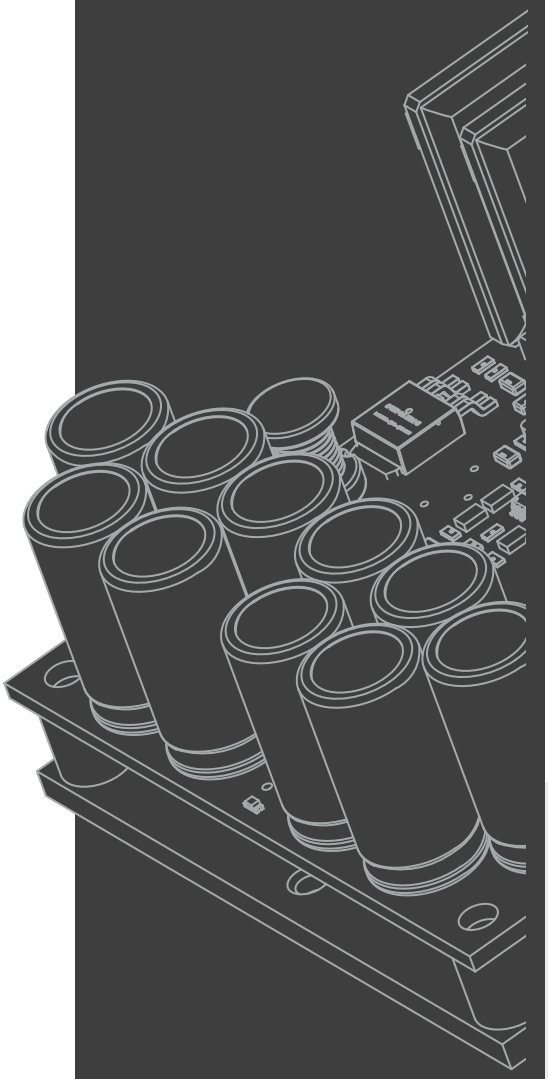
NCx500 OEM

- CLASS D AMPLIFIERS
  - NCx500 OEM
    - DATASHEET



Introduction

NCORE® evolved into NCOREx® where the added 'x' stands for eXceptional resulting in roughly two times better distortion and output impedance. The NCx500, like its predecessor, is a robust and easy-to-use amplifier module.

The trusted industry standard pin header makes system integration very easy. The NCx500 remains pin-compatible with the NC500, making it easier to update existing systems. The on-board buffer can be bypassed which makes it very easy to customize the sound.

Key Features

- Ultra Low Distortion
- Very Low Idle Power
- Very Low Noise
- Very Low Output Impedance
- Buffered / Unbuffered Input Selectable

Key Specifications

Output Power	700W@4Ω
THD+N	0.0006%
Output impedance	250µΩ
Frequency response	0 - 75kHz
Output Noise	7µV
Signal To Noise Ratio	137dB
Idle Power	5,3W

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ncorex
exceptional audio power conversion

Contents

1 Safety Precautions

This module operates at high voltages and carries hazardous voltages at accessible parts. These parts may never be exposed to inadvertent touch. Observe extreme care during installation and never touch any part of the unit while it is connected to the mains.

Allow all capacitors to discharge for 10 minutes before handling it.

Attention: Observe precautions for handling electrostatic sensitive devices. This module uses semiconductors that can be damaged by electrostatic discharge (ESD).

Damage due to inappropriate handling is not covered by warranty. This product has no user-serviceable parts.

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. Only use attachments/accessories specified or approved by the manufacturer.
7. 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.
8. 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.
9. Observe a minimum clearance of 3mm with all possible conducting parts (housing etc.).
10. Natural convection should not be impeded by covering the module (apart from the end applications housing).
11. This product is to be used with Hypex PS500DIY module only.
12. 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.
13. Changes or modifications not expressly approved by Hypex Electronics will void compliance and therefore the user's authority to operate the equipment.
14. Service or modifications by any person or persons other than by Hypex Electronics authorized personnel voids the warranty.

Précautions de sécurité

Ce module est sous tension secteur et certaines de ses pièces accessibles sont sous une tension dangereuse. Ces pièces doivent dans tous les cas être protégées contre contacts accidentels. Lors de l'installation, une prudence extrême s'impose. Ne jamais toucher les pièces du module quand celui-ci est relié au secteur. Isoler l'appareil du secteur et attendre 10 minutes pour laisser à tous les condensateurs le temps de se décharger avant de le manipuler.

Attention : Respecter les consignes de sécurité pour la manipulation d'appareils sensibles aux courants électrostatiques. Ce module est pourvu de semi-conducteurs qui peuvent être endommagés par les décharges électrostatiques (DES).

Les dommages causés par un usage non approprié sont exclus de la garantie.
Ce produit ne contient aucune pièce devant être entretenue par l'utilisateur.

2 Electrical Specifications

2.1 Recommended Operating Conditions & Supply Currents

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Input Voltage Main	Symmetric supply (+/-)	V_{MAIN}	55	84	98	V	1)
Input Current Main	Idle operation	I_{MAIN}		23		mA	
Input Voltage Vaux	Symmetric supply (+/-)	V_{AUX}	15	18	25	V	1)
Input Current Vaux		I_{AUX}		40	45	mA	
Input Voltage Logic		V_{UC}	4		25	V	
External Driver Supply Voltage		V_{DR}	15		24	V	1, 2)
External Driver Supply Current		I_{DR}		100	125	mA	
Effective Power Supply Storage Capacitance	Per rail, per attached amplifier. 4Ω load presumed.	C_{SUP}	4700			µF	3)

Note 1: Unit protects if allowable range is exceeded.

Note 2: Floating and referenced to HV-.

Note 3: The effective power supply storage capacitance of a Hypex SMPS is already in excess of 4700uF. Do not add supplementary capacitance.

2.2 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
Power Supply Voltage		HV+/-	+/- 100	V	
VDR Supply Voltage		V_{DR}	25	V	
Vaux Supply Voltage	Symmetric supply (+/-)	V_{AUX}	30	V	
Peak Output Current	Guarded by current limit at 27A	$I_{OUT,P}$	28	A	
Signal Input Voltage	Either input referenced to ground Buffered: Unbuffered:	 $V_{IN,B}$ $V_{IN,UNB}$	 +/- 5 +/- 15	V	
Input Current	Logical inputs and buffer inputs	I_{IN}	10m	A	
Collector Voltage	Open collector outputs when high	V_{OC}	35	V	
Collector Current	Open collector outputs when low	I_{OC}	2	mA	

2.3 Protection Limits

Parameter	Symbol	Max	Unit	Note
HV Undervoltage Lockout	HV_{UVLO}	50	V	
HV Overvoltage Lockout	HV_{OVLO}	100	V	
VDR Undervoltage Lockout	VDR_{UVLO}	14.5	V	
VDR Overvoltage Lockout	VDR_{OVLO}	25	V	
Overtemperature		85	ºC	
Overtemperature lower hysteresis		75	ºC	

2.4 NCx500 OEM Amplifier Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Peak Output Power	1kHz, THD=1%	$P_{R,\ 2\Omega}$	-	700	-	W	
		$P_{R,\ 4\Omega}$	-	700	-	W	
		$P_{R,\ 8\Omega}$	-	380	-	W	
Cont. Output Power		$P_{R,\ CONT}$	-	-	-		1)
Distortion	20Hz<f<20kHz, 4Ω, $P_{OUT}<P_R/2$	THD+N	-	0.0006	0.001	%	2)
CMRR			55	65		dB	
Signal-To-Noise Ratio	Unbuffered, 1W	SNR	-	109	-	dB	
	Unbuffered, 700W	SNR	-	137	-	dB	
	Buffered, 1W	SNR	-	100	-	dB	
	Buffered, 700W	SNR	-	128	-	dB	
Output noise	Unbuffered	V_N	-	7	-	µV	
	Buffered	V_N	-	20	-	µV	
Output Impedance	f<20kHz	Z_{OUT}	-	2	-	mΩ	
	f<1kHz	Z_{OUT}	-	250	-	µΩ	
Power Bandwidth		PBW	35	-	-	kHz	
Frequency Response	+0/-3dB. All loads		-	-	70	kHz	
	+0/-0.3dB. All loads		-	-	20	kHz	
Voltage Gain	Unbuffered	$A_{V,unbuf}$	11.3	11.5	11.7	dB	
	Buffered	$A_{V,buf}$	26.6	26.8	27	dB	
Supply Ripple Rejection		PSRR	-	80	-	dB	
Output Offset Voltage		$\|V_{OO}\|$			30	mV	
Efficiency	Full power	η		93		%	
Input for max power	Unbuffered	$V_{IN,PMAX}$	-	14,2	-	Vrms	
	Buffered	$V_{IN,PMAX}$	-	2,16	-	Vrms	
Output Current Limit		I_{OUT}	26	27	28	Apk	
Idle Losses	Powerstage only	P_0	-	5,3	5,8	W	

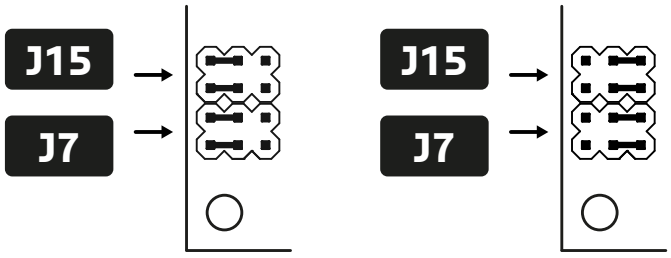
Note 1: Limited by thermal system implementation.

Note 2: At higher audio frequencies there are not enough harmonics left in the audio band to make a meaningful THD measurement. High frequency distortion is therefore determined using an 18.5kHz+19.5kHz 1:1 two-tone IMD test.

2.5 NCx500 OEM Audio I/O Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
DM Input Impedance	Unbuffered	$Z_{IN,DM}$		1,5		kΩ	
	Buffered	$Z_{IN,DM}$		47		kΩ	
Source Impedance	Differential	Z_{SRC}			50	Ω	
Load Impedance Range		$Z_{L,SE}$	1	-	-	Ω	

2.5.1 Audio Input



Unbuffered buffered

The INH/INC inputs form a differential pair. Note that the unbuffered input impedance is fairly low meaning that minimalist discrete circuits or valve input stages won't work. All op amps commonly used in audio can handle them though. Do not drive the input with fully floating sources, be it electrically floating ones like line driver IC's intended for driving XLR outputs or transformers. Using a floating source will always result in a common mode component that will exceed the common mode input range and will manifest itself as gross distortion. Make sure to set the outputs of your distortion analyser to grounded, not floating.

Signal Coupling

To achieve optimal signal coupling, the audio signal inputs are all DC coupled. One must make sure that the connected application is free of DC offset.

2.5.2 Buffered / Unbuffered Input

The NCx500 OEM incorporates a buffer stage to increase voltage gain and input impedance and therefor make it easier to drive the amplifier. This buffer stage can be omitted so control over the design of this stage and thereby tuning to a 'house sound' can be done more easily. The selection of either using the module buffered or unbuffered can be done through jumper settings on J7/J15.

2.6 Application Considerations

2.7 Cooling

Use four M3 screws[1)] to fasten the NCx500 OEM to an aluminium surface of reasonable thickness (>2mm). In most cases this will be the bottom of a moderate sized aluminium housing. The NCx500 OEM runs fairly cool so no use of fans, external heatsinks or thermal paste is required.

Defects caused by overheating due to poor thermal management are not covered by warranty.

Note 1. Be sure that the screws don't protrude the heatspreader too much to avoid damage to electrical components on the bottom side of the board.

3 Environmental Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Ambient temperature	Storage		-25		70	°C	
	Operation	T_{AMB}	0		65	°C	1)
Heatsink Temperature		$T_{H,MAX}$			90	°C	2)
Humidity	Max 85 percent relative humidity, non-condensing.						

Note 1: Lower improves lifetime.

Note 2: Thermistor limited. User to select heat sink to insure this condition under most adverse use case.

4 IO Specifications

Item	Symbol	Min	Typ	Max	Unit	Note
Pull-up	R_{WPU}		27		kΩ	nAMPON, OPTION, To 3V3
Logical high input voltage	V_{IH}	2.65		3.6	V	nAMPON, SCL, SDA
Logical low input voltage	V_{IL}	-0.3		0.5	V	nAMPON, SCL, SDA
Logical high ouput voltage	V_{OL}			0.4	V	nFATAL, SCCPIND, SDA, CLIP, I_{OL} =1mA

4.1 Operation In Hardware Mode

To operate in Hardware Mode, leave the OPTION (pin 31) unconnected.

4.1.1 nAMPON

Pulling nAMPON low enables the amplifier as soon as all error conditions have been cleared for at least one second.

4.1.2 READY

The READY pin is pulled high whenever the amplifier is amplifying audio. When it mutes, for whatever reason, READY goes low. This includes periodic mutes after sustained overcurrent events.

4.1.3 CLIP

The CLIP indicator pin is active low, open collector, meaning that the CLIP indicator of several channels may be paralleled. An external pull-up resistor should be attached. The CLIP indicator is asserted whenever the amplifier is unable to track the input accurately:

- Normal clipping
- Current limiting
- Signal input during mute

Note that whilst muted the amplifier is clearly unable to track any input other than zero. The application circuit should ignore the CLIP flag during mute as it is likely that the CLIP indicator will be chattering most of the time.

4.1.4 SCCPIND

SCCP stands for single-cycle current protect. The amplifier has a two-stage overcurrent protection. Short overcurrent events are covered by a cycle-by-cycle limiter which clips the output signal in the current domain. When too many switching cycles are terminated by the cycle-by-cycle limiter, indicating a sustained overload, the amplifier will mute momentarily to allow the output devices to cool down. SCCPIND is an open-collector, active low output that outputs the cycle-by-cycle pulses.

4.1.5 nFATAL

nFATAL is an open collector, active low output which is asserted when the amplifier senses a large DC voltage at the output. When a >15V DC potential is detected, the amplifier will first mute because the reason might well be DC at the input. If this fails to restore the output to zero, nFATAL will be pulled low to indicate catastrophic failure.

IMPORTANT: For safety reasons, the application must be able to respond to this line by turning the power supply off.

Do not use output relays. Apart from causing distortion, a relay is not suited to disconnect a heavily inductive load like a loudspeaker. Typical loudspeakers store enough energy to weld the relay shut, maintaining the safety hazard.

4.2 Operation In Software Mode

When OPTION (pin 31) is pulled-down, the amplifier is operated in Software mode. In software mode, pin 36 is configured as SCL and pin 35 as SDA. These lines should be pulled to 3.3V with 4.7k resistors externally. The I^2C bus should be operated at the standard 100kHz rate. Please make sure the I^2C bus to this amplifier is isolated from other I^2C buses, in order to prevent an I^2C bus hangup when the supply for the amplifier is turned off.

4.2.1 Address Selection

The NCx500 OEM supports up to 16 I^2C addresses. Set the address by pulling OPTION to GND through a resistor.

Pull-down resistor at Pin 31	Dec I^2C address	Binary I^2C address
0	88	1011000x
1.8k	89	1011001x
3.9k	90	1011010x
6.8k	91	1011011x
10k	92	1011100x
12k	93	1011101x
18k	94	1011110x
22k	95	1011111x
27k	96	1100000x
33k	97	1100001x
47k	98	1100010x
56k	99	1100011x
82k	100	1100100x
120k	101	1100101x
180k	102	1100110x
390k	103	1100111x

x = r/w bit

4.2.2 I²C Registers

I²C Register	Bits	Function	Description
0 (read only)	0	DCError	DC error occurred (latching)
	1	PlusHVOver	Overvoltage on +HV detected
	2	MinHVOver	Overvoltage on -HV detected
	3	PlusHVUnder	Undervoltage on +HV detected
	4	MinHVUnder	Undervoltage on -HV detected
	5	OverloadError	Current overload detected
	6	FreqError	Switching frequency out of range
	7	AmpFail	General amplifier failure
1 (read only)	0	VDROver	VDR overvoltage detected
	1	VDRUnder	VDR undervoltage detected
	2	AmpReady	Amplifier is up-and-running
	3	OverTemp	Temperature too high error
	4	FeedbackError	Feedback error detected
	5	VopError	Supply power failure
	6	B1B6	Bit is always 1
	7	OverloadPending	Overcurrent detector is detecting possible overload
2 (read/write)	0	AmpEnable	Enable amplifier when '1'
	1	Testing purposes	Keep this bit '0' at all times!
	2..7	Future options	Keep these bits '0' for future options
3 (read/write)	0..7	PlusHV	8 bits, range 0..250V **1)**
4 (read/write)	0..7	MinHV	8 bits, range 0..250V **1)**
5 (read/write)	0..7	VDR	8 bits, range 0..25.0V **1)**
6 (read/write)	0..7	Temperature	8 bits, range -10..+125 °C **1)**
7 (read/write)	0..7	FswLegacy	8 bits, range 0..10 (*64kHz=switching frequency)
8 (read/write)	0..7	ProductCode	**2)**
9 (read/write)	0..7	Version	Any value between 0..255
10 (read/write)	0..7	Build	Any value between 0..255
11 (read/write)	0..7	Constant	Reads 193 (0xc1)
12 (read/write)	0..7	Constant	Reads 193 (0xc1)
13, 14 (read only)	0..9	Fsw	Switching frequency. 10 bits, range 0..1023 = 0..1023kHz, register 13=lower eight bits, register 14=upper two bits (value 450 corresponds with 450kHz)
15 (read only)	0..3	Future options	Reads '0'
	4	Test flag	Reads undefined value
	5	Led	Represent LED status (lit when '1')
	6..7	Future options	Reads '0'
16 (read only)	0..7	Future options	Reads '0'
17 (read only)	0..7	Future options	Reads '0'
18 (read only)	0..7	Test flags	Reads undefined value

Note 1:

Registers 3 and 4 represent an unsigned byte-value and return a positive number between 0 and 250. For example: a value 76 corresponds with 76Volt.

Registers 5, 16 and 17 also represent an unsigned byte-value and return a positive number between 0 and 250, but that value needs to be divided by 10. For example: a value of 214 corresponds with 21.4Volt. Note that for register 17 a value of 214 would correspond with a value of -21.4V (as it represents -Vaux).

Register 6 represent a signed 8-bit value as a temperature. It is coded as 2's-complement in the range of -10ºC .. 125ºC.

Temperature	Registry 7 binary	Byte read
-10	11110110	246
-9	11110111	247
-8	11111000	248
-7	11111001	249
-6	11111010	250
-5	11111011	251
-4	11111100	252
-3	11111101	253
-2	11111110	254
-1	11111111	255
0	00000000	0
1	00000001	1
2	00000010	2
3	00000011	3
4	00000100	4
5	00000101	5
6	00000110	6
7	00000111	7
8	00001000	8
9	00001001	9
10	00001010	10
Etcetera		

Note 2:

Module	Product code
NC500	5
NCx500	50

4.3 Supply Connections

A symmetrical supply must be connected to the HV-, GND and HV+ pins. The amplifier will operate from the minimum voltage mentioned in Section '2.1' upward but rated output power is not available at low voltages. The floating VDR supply should be connected between HV- and VDR. Any other connection may cause damage or excessive heat output.

All GND pins are directly connected to the same ground plane. A GND pin (27) is provided near the small-signal end of the connector for convenience only. No distinction is made between "signal ground" and "power ground" because both inputs and outputs are configured as differential signal pairs that do not rely on GND as a reference potential.

4.4 Speaker And Feedback Connections

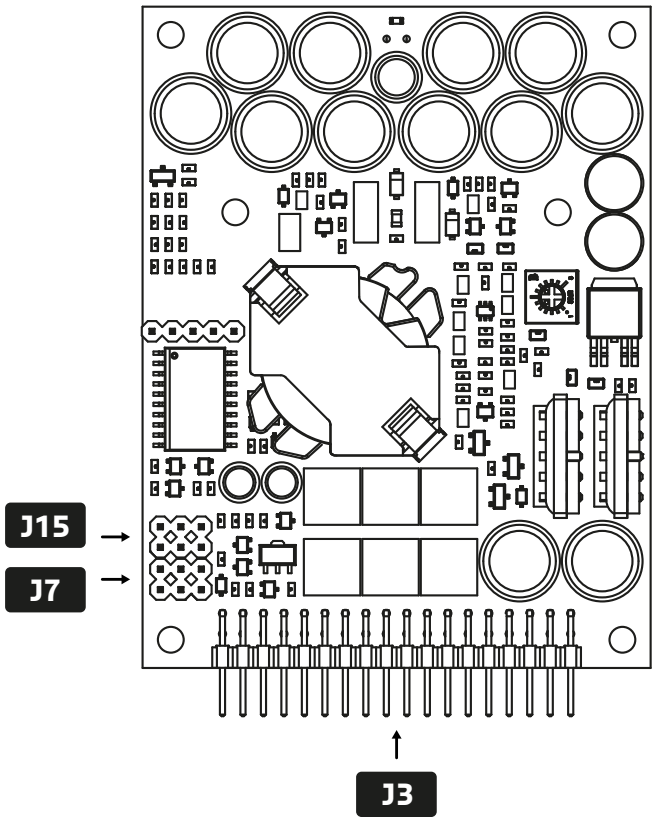
The speaker output is the OUTH/OUTC signal pair. Strictly connect the speaker between OUTH and OUTC. Do not treat OUTC as a ground terminal. FBH and FBC must be connected to OUTH and OUTC not more than a few cm away from the amplifier. This is done to eliminate the contact resistance of J3 from the output impedance. The points where FBH/FBC take off from OUTH/OUTC may be used to branch off biwired connections. Otherwise, simply connecting all 6 pins 13...18 (and 19...24 likewise) with one wide trace is perfectly acceptable. Using FBH/FBC to sense remotely (e.g. at the end of a speaker cable) does not work well. Do not leave FBH/FBC unconnected.

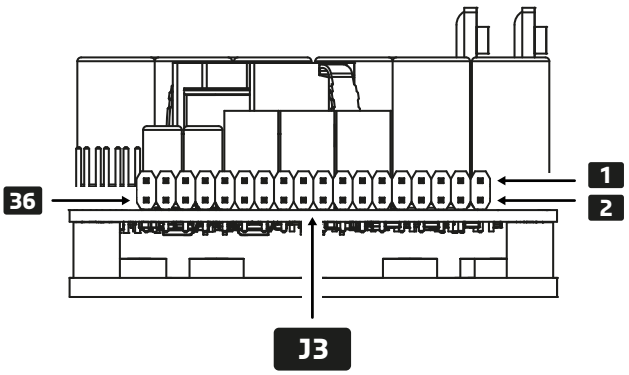
4.5 Microcontroller External Voltage

This pin can be used to keep the Microcontroller powered while the rest of the system is not.

5 Connector Pinouts

This chapter describes the functional connectors of the amplifier module. A connector not stated in this chapter is only used for production or quality control and must remain unconnected in the end user application





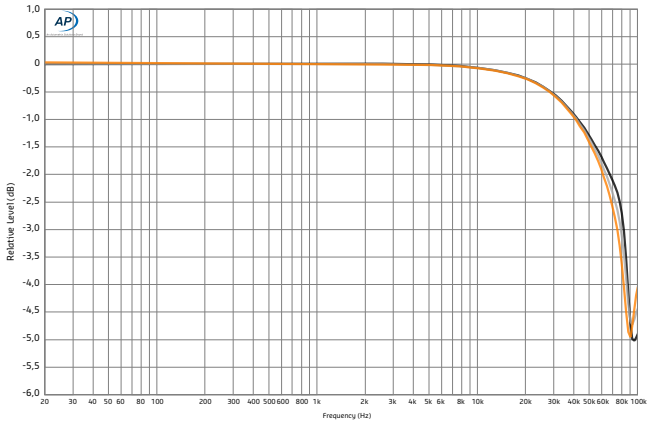
5.1 J3 - Interface Connector

Pin	Direction	Function	Remarks
1	Input	HV+	Unregulated supply
2	Input	HV+	Unregulated supply
3	Input	GND	-
4	Input	GND	-
5	Input	GND	-
6	Input	GND	-
7	Input	GND	-
8	Input	GND	-
9	Input	HV-	Unregulated supply
10	Input	HV-	Unregulated supply
11	Input	V_{DR}	External driver supply connection, referenced to HV
12	Input	V_{UC}	External voltage supply for microcontroller (optional)
13	Output	OUTC	Cold Loudspeaker Output
14	Output	OUTC	Cold Loudspeaker Output
15	Output	OUTC	Cold Loudspeaker Output
16	Output	OUTC	Cold Loudspeaker Output
17	Input	FBC	Cold Feedback (do not leave unconnected)
18	Output	OUTC	Cold Loudspeaker Output
19	Input	FBH	Hot Feedback (do not leave unconnected)
20	Output	OUTH	Hot Loudspeaker Output
21	Output	OUTH	Hot Loudspeaker Output
22	Output	OUTH	Hot Loudspeaker Output
23	Output	OUTH	Hot Loudspeaker Output
24	Output	OUTH	Hot Loudspeaker Output
25	Input	V_{AUX-}	Negative supply for modulator stage
26	Input	V_{AUX+}	Positive supply for modulator stage
27	-	GND	-
28	-	Not Connected	-
29	Input	INH	Non-inverting audio input
30	Input	INC	Inverting audio input
31	Input	OPTION	Control mode and I²C address selection
32	Input	nAMPON	HW mode: Amplifier enable control
33	Output	CLIP	Clip indication
34	Output	SCCPIND	Overcurrent indication
35	Output	SDA READY	SW mode: Data line of I²C bus HW mode: Operating indicator (active high)
36	Output	SCL nFATAL	SW mode: Clock line of I²C bus HW mode: Catastrophic fault indication, inverse of internal FATAL bit

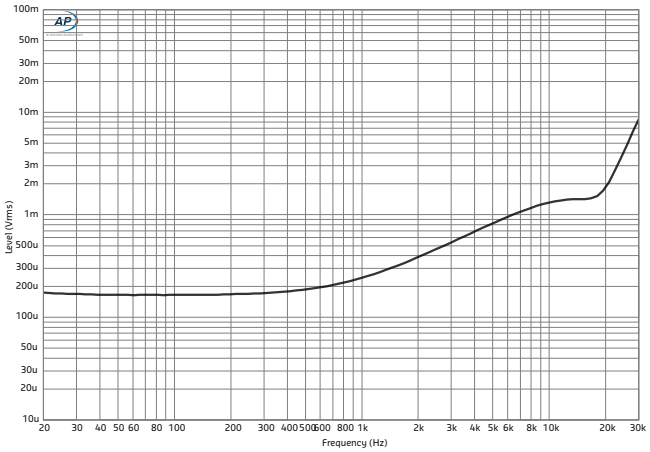
6 Typical Performance Graphs

Test conditions: NCx500OEM at typical voltages. Measurement bandwidth=20kHz except for small signal tests.

6.1 Small Signal Tests

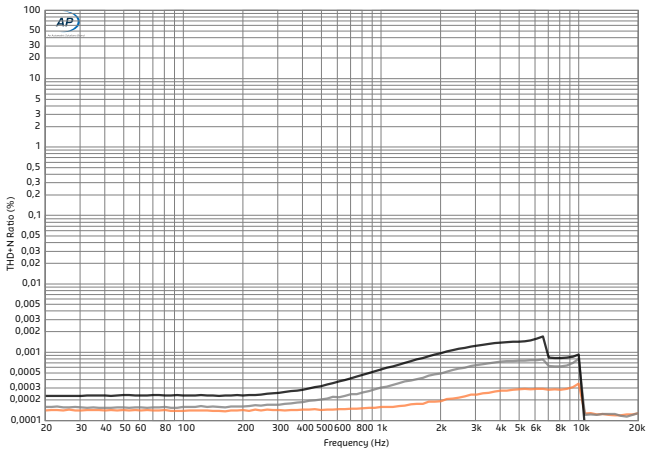


Frequency response into 2Ω, 4Ω and 8Ω

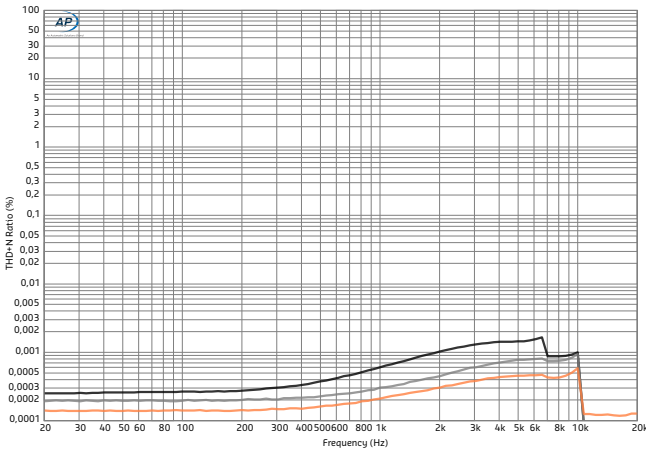


Output impedance, measured at output terminals

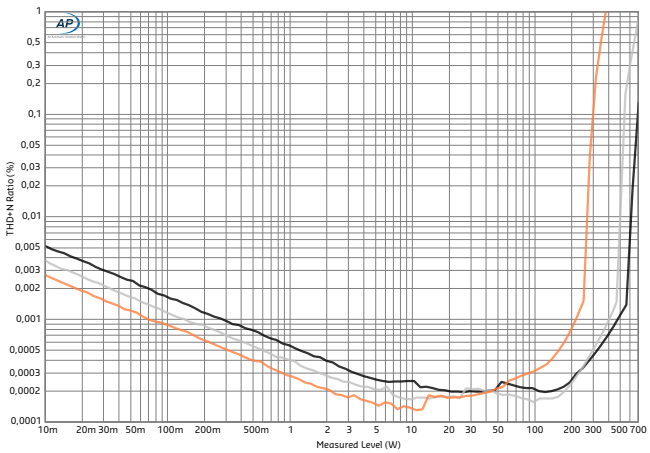
6.2 Large Signal Tests



THD vs. frequency into 8Ω at 5W, 50W and 150W

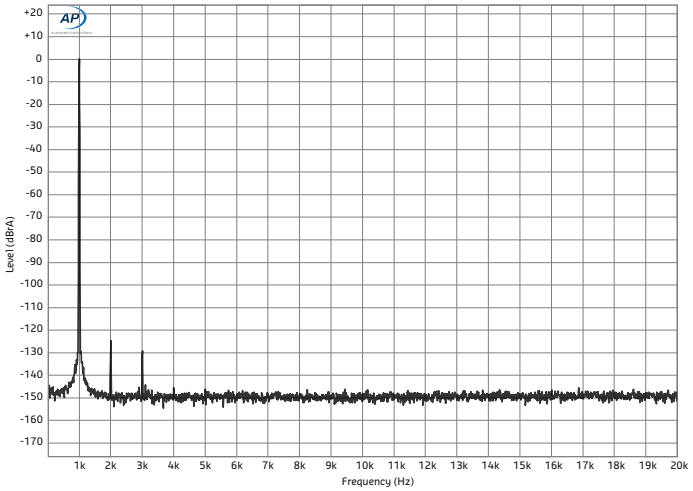


THD vs. frequency into 4Ω at 10W, 100W and 300W

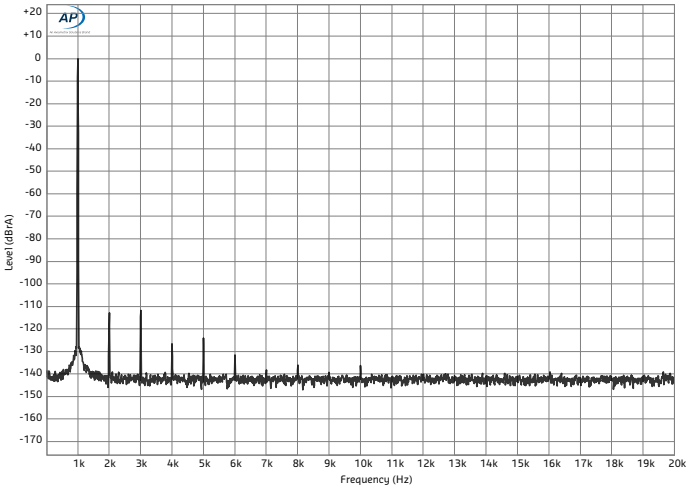


THD+N vs. power at 1kHz into 2Ω, 4Ω and 8Ω

6.3 FFT Tests (8Ω)

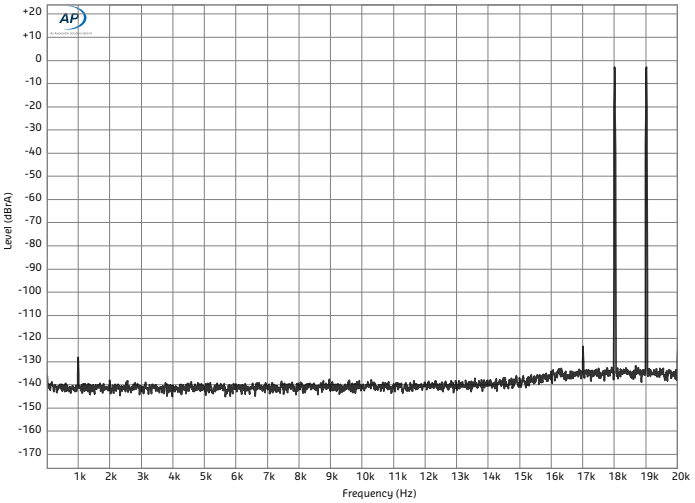


Noise floor and distortion residual at 5W

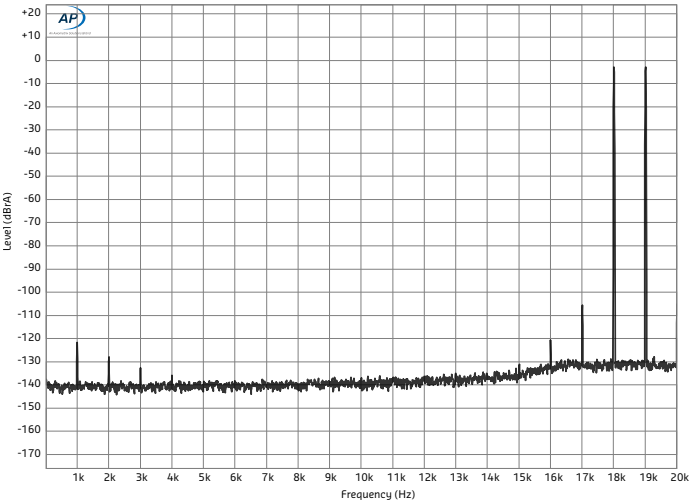


Noise floor and distortion residual at 100W

6.4 IMD Tests (8Ω)

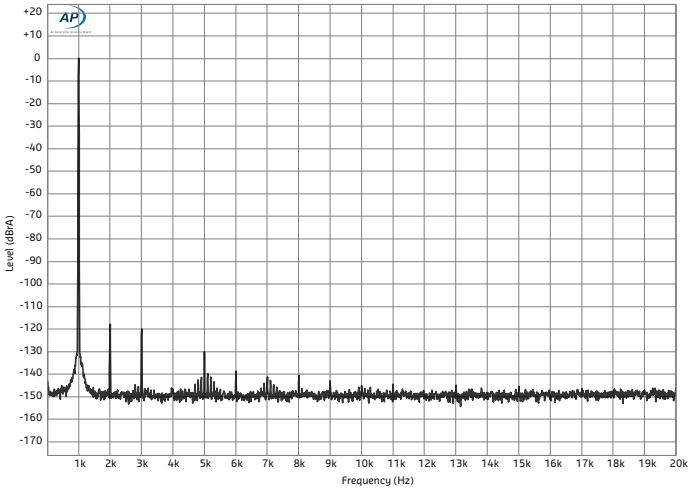


Noise floor and distortion residual at 5W

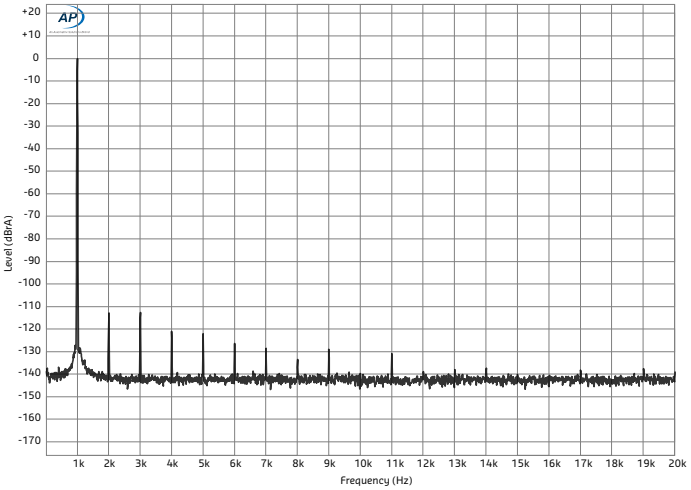


Noise floor and distortion residual at 100W

6.5 FFT Tests (4Ω)

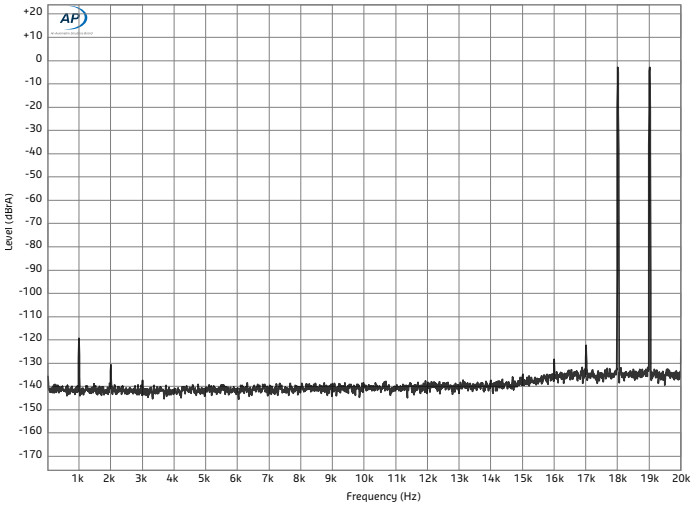


Noise floor and distortion residual at 10W

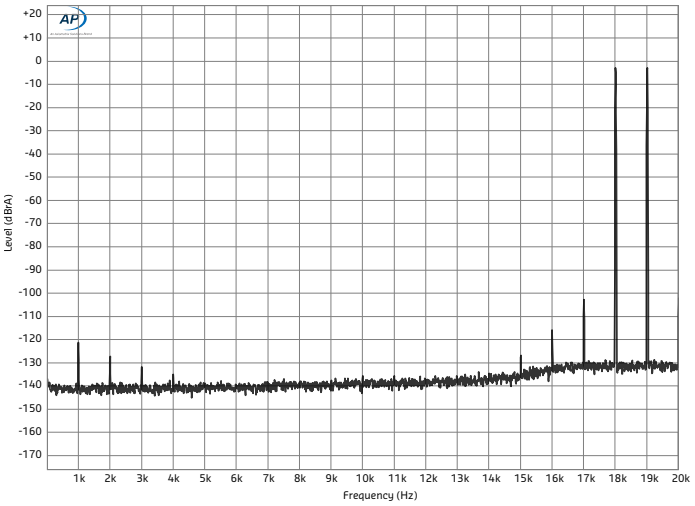


Noise floor and distortion residual at 200W

6.6 IMD Tests (4Ω)

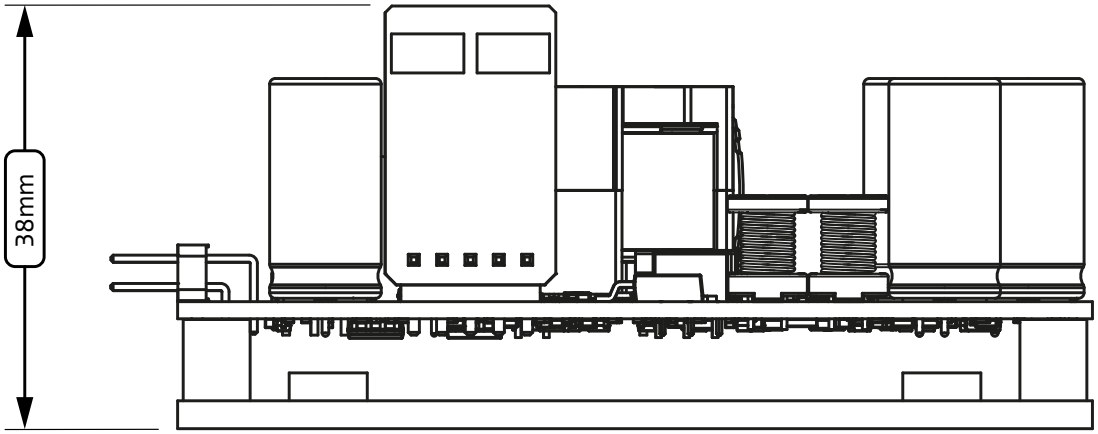


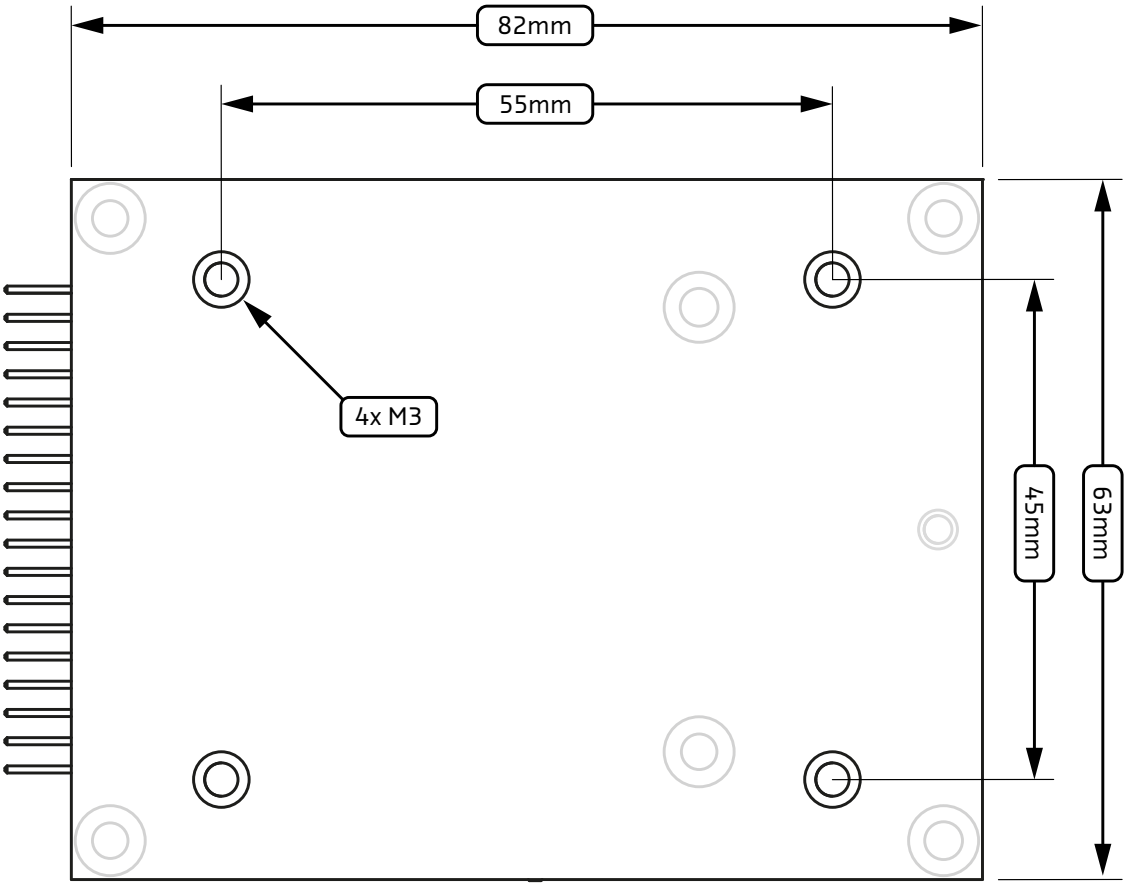
IMD 18.5kHz + 19.5kHz at 10W



IMD 18.5kHz + 19.5kHz at 200W

7 Dimensions & Drill Pattern





8 Revisions

Document Revision	Module Revision	Change Log	Date
R1	NCx500 OEM 01xx	First revision	07.03.2023

9 Disclaimer

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