300W rms Class-T Combinant Digital™ Shielded Amplifier Module using the TA0102A Digital Audio Amplifier with Digital Power Processing™ Technology SAM-TA0102

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General Description

The Tripath Shielded Amplifier Module (SAM) is a 300W amplifier module that uses Tripath's proprietary Digital Power Processing™ technology. The module can be configured as a mono-bridged subwoofer delivering 300W rms or as a stereo amplifier delivering 150W rms per channel. This technology is applied in audio as a Class-T amplifier that offers both the audio fidelity of Class-AB and the power efficiency of Class-D amplifiers. This fully functional amplifier module contains an auto-sensing switching power supply for use with 110V or 220V and is FCC/B and UL pending.

Applications

- Powered speakers
- Powered subwoofers
- Portable audio mixers
- Distributed home amplifiers
- Reference speakers
- Pro-audio amplifiers
- Home/PC speaker systems
- Multi channel home amps

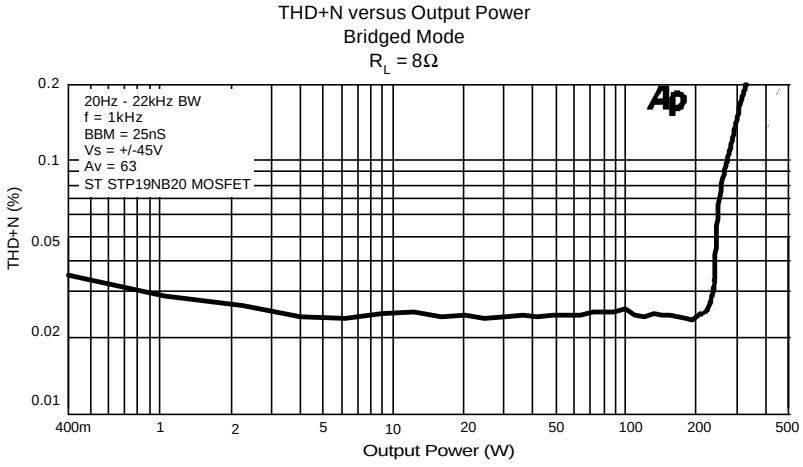
Benefits

- Reduced system cost with smaller/less expensive power supply and heat sink
- Signal fidelity equal to high quality Class-AB amplifiers
- High dynamic range compatible with digital media such as CD and DVD
- Fast time to market: complete amplifier, regulatory certified

Features

- Class-T architecture
- Proprietary Digital Power Processing™ technology
- 300W rms in bridged subwoofer mode @ 0.2% THD+N, 8Ω (per FTC 16 CFR Part 432)
- 150W rms per channel in stereo mode @ 10% THD+N, 8Ω (per FTC 16 CFR Part 432)
- "Audiophile" Sound Quality
  - 0.03% THD+N @ 85W rms, 8Ω
  - 0.04% IHF-IM @ 5W rms, 8Ω
- High System Level Efficiency
  - 67% @ 300W rms, 4Ω
- Mute input
- Outputs short-circuit protected
- Single ended and bridgeable outputs
- Complete with power supply and amplifier
- Bass, Treble, and Volume controls

Typical Performance – Bridged Mode



Absolute Maximum Ratings

SYMBOL	PARAMETER	Value	UNITS
Vs	Supply Voltage	265 AC	V
f_{Vs}	Supply Voltage Frequency	65	Hz
T_{STORE}	Storage Temperature Range	-40 to 150	ºC
T_A	Operating Free-air Temperature Range	0 to 50	ºC

Notes: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.

Operating Conditions

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS
Vs	Supply Voltage	90	110 or 220	250	VAC
V_{IN}	Audio input voltage level			5	V P-P
f_{Vs}	Supply Voltage Frequency	47	60	63	Hz

Note: Recommended Operating Conditions indicate conditions for which the device is functional. See Electrical Characteristics for guaranteed specific performance limits.

T_A = 25°C. See Note 1 for Operating Conditions and Test/Application Circuit Setup.
Minimum and maximum limits are guaranteed but may not be 100% tested.

Performance Characteristics – Bridged

Unless otherwise specified, f = 1kHz, Measurement Bandwidth = 22kHz. T_A = 25°C.
See Note 1 for Operating Conditions and Test/Application Circuit Setup.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
P_{OUT}	Output Power (continuous RMS)	THD+N = 0.05%, R_L = 8Ω T HD+N = 0.2%, R_L = 8Ω		240 300		W W
THD+N	Total Harmonic Distortion Plus Noise	P_{OUT} = 220W, R_L = 8Ω		0.03		%
IHF-IM	IHF Intermodulation Distortion	19kHz, 20kHz, 1:1 (IHF), R_L = 8Ω P_{OUT} = 5W		0.04		%
SNR	Signal-to-Noise Ratio	A Weighted, P_{OUT} = 1W, R_L = 8Ω		88		dB
η	Power Efficiency	P_{OUT} = 300W, R_L = 8Ω		66		%
f_p	Low Frequency Pole	Rin = 49.9K Ohms, Cin = 1µF		10		Hz
e_{NOUT}	Output Noise Voltage	A-Weighted, no signal, input shorted, DC offset nulled to zero		300		µV

Minimum and maximum limits are guaranteed but may not be 100% tested.

Performance Characteristics – Single Ended

Unless otherwise specified, f = 1kHz, Measurement Bandwidth = 22kHz. T_A = 25°C.
See Note 1 for Operating Conditions and Test/Application Circuit Setup.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
P_{OUT}	Output Power (continuous RMS/Channel)	THD+N = 0.1%, R_L = 8Ω THD+N = 1%, R_L = 8Ω THD+N = 10%, R_L = 8Ω		100 120 150		W W W
THD+N	Total Harmonic Distortion Plus Noise	P_{OUT} = 85W/Channel, R_L = 8Ω		0.03		%
IHF-IM	IHF Intermodulation Distortion	19kHz, 20kHz, 1:1 (IHF), R_L = 8Ω P_{OUT} = 5W		0.04		%
SNR	Signal-to-Noise Ratio	A Weighted, P_{OUT} = 1W, R_L = 8Ω		88		dB
CS	Channel Separation	0dBr = 10W, R_L = 8Ω		74		dB
η	Power Efficiency	P_{OUT} = 150W/Channel, R_L = 4Ω		67		%
f_p	Low Frequency Pole	Rin = 49.9K Ohms, Cin = 1µF		10		Hz
e_{NOUT}	Output Noise Voltage	A-Weighted, no signal, input shorted, DC offset nulled to zero		300		µV

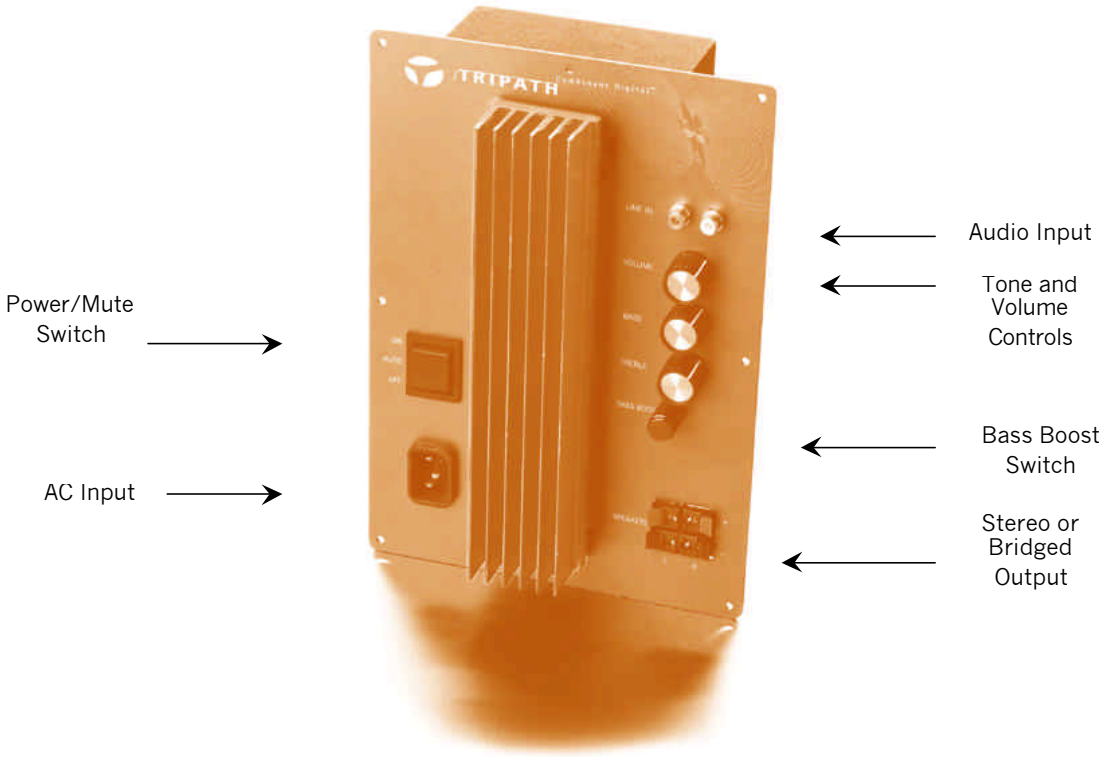
Minimum and maximum limits are guaranteed but may not be 100% tested.

Notes:

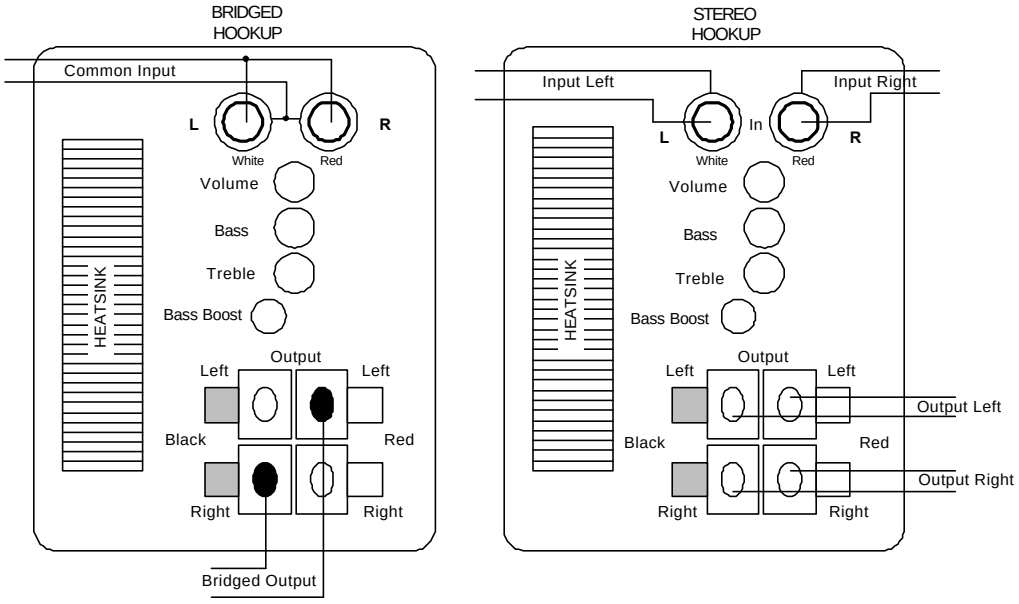
1) Amplifier Circuit Values:

D = MUR120T3 diodes, R_{IN} = 49.9KΩ
R_D = 33Ω, R_S = 0.01Ω, R_G = 5.6Ω
R_{OCR1} = R_{OCR2} = 30KΩ, L_F = 11.3uH (Amidon core T106-2)
C_F = 0.22uF, C_D = 0.1uF, C_{IN} = 1uF, C_{BY} = 0.1uF
Power Output MOSFETs = STP19NB20
BBM = 25nS

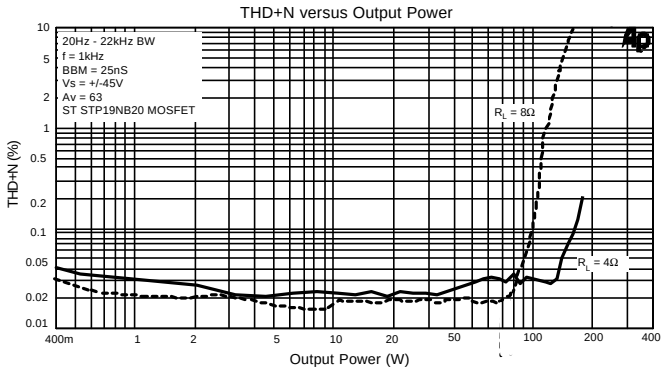
Module Functions

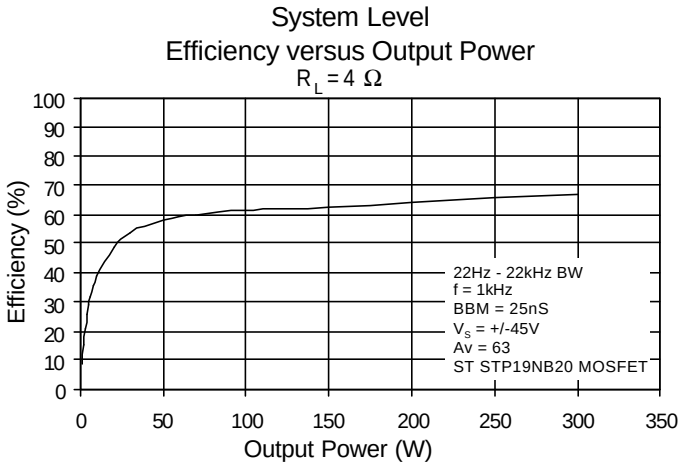


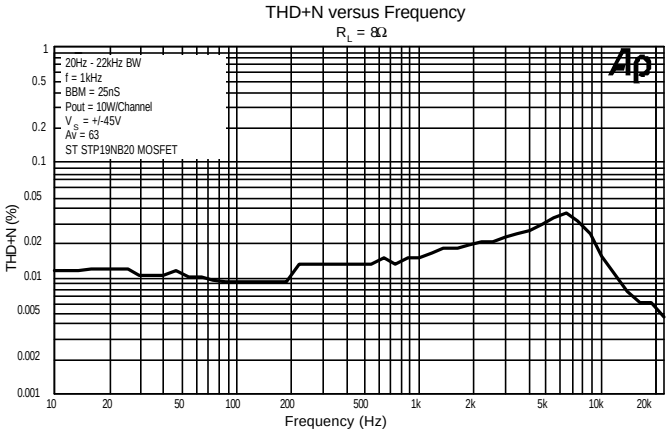
Connection Diagrams (Stereo and Bridged Modes)

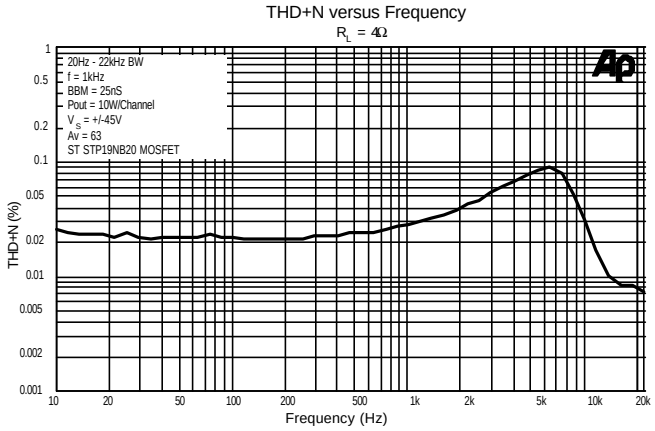


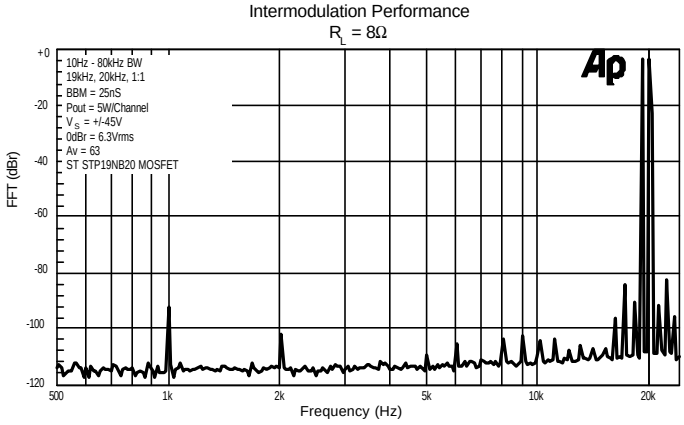
Typical Performance – Single Ended

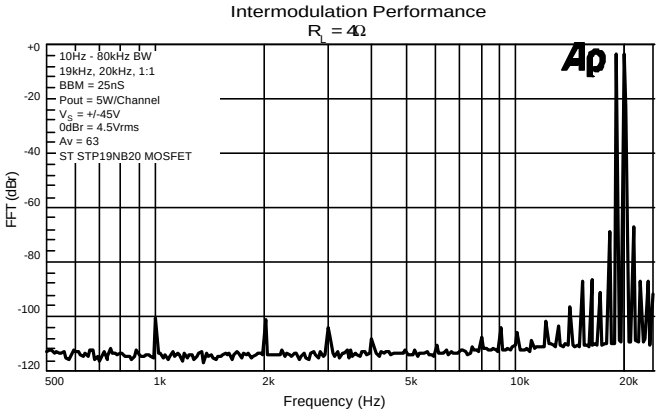






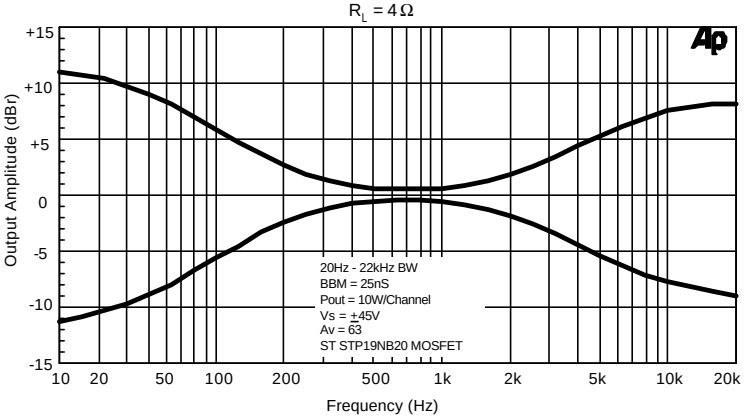




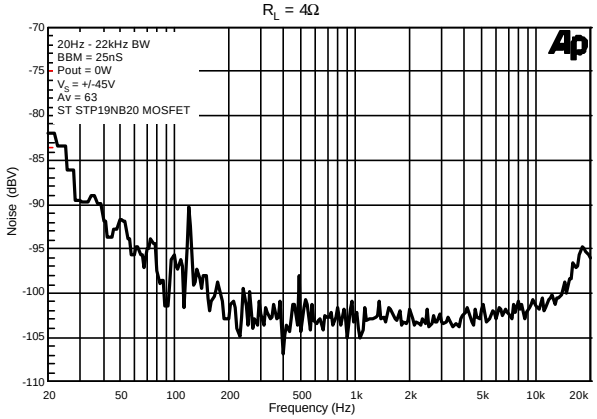


Typical Performance – Single Ended

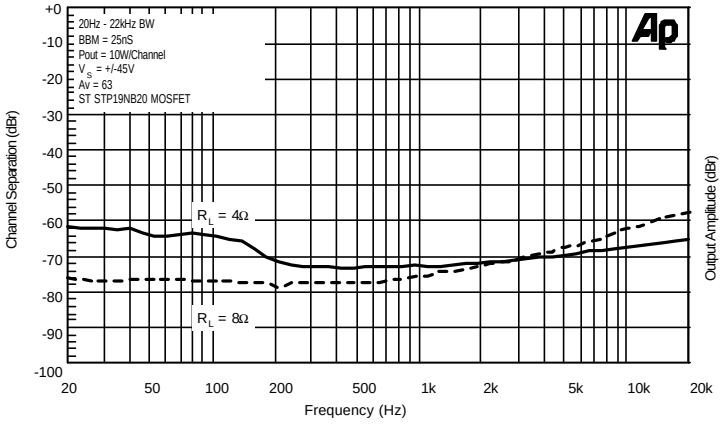
Bass and Treble Boost
$R_L = 4\,\Omega$



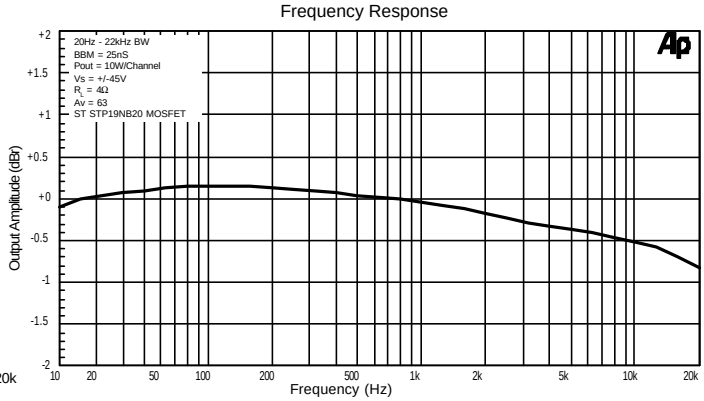
Noise Spectrum
$R_L = 4\Omega$



Channel Separation versus Frequency



Frequency Response



Application Information

Amplifier Gain

The gain of this amplifier has been pre-set to 63V/V maximum.

Bridged Operation

Two channels of this shielded module can be used to provide a single bridged amplifier of more than twice the output power of one of the single-ended amplifier channels. At the chip level, where the power supply is designed to handle maximum power, approximately four times the power can be obtained in bridged mode operation. To configure a bridged amplifier, the input to one TA0102A channel must be the inverted signal of the input to the other channel.

This amplifier has been supplied with a personality module that inverts the input and of one of the channels allows the outputs to be bridged. The correct procedure for bridging is:

- Power off the amplifier
- Connect the sub woofer terminals to the amplifier output as shown previously in this document
- Connect the input signal properly as shown previously in this document

Over-current Threshold

The over current threshold of the SAM has been set at 8.8Amps. For a full description of how this is achieved, please refer to the TA0102A Data Sheet

R_S has been set at 0.01 Ohms
R_{OCR1} and R_{OCR2} have been set at 30K Ohms

Turn-on & Turn-off Noise

The Tripath SAM uses a relay and some external circuitry. Turn-on pop is eliminated with a long RC time constant which begins as soon as the amplifier brings the HMUTE pin low. This occurs when the power supply rails are at the correct voltage. Sensing that the supply rails are coming down and immediately opening the relay eliminates the turn-off pop.

Performance Measurements of a TA0102A Amplifier

Tripath amplifiers operate by modulating the input signal with a high-frequency switching pattern. This signal is sent through a low-pass filter (external to the Tripath amplifier) that demodulates it to recover an amplified version of the audio input. The frequency of the switching pattern is spread spectrum and typically varies between 200kHz and 1.5MHz, which is well above the 20Hz – 20kHz audio band. The pattern itself does not alter or distort the audio input signal but it does introduce some inaudible noise components.

The measurements of certain performance parameters, particularly those that have anything to do with noise, like THD+N, are significantly affected by the design of the low-pass filter used on the output of the TA0102A and also the bandwidth setting of the measurement instrument used. Unless the filter has a very sharp roll-off just past the audio band or the bandwidth of the measurement instrument ends there, some of the inaudible noise components introduced by the Tripath amplifier-switching pattern will get integrated into the measurement, degrading it.

One advantage of Tripath amplifiers is that they do not require large multi-pole filters to achieve excellent performance in listening tests, usually a more critical factor than performance measurements. Though using a multi-pole filter may remove high-frequency noise and improve THD+N type measurements (when they are made with wide-bandwidth measuring equipment), these same filters can increase distortion due to inductor non-linearity. Multi-pole filters require relatively large inductors, and inductor non-linearity increases with inductor value.

Efficiency of a TA0102A Amplifier, FETs, and Output Inductors

The efficiency, η, of an amplifier is:

$$\eta = P_{OUT}/P_{IN}$$

The power dissipation of a TA0102A amplifier is primarily determined by the on resistance, R_{ON}, of the output transistors used, and the switching losses of these transistors, P_{SW}. For a TA0102A amplifier, P_{IN} (per channel) is approximated by:

$$P_{IN} = P_{DRIVER} + P_{SW} + P_{OUT}\,((R_S + R_{ON} + R_{COIL} + R_L)/R_L)^2$$

where:

P_{DRIVER} = Power dissipated in the TA0102A = 1.6W/channel
P_{SW} = 2 x (0.015) x Q_g (Q_g is the gate charge of M, in nano-coulombs)
R_{COIL} = Resistance of the output filter inductor (typically around 50mΩ)

For an 140W RMS per channel, 8Ω load amplifier using ST STP19NB20 MOSFETs, and an R_S of 25mΩ,

$$P_{IN} = P_{DRIVER} + P_{SW} + P_{OUT}((R_S + R_{ON} + R_{COIL} + R_L)/R_L)^2$$
$$= 1.6 + 2 \times (0.015) \times (40) + 140 \times ((0.025 + 0.31 + 0.05 + 8)/8)^2$$
$$= 1.6 + 1.2 + 153.8$$
$$= 156.6\ W$$

In the above calculation the $R_{DS\ (ON)}$ of 0.65Ω was multiplied by a factor of 1.7 to obtain R_{ON} in order to account for some temperature rise of the MOSFETs ($R_{DS\ (ON)}$ typically increases by a factor of 1.7 as temperature increases from 25ºC to 170ºC for many MOSFETs).

So,

$$\eta = P_{OUT}/P_{IN} = 140/157 = 89\%$$

This compares to the 90% measured efficiency (see Typical Performance graphs in the TA0102A data sheet).

Physical Dimensions

Panel w/controls:	7” W x 10” H
Shielded module:	4.6”W x 8.6” H x 5.0” D
Electronics on panel plus shielded module:	6”W x 8.6” H x 5.0” D

Reference Documents

Please refer to the TA0102A Data Sheet. It is a useful document in understanding the operation of the Tripath TA0102A amplifier used in this Shielded Amplifier Module.

A schematic diagram of this amplifier is available.

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