# Servicing DSP

By Andy Andersen
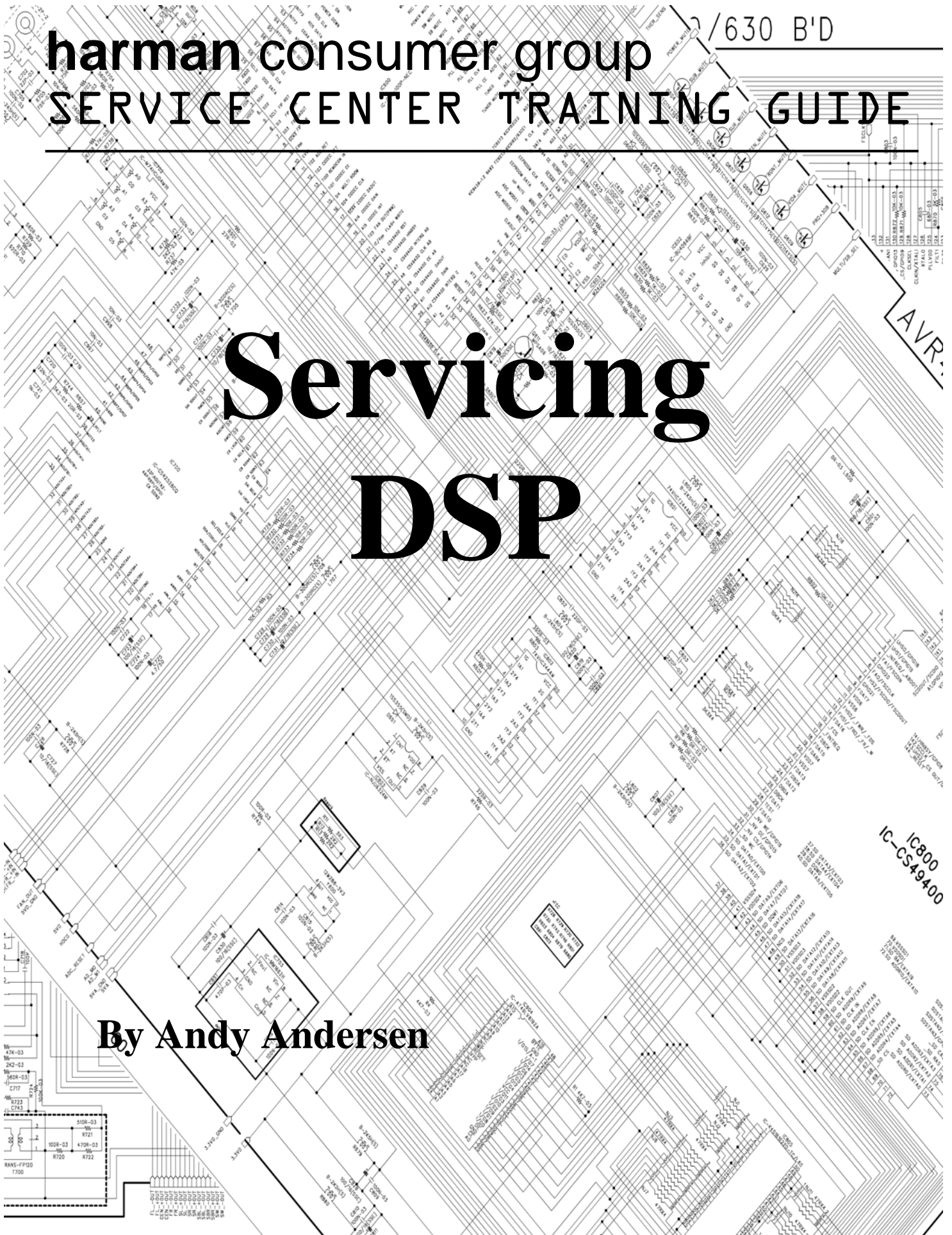
DSP technology is a very broad term covering many different functions and purposes in the world of electronics. The basic function of DSP is to take some form of digital data and make sense out of it for our hardware. It sounds fairly simple but it's a complex and growing portion of today's advanced audio equipment. The possibilities, features, and enhancements capable with DSP may be enough to discourage anyone but the architect from understanding it.

Luckily, there are enough consistencies in the DSP section of today's home audio video receivers so that we don't have to specialize in designing them in order to repair them. Our mission today is to provide the fundamentals for approaching a DSP related problem using standard troubleshooting techniques.

# DSP Service

Know what works!!!!

Tame the beast.

If the unit under test turns on and stays on;

Do the 6/8 channel analog test 1$^{st}$!!

Using the 6/8 input will quickly isolate audio problems in an AVR receiver. Most audio problems are not DSP related but are common Analog and power supply problems. Please review Tech Tip TIP#HKTT2004-03 Isolating audio problems in an AVR receiver Using 6/8 Direct In.

**Use the following procedures to help find what is working, then to locate the problem area.**

Equipment needed:

☑ 1 set of (RCA) Y adaptors.

☑ Function/signal generator.

☑ Oscilloscope.

## Procedure:

1) Do a factory reset of the receiver. (This may eliminate common micro processor problems.)
2) Print the block diagram from the service manual.
3) With no inputs or speakers attached to the AVR turn on the receiver and turn the volume all the way down.
4) Turn unit off.
5) Hook up an oscillator to the 6/8 Direct in jacks using the Y adaptors. Adjust the oscillator to about 0db (.775Volts RMS).
6) Hook up an oscilloscope to monitor the line out jacks. Or, if there are no line out (preamp out) jacks monitor the input to the power amps or the speaker outs. (AVR125, 225, 130 do not have preamp out jacks)
7) Turn the AVR on. Select 6 or 8 direct in, depending on the receiver.
8) Slowly turn the volume control up until you can easily measure the voltage at the line out jacks. ( -40 to -25db )
9) At this point you will be able to check and assure all output levels are the same.
10) IF THE OUTPUT LEVELS ARE NOT THE SAME STOP! Go no further. At this point you will need to use the charts to see where you are losing your signal. The chart shows the analog signal flow from the input jacks to the output jacks.
11) If the output levels are the same check the power out stage at the speaker out jacks.
12) If you find the levels at the speaker out jacks are OK, your problem will be in the DSP part of the receiver.

Congratulations! You have now eliminated 90% of the electronics in the AVR and confirmed that the problem is in the DSP section.

# If it fails, repair the analog portion of the AVR first before proceeding with the DSP check.
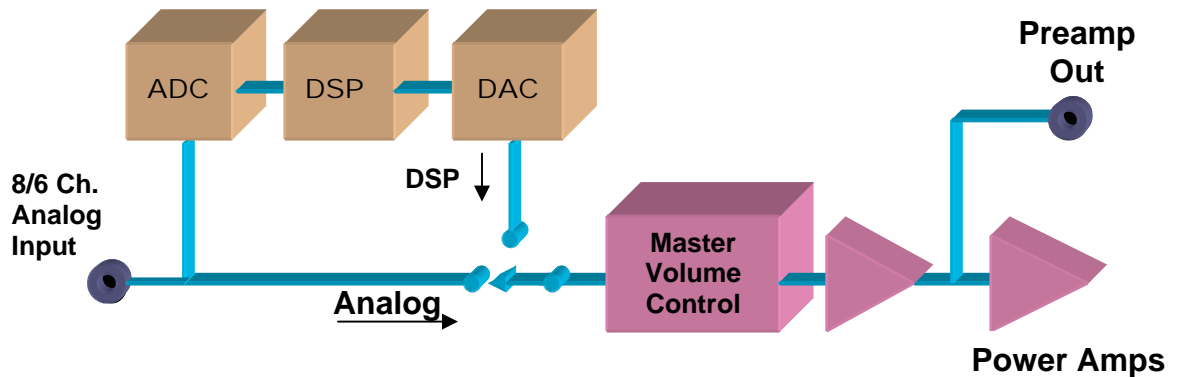


**Analog flow chart**

Figure 1.

## What does work!

## If the Analog passes through this is what we know.

1. The Analog path is OK from the input 6/8 channel direct jacks to the preamp out or the power amps.
2. Input selector switch is OK along with the +/- 15 volt power supply and the digital control of the device.
3. DSP, analog, 6/8 selector switch is OK.
4. Master Volume control is OK.
5. Power amps, and Op Amps are OK.
6. The main micro and sub micros along with the front panel display.
7. Clock, Data, CE lines to all controlled devices in the analog path are OK
8. Main Power supply voltages including the 5 volt, +/- 15 volt and some times a 3.3/2.5 volts for the DSP and micro.

**Moving on to DSP check.**
**Setup your bench for ease of service.**

**Equipment needed:**

Dvd with Coaxial and TOSLINK (optical) S/P DIF out
Dolby Digital test disk (must include a 400Hz -20 dbfs sine wave Dolby Prologic signal, and a 30Hz -3 dbfs sine wave Dolby signal)
1 set of (RCA) Y adaptors to check analog path.
1 Toslink cable (optical)
1 Coaxial cable (or a good quality audio cable)
Function/signal generator for analog path.
Oscilloscope.

**TIP:**

Try not to use the speakers for DSP service. Too many wires can lead to confusion, and mistakes can easily be made. If the amp has preamp out jacks, use them! If you are still in the preliminary test setup continue to use speakers until all of the failures can be identified. Once the cover has been removed for servicing, there is no further need to use the speaker out jacks to service the DSP board.
Step 1:
Do an AVR speaker test. You will need a remote control to perform this test on most AVRs.
This will test ½ of the DSP board. The speaker test tones are generated from inside the DSP chip. The first thing that will happen is the microprocessor has to communicate with the DSP chip. If the DSP successfully receives the signal the DSP will return a signal to let the micro know what speaker is being tested. You will see what speaker is passing the test tone by seeing that speaker flash. If the DSP and the DACs are working, the amplitude will be the same for all channels including the subwoofer.
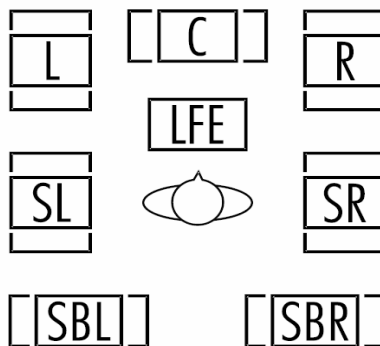


Figure 2.

Whew!!

**That is a lot of information so far, but if successful we now know a few things:**

1. The DSP chip can communicate to the micro.
2. The voltages to the dsp are probably ok.
3. If the DSP IC has an Eprom, the Eprom was successful in booting the DSP chip. (this does not mean the Eprom is ok but that it is not dead)
4. The DACs are communicating with the DSP
5. There is analog audio from the DACs through the op-amps.
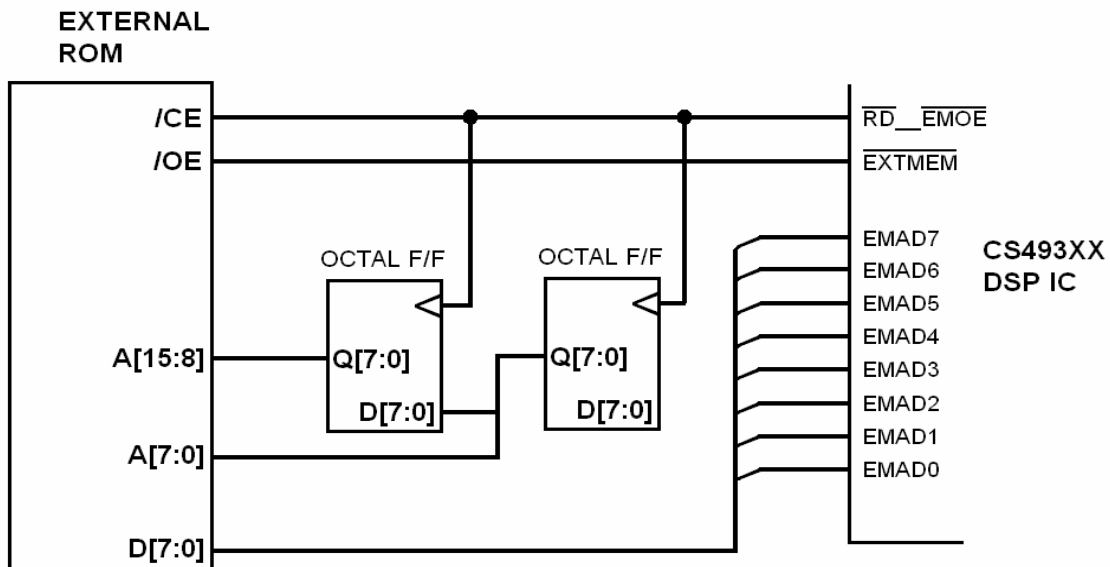


DSP Eprom data flow       Figure 3.

Now we are looking to see audio at the preamp out jacks. This is just a go/no-go check to see if we see the signal and <u>the amplitude is the same on all channels</u>.

TIP:

Make a checklist that you can use to check all modes.

**If the speaker test checks out OK, we now know some more of the receiver that works.**

1. The Data lines from the DSP to the DAC works.
2. The DACs work.
3. The Op Amps work.

**DSP IC**

L/R Clock
Slave Clock
Master Clock
Chip Enable

4 Lines
of Data

DAC

FL
FR
SL
SR
CNT
SW
SBL
SBR

L/R Clock
Slave Clock
Master Clock
Chip Enable

Data Lines
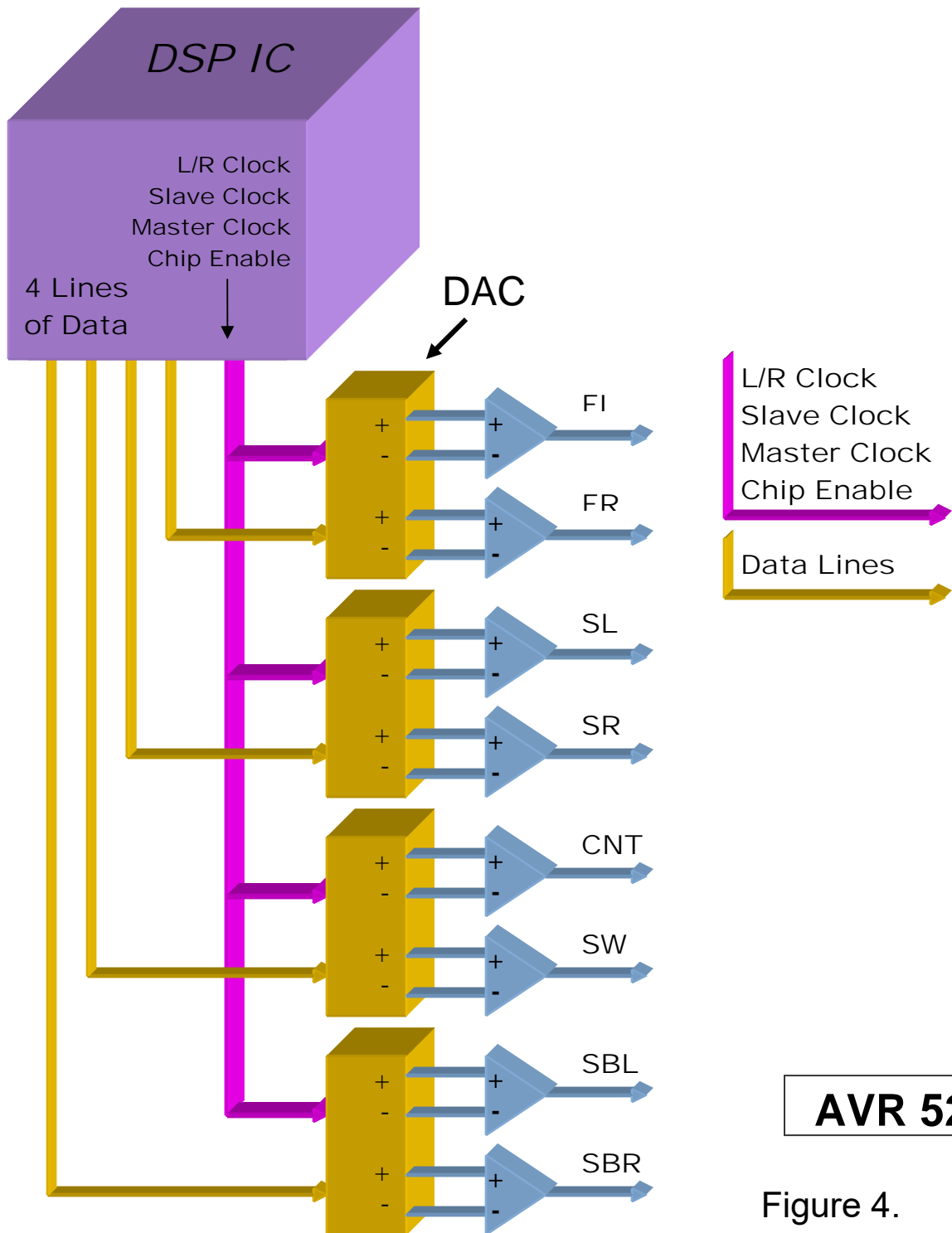
**AVR 520**

Figure 4.

**Block of what is happening from the DSP to the audio out.**

## Review:

What we know works:

CPU data to and from the DSP is OK
½ of the DSP is OK
Your voltages to the DACs are OK
+/- 15 volt line to the Op Amps are OK
Most of the DSP IC voltages are OK

| AVR 525 CS4382 | | AVR 520 CS4391 | |
|---|---|---|---|
| +5VD | +V Digital Side | +5VA | +V Analog side |
| +5VA | +V Analog Side | +3.3VL | +V Logic/Dig side |
| +3.3V | +V Logic | | |
| | | | |
| AVR 635 CS42518CQ | | OP-AMPS | DSP ICs |
| +5VA | +V Digital Side | +/- 15 volts | 5V |
| +5VD | +V Analog Side | | 3.3V |
| +3.3 VLB | +V Logic | | 2.5V |
| | | | 1.24V |

Voltages of common DACs, DSP, and Op Amps
## Figure 5.

**What have we not checked so far?**
1. Any input to the DSP.
2. The DSP clock frequency.
3. PCM or any compressed decoding ( Dolby Digital, MPEG)
4. PCM matrix coding (Harman's Logic 7 )
5. Analog to digital conversion
6. Coax in
7. Toslink in (optical)

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Page 8

**Next we need to check the input to the DSP.**
**We have 3 types of signals to check.**
1. Analog (converted to serial data)
2. PCM (44.1khz CD)
3. Compressed digital (96khz Dolby digital, Mpeg, 44.1khz Mp3)

**Let's start with the digital input.**
**Set up the bench using a DVD player for a source and test cd or cds.**
**NOTE on Test Disk:**

Must have a

Mono 400hz at –20db 44.1khz
Mono 30hz at –3db 44.1khz
Stereo music track 44.1khz
Mono 5 tracks 400hz at –20db Dolby digital 96khz
1 track 30hz at –3db Dolby Digital 96khz
1 Track full audio all channels.
Start with the CD using 400hz and 30hz Mono CD audio (PCM 44.1khz)

**If you get audio next check the stereo music track. If OK**
Now check using Dolby Digital. First check using the tones, then the music track.
If all of this passes….
Then there is nothing wrong with this unit.
… Just kidding!!!
This procedure should be the final check before service and done after the unit is serviced.

**A reminder:**
**This is done with the cover on, and does not need to be done by the tech that is doing the service. This procedure is a very important, and if done correctly it will reduce time spent, while improving the overall quality of service.**

*IF DONE CORECTLY, SERVICE TIME WILL BE REDUCED AND QUALITY IMPROVED!*

**Now the cover comes off**

ALL Service Procedures on the DSP starts with a quick check of all DC voltages.

First possible problem:
Let's start with the first thing we checked, the speaker test mode, and let's assume it has failed. We have no audio and the speakers do not sequentially flash on the front display.
Voltages were checked first and found OK (remember we checked all voltages first?).
We know the CPU works, (the analog part of the receiver works and we are able to change functions) but the DSP is not responding to a command from the CPU. If you are working with an AVR with the CPU on the front board check the cable first for loss of Data to the DSP. If your CPU is on the same board as the DSP, and if your data from the CPU is good I would suspect the DSP IC could be at fault.

Note:

When we are speaking of an IC being at fault we are not just talking about the IC Itself being bad but any component associated with the IC.

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Page 10

You should always look for the easy answer first!

You do not need to change the engine in a car if all you need is to just add gas. This also works for the DSP. For the DSP IC to work it needs lots of support from the components around it.
Check all the voltages to the IC. 2.5, 3.5, 5 volts first! Then check the logic lines to the DSP chip.
Start with the CPU clock to the DSP then the CPU data, CE lines. BE CAREFUL when checking. The logic data lines have similar names to digital lines in the DSP IC. Also be aware that what one IC calls a pin, the same line could be called something different elseware.

Second possible problem:
Speakers sequence change on the front display but two channels are not working properly.
Let's say its FR dead and FL distorted.
In diagram (4) you will note that FR and Fl come out of one DAC and the balanced out of the DAC comes out of one Op Amp. You know all the other DACs are ok so we can assume that the clock, data, CE, and L/R clock are ok.
Do we have balanced audio out of the DAC? If no, check the DAC. If yes, check the Op Amps.
Remember! It does not have to be the IC but could be any thing associated with the IC.

Note:
If all of your DACs are dead, then check what is coming out of your DSP IC. You must have Clock, Data, L/R Clock, and CE for any of the DACs to work.

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Page 11

# AVR 630 DSP BLOCK

**7 Lines of Coax or Toslink SPDIF Input**

**Master Clock**
**L/R Clock**
**Slave Clock**
**1 Serial Data Line To DSP** ↓

**CS42528CQ**

**CS49400 DSP**

**L/R IN Analog**

**4 Serial Data lines From DSP L/R Clock Slave Clock**

**8 Balanced Analog Line outs**

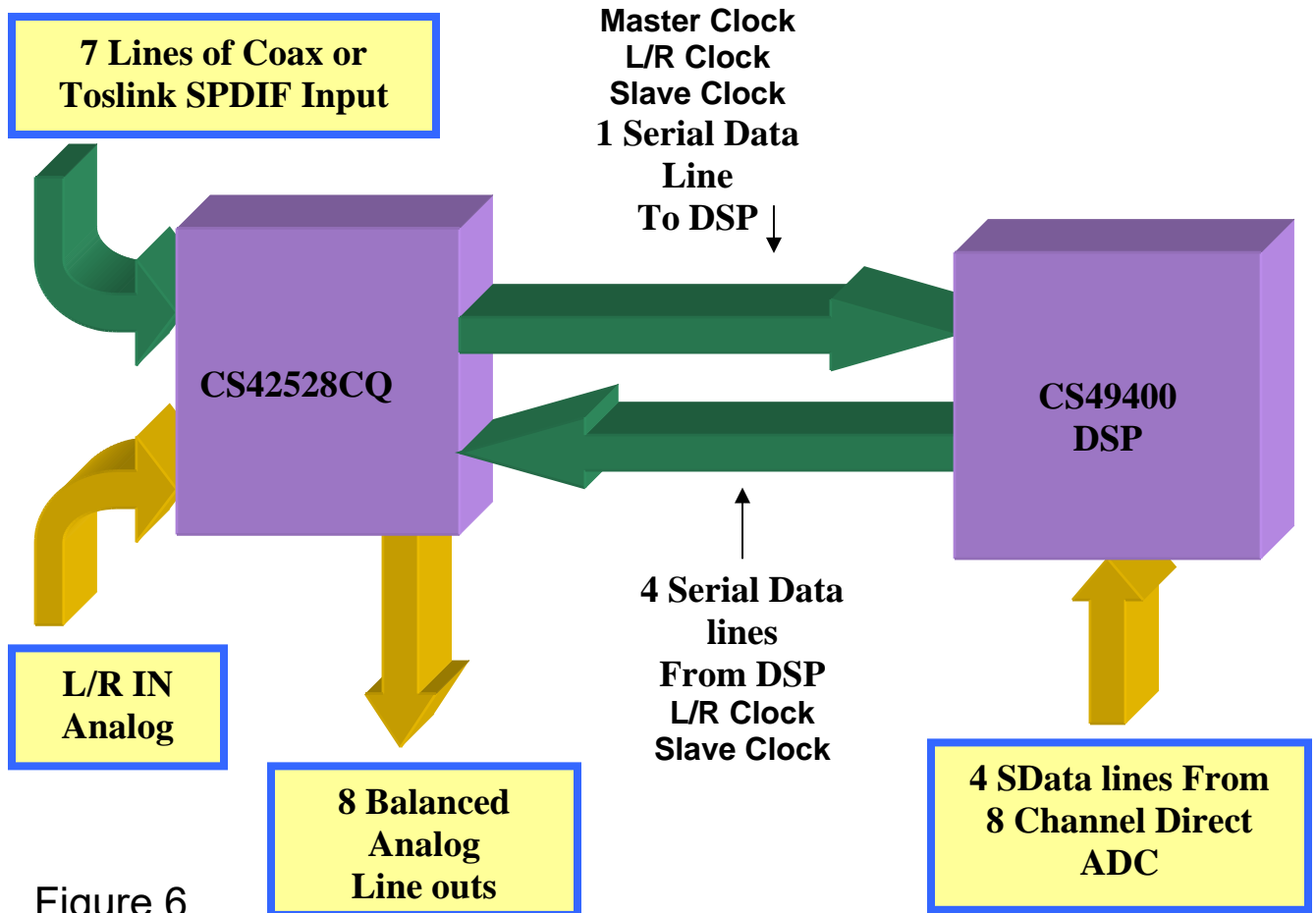**4 SData lines From 8 Channel Direct ADC**

Figure 6.

IC CS4252CQ is doing most of the work on the DSP board.
1. Digital in Router.
2. Input DAC  for stereo audio
3. S/P DIF decoder to serial Data
4. 4 channels of digital data from DSP to 8 channels of analog audio
5. Generation of master clock.

IC CS49400 only does a lot of math and has 8 channel direct input for base management.

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Page 12

Figure 7.

**7 Lines of Coax or Toslink SPDIF Input**

**Master Clock**
**L/R Clock**
**Slave Clock**
**Serial Data**
**1 Data Line**
**To DSP**

**CS42518CQ**

**TMS320 DSP**

**4 Serial Data lines**
**L/R Clock**
**Slave Clock**

**L/R IN Analog**

**8 Balanced Analog Line outs**

**AVR 635 DSP**
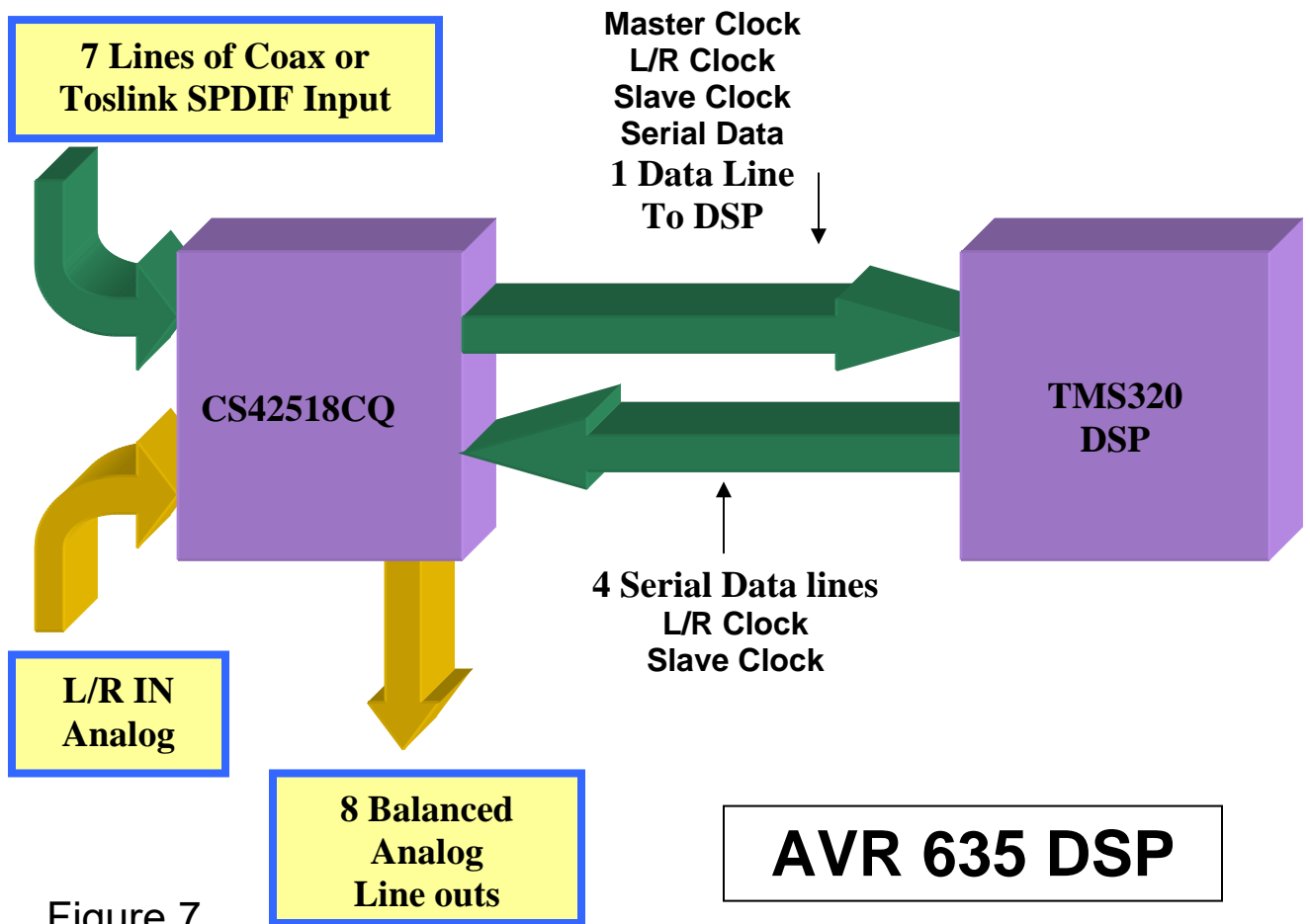
The TMS320 DSP IC is the fastest processor from Texas Instrument for DSP processing.

**CS493263 DSP**

**AK4358VQ DAC**

Data

**Analog Line outs**

L/R Clock
Master Clock
BICK (slave clock)

Data
Master Clock

**AK4114VQ SPDIF Decoder Master Clock**

**A/D Converter**

**L/R IN Analog**

Data

**SPDIF Coax or Toslink**
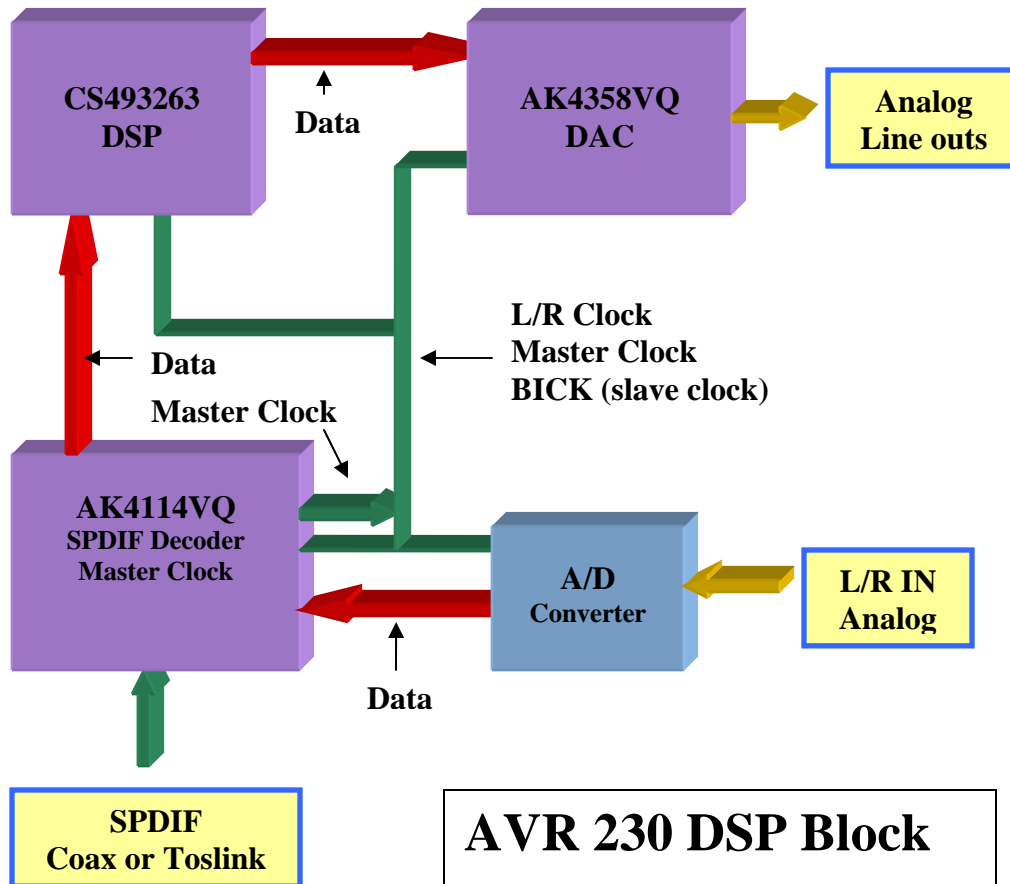
**AVR 230 DSP Block**

Figure 8.

NOTE:

It is important not to just have Clock and data lines be present, but also aware of there amplitude. We are working with different voltages on different chips so there I/O logic state parameters must be considered (2.5, 3.3, 5volts).

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Page 14

Lets say the speaker test was ok.

**Review time!**

What do we know that is working?
1. Data from the CPU to the DSP.
2. All the output DACs and Op Amps.
3. All voltages to the DSP, DACs, and Op Amps (2.5, 3.3, 5, +/-15)
4. Master Clock and sub clocks to and from DSP

Whew!!
Now we must check the inputs to the DSP.
Start with hooking up a DVD player to ether the coax input or optical input (toslink). Use the 400hz –20db 44.1khz test tone (PCM CD audio). If we have no audio we need to check the digital path from the in inputs to the DSP.
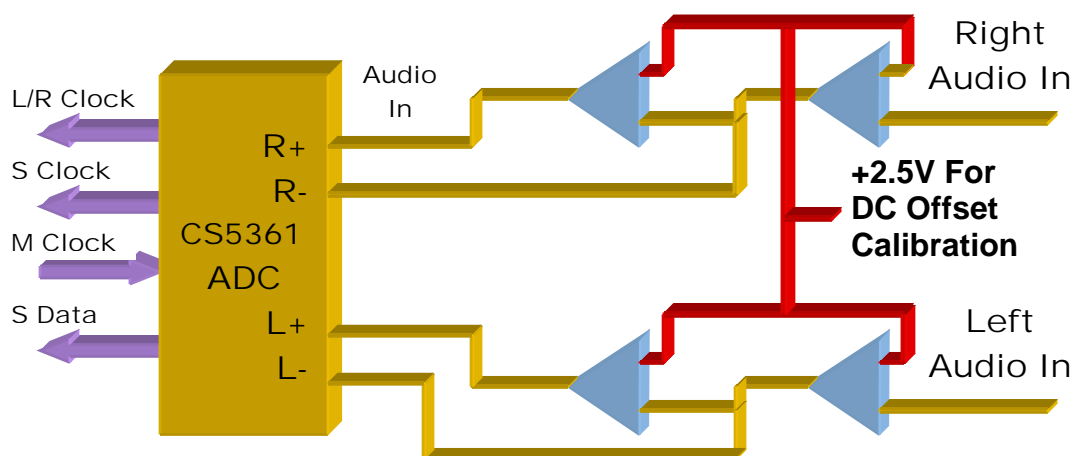
# Analog to Digital Converter
# And Analog Input Buffer

Figure 9.

Note:
The Master clock frequencies are different for CDs and DVDs.
If the DSP clock does not lock onto the input signal you will not get
audio! Clock frequency is very important!


*Master Clock Frequency's in megahertz (Mhz)*

Using Optical 1 on DVD input using a DVD player

| AVR 630 | | AVR 230 | |
|---|---|---|---|
| DVD play | 12.28735 | DVD Play | 12.2873* |
| CD play | 11.28903 | CD Play | 11.28904 |
| Opt. Cable Pulled | 24.57555 | Opt. Cable Pulled | 5.292*** |
| Speaker Test | 12.28773 | Analog In | 12.8783 |

## Figure 10.

If your PCM audio was ok but no DVD audio, first check your clock
freq. If clock is ok suspect the DSP chip is NG op the Eprom is NG.
Dolby Digital requires a decoder to work, and that is provided in the
software cared in the DSP and the E prom.


Common problems:
1.   Poor Soldering.
2.   Voltages NG do to
      A.   Decupling caps
      B.   Regulator ICs. If a bad regulator is found be aware of
            bad decupling caps.
      C.   Shorted ICs

3.   Strange problems??? Check with Customer service 1st! In
      this age of electronics, not everything works like we thing it
      should. What you are finding could be a fault with the
      customer's source material or there hardware. If there are
      any known compatibility issues we will help you resolve the
      problem.

4.   Depending on the age of the design of the DSP, check the P to P level of the Clock, Data, Chip Enable lines. Some logic problems are caused by the TTL logic levels. Logic levels should be 2.5, 3.3 or 5 volts. Remember the signal could be there but the peak to peak value could be low!

On most ICs that share Audio and Digital you must be aware of all the voltages on the IC.

1. The VD for the digital part. Could be 2.5, 3.3, or 5 volts.
2. Some ICs have a power in pin for the logic level voltage marked VL. The voltages could be 2.5, 3.3, or 5 volts
3. To keep the digital noise from interfering with the audio the audio part of the IC has it own source voltage, usually marked VA 5 volts

## CS5361 Audio Analog to Digital Converter

### Operating Voltages

GND = 0 V, all voltages with respect to GND.

| Parameter | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| DC Power Supplies: | Positive Analog | VA | 4.75 | 5.0 | 5.25 | V |
| | Positive Digital | VD | 3.1 | 3.3 | 5.25 | V |
| | Positive Logic | VL | 2.37 | 3.3 | 5.25 | V |

Figure 11.

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Page 17