



Engineering Change Notice (ECN) 001

LM-334 Voltage Regulator Thermal Management

Part/System: Dyna-70 Ultimate Upgrade Circuit Card Assembly (Auto. & Man. Bias configuration)
Effectivity: 3 April 2023
Priority: Optional; an upgrade to the Dyna-70 is not required

Introduction

This ECN addresses the operational environment of the LM-334 as utilized in the Dyna-70 Ultimate upgrade kit. As a part of our continuous product & process improvement efforts, Miller Audio LLC is recommending an assembly process change that addresses this operational impact. There is no defect or fault in the LM-334, the Dyna-70 Printed Circuit Board (PCB), the completed Dyna-70 Circuit Card Assembly, or in its design.

Background

Recent testing has demonstrated the LM-334 (i.e., all components in the LM134/234/334 family) exhibit thermal sensitivity (common with semiconductors) that can impart negative effects to the audio signal in the drive circuits in the 6SN7's for the left channel (V1) and right channel (V5).

This has not been an issue with Dyna-70 upgraded ST-70's where the amplifier is operated with the tube cage removed. However, from a safety standpoint with regard to children, pets, or flammable objects, MALLC recommends users keep the tube cage in place during operation of the amplifier. While a Dyna-70 modified ST-70 using the tube cage will play for long periods of time, it has been noted that changes in distortion levels increase over time due to thermal heating of the LM-334, reaching an equilibrium thermal environment that degrades sound quality and stereo image in those units where users keep the tube cage in place.

Engineering Analysis

The Dyna-70 Ultimate Upgrade utilizes two LM-334 voltage regulators for the amplifier drive stage of the left and right channel 6SN7 tubes, V1 and V5. Adjacent to the V1 and V5 6SN7 signal tubes, are V3 and V6, the left and right EL34/6CA7 power output tubes. The LM-334 is in this corner between tubes V1 & V3 on the left side and V5 and V6 on the right side, reference Figure 1.

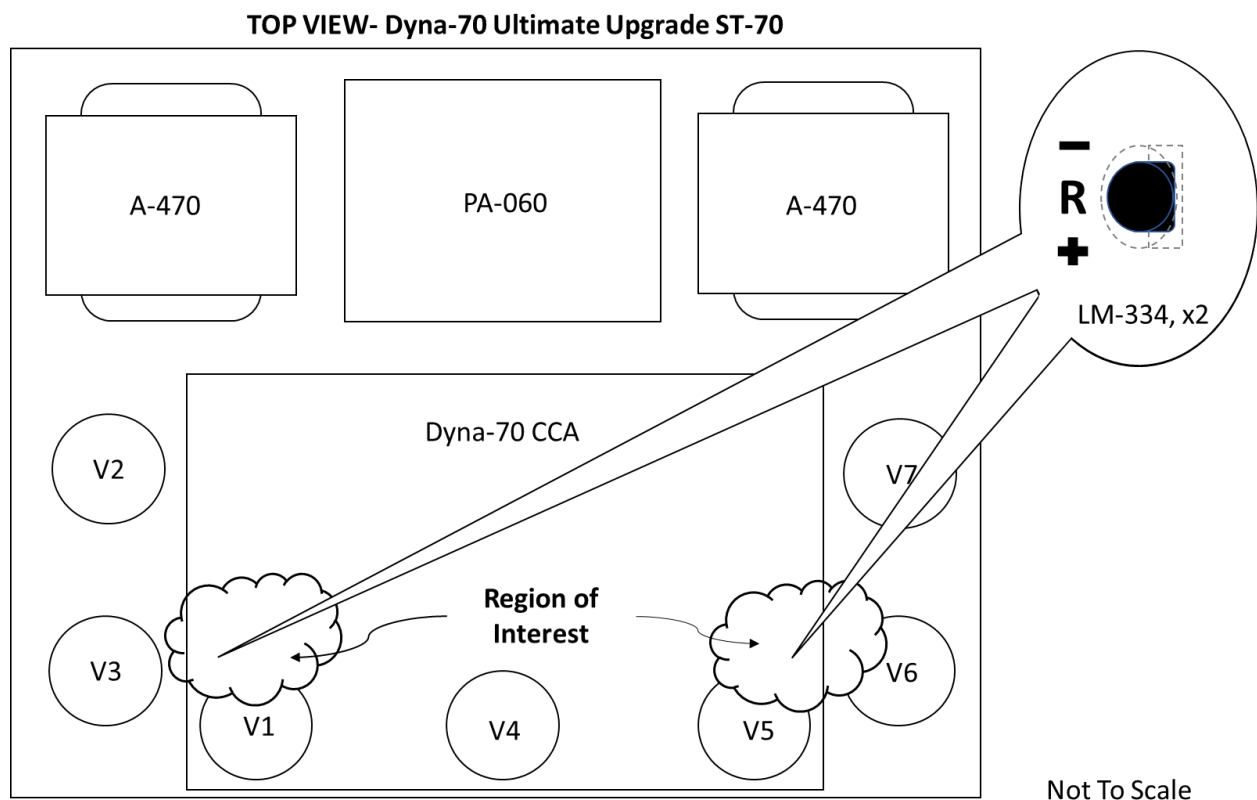


Figure 1- Thermal Region of Interest with LM-334 Regulator

MALLC investigated use of TO-92 style packages using heat sinks, however it was apparent that use of a heat sink in the Region of Interest only contributed to heating of the LM-334, where it reaches thermal equilibrium faster, not slower, inducing thermal distortion from the -334 sooner rather than later.

Additionally, while a heat sink on the TO-92 package helps remove some heat, the TO-92 package is a molded plastic body and the hermetic seal of the plastic encasing the semiconductor components itself forms a thermal barrier, reducing thermal conductivity. Despite the poor thermal transfer capability of the TO-92 package, we recommend use of a heat sink to aid in stabilizing the temperature of the overall LM-334 TO-92 package. Note the -334 is only "cooled" by the 3 metal leads of the device; the addition of the heat sink improves temperature stabilization and provides a secondary means to remove heat in the -334.

The analysis was based on the following observations and assumptions:

- Units fielded were built and operating as the original assembly instructions instructed, mounting the LM-334 on the top surface of the Dyna-70 PCB.
- No heat sink or other provisions were implemented or recommended in design during consumer and commercial life of Dyna-70 Ultimate Upgrade.
- No reports of failures LM-334 in the Dyna-70 upgrade have been received.
- MALLC recommends owners always use a tube cage on their amplifiers for safety. However, there is no way to know if in actual use and operation if a tube cage is on or off the unit. However, we assume most owners who can operate without the tube cage, will do so.

- MALLC applied a worst-case scenario and based its review and analysis work assuming a tube cage is always in place. Therefore, any solution would be optimized to be effective with the tube cage in-place.

Action & Resolution

MALLC in reviewing preliminary findings and reviewing technical documentation from Texas Instruments on the LM-134/234/334 family of power regulators, resolved that there are multiple options to address thermal induced distortion in the LM-334 for the Dyna-70 Ultimate Upgrade. Since this is an optional upgrade and not required to maintain amplifier function, the actions from least to most effort to implement are reviewed below.

1. Since many owners of Dyna-70 Ultimate Upgrade use their ST-70 amplifier without the tube cage, they don't experience or notice any thermal distortion: Continue operation without the tube cage, however it's suggested owners consider use of a small, quiet fan for improved air circulation across the Dyna-70 CCA.

2. For owners that operate their Dyna-70 Ultimate Upgrade with a tube cage, use of a small fan also helps to stir air circulation and convection cooling currents, lowering thermal distortion. This benefits both users who use a tube cage and those who do not use a tube cage. MALLC has measured a 30F degree decrease in LM-334 temperatures using forced air cooling from the Zippy Fan vs. no force air cooling. This did not involve use of a heat sink, but the bare, top-mounted LM-334. Use of a fan permits leaving the LM-334 in its topside location, which will also extend service life of all hot components in the amplifier.



Figure 2- Vornado Zippy Fan

NOTE: We use and can recommend the Vornado brand Zippy cloth three- bladed personal fan, see image, Figure 2. They are available at Home Depot, Amazon, Target, etc. for approximately \$25. They feature 2-speeds and are quiet and safe to use since the blades are fabric.

3. For new builds or retrofit of the Dyna-70 Ultimate Upgrade kit in either Automatic or Manual Bias configurations, we recommend the LM-334 be mounted on the underside (backside) of the Dyna-70 PCB, reference following illustration, Figure 3.

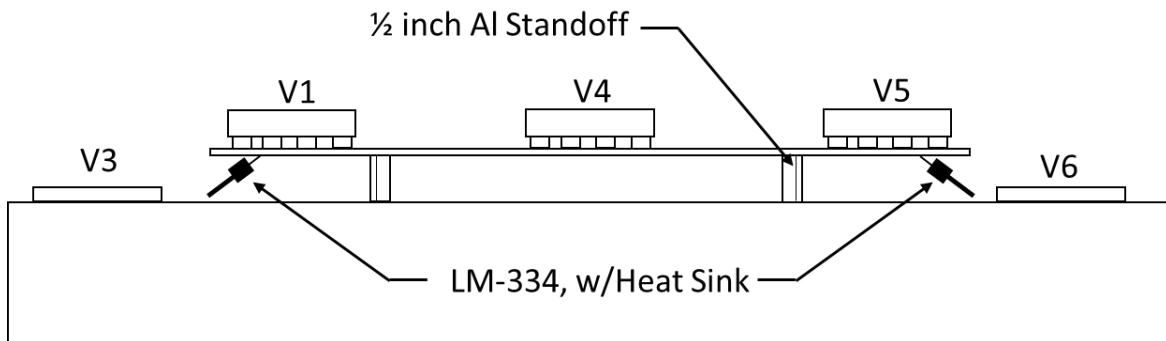


Figure 3- Front View Dyna-70 CCA with underside mounting of LM-334 & Heat Sink

While this is not a complication for the Manual Bias version of the Dyna-70, the Auto Bias version will require more attention to detail during assembly since there are more wires that can snag and interfere with the LM334 and its heat sink. It is recommended the LM334 be installed after all wiring between the Dyna-70 CCA and the Auto Bias CCA has been completed allowing for insertion of the LM-334 from the bottom of the PCB and soldering from the top of the CCA, then trimming the remaining lead excess from the top surface of the PC board.



It's acceptable for the heat sink to touch the ST-70 chassis, but in no way should it ever be forced into place. Also ensure that the heat sink does not contact the solder points for R12. This was not an issue in our prototype development, but if not aligned properly, it could touch one of these R12 solder locations and ground the circuit through the heat sink to the chassis. Do Not Let the heat sink touch any electrical connection points.

4. For fully assembled and operating Dyna-70 Ultimate Upgrade ST-70's, owners are encouraged to remove and retrofit the top mounted LM-334 and install on the underside of the Dyna-70 PCB. We suggest you obtain 2 new LM-334's and heat sinks rather than trying to de-solder and then re-solder the same LM-334's on the underside. Often the components experience a long heating cycle during removal that exceeds the rated thermal time-at-temperature for the device.

Users are cautioned to permit their amplifier time to cool to room temperature while ensuring that all electrolytic power capacitors have discharged. We suggest a minimum of 20-30 minutes or more to cool the amplifier and discharge the capacitors. Finally, we recommend use of an Aluminum heat sink clamp to prevent overheating of the LM-334 during soldering into the PCB, see figure 4.



Figure 4- Heat Sink Clamp

#5. MALLC will update the Dyna-70 Ultimate Upgrade Kit Assembly Manual to reflect this change.

#6. MALLC will post this ECN in its' website documentation pages for reference.

Miller Audio LLC reserves the right to make design changes, parts replacement, substitutions and specification revisions at any time without notice. If you have questions about these changes/updates, please contact us.