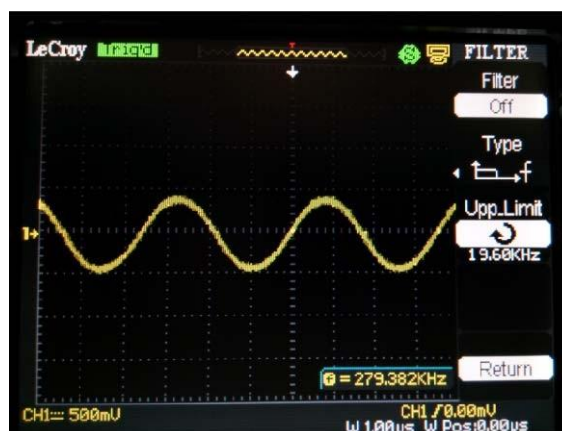


### Part 3

#### Class D Amplifier LPF Design

LPF Filter is a very crucial part of class D Amplifiers. The selection of components and design must be done correctly because this LPF filter determines whether or not the sound produced by the amplifier. An important part of this design is choosing the type of inductor core, the number of turns, the physical size and determining the capacitors. Many class D amplifiers sound bad because they fail in designing LPF filters. In this section, it is explained simply, more towards the results of practice, not in detail to make it easier for beginners. Detailed calculations can be obtained from the reference.

The number of turns of the inductor and the size of the capacitor depends on how much the LPF wants to cut off frequency. But in class D, LPF functions differently in passive crossovers. In addition to cutting PWM frequencies, LPF must ensure that the output signal is clean enough of the remaining PWM. The higher the PWM frequency, the easier it is to make the remaining PWM ripple smaller, and vice versa. To do LPF settings, tools such as LC Meters to make inductance ( $\mu\text{H}$ ) are needed. If there isn't, the only way is by trial and error. The amp is turned on and the residual voltage is checked with an oscilloscope. Even if there is an LC Meter, a PWM residue checking is still needed.



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Figure-1 Vout shows 1 Vpp PWM residue, measured at the terminal output in the built-in speaker state

The detailed calculation to determine the  $\text{UH}$  size of the inductor must refer to each manufacturer's website such as:

[http://www.micrometals.com/downloads/MicroRelease\\_March2010.exe](http://www.micrometals.com/downloads/MicroRelease_March2010.exe)

<http://www.micrometalsarnoldpowdercores.com/upload/ArnoldDesigns.exe.zip> <http://www.mag-inc.com/design/software>

The amount of inductance depends on the FSW switching speed, as follows:

FSW	Inductor
150 – 200 kHz	40 – 60 $\mu\text{H}$
200 – 250 kHz	30 – 40 $\mu\text{H}$
250 – 325kHz	22 – 30 $\mu\text{H}$
325 – 400kHz	18 – 22 $\mu\text{H}$

Whereas the output size (Watt) determines the physical size of the inductor which determines the saturation value limit. The greater wattage means the greater the output current until the higher saturation value limit is needed. So what determines the size of the core is the current not wattage. To find out for sure you have to use the help of core manufacturer software like the link above. As an initial reference based on the results of practice, here are estimates of the use of cores that have been tested in the field

Core	Max. Arus Output Rata-Rata
MS130060	5-10A
T130-2	5-10A
MS157060	15 – 20A
T157-2	15 – 20A

The third thing that is not less important is the characteristics that determine the properties that need attention in design. Not that which is good and bad, but the selection is adjusted to the application. These properties determine the number of turns, physical size, permissible heat levels and losses. So it should always refer to the factory datasheet. Example of Kool Mu factory data.

<http://www.mag-inc.com/products/powder-cores>

	Kool Mu	MPP	High Flux	XFLUX	AmoFlux
Perm	14-125	14-550	14-160	26-60	60
Core Loss	Low	Very Low	Moderate	High	Low
DC Bias	Good	Better	Best	Best	Better
Saturation Flux Density (Tesla)	1.0	0.75	1.5	1.6	1.5
Curie Temperature (°C)	500	460	500	700	400
Operation Temp. Range (°C)	-55~200	-55~200	-55~200	-55~200	-55~155
60u, u flat to...	900 kHz	2 MHz	1 MHz	500 kHz	2 MHz

The following is a list of the number of turns for a particular core at a PWM frequency between 250 s.d. 300kHz and also capacitors from the results of the practice so far:

Core	Diameter mm	AL	Number of turns 250-300kHz Single	Number of turns 250-300kHz Double	Number of turns 200kHz Fullbridge for Low Sub
MS130060	33	80	20 - 25	15 - 18	(3x) 17
77071A7	33	80	20 - 25	15 - 18	(3x) 17
MS157060	57	80	16 - 20	16 - 20	(2x) 16
0077083A7	57	80	16 - 20	16 - 20	(2x) 16
T157-2	57	25	35 - 45	35 - 45	(2x) 40

For the amount of LPF capacitors depends on the high and low PWM switching because the function of the capacitor to cut the remaining PWM ripple. The lower the switching speed, the greater the ripple and vice versa. As a rule for the following table LPF capacitors:

PWM	Capacitor
150 – 200 kHz	1 uF
200 – 250 kHz	680 nF
250 – 325kHz	470 nF
325 – 400kHz	390 nF

Referensi:

<http://www.ti.com/lit/an/sloa119b/sloa119b.pdf>

<http://www.irf.com/product-info/audio/classdtutorial2.pdf> Chapter 4.