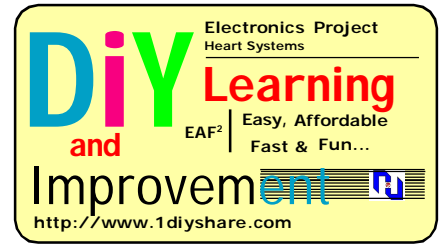


No.04

DIY Issue No. Four

- diy Assembly Power Amplifier
- designed for DATC Tone Control
- Mute & Standby Control
- solution voted by the 1diyTEAM
- On the board Interfacing, Input, Speaker, Controls
- Control by DATC to automatic Turn On / Off via programmable Timer
- Easy Interface with "do diy MP3 Player"



The DR20W Power Amplifier

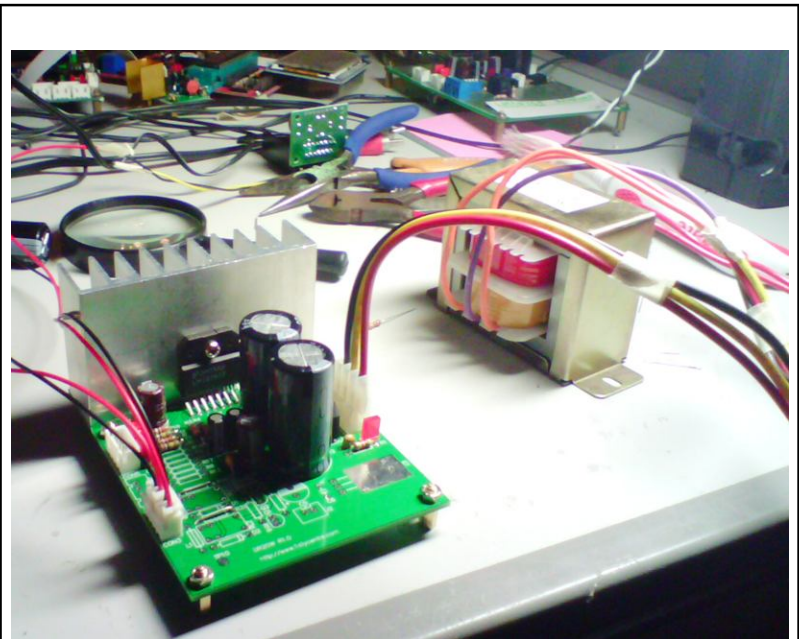
- a Power Amplifier dedicated for the Digital Audio Tone Control - a Tone Control that process digitally.

What is so special about it? The DR20W is controlled to automatically Turn On / Turn Off at specified time by the Digital Audio Tone Control - DATC. The DR20W can be put into sleep mode (standby mode) or active mode to provide the true music power.

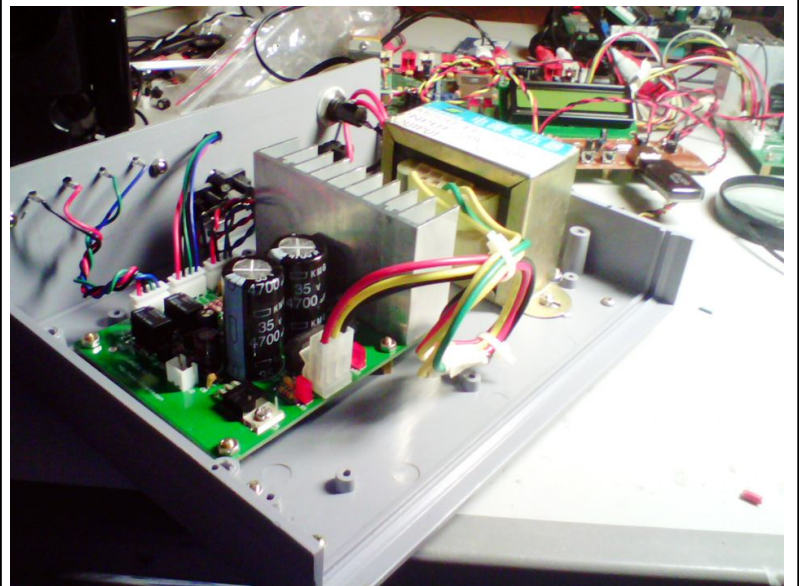
At night time, when used to play high-fidelity music with surround enhancement for your relaxation, the DR20W + DATC Tone Control can be programmed to automatically turn off at 11:30 PM (or anytime), a time that probably you were fall sleep already. In the morning before you wake up, it automatically turned on to provide you that quality music or play your favorite music, that makes your day start with your favorite music.

Though, it is designed for the DATC Tone Control, the DR20W can be easily used in other Tone Control. It has a hardware option to have excellent pop noise - automatically killing the pop-noise during the turn-on and off of the Power Amplifier. It has also Hardware option to use or not to use the Speaker Control (Mute) and Power Supply (Standby Mode) Control.

The DR20W - with core Amplifier of NS LM1876F can deliver maximum continuous 20Watt_{rms}/channel of music power into a 4 ohms speakers systems, that is 40Watt_{rms} Stereo music power - a home choice power level that satisfy the need of true music strength without having a police call from your neighbor.



(a) The DR20W Power Amplifier in Testing mode - standalone without control from the DATC Tone Control



(b) The DR20W Power Amplifier building on its plastic casing

Figure 1 : The DR20W Power Amplifier

Audio Building Block

National Semiconductor described the LM1876F in details in the datasheet and I will not be repeating here, please refer to LM1876F datasheet.

Instead, gusto kong i-discuss ang Audio Building Block - ang different function ng

- (1) Music Source
- (2) Tone Control
- (3) Power Amplifier, at saka
- (4) Speakers

para magkaroon ng isang Kumpleto'ng Home Audio Systems.

Music Source :

Sa Information Age, marami ng gadget ang puwede'ng gawin music source. Ang pinaka-popular ay ang MP3 Player, ipod, MP4, etc. Puwede rin ang Mobile Phone, PC, TV, STB (Set Top Box) at iba't iba pang music source.

Ang output ng mga devices/gadgets ay maari'ng "flat response" o "normal", ibig sabihin na wala ito'ng

equalization. For example, ang MP3 player o ang Mobile Phone ay mayroon Equalizer (EQ) function, kung ang Setting ng EQ ay *Normal*, ito ay naka "flat response" - walang "boost" walang "cut". Kung i-set ito sa *Rock*, ang equalization response nito ay "Rock", o malakas ang Bass (minsan tinatawag din Bass Boost). Minsan ang EQ ay hindi sapat para magkaroon ng isang maganda'ng "tone" o tonal quality, kaya naman ginagamitan ito ng *Tone Control*.

Tone Control :

Ang Tone Control, gaya ng kanyang pangalan na *tone control*, kino-control nito ang "tone" ng music. Ang Tone Control ay mayroon controls na :

- BASS Control
- TREBLE Control
- BALANCE Control
- VOLUME Control

Ang *BASS Control* ay para palakasin (bass boost) o pahinain (bass cut) ang Bass sound gaya ng Bass

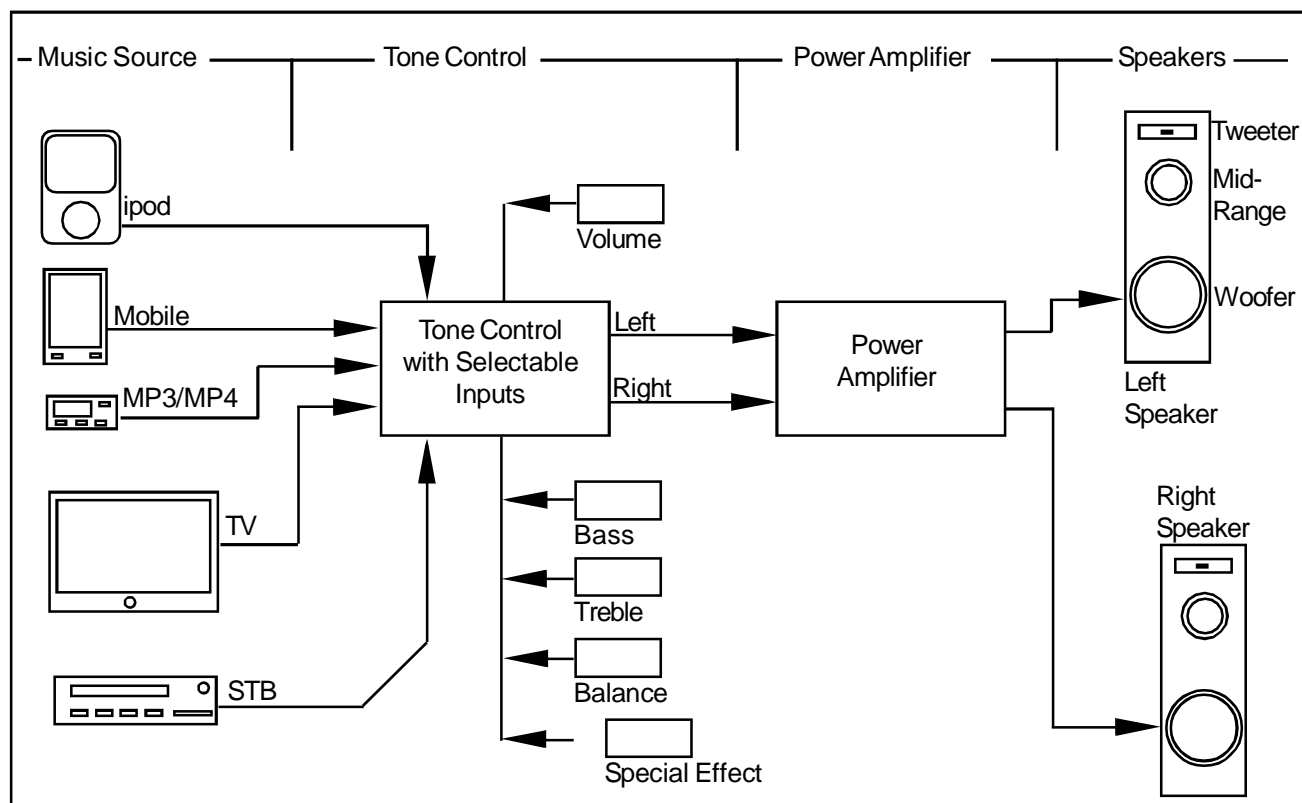


Figure 2 : Audio Building Block Diagram

Guitar o Bass Drum. Ang Bass ay low frequencies at kadalasan ay nararamdaman ito, lalu na sa mga pa-disco sa Baranggay (Mobile Disco). Ang Bass ay naririnig ito sa Woofer Speaker .

Ang **TREBLE Control** ay para palakasin (treble boost) o pahinain (treble cut) ang Treble sound gaya ng Cymbals, Hi-Hat. Ang Treble ay High Frequencies at naririnig ito sa Tweeter Speakers.

Ang **Balance Control** ay para sa “balanse” o “equal strength” ng Left at saka ang Right channel.

Ang **Volume Control** ay para palakasin o pahinain ang Sound sa speakers.

Sa mga makabago'ng Tone Control - mayroon ito'ng special functions na gaya ng “spatial sounds”, 3D, surround, etc. Ang ganito'ng features ay para pagandahin lalu ang output ng music na maririnig sa speakers. Gaya ng “spatial sounds”, ang ginagawa nito ay para maramdaman lalu ang **stereophonic effect**, kung maririnig natin ito, para'ng lalu'ng gumanda ang pandinig natin sa music.

Ang Digital Audio Tone Control (DATC) ng 1diyTEAM ay mayroon din special effect, ito ay Surround Effect, L-R at saka L+R, 90 degrees out of phase sa original signal saka may delay, saka i-reproduce sa front speakers. Well, ang epekto nito ay para'ng ang music ay naririnig sa ibat-ibat directions - parang hindi lang sa front speakers.

Basta, ang pinaka-aim ng mga effects na ito ay para pagandahin ang music sa ating pandinig - ito ang tinatawag na **Music Quality**, hindi lang basta music, pero, music na may quality ang dating.

Power Amplifier :

Ang Power Amplifier - gaya ng kanyang pangalan, i-amplify (palakasin) ang music para marinig ito sa comfortable listening level. Ang output ng Tone Control ay mahina (kahit na headphone ay di kayang i-drive), kaya kailangan ang Power Amplifier para palakasin ang music signal - ang lakas ng amplifier ay measurable in terms of Power (real power o root mean square (rms) power) na kadalasan tinatawag na Average Power.

Ang ginagawa lang ng Power Amplifier ay para palakasin ang electrical music signal na maririnig

sa Speakers. Ang DR20W ay kaya niyang palakasin ang music ng maximum 20Watts / channels sa 4 ohms na speaker Systems.

Para'ng ang hina, 20W lang, samantalang mga nakikita sa mga portable Karaoke with Amplifier ay 1000watts, eh, di ang hina ng 20W niyan....!

And DR20W ay naka-rated sa Watt rms na Average Power (root mean square), ibig sabihin na totoo'ng Power na kaya'ng i-deliver ng Power Amplifier. Ang 20Watt(rms) / channel (40 Watt rms Stereo) ay ideal for home use. Of course, hindi ito puwede na pang-mobile disco sa mga Baranggay o Stadium.

Ang DR20W ay para sa iyong listening pleasure, listening to your favorite music with quality tune, high power enough to filled your home or room with the kind of tune other audio system don't have, since, DR20W comes with a dedicated Digital Tone Control that makes the music sounds better to our ear.

Minsan, sabi ng iba na kung malakas ang Amplifier mo, mas maganda din ang tunog. Strictly, ang Power Amplifier ay para lang palakasin ang electrical Music at hindi ito nag-a-alter ng music equalization, para'ng ito ay naka normal. Siguro, kung ang Power Amplifier gaya ng DR20W ay gagamitin sa pang-labas na Audio Applications gaya ng Auditorium at itodo ang Volume para lumakas hanggang sa over-driven na ito at pangit na ang tunog sa speakers, dito, hindi kayang i-supply ng DR20W ang music power para sa isang malaking Auditorium, kailangan dito ang mas malakas na Power Amplifier gaya ng 500Wrms o kaya 900Wrms.

Speakers :

Ang Speaker ay para i-convert ang Electrical signal sa Sound waves.

Ang Speakers ay mayroon 3 klase, ang Tweeter, Mid-range at saka Woofer. Ang Tweeter ay para sa mga high Frequencies, mga makalansing na tinig ng Cymbals. Ang Woofer ay para sa mga Low Frequencies gaya ng Bass Drum at Bass Guitar. Ang Mid-range speaker ay para sa mga frequencies sa gitna ng tweeter at woofer. Ang combination ng 3 speakers ang siyang nagbibigay sa atin ng quality music.

DR20W Design Consideration

Ang design ng DR20W ay naaayon sa function ng Digital Audio Tone Control (DATC) na :

1. Automatic Turn On / OFF
2. Standby Mode / Speaker Control

Ang mga requirements na ito ang basis ng design.

Automatic Turn On/Off :

Ang DATC ay programmable, puwede'ng i-program kung anong oras i-OFF ang Power Amplifier at kung anong oras mag-ON ang Power Amplifier. Ang oras ay programmable 24 hours.

Standby Mode / Speaker Control :

Ang DATC ay kino-control nito ang Power Amplifier Standby Mode. Kung naka Standby ang Power Amplifier, ang power consumption nito ay maliit, kung baga hindi kumakain ng kuryente. Ang Speaker ay naka "Mute" o walang tunog na maririnig, kasi naka-"sleep mode".

Ang dahilan nito ay, sa mga music lovers, nakikinig ng music para antukin o talagang hobby na makinig ng music bago matulog. Kung tulog ka na, puwede na i-standby mode na ang music via automatic turn-off, "sleep mode na rin" at ma-save ang power.

Kinabukasan mga 7:30 AM, mag-auto-turn-ON ang Power Amplifier via programmable timer sa DATC para i-play nito ang iyong favorite music.

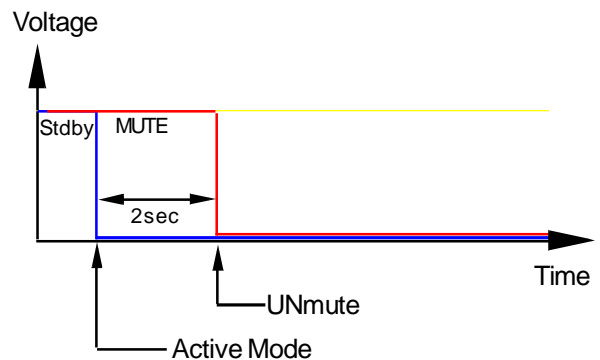
Ang electrical signal logic na galing sa DATC at komo-control sa DR20W ay :

Standby Mode : High
Mute : High

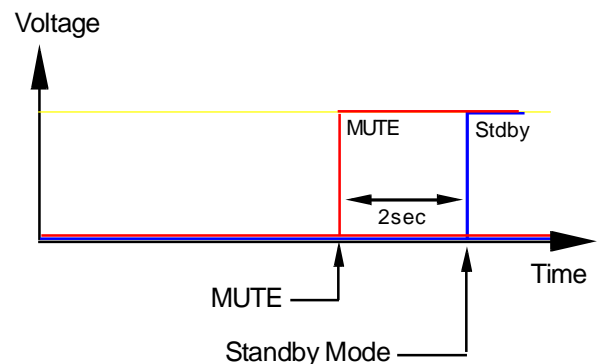
Active Mode : Low
UNmute : Low

Sa Power On, ang sequence ay mula Standby Mode papunta Active Mode, ibig sabihin na magiging na ang Power Amplifier. Mauna na mag-connect ang Standby Mode control, pagkatapos ng 2 seconds, ang Speaker ay magiging UNmute, ibig sabihin na mayroon na maririnig na tunog. Ang sequence na ito ay para di marinig ang mga noise

sa Speaker kung magising ang amplifier. Kung Power Off naman ang Power Amplifier, mauuna muna na mag-MUTE ang Amplifier, pagkatapos ng 2 seconds saka ito pupunta sa Standby Mode. Dito, wala rin maririnig na mga noise kung matutulog na ang Amplifier dahil naka "mute" na ito.



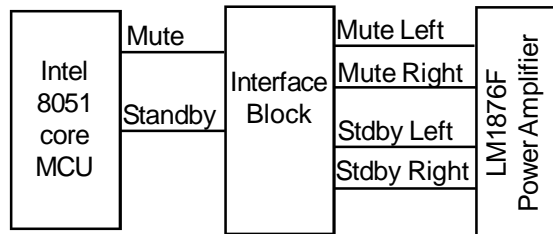
Graphical Representation of MUTE / Standby during Turn On



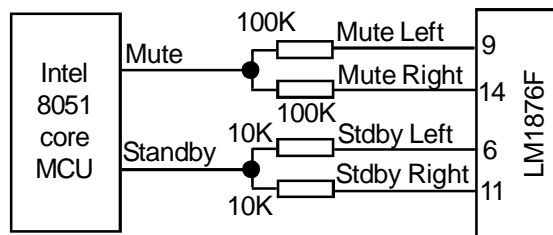
Graphical Representation of MUTE / Standby during Turn OFF

Control Interfacing :

Ang Standby Mode at saka Mute (Speaker) Control ay mula sa MCU (Micro Controller Unit) ng DATC Tone Control.

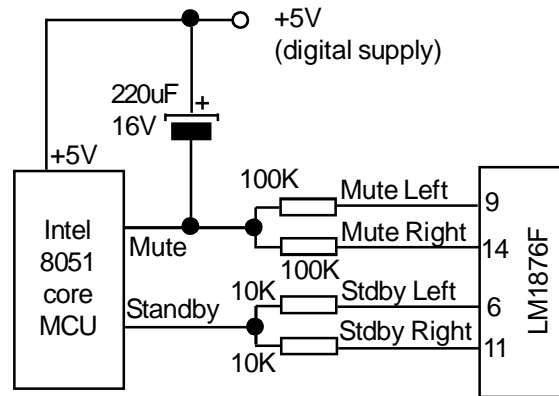


Sa Page 13 ng NS datasheet, Figure 5 ay mayroon suggested na interface ng MCU at saka ang LM1876F Power Amplifier IC. Dahil gagamit tayo ng split power supply, puwede'ng hindi sundin ito, puwede'ng direct connection ang interface mula sa MCU. Ang final interface circuit ng DATC tone control at ang DR20W ay :



DATC
micro Controller

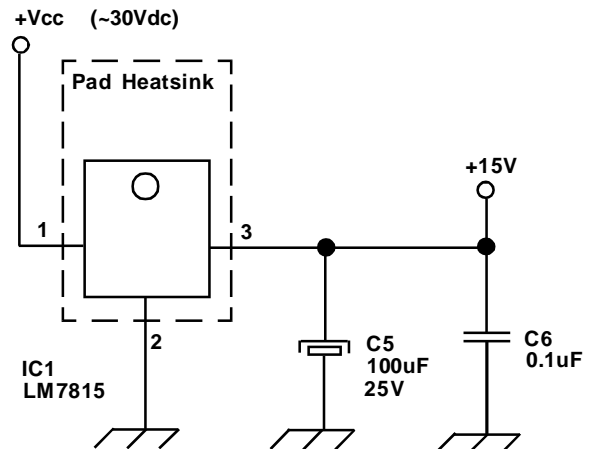
Pero mayroon pa rin problema sa ganitong Interfacing, sa unang pag-kasaksak ng 220Vac power, ang problem ay doon sa DATC Tone Control, dahil sa unang gising ng AT89S52 MCU (just wake up) pagkasaksak ang power, medyo nahuhuli'ng gumising ang MCU ng DATC kumpara sa DR20W LM1876F IC, at dahil dito, ang Mute line ay naka Logic Low, ibig sabihin na naka-UNmute ang DR20W, dahil dito may maririnig kang pop-noise sa Speakers. Ang solution dito ay maglagay ng temporary pull-up sa Mute Line gaya ng nasa larawan sa ibaba.



Ang function ng 220uF electrolytic capacitor ay para ang MUTE line ay naka-logic high kung first time magkaroon ng power ang DATC

Power Supply Interfacing :

The DATC is powered by 12V~16Vdc, I want to use only one power supply from the DR20W. With the split power supply of +V, the voltage is close to 30Vdc, masyado'ng mataas para sa DATC, puwede ito kaya lang masyadong maiinit ang LM7809 regulator ng DATC. Ang solusyon dito ay maglagay ng LM7815 regulator sa DR20W PCB, para magkaroon ng +15Vdc output, na nasa range ng DATC input. Ang +15V ay standard voltage din sa ibang Tone Control na single supply.



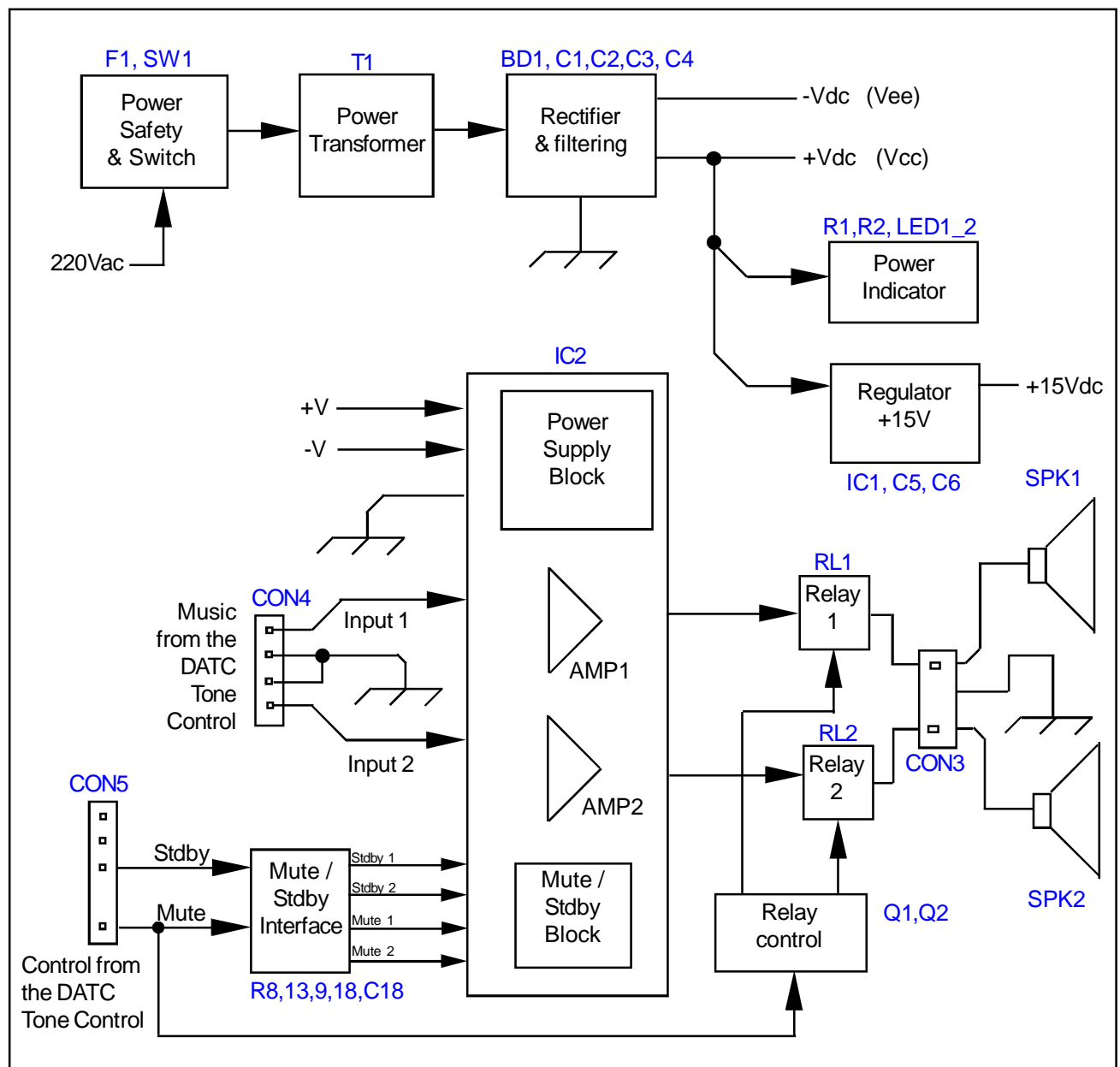
DR20W Block & Schematic Diagram

Block Diagram & Circuit Diagram :

Ang DR20 Block diagram ay makikita sa Figure 3 sa ibaba at ang Circuit Diagram ay makikita sa Figure 4.

Power Safety and Switch :

Ito'ng circuit block ay para sa Power On/Off Switch at saka protection, kailangan na maglagay ng Fuse para kung mayroon mali sa Power ay ma-protectahan ang system via Fusing.



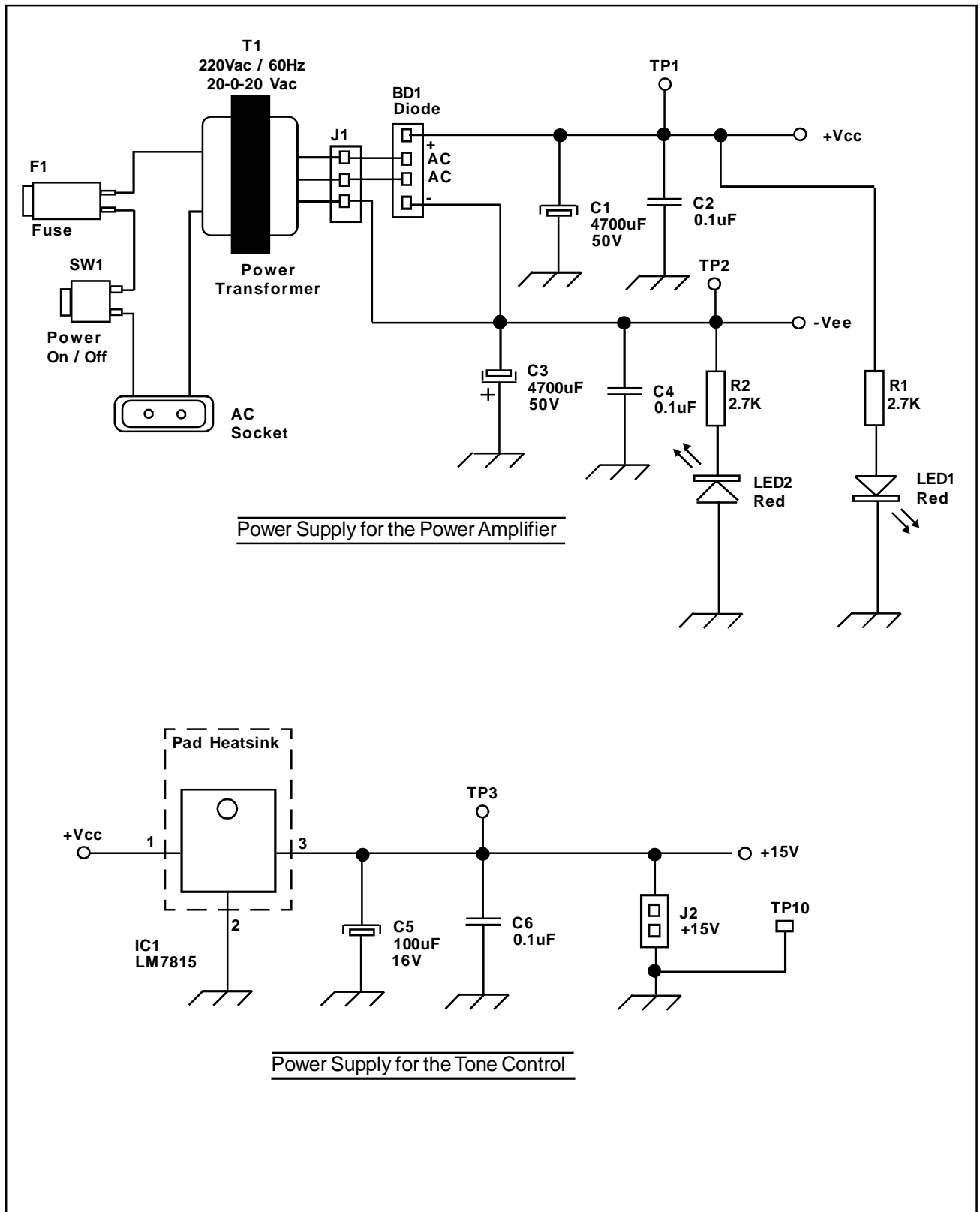


Figure 4(a) : DR20W Power Supply Schematic Diagram

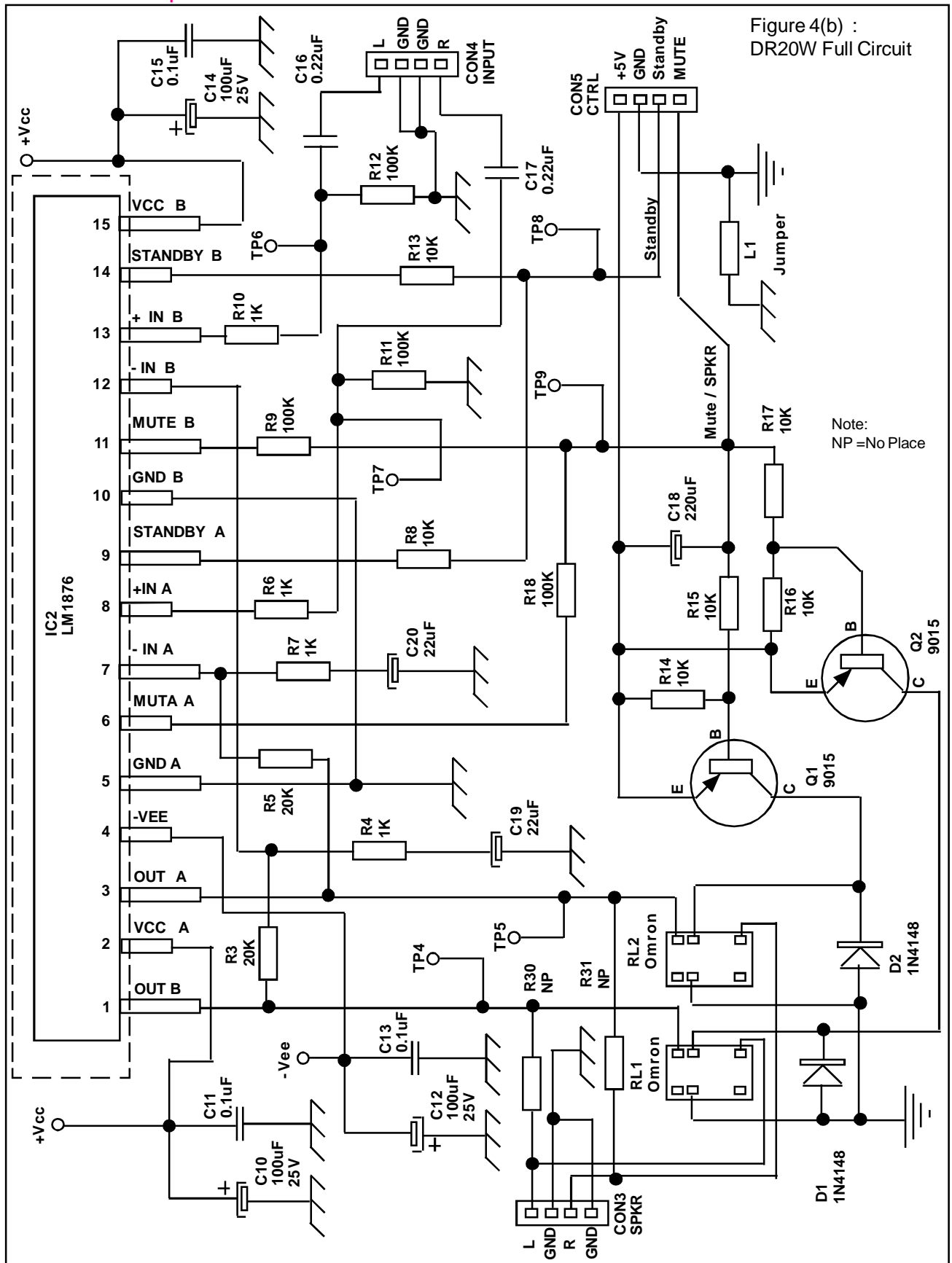


Figure 4(b) :
DR20W Full Circuit

Note:
NP =No Place

20W RMS / CH IC Power Amplifier

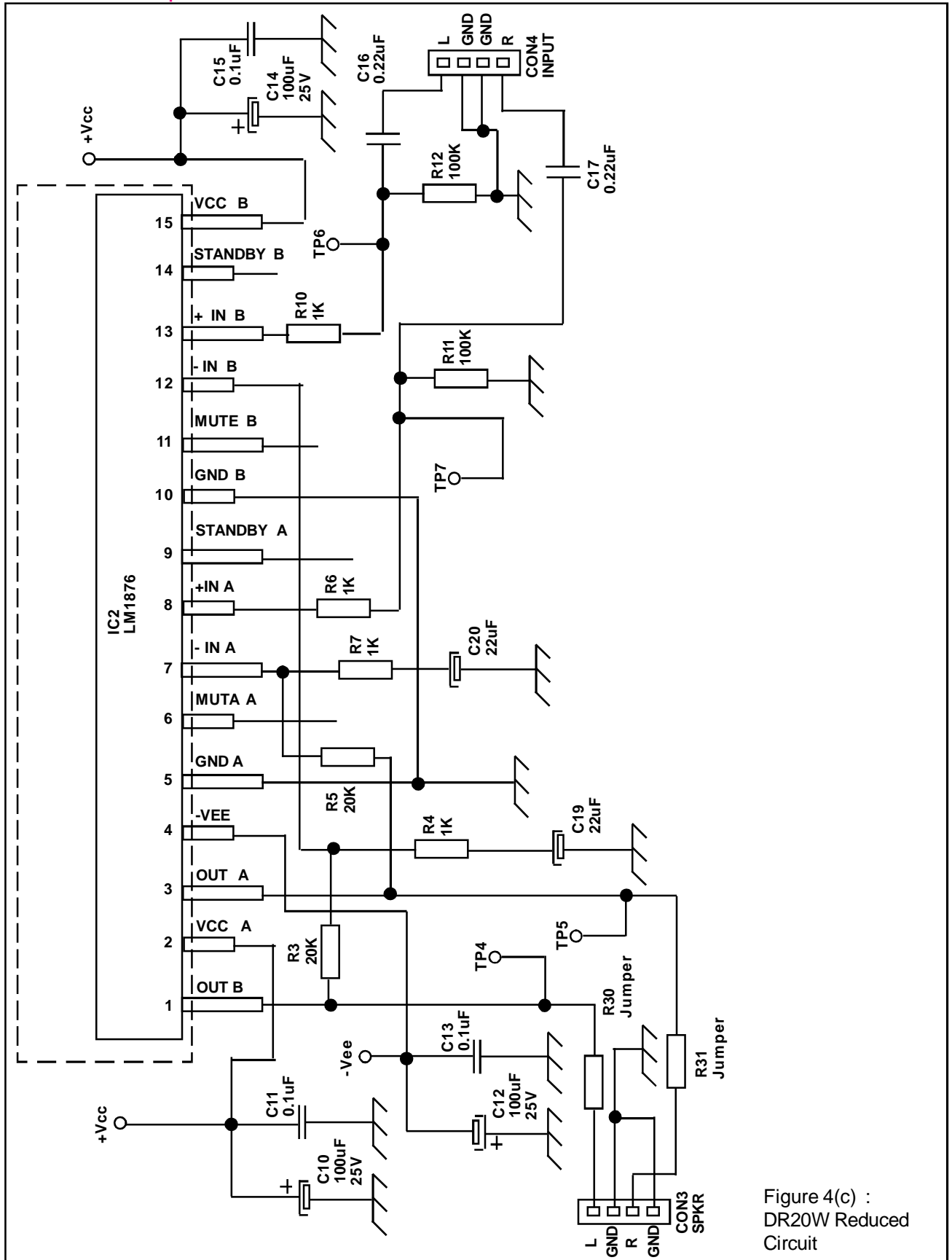


Figure 4(c) :
DR20W Reduced
Circuit

Power Transformer :

Ang Power Transformer ay ibaba ang household 220Vac/60 Hz at gawin niya itong 20-0-20Vac, ito ay para sa split power supply na kailangan ng LM1876F Power Amplifier IC.

Rectifier and Filtering :

Ang BD1 ay mag-convert ng AC (Alternating Current) to DC voltage (Direct Current) pulsating DC. Ang DC voltage output ng BD1 ay plus (+) at saka minus (-), normally ang tawag dito ay split power supply. Ang C1 at saka C2 ay para sa Filtering ng split DC voltage, para maging pino na DC voltage, at ang C3 at saka C4 naman ay para sa filtering ng high frequency noise, na kung hindi ma-filter ay maari'ng sanhi ng noise na maririnig sa speaker.

Power Indicator :

Ang LED1 at saka LED2 ay Power Indicator, iilaw ito kung mayroon DC voltage.

Regulator +15V :

Ang Regulator ay binubuo ng LM7815 IC, ang gagawin ng IC ay iyong +30V DC na galing sa plus (+) ng split power supply ay gagawin niyang +15Vdc well regulated supply. Ito'ng +15Vdc ay para sa power supply ng DATC o iyong Tone Control. Ang C5 saka C6 ay mga associated component para sa normal operation ng LM7815 IC.

LM1876F Power Amplifier IC :

Ang LM1876F Integrated Power Amplifier ay binubuo ng major 3 internal blocks , power supply block, linear amplification at saka logic control block.

Power supply :

Para sa split power supply distribution sa Channel 1 at saka sa Channel 2 at sa internal logic control gaya ng Mute at saka Standby mode.

Linear Amplification :

Ito ay para sa amplification ng signal, ina-amplify nito ang signal mula sa input several times bigger sa speaker output.

Logic Control :

Ito ay para sa management ng Mute at saka Standby Mode pati na rin ang detection ng overheating (Thermal protection), etc.

In addition, paki-basa na lang po ang LM1876F datasheet.

Mute / Standby Interface :

Kung paano ang connection ng host MCU sa LM1876F. Ang implementation dito ay simple direct interface, na-discuss na po earlier sa Design Consideration.

Relay Control / Relay 1 & 2 :

Ito ay optional, isinama ito dahil sa isang matindi'ng requirement ng aming "good friend". Ganito iyon, kung naka active mode ang DR20W + DATC Tone Control, tapos saka mo huhugutin ang 220Vac power supply, mayroon kang maririnig na series of noise (dies out oscillation) sa speaker. Para mawala ito'ng noise na ito, naglagay ako ng option na relay para kung biglaan mawala ang power, ang speaker ay completely disconnected from the LM1876F Power Amplifier, at di na maririnig pa ang noise (*kahit minsan lang mangayri na brown out*).

In most case, kung ang DR20W + DATC Tone Control ay tama'ng isara, kung pindutin mo ang Power Off sa Remote Control ng DATC, maayos naman ang response, wala naman noise.

Speaker Systems :

Yes! Kailangan dito ang maganda'ng speaker para sa good quality music. Ang DR20W ay naka rated sa 4 ohms para ma-attained ang 20Wrms/channel. Kadalasan, ang mga speaker systems ay naka 8 ohms, kung gagamitin ang 8 Ohms, di mo makuha ang full 20Wrms / channel.

Of course, kahit na gamit ka ng 8 ohms, maganda at malakas pa rin ang performance ng DR20W.

DR20W Bill Of Materials (BOM)

Ang DR20 BOM ay makikita sa Figure 5. Ito ay Basic DR20W components ayon sa schematic na Figure 4(c). Kung mayroon ka DATC Tone Control o similar Tone Control na mayroon Mute at saka Standby Control, sundin ang Figure 6, ito ay ayon sa schematic na Figure 4(d). Ang BOM listing sa Figure 7 ay para sa Relay components. Hindi lahat ay gustong gamitin ang relay, kaya optional na ito.

Basic DR20W BOM	
Integrated Circuit :	
LM1876F	IC2
Diode :	
KBP307	BD1
Resistors :	
1K	R4, R6, R7, R10
2K7	R1,R2
20K	R8, R9
100K	R11, R12
Capacitor :	
22uF /50V	C19, C20
100uF / 50V	C10, C12, C15
4700uF /50V	C1, C2
0.1uF /50V	C2, C4, C11, C13, C15
0.47 uF/50V	C16, C17
LED:	
Red LED	LED1, LED2
Connectors :	
4 pins	CON3, CON4
3 pins	J1
Others :	
Heatsink	
Fuse with 1 Amp	F1
Power Swtich	SW1
AC socket	
AC cord	
RCA Jack	
Speaker Jack	
Power Transformer	
220Vac 60Hz / 20-0-20 @ 4A	T1

Figure 5 : DR20W basic BOM (without DATC control Interface and +15V Power Supply)

Basic + 15V + Control DR20W BOM	
Integrated Circuit :	
LM7815	IC1
Resistors :	
10K	R8, R13
100K	R9, R18
Capacitor :	
100uF / 50V	C5
220uF / 16V	C18
0.1uF /50V	C6
Connectors :	
2 pins	J2
4 pins	CON5

Figure 6 : Adding the +15V and DATC Control Interface BOM

Basic + 15V + DATC Control + Relay	
Transistors :	
FCS9015	Q1, Q2
Diode :	
1N4148	D1, D2
Resistors :	
10K	R14, R15, R16, R17
Relay :	
Relay	RL1, RL2

Figure 7 : Adding the Relay BOM

PCB Assembly

The DR20W can be assembled easily, basta sundin lang ang mga recommended Assembly Instruction.

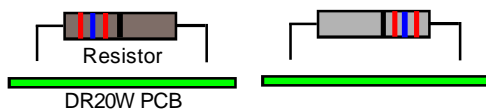
Ang tinutokoy na Assembly Instruction ay para sa DR20W Kit version.

Work Instruction 1 : Preparation

- [1] Ihanda ang mga gagamitin tools gaya ng Soldering iron, Soldering Lead, Multimeter,
- [2] I-print ang BOM at saka ito'ng procedure.
- [3] Linisin ang iyong working table kung saan kayo mag-a-assemble. Ihanda ang mga parts. Ihiwalay at pagsamahin ang mga Resistor, ganun din ang Capacitors, IC,
- [4] Buksan ang Soldering Iron at i-check mabuti na ang tip ay maganda ang soldering performance. Kung hindi, linisin ito para

Work Instruction 2 : Manual Insertion

- [1] Ihanda ang mga Resistors. Magsimula muna sa DR20W Basic ayon sa BOM sa Figure 5. I- check ang mga Resistor na gamit ang Ohmmeter kung nasa corect values o hindi.
- [2] I-insert at i-solder lahat ng Resistor ayon sa Figure 5. Ang Resistor ay wala'ng polarity kaya puwede i-insert ito sa iyong palagay na best orientation.

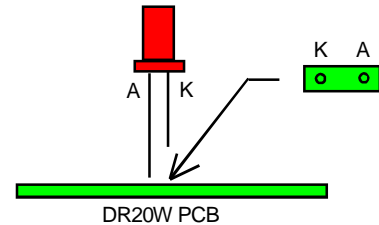


- [3] I-insert at i-solder lahat ng ceramic capacitor. Ang ceramic capacitor ay wala'ng polarity kaya puwede i-insert ito kahit na mabaliktad.

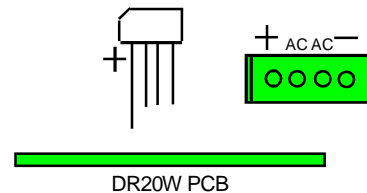


Work Instruction 2 : Manual Insertion

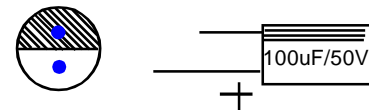
- [4] I-insert at i-solder ang LED. Ang LED ay mayroon polarity kaya sunding ang polarity Insertion.



- [5] I-insert at i-solder ang mga Connectors J1, CON4 at CON3, sundin ang legend ink ng J1, CON4 at saka CON3 sa PCB.
- [6] I-insert at i-solder ang BD1, ang BD1 ay mayroon polarity kaya sundin ang tamang orientation.



- [7] I-insert at i-solder ang mga Electrolytic Capacitor, simula muna sa 100uF. Ang Electrolytic Capacitor ay mayroon Polarity. I-insert ang electrolytic Capacitor sa direction na



Isunod ang 4700uF. Ayusin ang pagkakatagay ng 4700uF, dapat lapat na lapat sa PCB at saka ito i-solder. I solder muna ang isang paa nito at i-double check kung maganda at tama ang pagkakatagay sa PCB. Kung ayos na, saka i-solder ang isang paa nito. Pagkasolder, i-check ang position - dapat hindi ito galaw na parang sasayaw kung galawin mo.

PRELIM TEST

Ang preliminary Test ay i-carried out para ma check kung may mali sa Insertion sa power supply section. Linisin muna ang PCB, gamitin ang toothbrush, huwag lagyan ng toothpaste.

Equipment for Test :

(1) Voltmeter

Testing Connection :

Sundin ang Connection sa Figure 8.

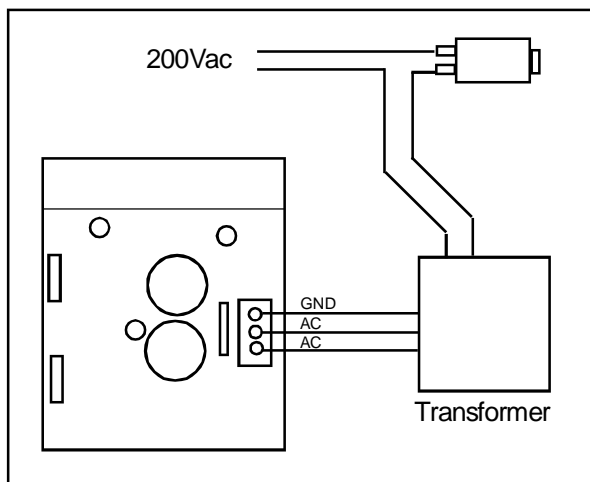


Figure 8 : Power Supply Testing Setup

Prelim Testing Procedure :

- [1] Sundin ang Setup sa Figure 8. Habang ginagawa ito, huwag muna'ng isaksak ang AC cord sa 220Vac.
- [2] Double check ang connection, connection sa Fuse, sa transformer at saka ang connection sa J1. Final check ang orientation ng mga Electrolytic Capacitor - wala'ng baliktad.

Kung sigurado na, isaksak ang AC cord sa 220Vac.
- [3] Makita na iilaw ang LED1 at saka ang LED2. Maghintay ng 10 seconds, kung wala pumutok na capacitor, OK ang orientation ng mga Electrolytic Capacitors.
- [4] Kunin ang Voltmeter (o Digital Volt Meter), hanapin ang TP1 at TP10 o GND. Ilagay ang red na probe sa TP1 at ang black na probe sa TP10 o GND, ang voltage ay around 28V.

- [5] Ilagay ang red na probe sa TP10 o GND at ang black na probe sa TP2, ang voltage ay around 28V, hindi magkalayo ang reading ng TP1 at saka TP2.

Note:

Minsan, ang Transformer ay naka-rated ng 20Vac pero ang actual na output nito ay 19V lang, kaya ang 19Vac ay 26.8V lang kumpara sa 28V.

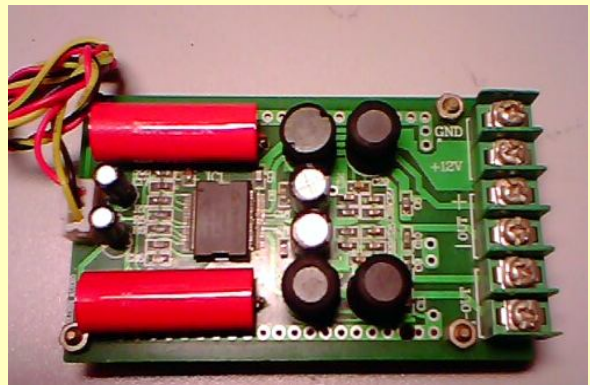
- [6] Wala pa ba pumutok na Electrolytic Capacitor? Good - at wala pa. Ilagay ang red na probe sa TP1 at ang black na probe sa TP2, ang voltage ay around 56V.
- [7] Tanggaling ang pagka-saksak ng AC cord sa 220Vac, hayaan lang na ma-discharge ang voltage - - hintayin mamatay ang ilaw ng LED1 at saka LED2.

Tanggaling ang connection sa J1, itabi muna ang Power Transformer sa isang safe place.

Now, go back to PCB Assembly, to add the LM1876F Power Amplifier IC.

Class T - Digital Audio Amplifier (by Tripath)

Class T amplifiers offer both the audio fidelity of Class AB and the power efficiency of Class-D amplifier. The TA2024 15W/channel continuous average 2 channels Class-T digital Audio Power Amplifier IC using Tripath propriety digital power processing technology



new toy, something I am playing on my working bench

Work Instruction 3 : LM1876F Soldering

- [1] Kunin ang LM1876F IC, i-check mabuti kung maayos ang mga paa nito.
- [2] Kunin din ang Heatsink, ilagay ang IC sa IC2 location sa PCB, i-insert lahat ng mga paa nito. Ilagay ang Heatsink sa likod ng IC, saka i-screw ang IC sa heatsink. Hawakan mabuti ang heatsink at ayusin ang pagkakatagay sa PCB - may dalawa'ng butas ang PCB para sa soldering ng Heatsink. Kung ayos na ang heatsink at ayos din ang mga paa ng IC, kunin ang Soldering iron at i-solder ang magkabilang paa ng IC, siguraduhin maayos ang pagkasolder at di gagalaw. Check uli kung lapat na lapat ba ang Heatsink sa PCB.
- [3] I-solder lahat ang paa ng IC, pagkatapos ma-solder, i-check uli ang Heatsink kung ayos ang pagkakatagay a PCB ngayon na-solder na ang IC.
- [4] I check ang paa ng IC kung may cold solder, no solder, short, etc. Siguraduhin na walang mali.

Work Instruction 4 : Cleaning / Final Check

- [1] Kumuha ng isang di na ginagamit na toothbrush, gamitin ito para linisin ang solder side ng PCBA (huwag po lagyan ng toothpaste).
- [2] Kunin ang Assembled DR20W basic at i-double check lahat ng soldering.
- [3] Kunin ang 4 wires para sa Speaker at isaksak sa CON3. I-connect ang wires sa speaker terminal.
- [3] Kunin ang 4 wires para sa Input at isaksak sa CON4. I-twist ang wires at ang haba ay 4~54 inches lang saka i-connect sa RCA.

We're going now for the Final Testing.

FINAL TEST

Ang Final Test ay para i-test ang function ng DR20W na Power Amplifier. Dito, i-check natin kung may amplification ang input signal, malakas o sapat ba ang output, mainit ba ang heatsink, may oscillation ba, noise, etc. etc.

Testing Equipment :

- (1) Voltmeter
- (2) Speakers, preferably 4 ohms
- (3) Music Source (MP3, MP4)
- (4) RC Cable

Test Procedure 1 : DC Output Voltage

- [1] Sundin ang Setup sa Figure 9. I-check dito ang dc output voltage sa speaker.
- [2] Isaksak ang AC cord sa 220V, ang reading sa Channel 1 ay dapat di tataas ng 0.5Vdc. Maghintay ng 10 seconds, dapat ang reading ay hindi tataas, typical reading 0.01Vdc.
- [3] Tanggalin ang pagkasasak ng AC cord sa 220V ac line.
- [4] Ilipat ang Voltmeter sa Channel 2, tingnan ang Figure 10.
- [5] Isaksak ang AC cord sa 220V, ang reading sa Channel 2 ay dapat di tataas ng 0.5Vdc. Maghintay ng 10 seconds, dapat ang reading ay hindi tataas, typical reading 0.01Vdc.
- [6] Tanggalin ang pagkasasak ng AC cord sa 220V ac line.
- [7] I-setup ang DR20W ayon sa Figure 11. Isaksak ang AC cord sa 220V, ang reading sa Channel 1 ay dapat di tataas ng 0.5Vdc.
- [8] Wala dapat marinig ng big noise, humming noise o oscillation sa speaker. Kung malakas ang Noise na maririnig sa speaker, tanggalin kaagad ang pagkasaksak ng AC cord sa 220Vac socket.

Kung wala'ng noise, subukan ilapit ang kamay o daliri sa CON 4, maririnig mo na lalakas ang humming, hawakan saglit ang pins sa CON4, may maririnig kang malakas na Humming.

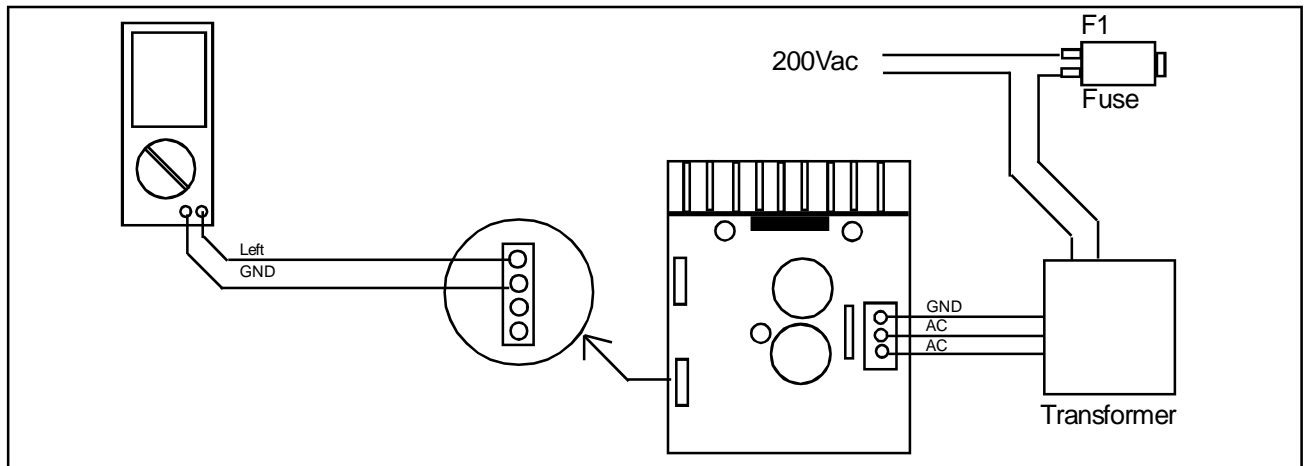


Figure 9 : Setup to check the DC Output Voltage of Channel 1

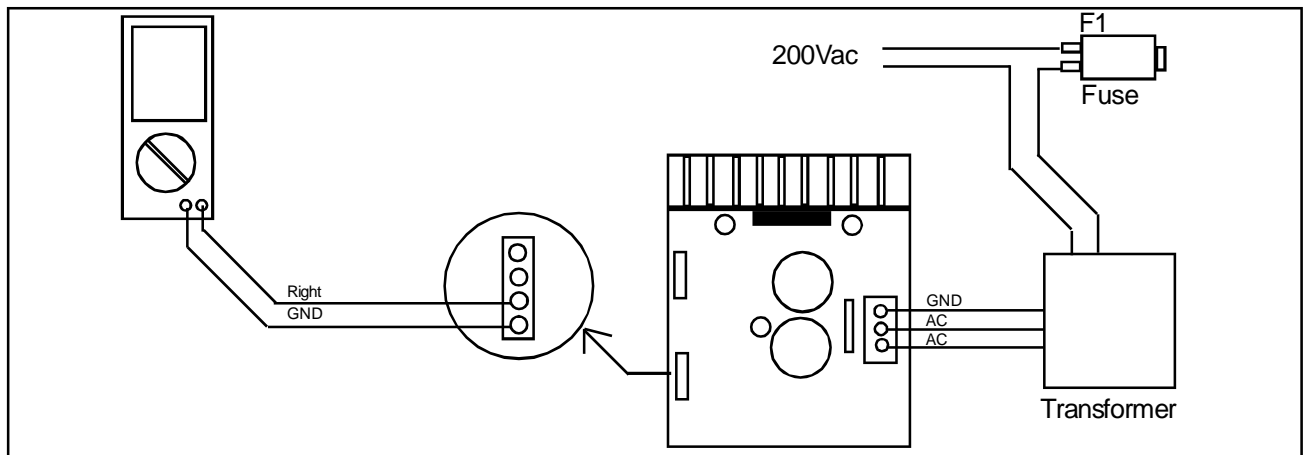


Figure 10 : Setup to check the DC Output Voltage of Channel 2

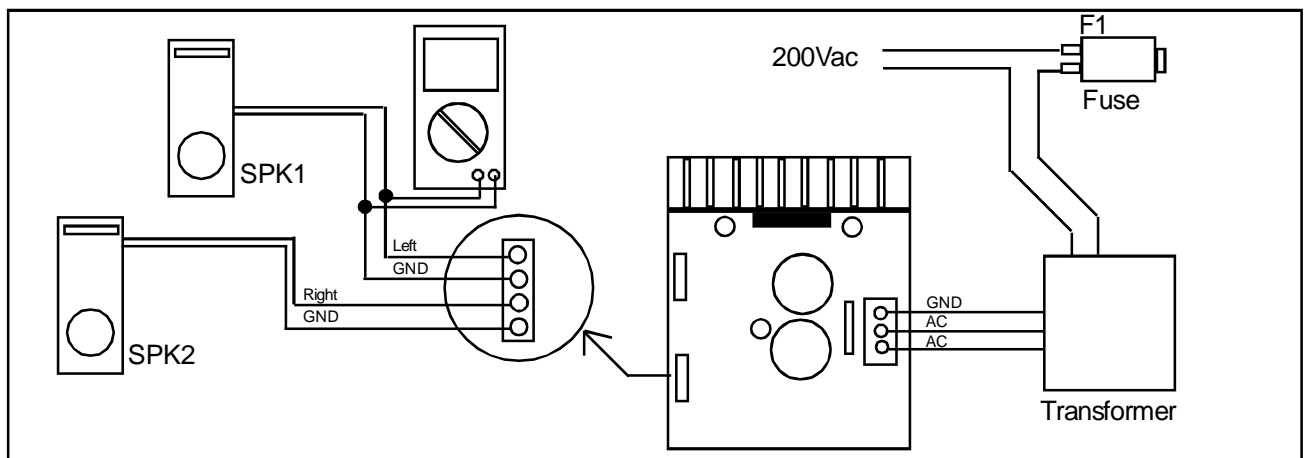


Figure 11 : Setup to check the DC Output Voltage with Load of Channel 1

Test Procedure 1 : DC Output Voltage

- [9] Ilipat ang Voltmeter sa Channel 2, ang reading sa Channel 2 ay dapat di tataas ng 0.5Vdc, typical reading 0.01Vdc (10mVdc)

Test Procedure 2 : Live Test

- [1] I-setup ang DR20W ayon sa Figure 12. Huwag munang isaksak ang 220Vac cord sa 220V socket habang ginagawa ang connection.
- [2] Ang 4 wires cable sa CON4 ay dapat i-twist (tirintasin) para hindi mag-pick-up ng maraming noise, dapat hindi rin mahaba ang wires na galing sa Music Source.
- [3] Buksan ang Music Source, kung ito ay MP3 mag-patugtog ng Music at ilagay ang Volume sa minimum. Isaksak ang AC cord sa 220Vac socket, dapat wala kang maririnig na mga pop-noise sa speaker at marinig kaagad ang music na galing sa MP3 Player. Kung hindi, tanggalin kaagad ang pagkasaksak ng AC cord sa 220 Vac socket.

Test Procedure 2 : Live Test

- [4] Lakasan ang volume ng MP3, ang increased ng Volume ay maririnig sa Speakers. I check muna kung hindi ka nakakagambala sa iyong kapit bahay o mga kasamahan mo sa bahay, kung hindi naman, subukan mong ilagay sa maximum Volume ang MP3 at pakinggan ang Music Power sa Speaker.
- [5] Ilagay ang Volume sa "comfortable listening level" at hayaan lang ng ilang minuto, i-check ang heatsink, makaramdam ka ng kaunting init pero hindi ito mainit na mainit na hinid na kayang hawakan pa.

Note:

Maaring hindi sapat ang bass o treble na maririnig mo sa speaker, subukan ilagay ang EQ ng MP3 sa Rock or Bass Boost. Ang Tonal Quality ay maaring di sapat dahil wala iyong Tone Control.

- [6] *Ok! Kung wala naman makitang problema, puwede nang i-solder ang Heatsink sa PCB solder pad - sa likod ng PCB.*

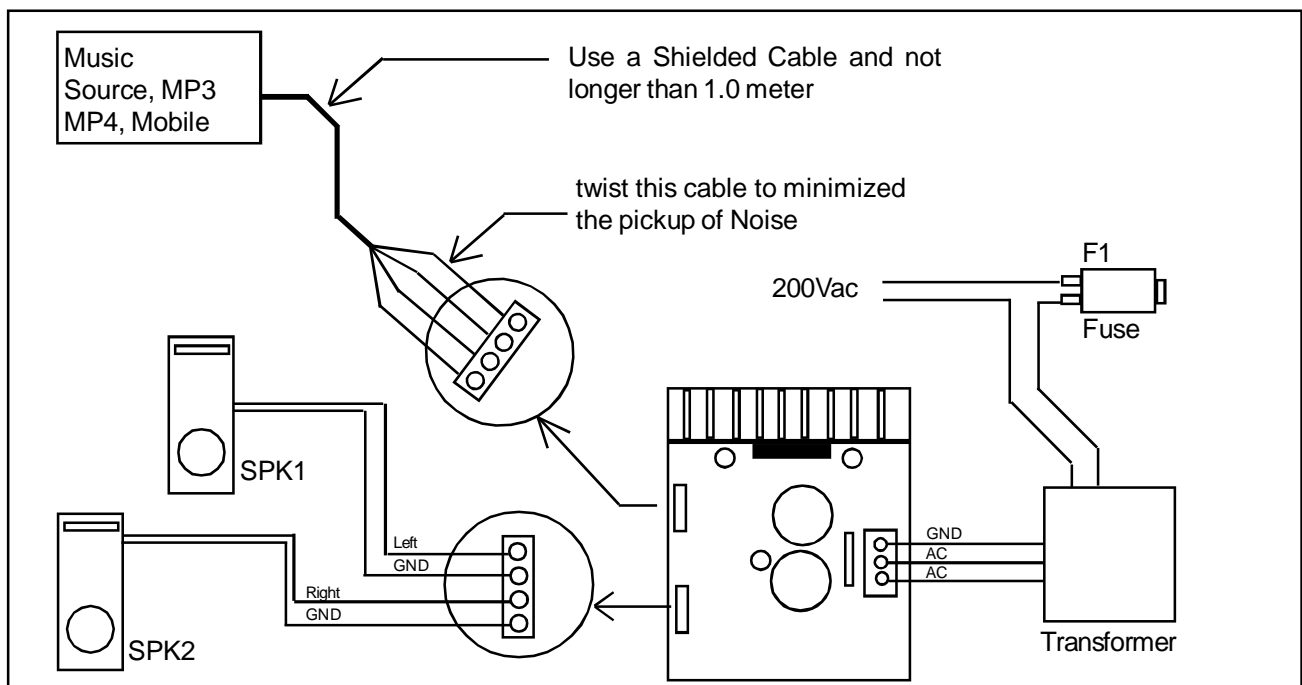


Figure 12 : Live Test

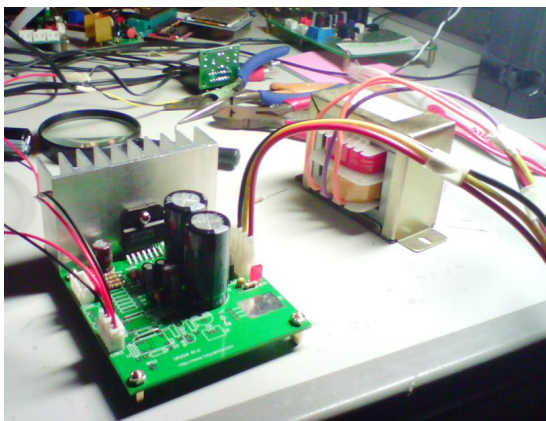
Electrical Performance Test - check the Power

Test Procedure 3 : Soak Live Test

- [1] I-setup ang DR20W ayon sa Figure 12. Huwag munang isaksak ang 220Vac cord sa 220V socket habang ginagawa ang connection.
- [2] Ang 4 wires cable sa CON4 ay dapat i-twist (tirintasin) para hindi mag-pick-up ng maraming noise, dapat hindi rin mahaba ang wires na galing sa Music Source.
- [3] Buksan ang Music Source, kung ito ay MP3 mag-patugtog ng Music at ilagay ang Volume sa minimum listening Level.
- [4] Buksan ang DR20W, hayaan lang na tumutogtog ng ilang oras (3~4 hours) at i-monitor kung ito ay :

- may maririning ba na biglang noise
- mainit ba ang heatsink, di na kaya hawakan pa, iyo'ng subrang init
- mainit ba ang Transformer, di na kaya hawakan pa, iyo'ng subrang init at ang amoy ay parang nasusunog na coil?

Kung mapapansin ito, itigil ang soak test. Kung wala naman, well enjoy the music.



Ito'ng Test ay para malaman ang performance ng Amplifier electrically. Ang consideration ko dito ay ang capability ng DR20W na i-deliver ang 20Wrms/channel. I believe, the LM1876F datasheet is correct in terms of the Test Conditions, but that condition in my Working Bench maybe different, and that differences should be known. I would like to test the DR20W according to the test condition available in my Working Bench, after then, let see if it can still able to deliver the 20Watt/channel.

Equipment Needed :

- (1) Signal Generator
- (2) Oscilloscope
- (3) Distortion Meter
- (4) 4 ohms Dummy Load, 50W

Ang mga equipment na ito ay hindi lahat makikita sa Hobbyist Bench, kaya naman hindi lahat ay kayang i-peform ito. In this case, ang discussion ng Electrical Performance Test ay para sa technical "know how" at malaman ang difference ng [Wattrms](#) at saka iyong [Wattmpo](#).

The Watt - root mean square :

Ang Wattrms (Watt - root mean square) ay iyong totoo'ng Power (actual power o Average Power) na kayang i-deliver ng Power Amplifier sa kanyang Load. Mathematically, ito ay computed ng :

$$P_{rms} = E^2 / R$$

Where :

- P = power ins Watts
- E = voltage at Load-R read in Vrms
- R = Load resistance (4 ohms)

Para ma-intindihan natin ang computation sa taas, i-consider natin ang Procedure kung paano i-measure ang Average Power o Watt(rms).

Procedure to determine the Wattrms:

- [1] I-setup ang mga equipment ayon sa Figure 12(A). Habang sine-setup ang logical equipments, huwag muna'ng isaksak ang AC cord sa 220Vac line socket. Please follow the Grounding Systems.

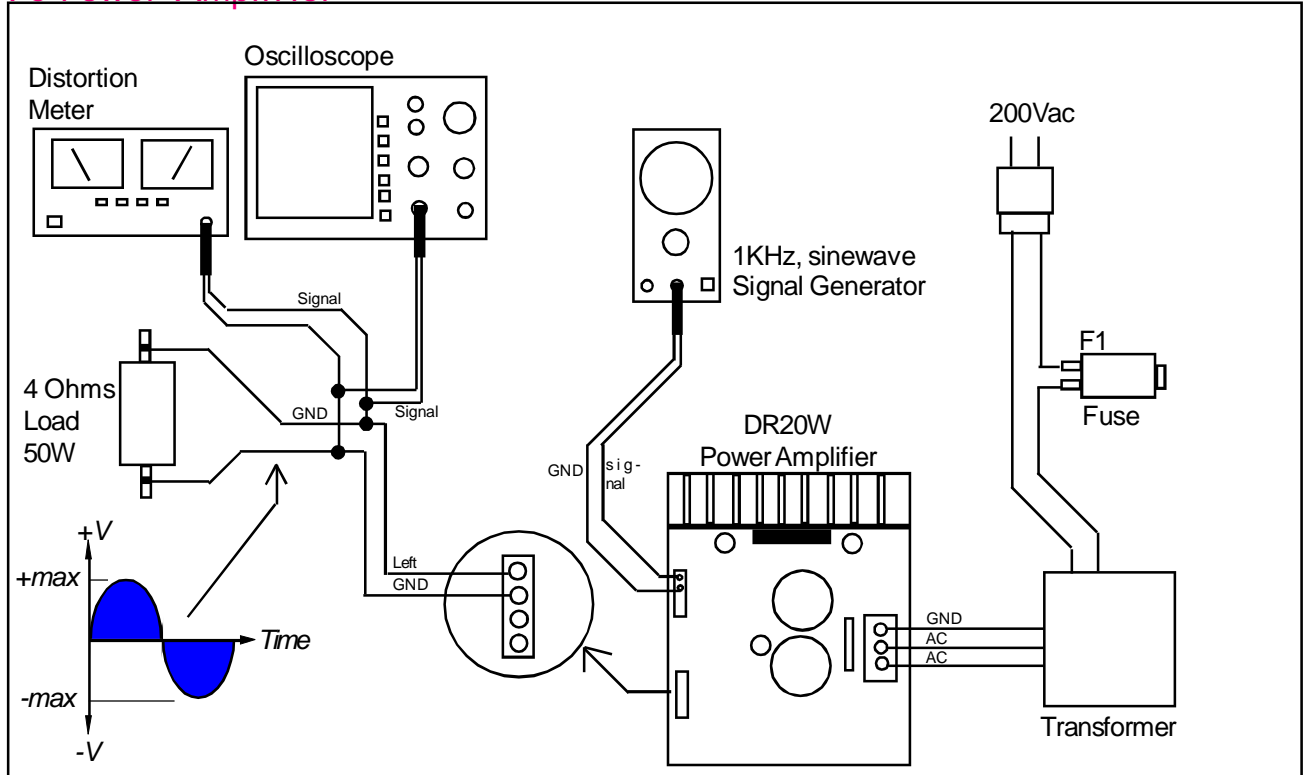


Figure 12(A) : Setup to check the Maximum Voltage Swing at the Load to determine the Maximum Power the DR20W can deliver to its load

- [2] Buksan ang mga equipment, Oscilloscope, Distortion meter, Audio Generator. I-set ang tamang Time Sweep ng oscilloscope at saka Amplitude, ang tamang reading/setting ang Distortion meter, set sa 10% distortion range, AC reading sa 30Vac. I set ang Audio Generator sa 1KHz, ilagay muna ang Amplitude sa minimum.
- [3] Isaksak sa 220V AC power outlet and AC cord ng DR20W, at i-monitor ang Oscilloscope, distortion meter, dapat wala kang makikita na mga magulong waveform, dapat malinis na straight line o kaya sine wave.
- [4] Sa Audio Generator, i-increase ang amplitude kaunti, may makikita ka na sinewave sa oscilloscope, mayroon ka rin reading sa distortion meter at AC meter. I-increase ang amplitude habang nakitingin sa Distortion meter % reading, hanggang maging 10% ang distortion, itigil ang amplitude. Makikita mo rin dito na ang Sinewave peaks ay mayroon clipping, gaya ng nasa Figure 15.

- [5] Basahin ang reading ng AC meter sa distortion meter. Example reading ay 9vac. Basahin din ang *peak to peak* voltage swing sa Oscilloscope, example reading ay 25Vp-p.
- [6] Sa Audio Generator, ilagay sa minimum ang Amplitude, maari nang isara muna ang DR20W.

Ayon sa Procedure sa taas, ang gusto natin malaman ay kung ilang volt ang mababasa sa load (voltage swing) - ang mababasa na voltage sa 4 ohms load ay iyong maximum voltage swing na mayroon 10% distortion, ito ang kaya'ng i-deliver ng DR20W na voltage sa load na mayroon kaunting distortion na 10%.

Ito'ng 10% na ito ay resulta ng *Clipping*, kapag nagkaroon ng clipping sa waveform, ito ang senyales na nahihirapan na ang amplifier na i-reproduce ang original signal sa input, ibig sabihin na di na niya kayang i-amplify. Kapag mas-malaki ang clipping, mas mataas din ang distortion.

Ang mababasa sa Oscilloscope ay iyong peak-to-peak sinewave value ng voltage swing sa 4 ohms load. Tingnan ang Figure 13. Ang mababasa sa Distortion meter AC meter ay iyong RMS sinewave value ng voltage swing sa 4 ohms load. Ang RMS value representation ay iyong naka-shaded ng black sa Figure 14. Makikita dito na, nawala ang minus voltage swing dahil sa $(-V_{max})^2$ na ang resulta ay positive, dahil wala naman kasi negative power.

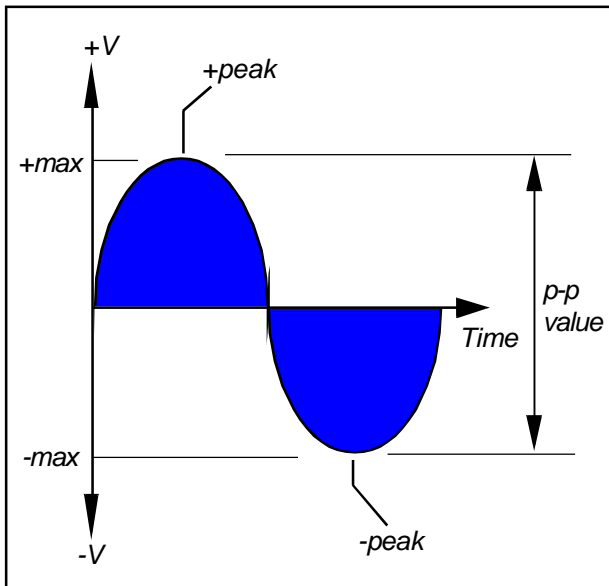


Figure 13 : Simplified Representation of Voltage swing peak-to-peak at the Load

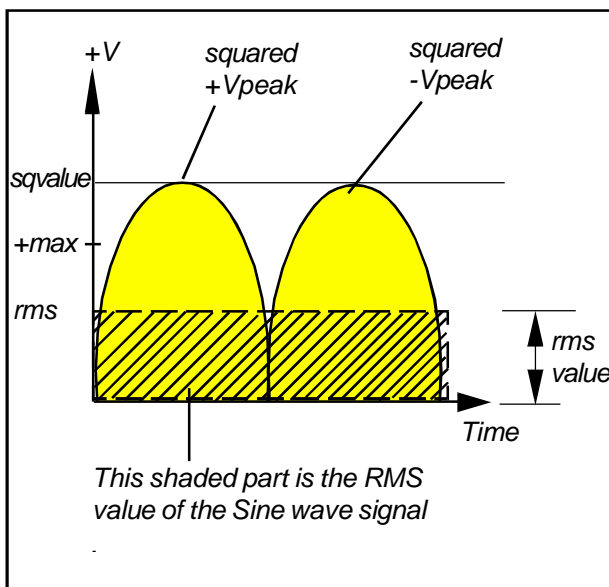


Figure 14 : Simplified Representation of sinewave RMS value

With the use of calculus, you will be able to derived a formula in terms of peak-to-peak as :

$$P = \frac{\left[\frac{V_{p-p}}{2\sqrt{2}} \right]^2}{\text{Load}} \quad \text{where: } V_{p-p} = \text{Peak to peak value}$$

Which is equal to $P = E^2 / R$ in Vrms

Sa Formulas na $P = E^2 / R$

$$E = 9 \text{ Vrms} \\ R = 4 \text{ ohm}$$

ma compute ang power na,

$$P = (9 \times 9) / 4 \\ = 81 / 4 \\ = 20.25 \text{ Wrms}$$

Dito sa example na ito, ang Power na kayang i-deliver ng DR20W ay 20.25Watt rms.

The Watt - pmpo :

Ang Watt - pmpo (Peak music Power Output) ay isang rating din ng Power Amplifier capability na kadalasan makikita sa mga portable Karaoke Amplifier (**hindi ito kanais nais na unit ng power**). Ito ay hindi totoong power na kayang i-deliver ng Power Amplifier, ito ay instataneous power lang na kayang i-deliver ng power amplifier at hindi sa lahat ng oras.

Paano ba ito kino-compute? "Sa aking palagay", sa pangalan pa lang ng peak music power output, maaring sinasabi nito na ang peak to peak value o ang peak ng sinewave sa Figure 13. Sabihin natin na ang "assumption ko" ay ang peak value.

Ok, ang peak value ng 9Vrms ay 12.69Vpeak. Kapag gagamitin natin ang formula (**for the same of explanation**) na $P = E^2/R$, ang magiging resulta ay :

$$P_{\text{peak}} = (12.69)^2 / 4 = 161.03 / 4 \\ = 40.25 \text{ W}$$

Kung ang assumption natin ay peak-to-peak, ang 9Vrms ay 25.38Vp-p. Ang Power ay

$$P_{p-p} = (25.38)^2 / 4 = 644.144 / 4 = 161 \text{ W}$$

Note:

Ang mga computation ay para i-explained ang differences ng power Rating.

DR20W True Power at 4 / 8 ohms load:

In actual, I performed the setup in Figure 12(A) minus the distortion meter, since I do not have a distortion meter. Ang point of reference ko na lang ay, kung mag-clip na ang sinewave - positive or negative, dito ko na i-read ang V_{rms} voltage swing sa load, see Figure 15.

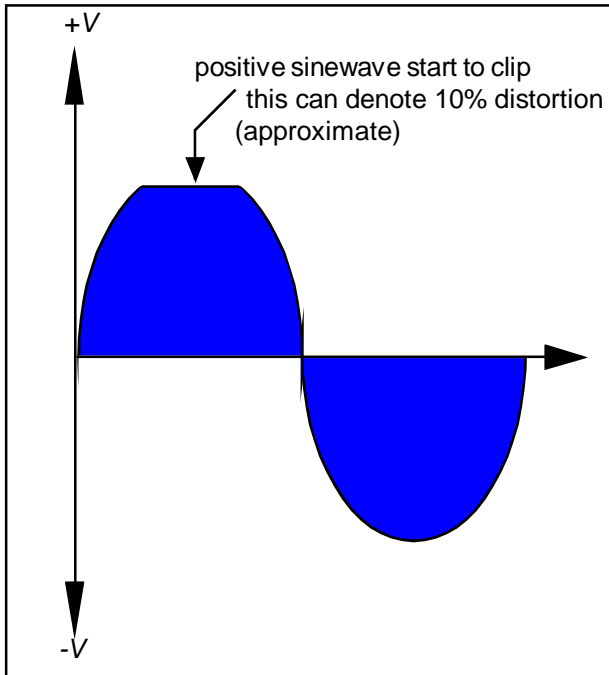


Figure 15 : The sinewave start to clip

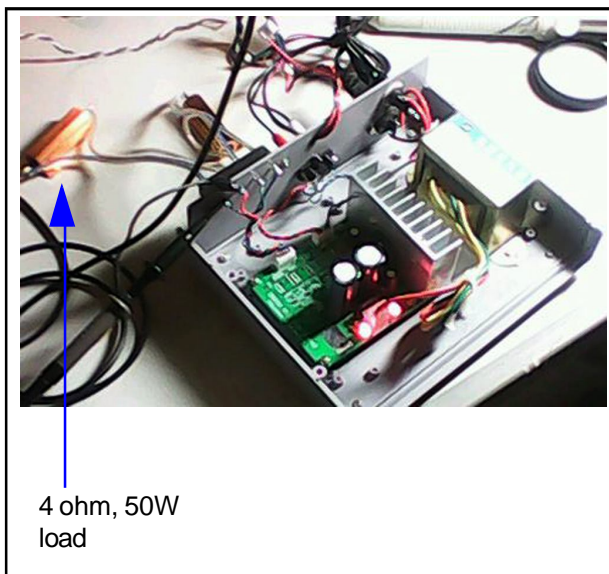


Figure 16 : The 4 Ohms Load 50 Watt

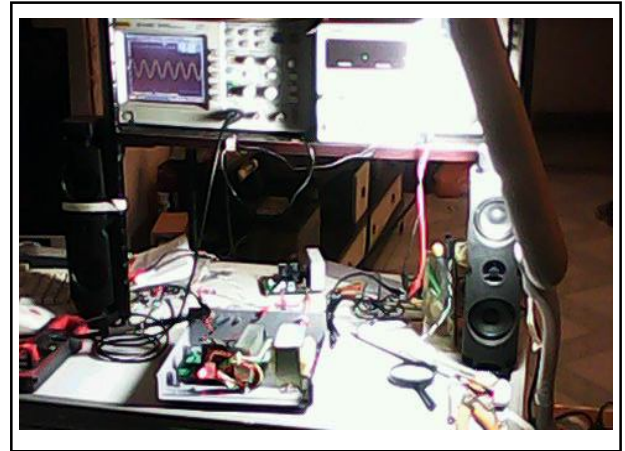


Figure 17 : Setup and Testing the DR20W

Ang actual sinewave reading at approximate 10% ay 8.97V_{rms}, see Figure 18. Ang actual ohmmeter reading ng Load ay 4.02 Ohms. Now can compute the Power from formula : $P = (8.97)^2 / 4.02 = 20.015$ Watt (rms).

Ngayon, dahil ang 4 ohms load ay hindi Universal (hindi karaniwan sa mga speaker systems), sinubukan kung gumamit ng dummy load na 8 ohms, 100 watts. Ang Voltage Swing sa 8 ohms load ay 11.8V_{rms}, makikita ito sa Figure 19. Ang Power ay $P = (11.8)^2 / 8 = 17.405$ Watt(rms).

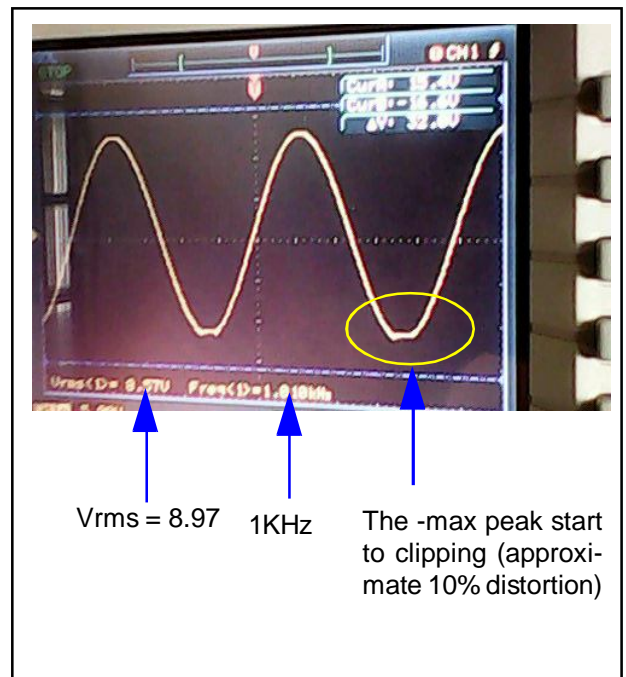


Figure 18 : Actual Voltage Swing at the Load of 4 Ohms

Ngayon, alam ko na na ang Power Amplifier ay kaya niyang i-deliver ang 20Wrms / channel. Ang testing ko na ito ay hindi absolute - isang Channel lang iyong testing ko. **In actual operation ay 2 channels ang working, ang left at saka ang right channels. Kaya ang gagawin ko, uulitin ko ang test na sabay driven ang Channel 1 at saka Channel 2.**

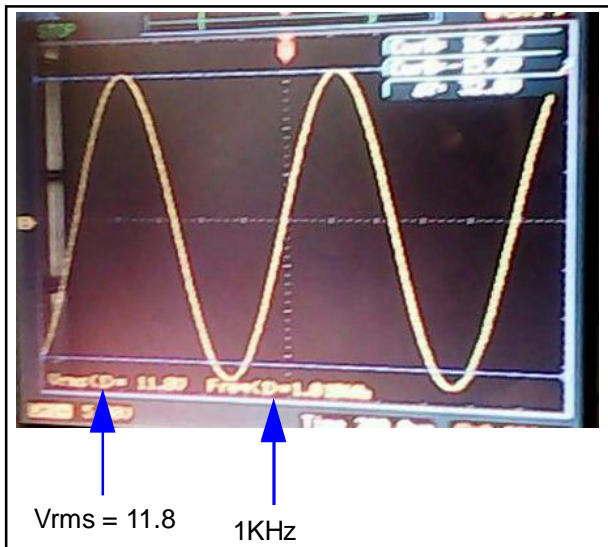


Figure 19 : Actual Voltage Swing at the Load of 8 Ohm

DR20W True Power both Channel Driven :

The Setup is shown in Figure 20, makikita dito na ang Channel 1 at saka Channel 2 Amplifier (left and right channels) ay fully driven. Ang input signal ay sinewave, 1 KHz. Gumamit ako ng simple resistor para i-split ang signal sa input.

Sa Audio Generator, i-increase ko ang amplitude habang nakatingin sa Oscilloscope, ititigil ko ang increase ng amplitude kung may makita ako sa waveform na mag-clip na.

Hmmmm...! With both channel driven, I can only get roughly 14Watt(rms) per channel. Anong nangyari? Ang issue dito ay hindi kaya ng Power Transformer na i-deliver ang kailangan ng DR20W na power para ma-i-produced niya ang 20Watt(rms) / channel. Pero kung single channel lang naman kayang -kaya niya na i-deliver ang power.

I borrowed another Transformer, this time, I used 24-0-24 Vac at 6 Amperes, this time i can get 20Watt(rms) per channel.

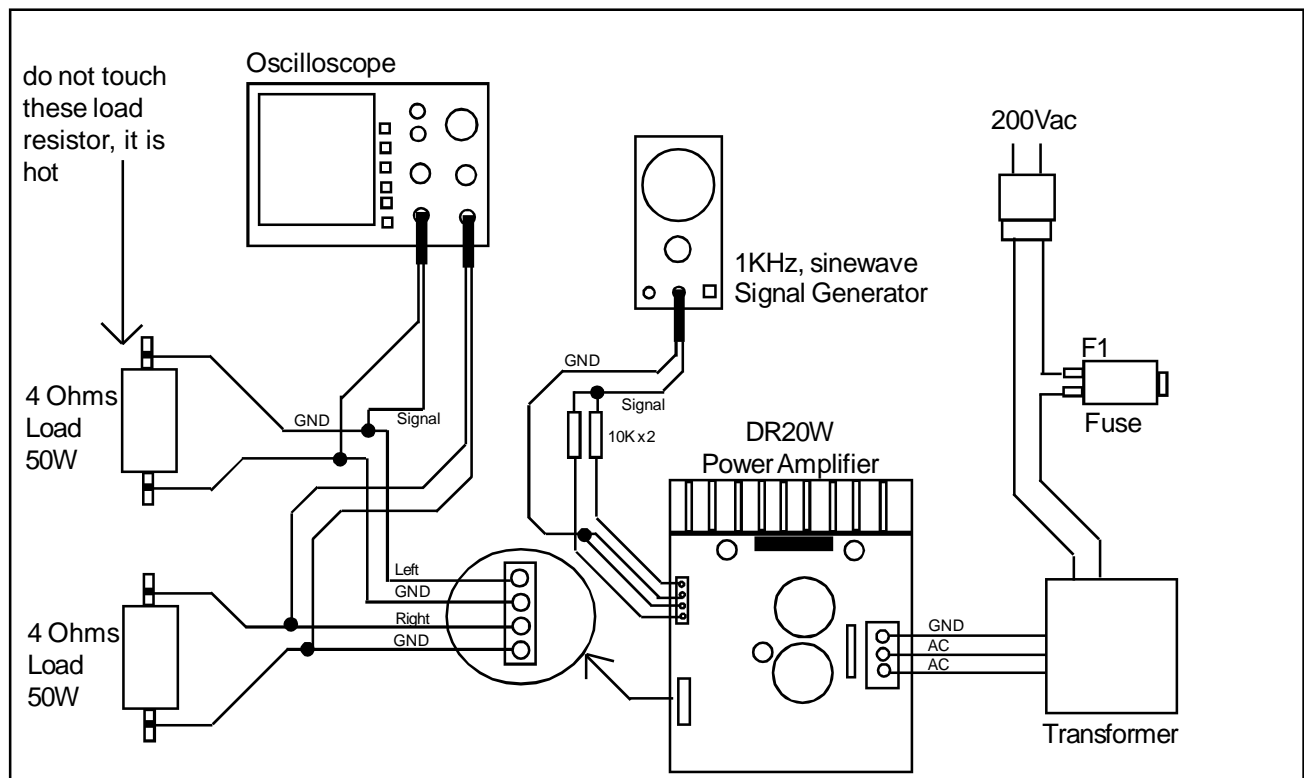


Figure 20 : The Actual Power the DR20W can deliver when both Amplifier are driven

Well, with my 20-0-20 Vac Transformer, with 17Watt(rms)/channel (34 Watt(rms) Stereo) instead of 20Watt(rms)/channel due to power supply issue, in my opinion is acceptable. I still can enjoy the true power of music in my room, I guess I can only use 50% of its total power - - about 10watt(rms) per channel, that situation during Sunday afternoon, when I am cleaning my room / house. Sad to say, I am living in a small place when - - - a loud music is not allowed, otherwise you will get a knock-knock on your door from building management or police, and you might be charged with public disturbance.

Why I not opt to use the 24-0-24 Vac Transformer to keep the full rated Output? The expected Vdc at 24Vac is about 33.8Vdc, total rail is 67.68 Vdc. According to LM1876F Absolute Maximum Rating on page 2 of the datasheet, the Vcc+Vee is 64V with or without input. With 67.68V, I already exceeded the Absolute Maximum Rating which might damage the LM1876F.

In actual, I soak test the system for several hours and I do not get a failure. With this power supply, operating at maximum power for several hours is expected to exhibit thermal run away. It did not! it's amazing performance! Heatsink is really hot, so as the 4 ohms load resistor, I cannot touch it.

However, it is not guaranteed that this may happen to all IC at all situations at all build. The safest is to use 20-0-20 Vac Transformer. I tried to use also 18-0-18 Vac at 2 Amperes Transformers, the Power Output I can squeeze both channels driven is 8watt(rms)/channel or 16watt(rms) Stereo.

Input Sensitivity :

Para ma-drive ang DR20W sa full rated output of 20Watt(rms)/channel, kailangan na ma-satisfy ang input. Ang input signal ay about 500mVac(rms), ibig sabihin nito na mayroon ka dapat 500mVrms sa output ng iyong Tone Control para ma-drive mo ang DR20W sa kanyang full rated output power.

Sa DATC Control, ang maximum output signal ay 1Vrms, ibig sabihin na, sa 50% output ng DATC kaya na niyang i-drive ang DR20W sa full rated output.

Other Electrical Test:

Mayroon pa'ng ibang Electrical Performance Test gaya ng :

- (1) Frequency Response Curve
- (2) Power Bandwidth
- (3) Load Sensitivity
- (4) Crosstalk / Stereo Separation
- (5) Damping Factor

para i-rate ang performance ng Power Amplifier. At this moment, I planned to perform them next time.

Final Applications

Integrate with the DATC :

Kung balak i-integrate ang DR20W sa DATC Tone Control, kailangan na idagdag ang Control circuits ayon sa Figure 6.

Puwede din naman ang Figure 7, kaya lang i-avail ninyo ang mga Relays at saka iyong transistor, ito ay optional sa Kit version, kaya di nakasama.

Ang circuit sa Figure 4(b) na mayroon Control ng Standby at saka Mute ay para sa controlling ng DATC Tone Control sa DR20W.

Power Supply :

The DR20W can provide +15Vdc of power to the DATC. The connection is shown in Figure 21.

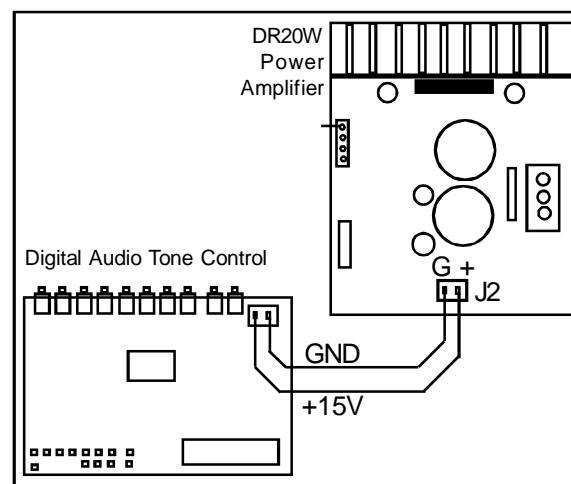


Figure 21 : Power Supply Connection

Integrate with the do diy MP3 Player :

Kung balak i-integrate ang DR20W sa **do diy MP3 Player**, maaring palitan ang IC1 sa Figure 4(a) ng LM7806 at magdagdag ng small heatsink sa DR20W IC pad heatsink, see Figure 23.

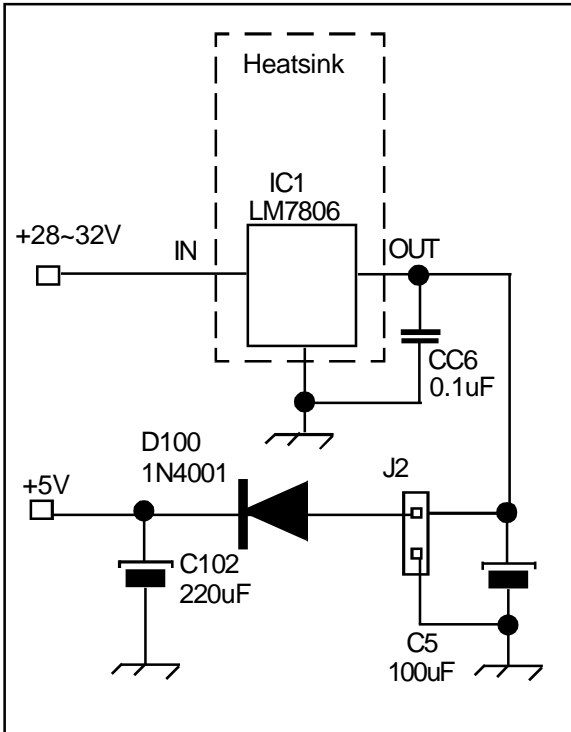


Figure 22 : Do diy it MP3 Player Stand alone Power Supply

Ang Heatsink ay kailangan para ma-dissipate ang heat effectively mula sa IC1, LM7806 Fixed Regulator IC. Dahil mas mababa ang output voltage ng regulator (+6V), magiging mas-mainit ang IC1. By the way, please check ang IC1 substitute, may mga voltage regulator na ang maximum input lang ay +18Vdc, hindi ito puwede'ng gamitin dahil ang input voltage ay +28Vdc, mas mataas kesa sa input ng Regulator IC.

Ang D100 at saka C102 sa Figure 22 ay kailangan para mawala ang noise na generated ng do diy MP3 player due to power supply integration at saka digital noise generated when using the SD card / USB. Kung mayroon pa rin noise, mainam na palitan ang C102 ng 1000uF. Please read the do diy MP3 Player solution for noises due to power supply integration and digital noise.

Integrate with your own Tone Control :

I wish you can tell us something about your own integration. I would be happy to see of anything you can come up with in using the DR20W Power Amplifier.



Figure 22 : Added Heatsink

Casing the DR20W

Gusto ko sana'ng i-case ng DR20W sa see thru fiber glass - for sure magiging maganda ang resulta. For now, I only case it into the cheap and available plastic I can find in the market, see the Photo Gallery.

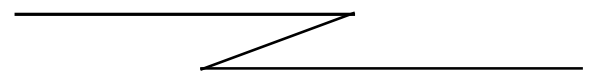
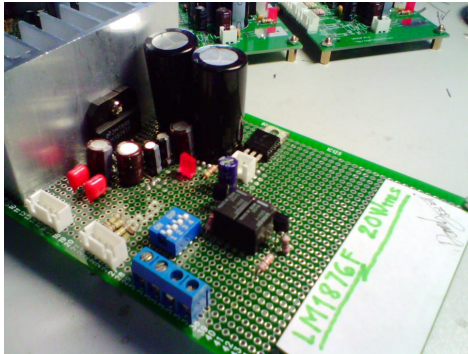
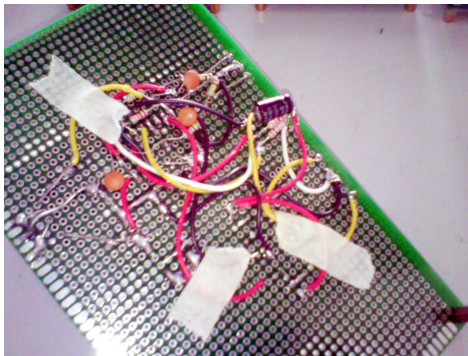


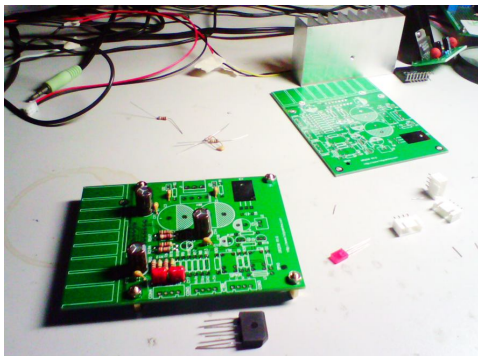
Photo Gallery :



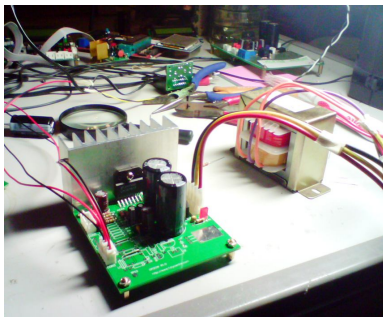
The DR20W prototype



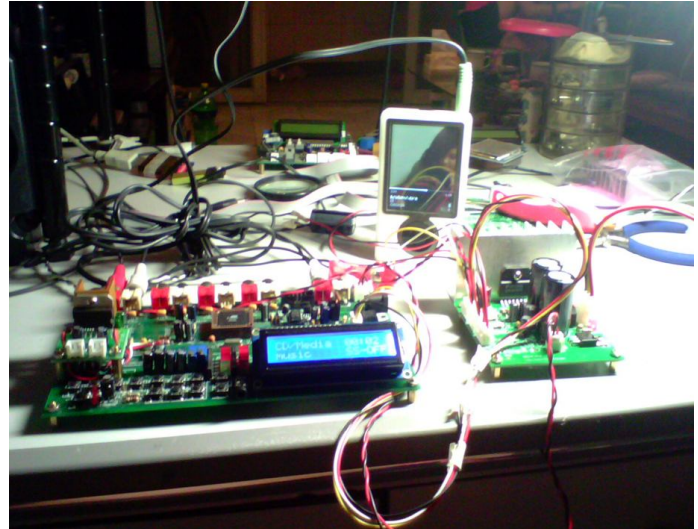
"Watch my back"



First PCB in the Engineering Sample, Prototyping



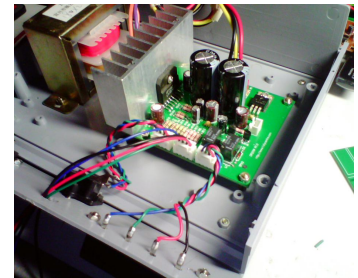
Testing standalone



Testing with the Digital Audio Tone Control using my Zune Player



Let's get a casing for it. The acrylic is very expensive, so, how about this one?



I got a business trip, and the DR20W is just dumped into the dining table. My small house becoming no place for the 1diyTEAM toys.



The DR20W in its casing

Dr20W project is a 1deBB
(1diy electronics Building Block)

Kit Version :

The 1diyTEAM put a small budget to get some materials for the DR20W - specially packed for some Audio Hobbyists who would like to build the DR20W, **dedicated for :**

- 1) New comer in the DIY Audio Hobby
- 2) Audio Hardware Starters
- 3) School project.

The Kit version which included all components (except for the relay and transistor as shown in Figure 7). It includes also the RCA, Speaker Terminals, cables, etc. so you can build the DR20W without roaming around to find the extra components to complete an Integrated Power Amplifier.

You can also choose to have only the Industry Standard PCB and get your components from other, see the ordering information below.

Feedback :

We thank those guys who will feedback about our DR20W Integrated Power Amplifier. I'll be glad to hear from your comment, improvement and re-design - dandymenor@hotmail.com

diy improvement issue 04

Thank you for having this document published by HSEC Baguio, *The Philippines*. First publication on December 12, 2009, updated in December 12, 2019.

This project involved the use of electricity, **careful and electrical safety must be applied when doing the project.**

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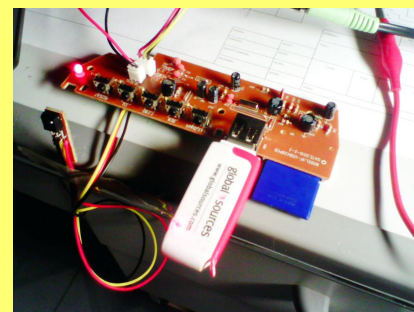
It is published as it is to support its electronics educational do-it-yourself (diy) learning, and published as free document with the EAFF² mark (*Easy, Affordable, Fast and Fun ways of learning electronics & Simple MCU Programming thru diy*)



Next Project : **It is ??????**

Frankly, I do not know what is the next Project.

Can you suggest? We hope to hear from you. Contact me at danztherock@hotmail.com & dandy@gadgetslyph.com



do diy MP3 Player

20W_{RMS}/CH I C Power Amplifier

Audio Hardware Starter Project : DR20W

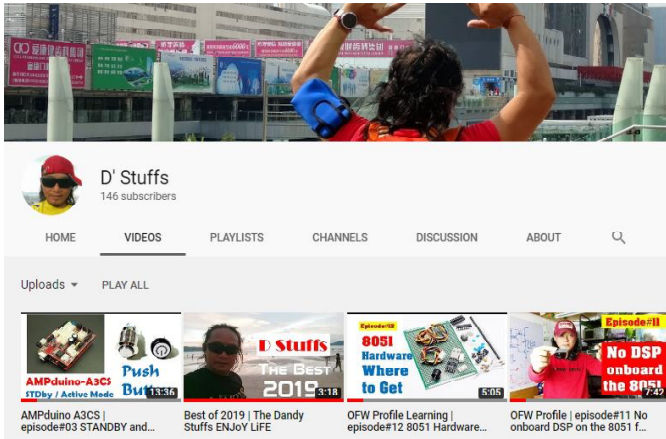
1deBB
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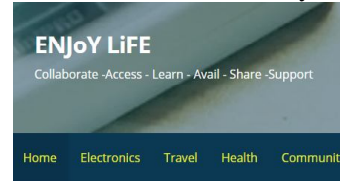
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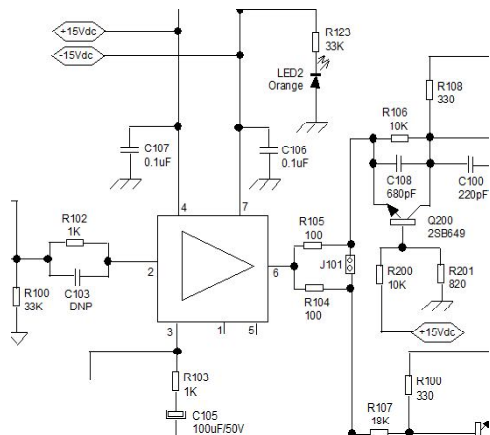
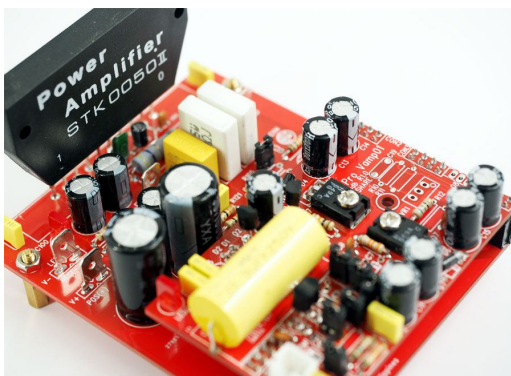
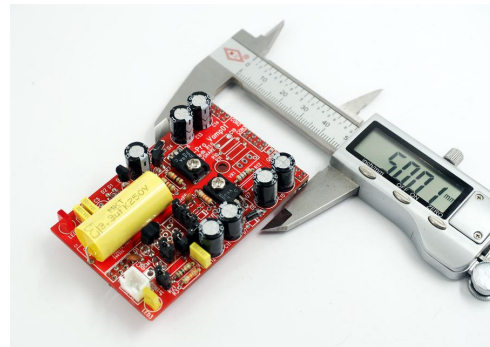
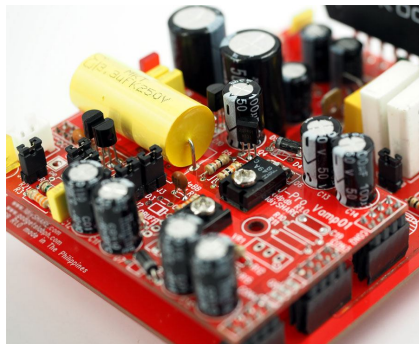


The DIY Hobbyist Corner : www.elab.ph



email : dandymenor@hotmail.com

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20W_{RMS/CH} IC Power Amplifier

myhobby Educational Trainer
Heart Systems **EAF²** Electronics Series

Feedback :

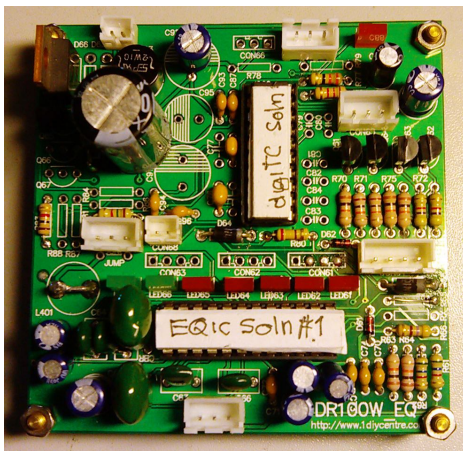
I would like to thank you for your feedback about the DR20W project. I'll be glad to hear from your comment, improvement and redesign - making the project a better Trainer Kit : **email me :**

dandymenor@hotmail.com
philgadgetsab@gmail.com

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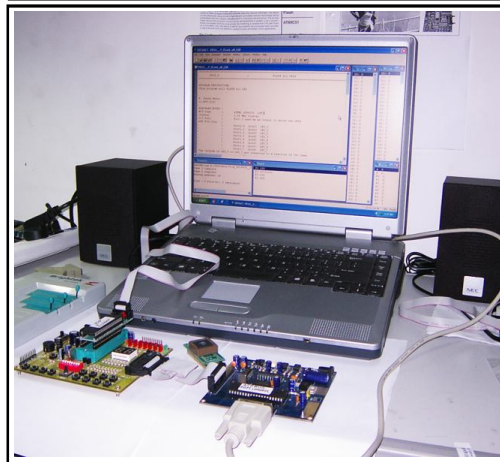
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the Intel 8051 core and the ATMEL AT89C51 Microcontroller

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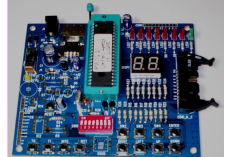
Ver 1.1



- Affordable
- Easy
- Fast &
- Fun

EAF²

..... ways of
learning the Intel
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The *Educational Trainer Kit* for a discrete power Amplifier builder, see it in issue #28.