

Class D Audio Product Update

January 2009



International
IOR Rectifier

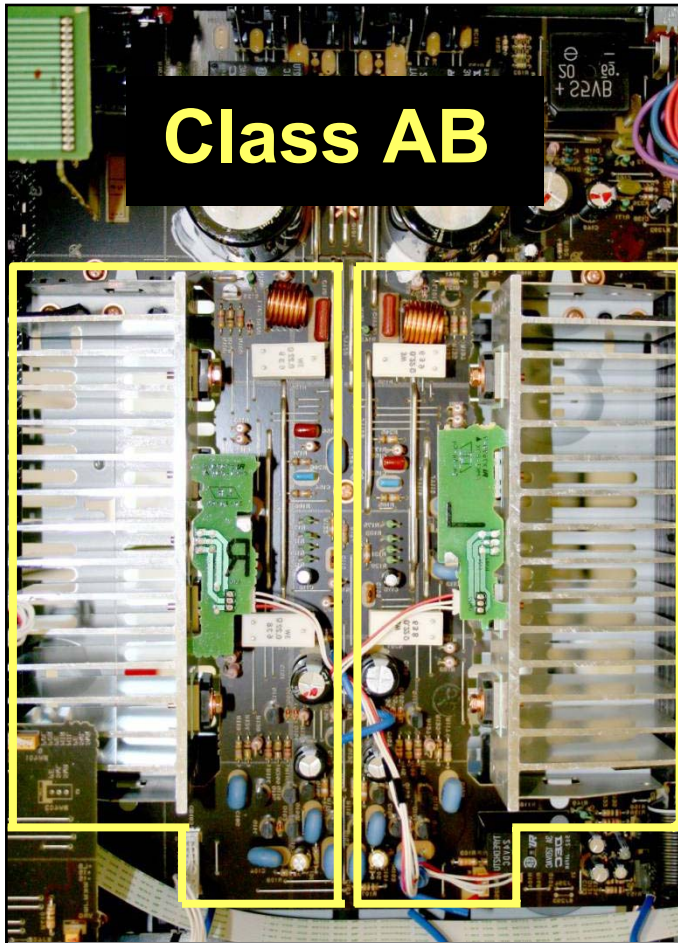
Agenda



- IR Class D Audio Solution**
- Class D Audio Driver IC**
- Key IC Features**
- Audio MOSFET**
- DirectFET® Features**
- Reference Designs**
- Future Roadmap**



Class AB to Class D Conversion



Audio Market Trend

- More Channels
- Smaller Size

- **Smaller Size**

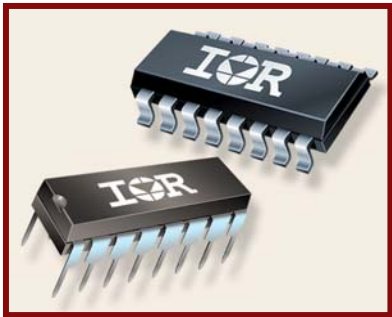


- **Higher Performance**

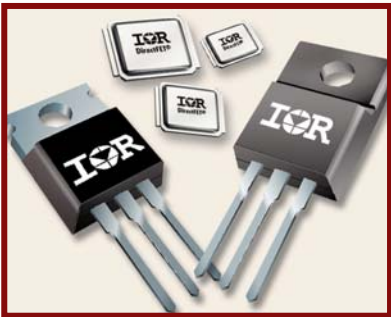
Device Technology

- Advanced MOSFET
- High Speed High Voltage IC

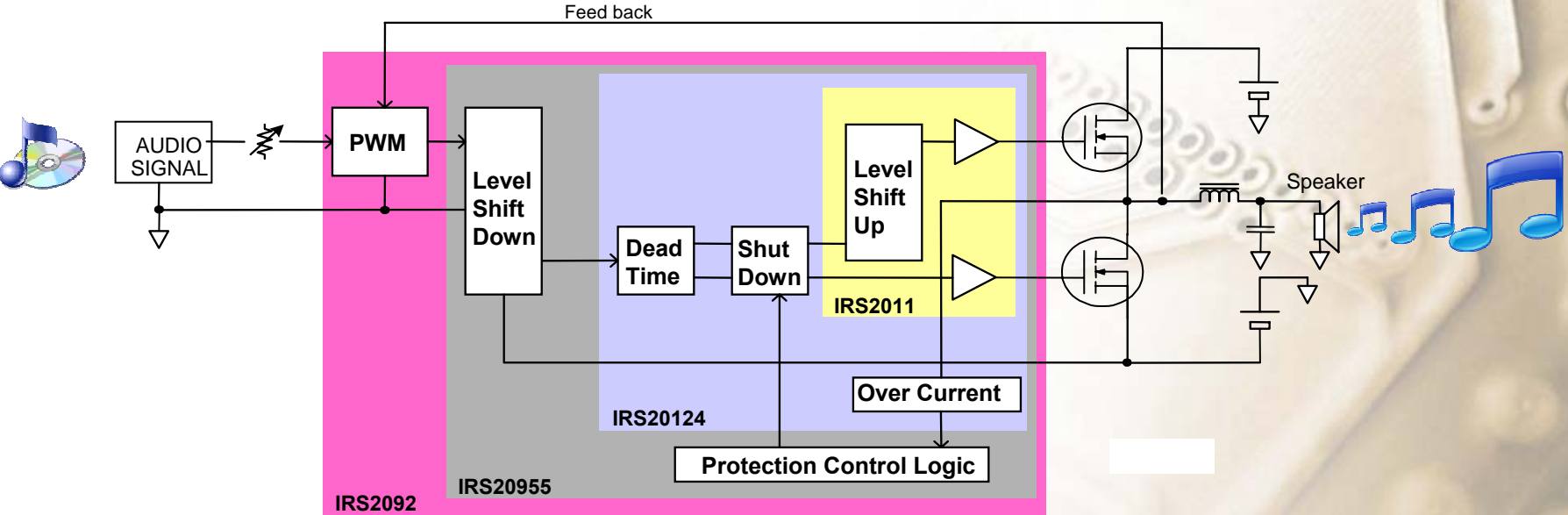
Award Wining IR Class D Audio Solution



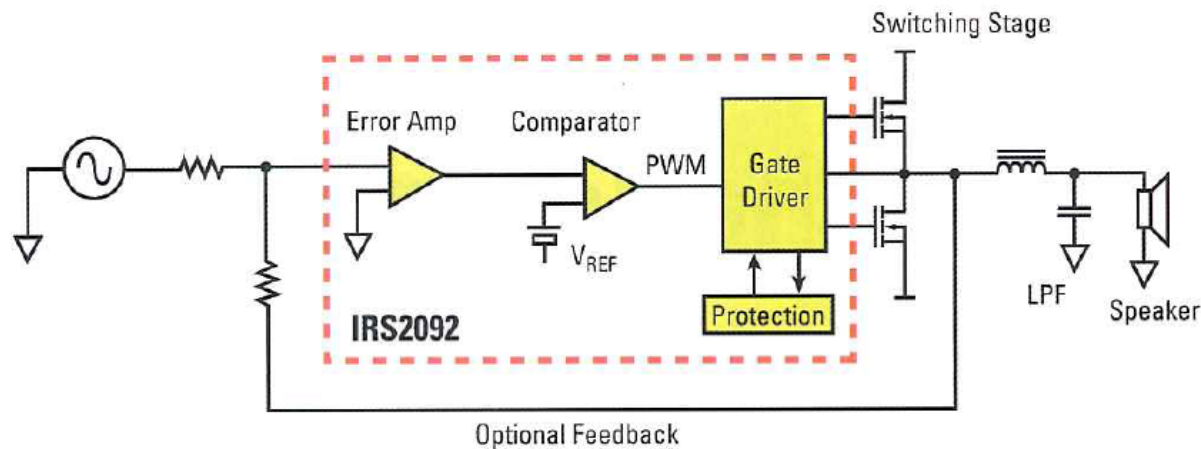
High Voltage High Speed IC



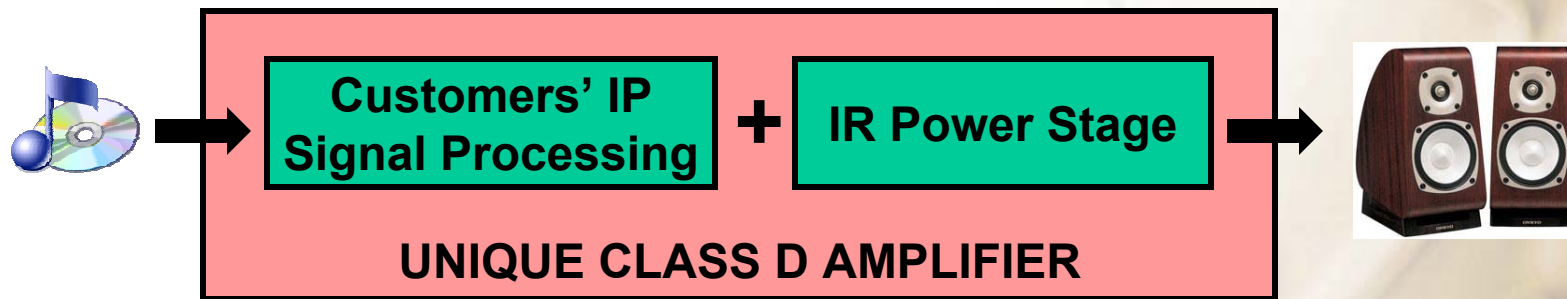
Digital Audio MOSFETs



IR Class D Audio Value Proposition



- High design scalability with full range of audio MOSFETs
- Best of class efficiency enables small foot print
- Flexible versatile building block approach allow countless unique implementations



Class D Audio IC Family



IR's Gen5 High Voltage IC Features

- Lower pulse distortion
- Higher output sink/source capability
- UVLO protection
- Improved propagation delays
- Fast t_{ON} & t_{OFF}
- Allows accurate PWM control

Specifications	IRS20124SPbF	IRS20955SPbF	IRS2092(S)PbF
Offset Voltage	200V	200V~+/-100V	200V~+/-100V
Sink/Source Current	1.2/1.0A	1.2/1.0A	1.2/1.0A
VCC Range (with UVLO)	10-18V	10-18V	10-18V
Min/Max Output Voltage	10-18V	10-18V	10-18V
Propagation Delay: TON/OFF	60ns	90/105ns	360/335ns
Max Delay Matching	Specified by the dead time	Specified by the dead time	Specified by the dead time
Programmability	IRS20124SPbF	IRS20955SPbF	IRS2092(S)PbF
Selectable Dead Time	15/25/35/45ns	15/25/35/45ns	25/40/65/105ns
Bi-directional Over-Current Sensing with Self-Reset Function	-	•	•
Features	IRS20124SPbF	IRS20955SPbF	IRS2092(S)PbF
Bi-Directional Over-Current Sensing (no external sense resistor)	•	•	•
Max Frequency	1MHz	800kHz	800kHz
Logic Compatible Input	3.3/5.0V	3.3/5.0V	3.3/5.0V
Max Over-Current Propagation Delay	300ns	500ns	500ns
Floating PWM Input	-	•	•
Max Power (in half-bridge)	500W	500W	500W
Shut Down	•	internal/external	internal/external
Protection Logic Control	-	•	•
Integrated PWM modulator	-	-	•
Start and stop click noise reduction	-	-	•

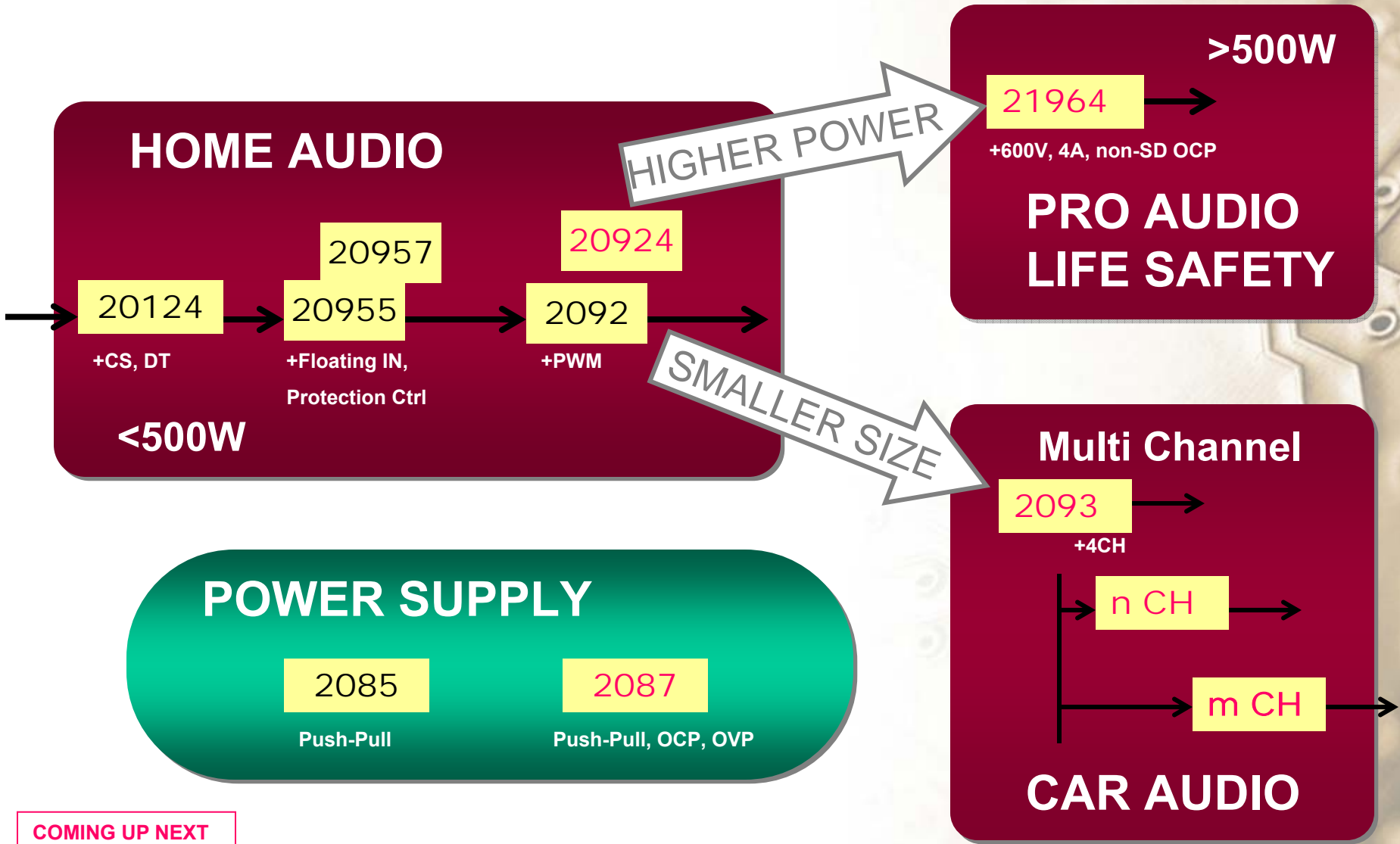
Strengths of IR Class D Audio Solution

- **Semiconductor Ruggedness proved in 20+ yrs of automotive application experiences**
 Over-load and Short-Circuit Protection, noise immunity, wide temperature capability, etc
- **Unlike Class AB, the power device and its driver determines the performance of Class D amplifier; IR has key silicon technologies to continue providing state-of-the-art solutions**
 Advanced silicon platform, Optimized MOSFET, optimized gate driver, etc
- **IR solution is scalable (power, # of ch), minimizing the time-to-market**
 Complete portfolio of chip-set to tailor to your needs
- **EMI: DirectFET provides high performance at low EMI**

Class D Audio High Voltage IC



Class D AUDIO HVIC Roadmap



COMING UP NEXT

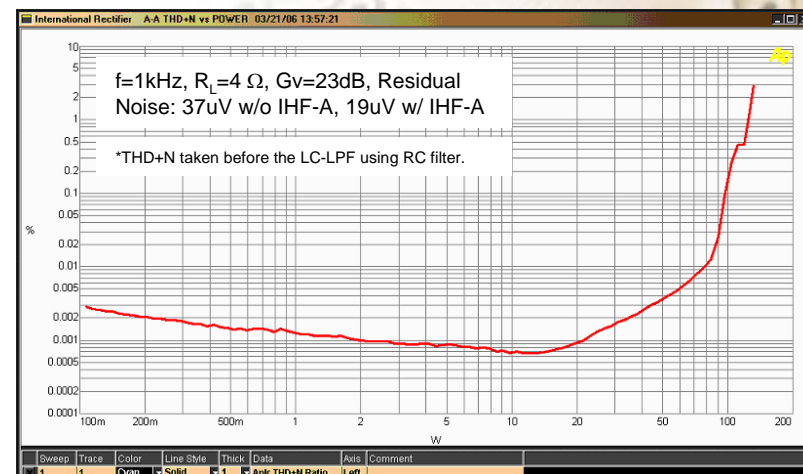
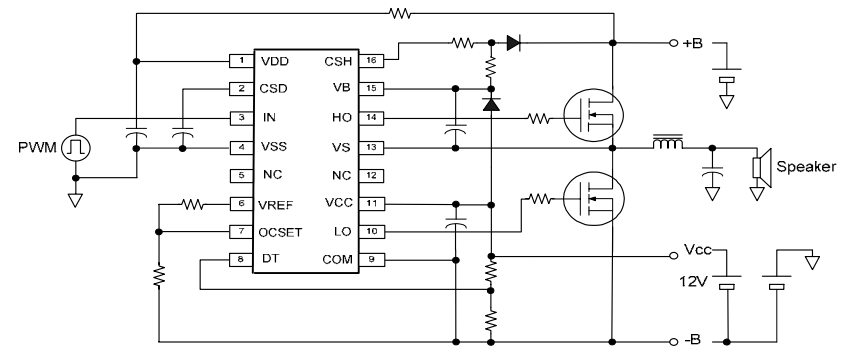


16pin SOIC

Class D Audio Amplifier Driver

- Floating input structure designed for half bridge topology with dual power supply
- Programmable bi-directional over-current protection with self-reset function
- Simplify design due to selectable internal dead-time
- Improved THD performances and stable switching timing over temperature and noise due to internal dead time
- Shutdown function to protect devices from over loaded conditions
- Improved noise immunity over IRS20955

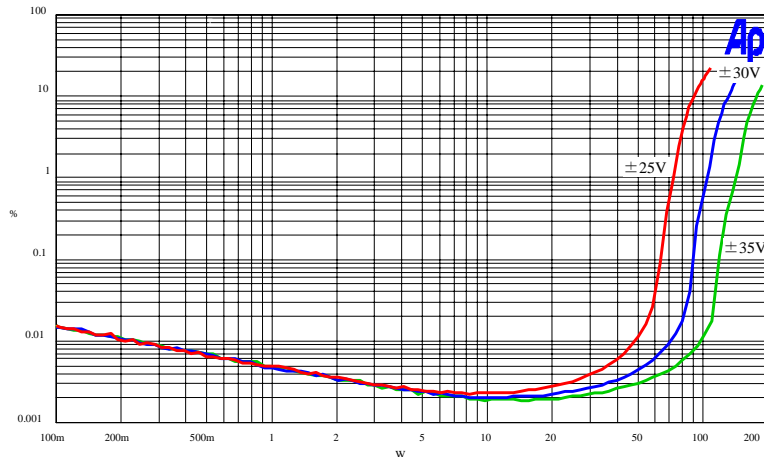
Note: IRS20955 is no longer recommended for new design.



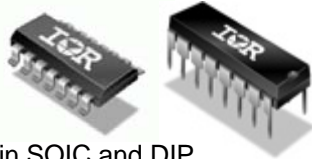
IRAUDAMP4 Reference Design



- **IRS20955S + IRF6645 DirectFET**
- **Output Power: 120W x 2 channels,**
- **Residual Noise: 52 μ V, IHF-A weighted, AES-17 filter**
- **Distortion: 0.004% THD+N @ 60W, 4 Ω**
- **Efficiency: 96% @ 120W, 4 Ω , single-channel driven, Class D stage**
- **Multiple Protection Features:**
 - **Over-current protection (OCP), high side and low side**
 - **Over-voltage protection (OVP), high side and low side**
 - **Under-voltage protection (UVP), high side and low side**
 - **DC-protection (DCP),**
 - **Over-temperature protection (OTP)**
- **PWM Modulator: Self-oscillating half-bridge topology with optional clock synchronization**



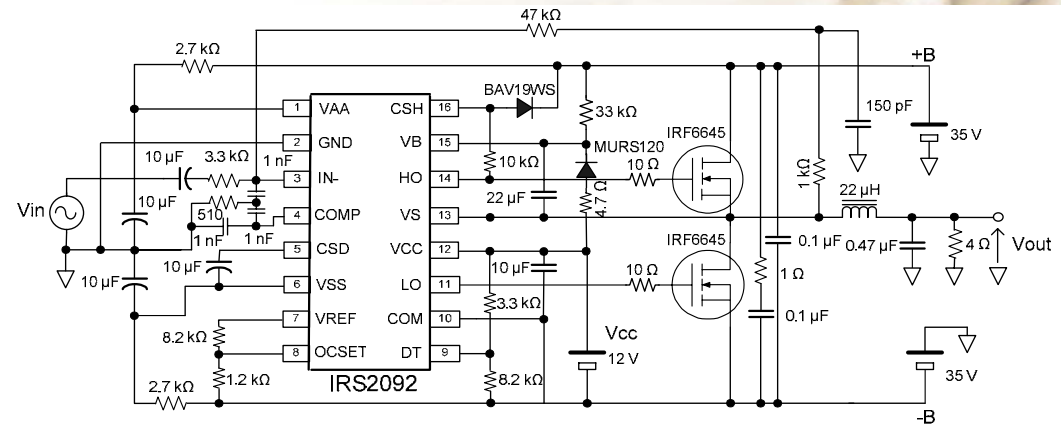
IRS2092(S)



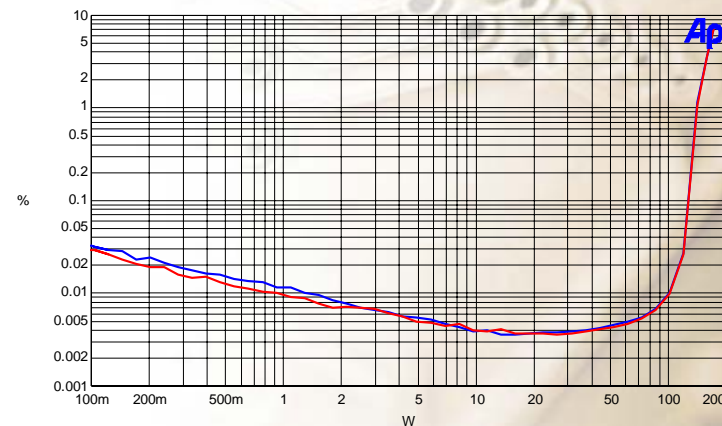
16pin SOIC and DIP

Protected Class D Audio Amplifier Driver

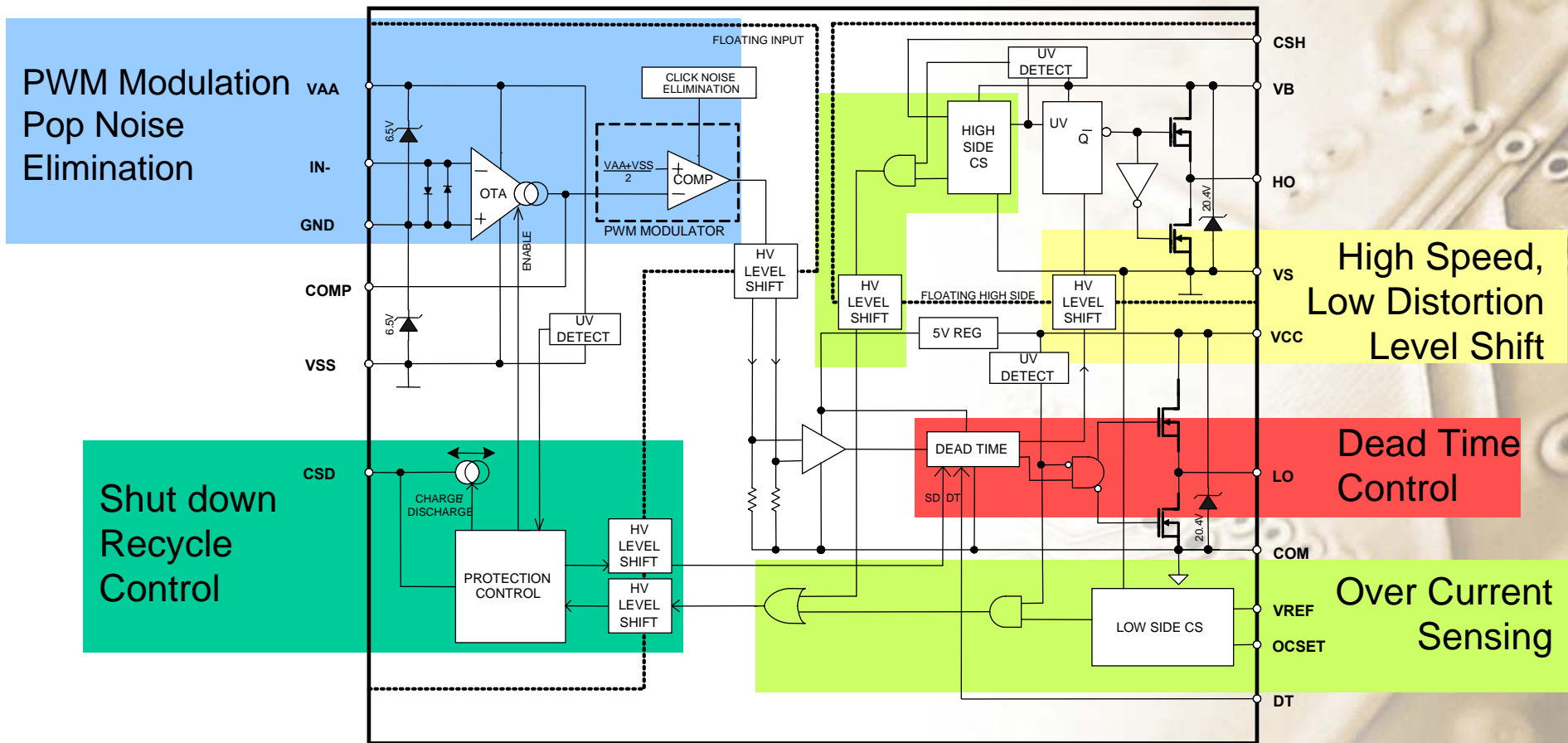
- **Integrated analog input Class D audio amplifier driver in a 16 pin package**
- **Self-oscillating PWM with optional external clock synchronization**
- **Start and stop click noise elimination**
- **Programmable over current protection**
- **High noise immunity**
- **+/-100V high voltage ratings deliver up to 500W output power**



120W Class D Amplifier Example



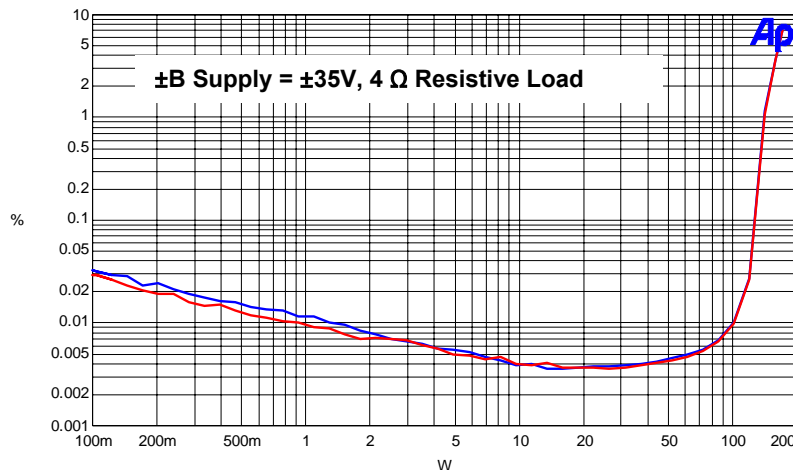
IRS2092(S) Block Diagram



IRAUDAMP5 Reference Design



- **IRS2092S + IRF6645 DirectFET**
- **Output Power: 120W x 2 channels**
- **Residual Noise: 170 μ V, IHF-A weighted, AES-17 filter**
- **Distortion: 0.005% THD+N @ 60W, 4 Ω**
- **Efficiency: 96% @ 120W, 4 Ω , single-channel driven, Class D stage**
- **Multiple Protection Features:**
 - **Over-current protection (OCP), high side and low side**
 - **Over-voltage protection (OVP), high side and low side**
 - **Under-voltage protection (UVP), high side and low side**
 - **DC-protection (DCP),**
 - **Over-temperature protection (OTP)**
- **PWM Modulator: Self-oscillating half-bridge topology with optional clock synchronization**



IRAUDAMP7D,S Reference Design



- IRS2092 (AMP7D), IRS2092S (AMP7S) + IRFI4019H-117P
- Single layer PCB, designed for wave-soldering
- No surface mount component (AMP7D)
- Output Power: 250W x 2 channels
- Residual Noise: 200 μ V, IHF-A weighted, AES-17 filter
- Distortion: 0.007% THD+N @ 60W, 4 Ω (AMP7S)
- Scalable Output Power

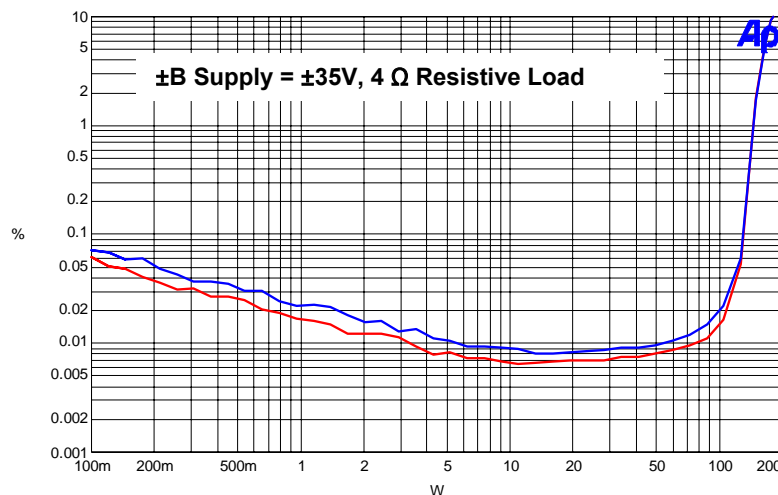
IRFI4024H-117 (55V) : 50W, 4 Ohms

IRFI4212H-117(100V): 120W, 4 Ohms

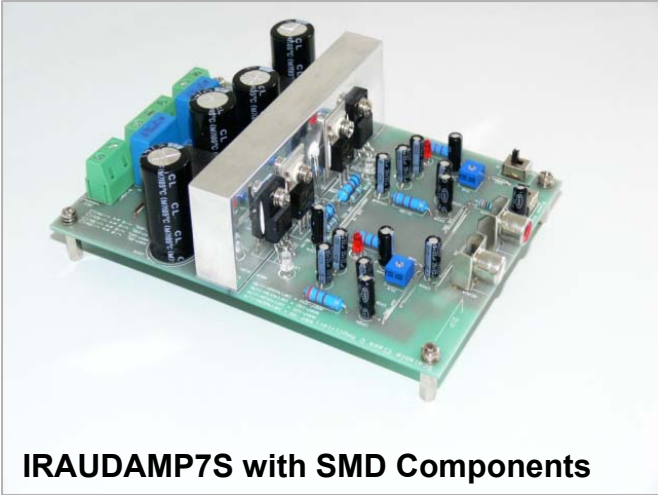
IRFI4019H-117(150V): 250W, 4 Ohms

IRFI4020H-117(200V): 250W, 8 Ohms

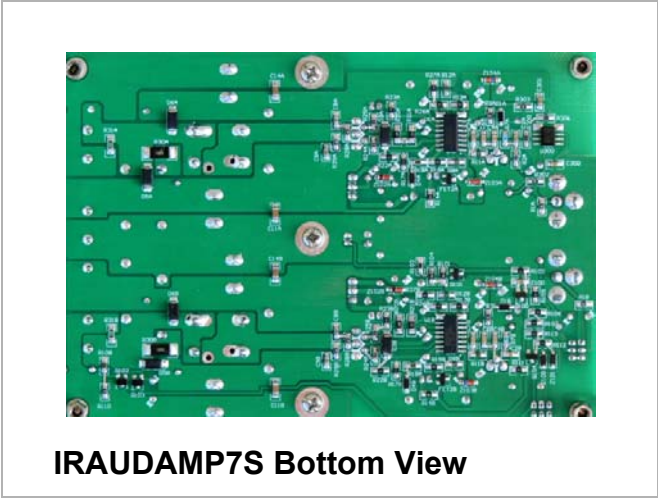
- Half Bridge/Full Bridge Selectable Switch
- Protections (Over Current, Over Temperature, Under Voltage, Over Voltage, DC Offset)



IRAUDAMP7D,S



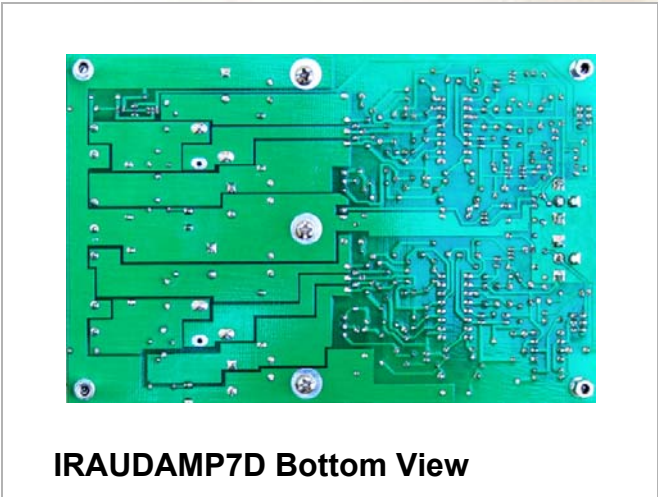
IRAUDAMP7S with SMD Components



IRAUDAMP7S Bottom View

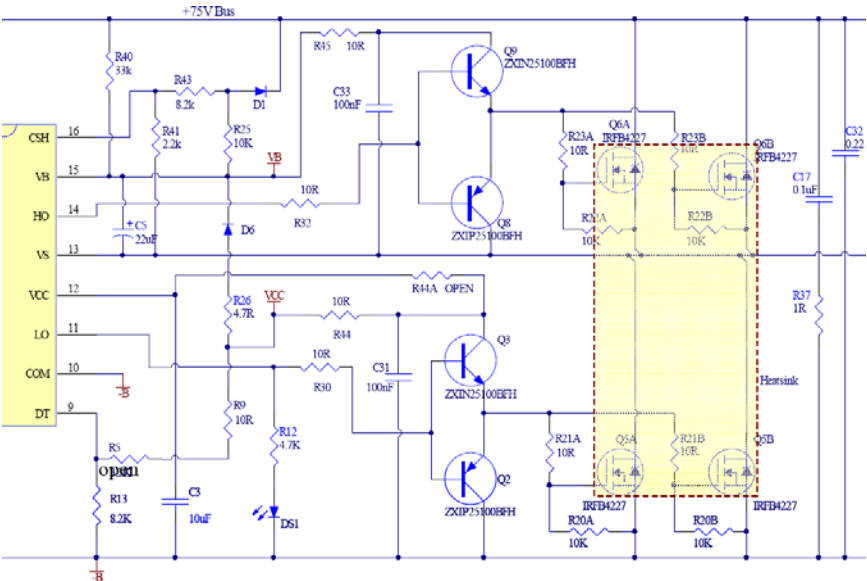
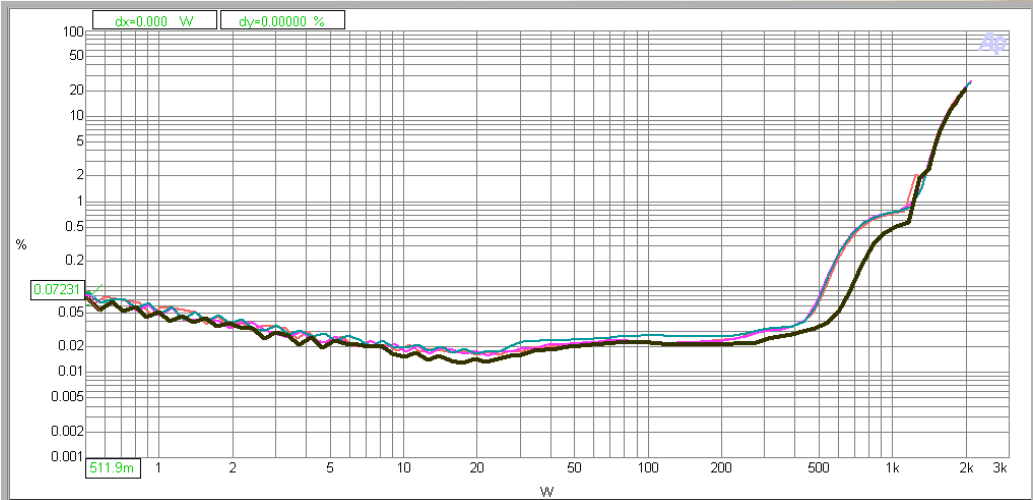
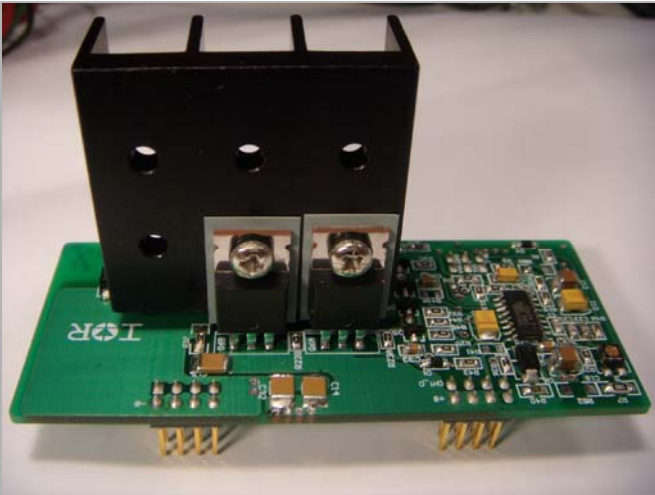


IRAUDAMP7D with no SMD Components



IRAUDAMP7D Bottom View

Buffering Gate Drive to Reach 1 kW !



Design Example

- IRS2092S + external BJT buffer driving 2 x IRFB4227
- Maximum power: 1 kW, 2 ohms, THD+N<1% @ +/-75V supply, Half bridge
- Application information available upon request

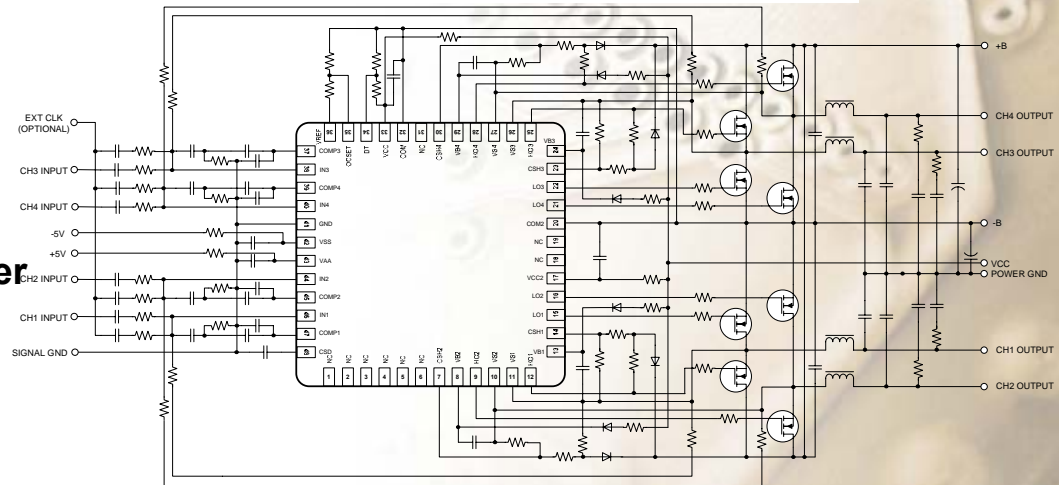


48 pin MLP (7X7mm)

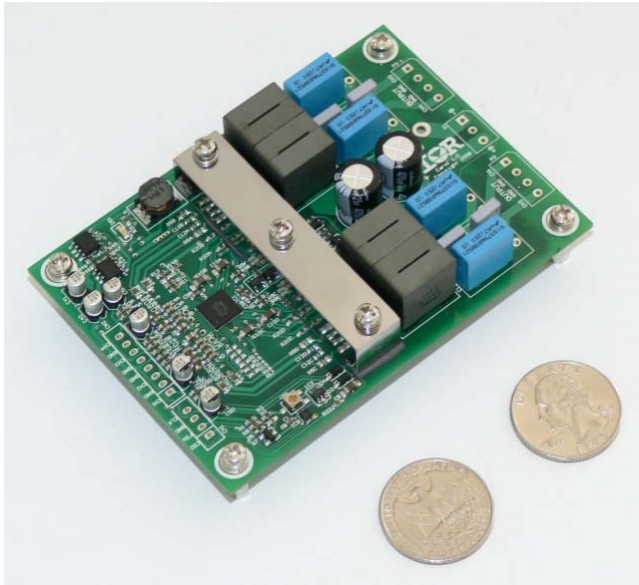
4 CH Class D Audio Amplifier Driver

- Integrated 4 channel analog input Class D audio amplifier driver in a MLP48 package
- Self-oscillating PWM with optional external clock synchronization
- Start and stop click noise elimination
- Programmable over current protection
- High noise immunity
- +/-100V high voltage ratings deliver up to 150W output power

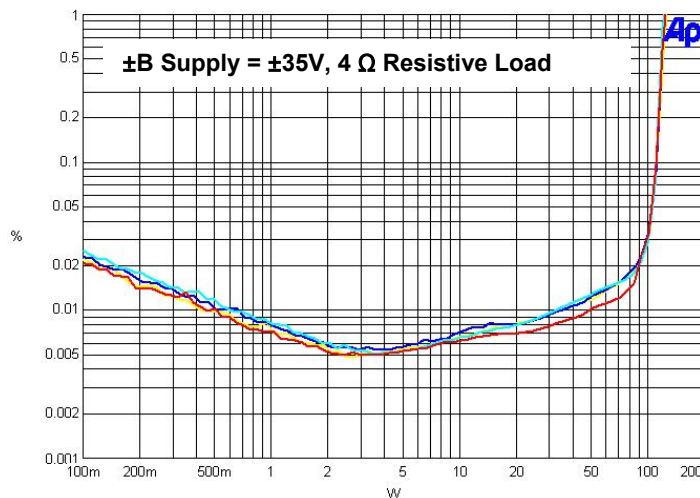
V _{OFFSET} (max)	± 100 V
Gate driver I _{o+}	0.5A (typ)
Gate driver I _{o-}	0.6A (typ)
Selectable Dead-time	25/45/75/105ns
OC protection delay	1 μsec (max)
DC offset	<20mV
PWM frequency	~800kHz
Error amplifier open loop gain	>60dB



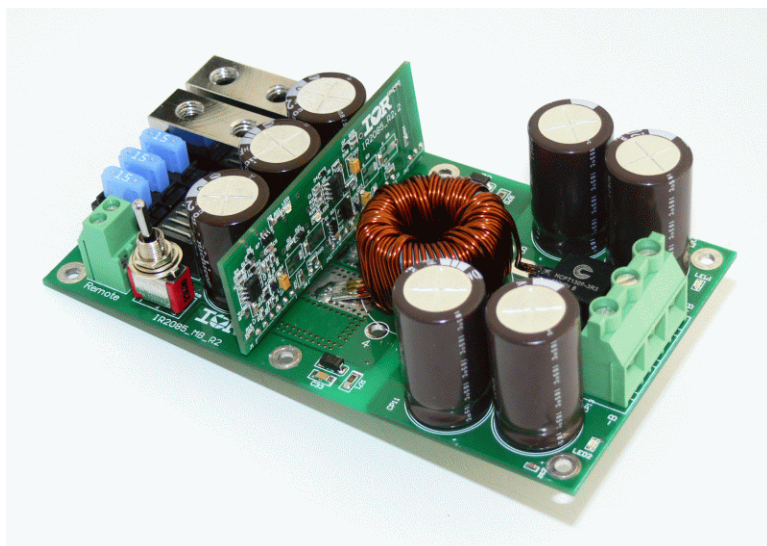
IRAUDAMP8: IRS2093M Reference Design



- IRS2093M + IRF6665 DirectFET
- Output Power: 120W x 4 channels
- Residual Noise: 200 μ V, IHF-A weighted, AES-17 filter
- Distortion: 0.02% THD+N @ 60W, 4 Ω
- Clock synchronization
- Multiple Protection Features:
 - Over-current protection (OCP), high side and low side
 - Over-voltage protection (OVP), high side and low side
 - Under-voltage protection (UVP), high side and low side
 - Over-temperature protection (OTP)
- PWM Modulator: Self-oscillating half-bridge topology with optional clock synchronization



IRAUDPS1: Aftermarket Car Audio Power Supply

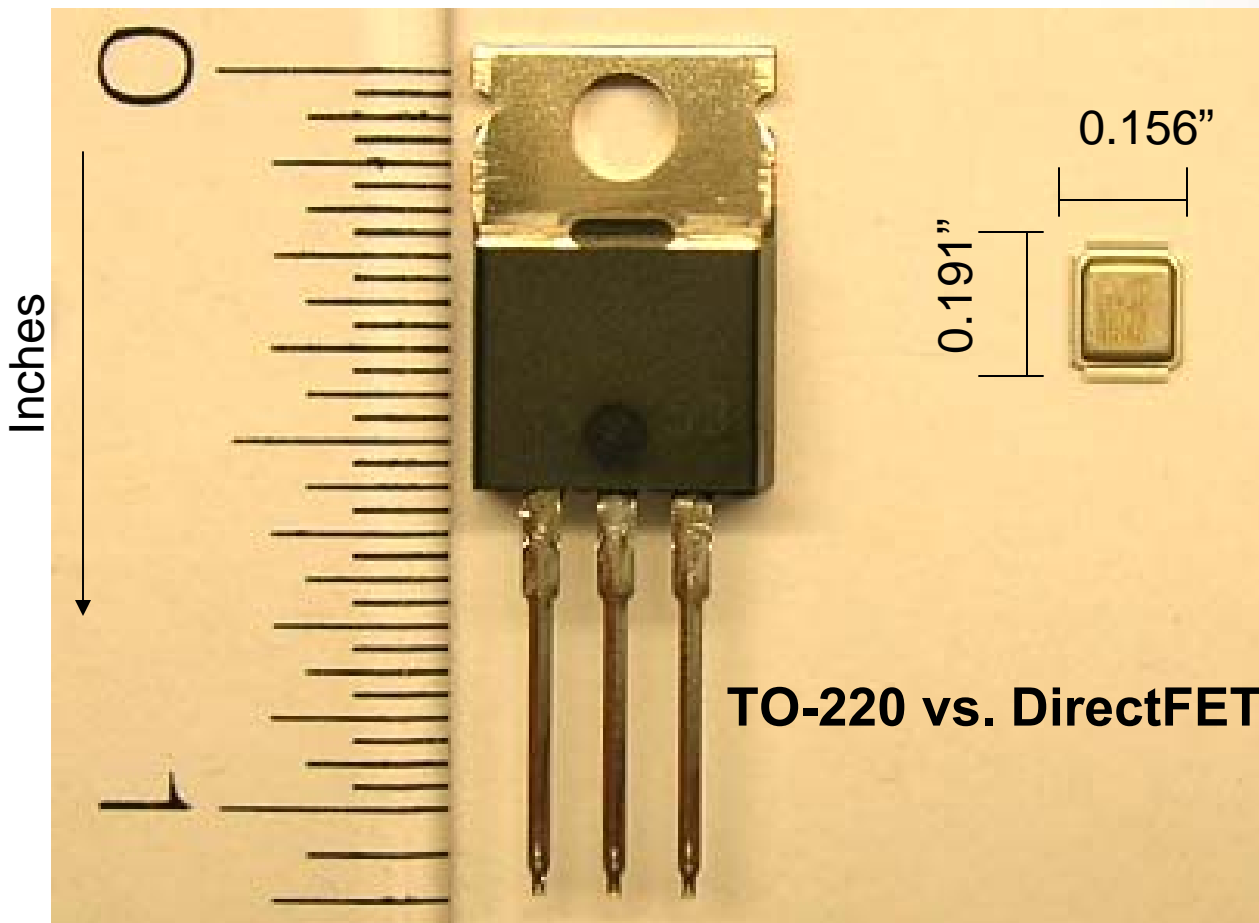


- IR2085S + IRF6648 DirectFET
- Input Voltage: 14.4V nominal (8.5V ~ 18V)
- Output Voltage: +/-35V
- Output Power: 500W, designed to meet CEA power criteria, scalable from 250 to 1,000W
- Topology: Push-Pull
- Remote power control with soft-start
- Multiple Protection Features:
 - Over-current protection (OCP), high side and low side
 - Over-voltage protection (OVP),
 - Under-voltage protection (UVP), high side and low side
 - Over-temperature protection (OTP)

Class D Audio MOSFET



Package Size & Performance Comparison

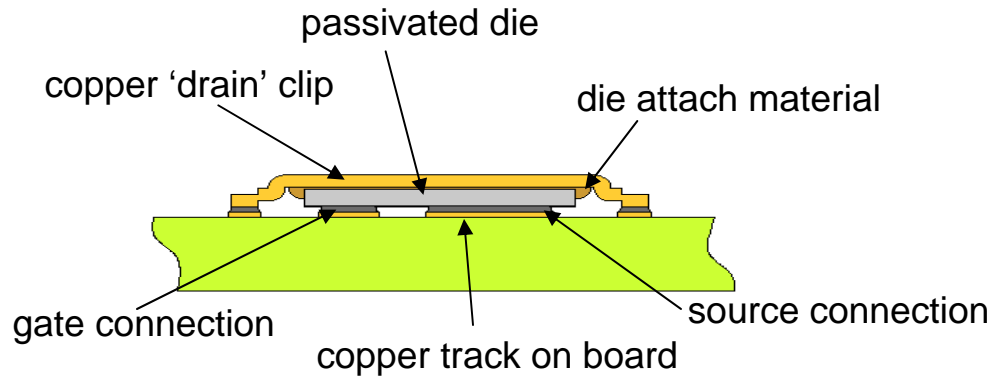


The To-220 is used in majority of the Class D amplifiers manufactured today.

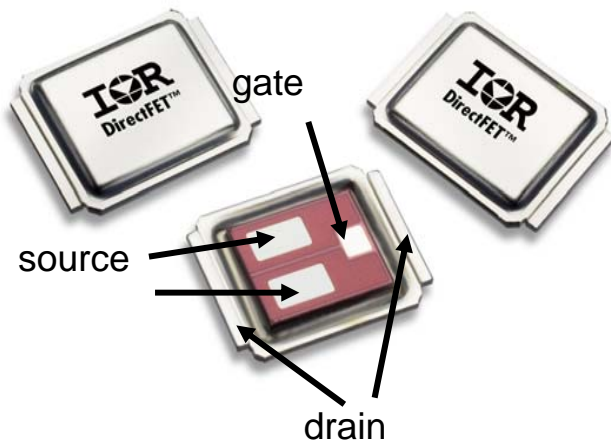
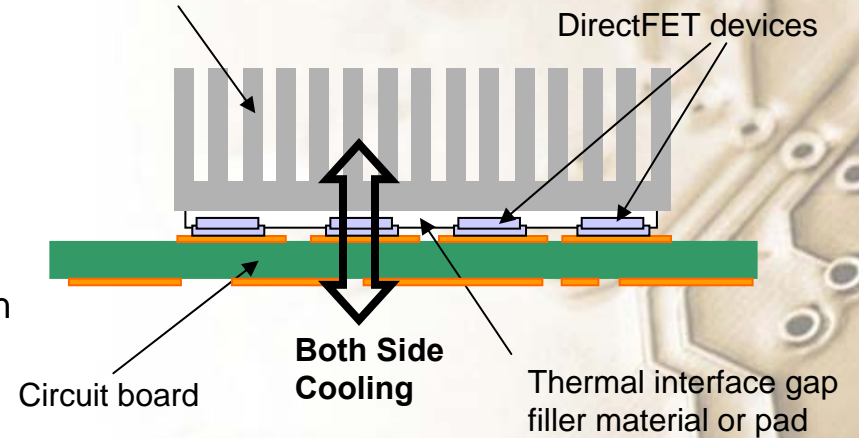
The DirectFET™ Small Package provides more Potentials than the TO-220:

- **Smaller and Lighter**
- **Higher Efficiency**
- **Runs Cooler – Higher Reliability**
- **Lower Audio Distortion, Higher Fidelity**

SMALL SIZE = BIG PERFORMANCE

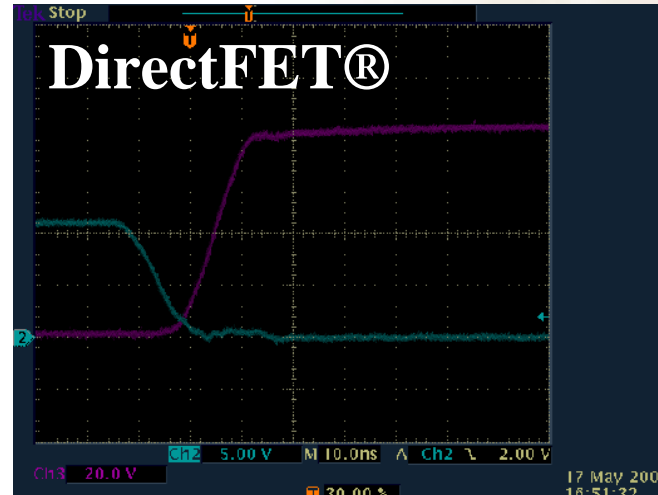
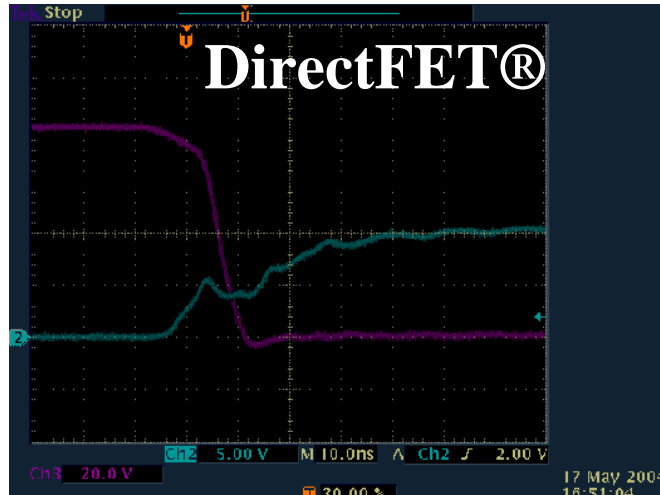


Use a single multiple-finned heat sink to dissipate heat from devices



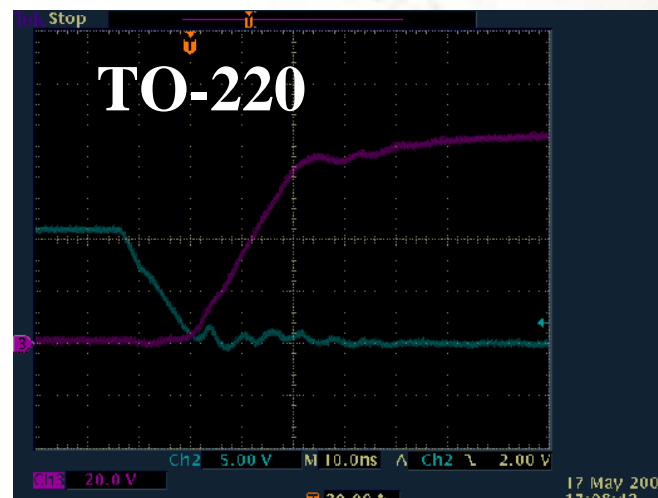
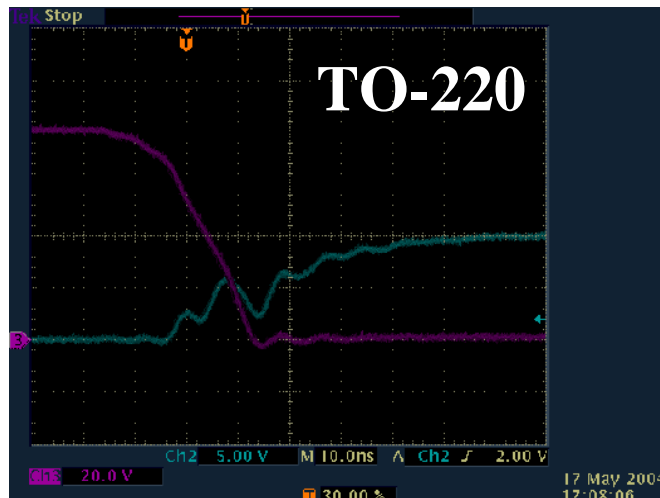
- Removed wire bonds from package and replace with large area solder contacts
- Reduced package inductance and resistance
- Copper case enables **dual sided cooling**

DirectFET® Reduced Ringing



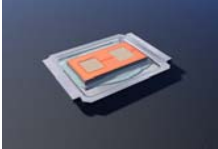
Blue : Low Side
Pink : High Side

IRF6665 DirectFET®



IRF6665 die in TO-220

MOSFET Selection by Output Power



DirectFET®				
Clipping Power	Without Heatsink		With Heatsink	
	4 Ohms	8 Ohms	4 Ohms	8 Ohms
50W - 100W	IRF6645	IRF6665	IRF6665	IRF6665
100W - 120W	IRF6645		IRF6645	IRF6775M
120W - 200W			IRF6645	IRF6775M
200W - 250W			IRF6775M	IRF6785M

IRFx Families			
Clipping power	Package	Load	
		4 Ohms	8 Ohms
50W - 60W	TO-220 Full-Pak 5-Pin	IRFI4024H-117P	IRFI4212H-117P
	TO-220	—	IRFB4212PbF
60W - 100W	TO-220 Full-Pak 5-Pin	IRFI4212H-117P	IRFI4212H-117P
	TO-220	IRFB4212PbF	IRFB4212PbF
100W - 200W	TO-220 Full-Pak 5-Pin	IRFI4212H-117P	IRFI4019H-117P
	TO-220	IRFB4212PbF	IRFB4019PbF
200W - 300W	TO-220 Full-Pak 5-Pin	IRFI4019H-117P	IRFI4020H-117P
	TO-220	IRFB4019PbF	IRFB4020PbF
300W - 500W	TO-220 Full-Pak 5-Pin		
	TO-220	IRFB4227PbF	IRFB4229PbF

Class D Audio MOSFET Selection by Supply Voltage

Standard Selection			
Voltage	Package	MOSFET	RDS(ON)/Qg
55 V		IRFI4012H-117P	60 mΩ
			8.9 nC
		IRF6668	15 mΩ
			22 nC
100 V		IRFI4212H-117P	73 mΩ
			15 nC
		IRFB4212	73 mΩ
			15 nC
		IRF6645	35 mΩ
			14 nC
		IRF6665	62 mΩ
			8.7 nC

Standard Selection			
Voltage	Package	MOSFET	RDS(ON)/Qg
150 V		IRFI4019H-117P	95 mΩ
			13 nC
		IRFB4019	95 mΩ
			13 nC
200 V		IRF6775M	56 mΩ
			25 nC
		IRFI4020H-117P	100 mΩ
			18 nC
	IRFB4020	100 mΩ	
		18 nC	
	IRF6785M	100 mΩ	
		26 nC	





Voltage Rating Selector

Half Bridge	BV _{DSS} Minimum (V)			Corresponding IR MOSFET BV _{DSS} (V)		
	Load (Ohms)			Load (Ohms)		
	4	6	8	4	6	8
Output Power (W)	4	6	8	4	6	8
100	73.2	89.7	103.5	75	100	150
150	89.7	109.8	126.8	100	150	150
200	103.5	126.8	146.4	150	150	150
250	115.7	141.8	163.7	150	150	200

Full Bridge	BV _{DSS} Minimum (V)			Corresponding IR MOSFET BV _{DSS} (V)		
	Load (Ohms)			Load (Ohms)		
	4	6	8	4	6	8
Output Power (W)	4	6	8	4	6	8
100	36.6	44.8	51.8	40	55	55
150	44.8	54.9	63.4	55	55	75
200	51.8	63.4	73.2	55	75	75
250	57.9	70.9	81.8	75	75	100

Note: Modulation factor, M = 85%

Lower $R_{DS(ON)}$ MOSFETs

Lower $R_{DS(ON)}$			
Voltage	Package	MOSFET	$R_{DS(ON)}/Q_g$
80 V		IRF6646	9.5 m Ω
			36 nC
		IRF6668	15 m Ω
			22 nC
100 V		IRF6644	13 m Ω
			35 nC
		IRF6662	22 m Ω
			22 nC
150 V		IRFB5615 NEW	39 m Ω
			26 nC
		IRFB4228	15 m Ω
			72 nC
200 V		IRFB5620 NEW	73 m Ω
			25 nC
		IRFB4227	26 m Ω
			70 nC

- Lower $R_{DS(ON)}$ for lower load impedance
- New IRFB5615 and IRFB5620 are tailored to 4 ohms loading
- Full bridge demands lower $R_{DS(ON)}$ as each leg sees a half load impedance

Thank you

WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245 Tel: (310) 252-7105
Data and specifications subject to change without notice. 11/12/2008