	Unregulated input
J1.4	Output	OUT	Regulated Output
J1.5	Sense	SO	Output Sense input

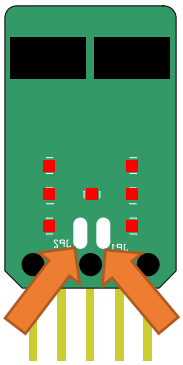
Footprint type equivalent: Fischer Elektronik SL 3.25.36G or Wurth Elektronik 61300511021

6 Typical Application Schematic



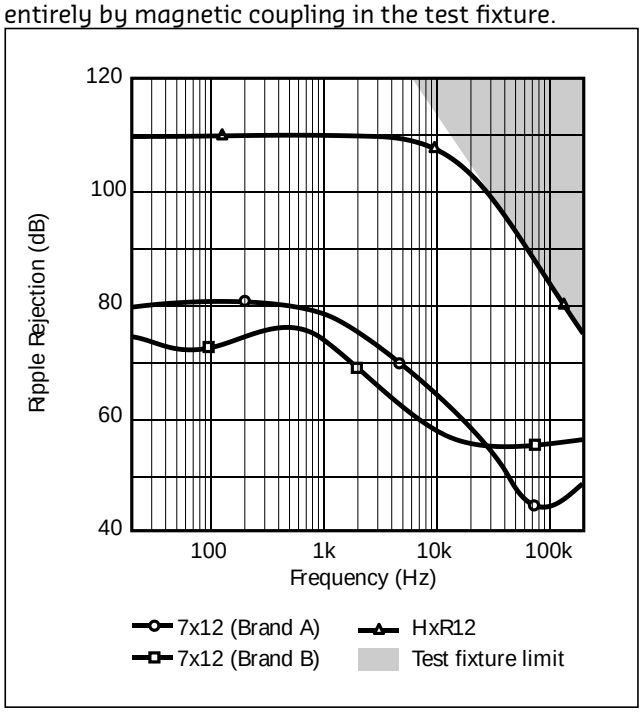
7 Regular LDO replacement

The middle three pins on the HxR12 modules match the pin-out of the standard LM7812CT/LM7912CT devices. If the decoupling capacitor is placed very close to the regulator, full pin-compatibility can be achieved by shorting the two solder jumpers on the back of the module and clipping the two outer pins. This adversely affects all performance parameters so this should only be done when retrofitting pre-existing equipment. In case of doubt, run two wires from the decoupling capacitor to the kelvin sense connections.

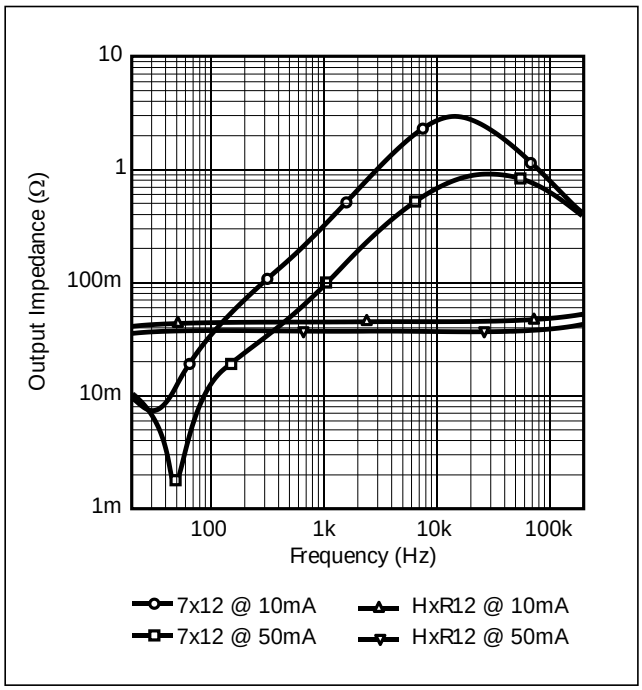


8 Typical Performance Graphs

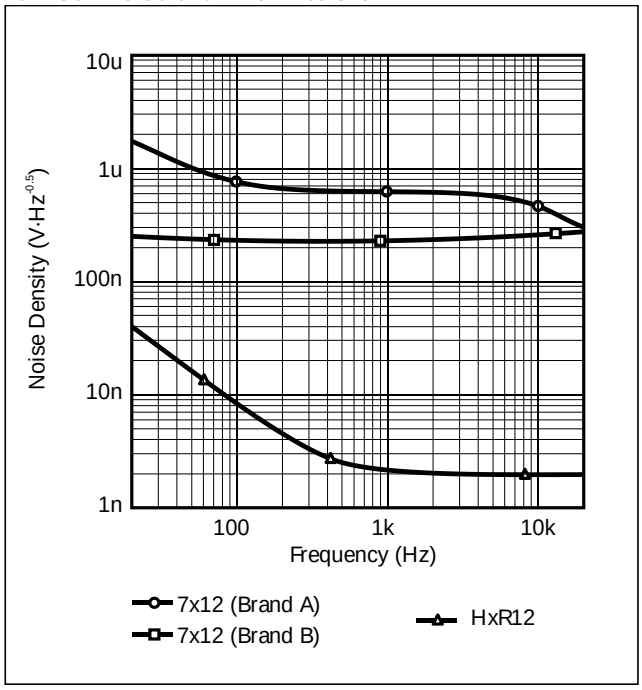
Ripple Rejection. HF ripple rejection is dominated entirely by magnetic coupling in the test fixture.



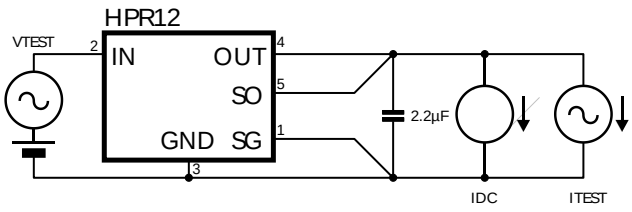
Output impedance at two load currents.



Output noise density. Even though the internal reference has no filtering at all, noise is as low as the Johnson noise of a 250Ω resistor.



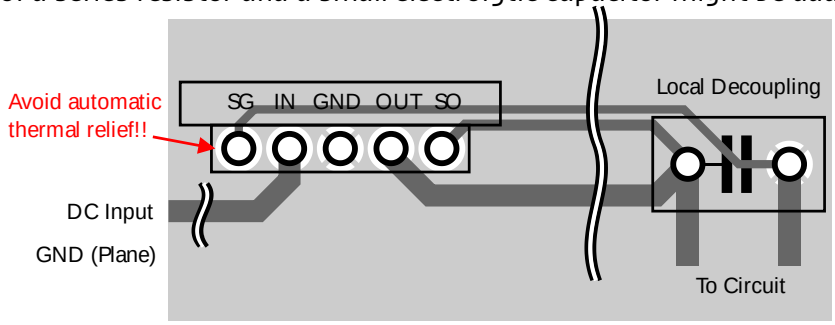
Test circuit.

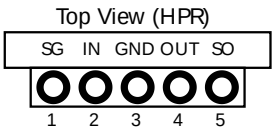


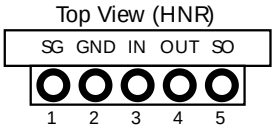
An audio analyser with a typical 40Ω output impedance may be used both as the voltage source at the input or as the current source at the output, since 40Ω is low compared to the input impedance of the regulator and high compared to its output impedance. In that case, the input circuit is rearranged for the analyser output to be capacitively coupled to the circuit input.

9 PCB Layout Considerations

The HxR12 regulators are fast, high-performance circuits. Care must be taken not to degrade performance by lay-out oversights. Most CAD tools automatically assign the output and sense pins to the same net. The sense traces must be routed manually from the decoupling capacitor to the regulator. When using a ground plane, special care should be taken to keep the layout program from drawing a thermal relief star straight to the ground plane. If necessary, use "0 ohm" jumpers to forcibly separate the negative kelvin sense from the GND net. Sense traces should be treated like a differential signal connection. Run them parallel and close to each other, not necessarily parallel to the output traces. The regulator has minimal decoupling internally. If the power traces from the unregulated supply to the regulator are particularly long, some extra decoupling in the form of a series resistor and a small electrolytic capacitor might be added.







10 Upgrading UcD/HG modules

The new High Grade UcD modules have a stuffing option to easily allow users to upgrade their amplifier modules with these regulators. The use of these regulators in combination with the HG UcD amplifier modules further improves the sound quality. The following jumpers need to be removed in order to use these regulators.

UCD180HG V2	Remove R68 & R69
UCD400HG	Remove R85 & R86
UCD700HG	Remove R111 & R112

11 Revisions

Document Revision	PCB Version	Description	Date
R1	HxR12V1	Initial draft.	26.06.2007
R2	HxR12V2	Current source altered. Functionality has not changed.	03.01.2008
R3	HxR12V3	Instructions for UcD180HG changed	21.02.2011
R4	HxR12V3	Added recommended operating conditions Clarified the thermal resistance figures	01.04.2016
R5	HxR12V3	Typing errors corrected	20.06.2019

12 Disclaimer

All products, product specifications and data are subject to change without notice to improve reliability, function or design or otherwise.

Hypex Electronics BV, its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Hypex Electronics"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

This subassembly is designed for use in music reproduction equipment only. No representations are made as to fitness for other uses. Except where noted otherwise any specifications given pertain to this subassembly only. Responsibility for verifying the performance, safety, reliability and compliance with legal standards of end products using this subassembly falls to the manufacturer of said end product.

LIFE SUPPORT POLICY: Use of Hypex products in life support equipment or equipment whose failure can reasonably be expected to result in injury or death is not permitted except by explicit written consent from Hypex Electronics BV.