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A New Laminated Bus for the Nuclear Instrument Module System

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A NEW LAMINATED BUS FOR THE
NUCLEAR INSTRUMENT MODULE SYSTEM

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ABSTRACT

A new design for a Nuclear Instrument Module (NIM) laminated bus is presented. Electrical performance and fabrication concepts are discussed.

I. INTRODUCTION

When the Nuclear Instrument Module (NIM) Standardization Concept (TID-20893)[1] was first formulated, Eldre Components, Inc., proposed a laminated bus design for power supply distribution within the NIM bin. Oak Ridge National Laboratory (ORNL) adopted a version of the Eldre bus for use at their laboratory and subsequently, Los Alamos Scientific Laboratory adopted a simplified version of the ORNL bus about a year later. At least one commercial vendor supplies busses as an option on their bins.

Three years of contracting for this bus design continually resulted in disappointing fabrication and assembly problems. The decision was made in late 1971 to design an entirely new bus concept which would eliminate all the known fabrication and assembly problems without introducing a new set of problems. This paper presents the result of this design effort and includes additional descriptive information.

ORNL simultaneously started a new bus design independently of LASL. This is described on their engineering drawing Q-2800-25D. This design produces a neat and permanent assembly with the NIM bin but will still allow a mechanical interference problem when using the bus on a particular commercial NIM bin and a particular commercial NIM power supply. This does not present a problem to ORNL at this time, as they use their own NIM bin design.

II. NIM BUS DESCRIPTION

Figure 1 shows the new NIM laminated bus assembled onto a NIM bin with five additional "daisy-chain" busses. The NIM power supply fits over and completely encloses the wiring assembly and the 12 module connectors (see sketch in upper corner of Fig. 5). Thus the laminated bus has a space of 1/4-in. above the 12 connectors, a maximum of 1-in. from the 12 connector mounting plate, and can be approximately 15-in.-long. Space between connectors can be utilized by the laminated bus assembly. Figure 2 shows the wiring assembly before installation onto the NIM bin. Figure 8 defines the positional installation onto the NIM bin. The daisy-chain details are shown in Fig. 7 while NIM bus copper strip detail is shown in Figs. 3 and 4.

On earlier bus designs, the wires going to the 12 module connectors would exit the bus in an outward direction along the 1-in. dimension. Power supply mounting was extremely difficult for the old design as the wires were difficult to squeeze down to the 1-in. dimension. This problem was corrected by having the 12-module-connector wires exit the bus between the 12 connectors. The power supply can now be mounted onto the NIM bin with ease and also can be easily removed from the NIM bin.

The one-plane wiring onto the bus, vs 2-plane wiring of the old bus designs, has considerably eased the epoxy-casting operation during fabrication.

This was another design requirement for repositioning the 12-connector wires.

The copper laminate material is cut from 14-gage (0.064) and from 11-gage (0.086) copper sheet stock. Normal shearing of sheet stock will put a severe twist in the copper strips. There is a special "slitting" machine that performs the shearing operation without copper strip distortion or the strips can be "sawed" from sheet stock. The notches in the copper strips are best cut with a slotting saw in a milling machine. Thus, the copper strips can be fabricated in most-typical "job-shop" machine shops.

The fabricated copper strips must be carefully deburred, deoxidized, and then tin plated. The plating can be either electroless or electrotinning with a sufficient tin thickness (0.1 mil typical) to assure correct solder application when attaching the wires.

Section A-A in the lower corner of Fig. 5 shows an enlarged cross section of the laminated bus. The 6-volt busses are likely to have the largest transients and are considered the "noisy" busses. You will notice that these 6-volt busses are oriented between two ground busses to obtain a quasi-shielding effect.

The thickness of the copper strips was determined by the diameter of the copper feed wires used in the power feed umbilical cord terminated in PG-13 (Fig. 5). The lower left corner of Fig. 6 illustrates how the stripped wire is placed in the copper strip slot. Soldering is best accomplished with an induction soldering machine or a resistance soldering machine. In both cases the copper strip is placed between two electrodes, heat applied and solder flowed into the wire strip slot. A conventional 250-watt soldering iron could be used but previously soldered wires may fall out as new wires are soldered. After the solder operation is performed, the wire insulation should not have pulled back more than 0.025 in. from the copper strip.

All wires used have type E, 600 volt, extruded Teflon insulation. The 14 AWG wire is 19/27 stranded. The 16 AWG wire is 19/29 stranded and the 18 AWG wire is 19/30 stranded. The insulated wires should be stripped only with thermal wire strippers to avoid nicking the wire strands thereby contributing to possible wire strand breakage. The wires are best cut by a shearing action tool rather than "dikes" thus having a nice butt-type fit into the copper strip. The socket contacts must be crimped onto the wires using factory-recommended procedures and tools.

An additional benefit of this NIM bus fabrication technique is the improved performance of voltage variations at the NIM module due to bin bus voltage changes and load changes.[2] TID-20893, page C-1, lists a summary of the percentage changes for various wiring techniques. Method B describes the old style laminated bus. Please note that Method B has a #12 wire effective cross section for all six voltage busses and a #9 wire effective cross section for the ground return bus. Thus, the tabulated changes for Method A, specifying #14 and #10 wires, respectively, are somewhat in error and Method B is essentially the best power distribution method listed in this report. Power supply voltage sense is at the laminated bus. Our new bus design shows a 46% improvement for ± 6V distribution from 0.17% voltage variation on the old bus to 0.091% voltage variation on the new bus. Likewise, there is a 39% improvement for the ± 12V distribution from 0.028% to 0.017% and the ± 24V distribution has a 23% improvement from 0.013% to 0.010%. In addition, the old bus design had a possible 5 millivolt difference in ground potential from module 1 to module 12 while the new bus design restricts this change to 2 millivolts. This improvement is achieved by the effective cross section of the new bus having a #5 wire ground return size, a #8 wire size for ± 6V, and a #9 wire size for the ± 12V and ± 24V busses.

Insulation between copper strips is not critical. Figure 6, lower center, shows the best method to use. Vinyl plastic electrical tape, 1/2-in.-wide and about 0.007-in.-thick works very well by wrapping the tape around alternate copper bus strips. After aligning the bus strips, alternately insulated and uninsulated, vinyl tape can be tightly wound to secure the assembly at three or four different places. Effectively, the bus should now be assembled except for epoxy casting. This assembly technique allows the unit to be 1000 V high-voltage tested for insulation punch-through from burrs on the bus strips before epoxy casting. Thus with appropriate checking techniques, all epoxy-casted bus units should be electrically good.

Epoxy casting is best accomplished with a casting mold. Mold detail information is shown in Fig.

9 and in Fig. 5, including cross section AA of Fig. 5. It has been found that excess epoxy can be left around the wires during casting. This is a beneficial side effect which helps to support the wires.

In addition, the NIM bus is spaced properly in the mold by the tape thickness at the three or four assembly taping positions. The best material found to date for epoxy casting has been Emerson and Cuming's Stycast 2850 epoxy casting resin. The casting resin should set up in a vacuum but if air bubbles are avoided during the potting process, a vacuum chamber may not be necessary. Any voids greater than 0.032-in.-diam should be refilled.

The finished bus unit can be assembled onto the NIM bin as per the detail in Fig. 8. The bus must be held in the correct position on the NIM bin as each pin is placed in the proper socket hole. If this procedure is not used, the bus will not stay in its proper position and difficulty in assembling the power supply to the bin will result. Do not pull excessively on the PG-13 umbilical feed assembly during installation as the major strain will be on just two or three of the wires.

III. CONCLUSIONS

A NIM-laminated bus was designed that could be used on any NIM bin and NIM power supply combination. The design considers the small fabrication shops and can be built by them. The design has eliminated fabrication problems of older designs and has proven to have superior electrical performance. Over 40 NIM busses of this new type have been installed and are in use without any new problems developing although one bus had two wires from the PG-13 umbilical feed assembly pull loose because of mishandling during installation.

ACKNOWLEDGEMENTS

The authors gratefully acknowlege the assistance of Ed Schoolcraft of Southwest Precision Electronics for his technical assistance during construction of the initial prototype units.

REFERENCES

1. Standard Nuclear Instrument Modules, TID-20893 (Rev. 3), United States Atomic Energy Commission, Washington, D. C. 20545.

2. Ibid.

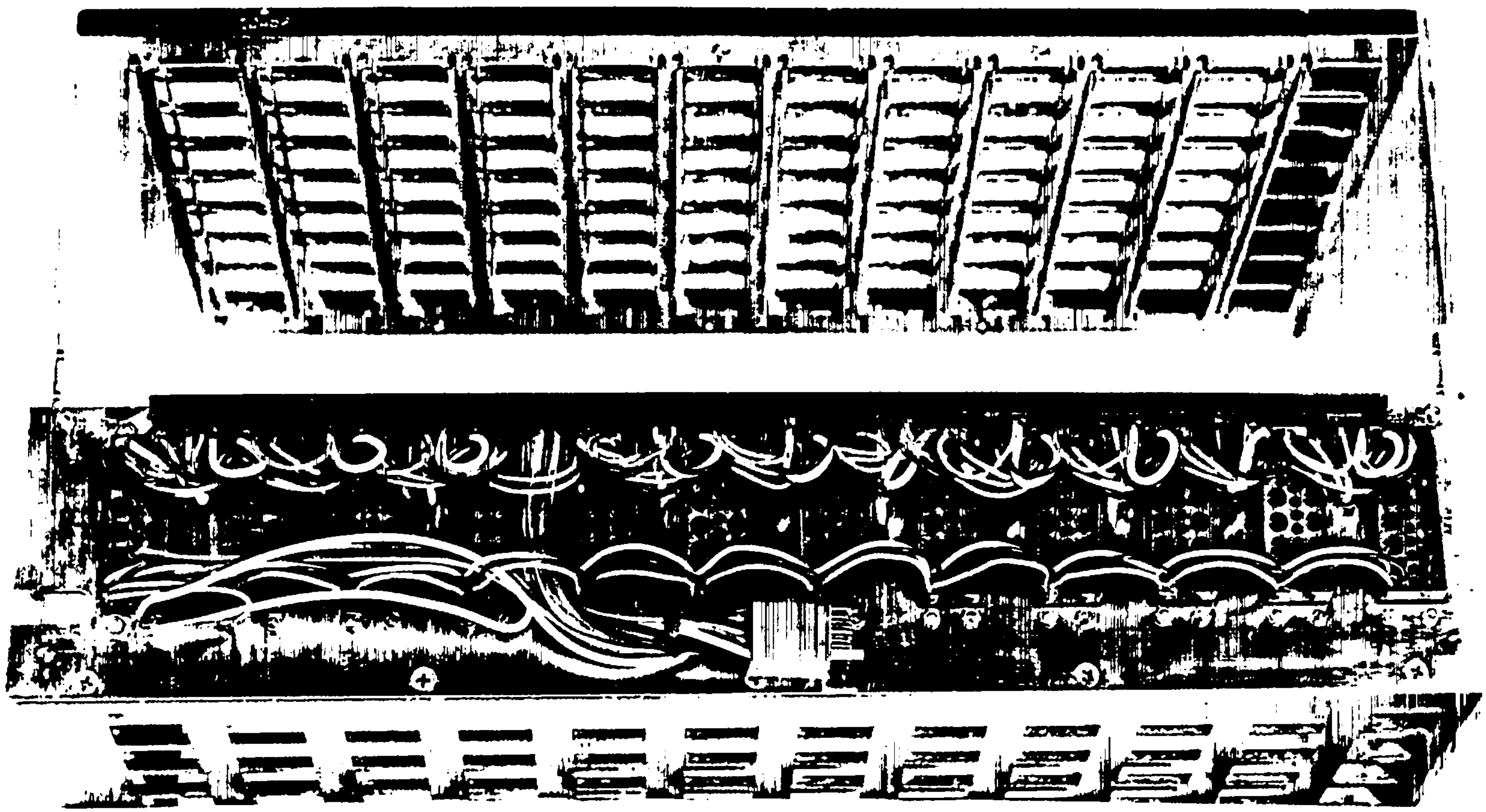


Fig. 1. Bin with laminated bus and "daisy-chains."

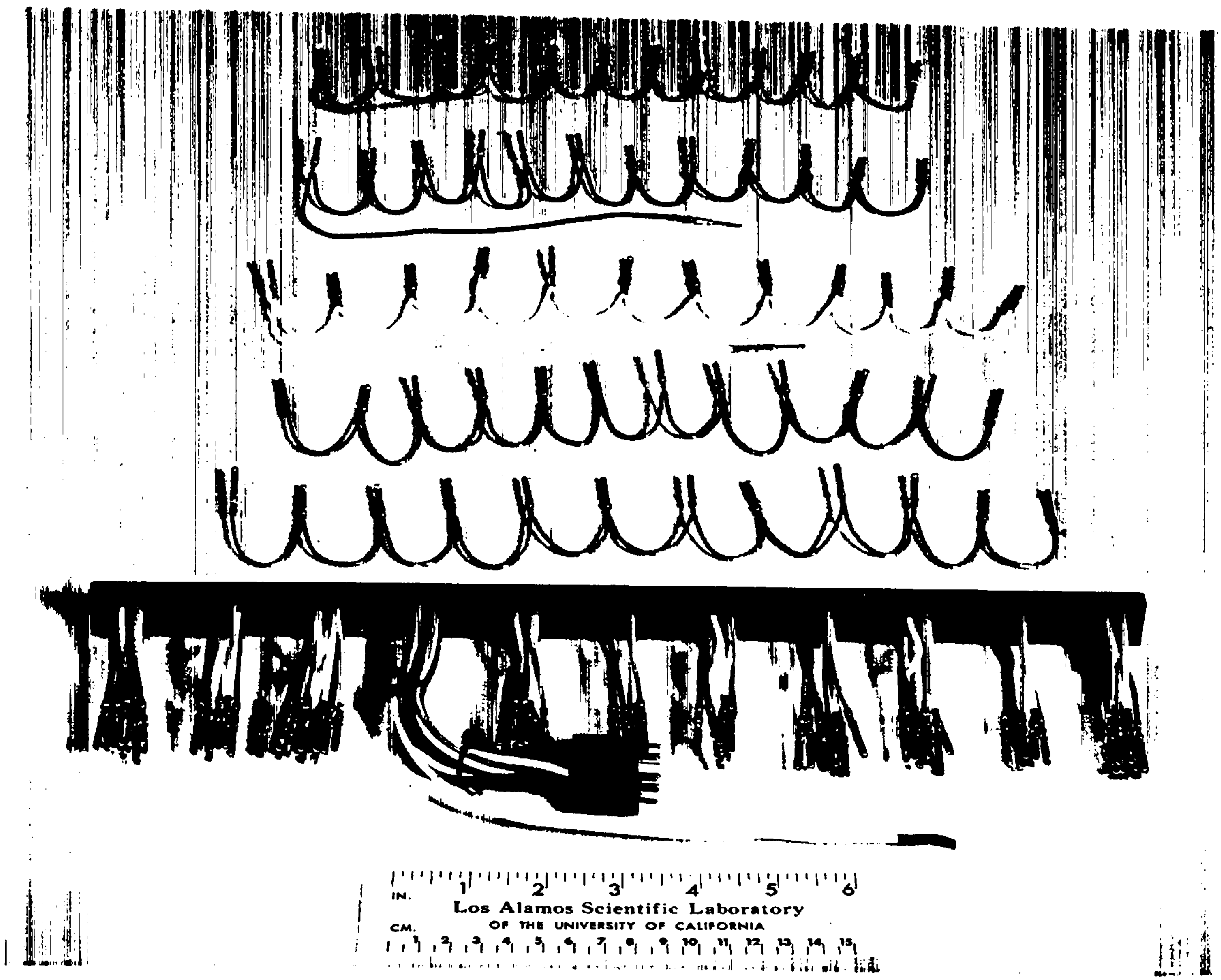


Fig. 2. Laminated bus and "daisy-chains."

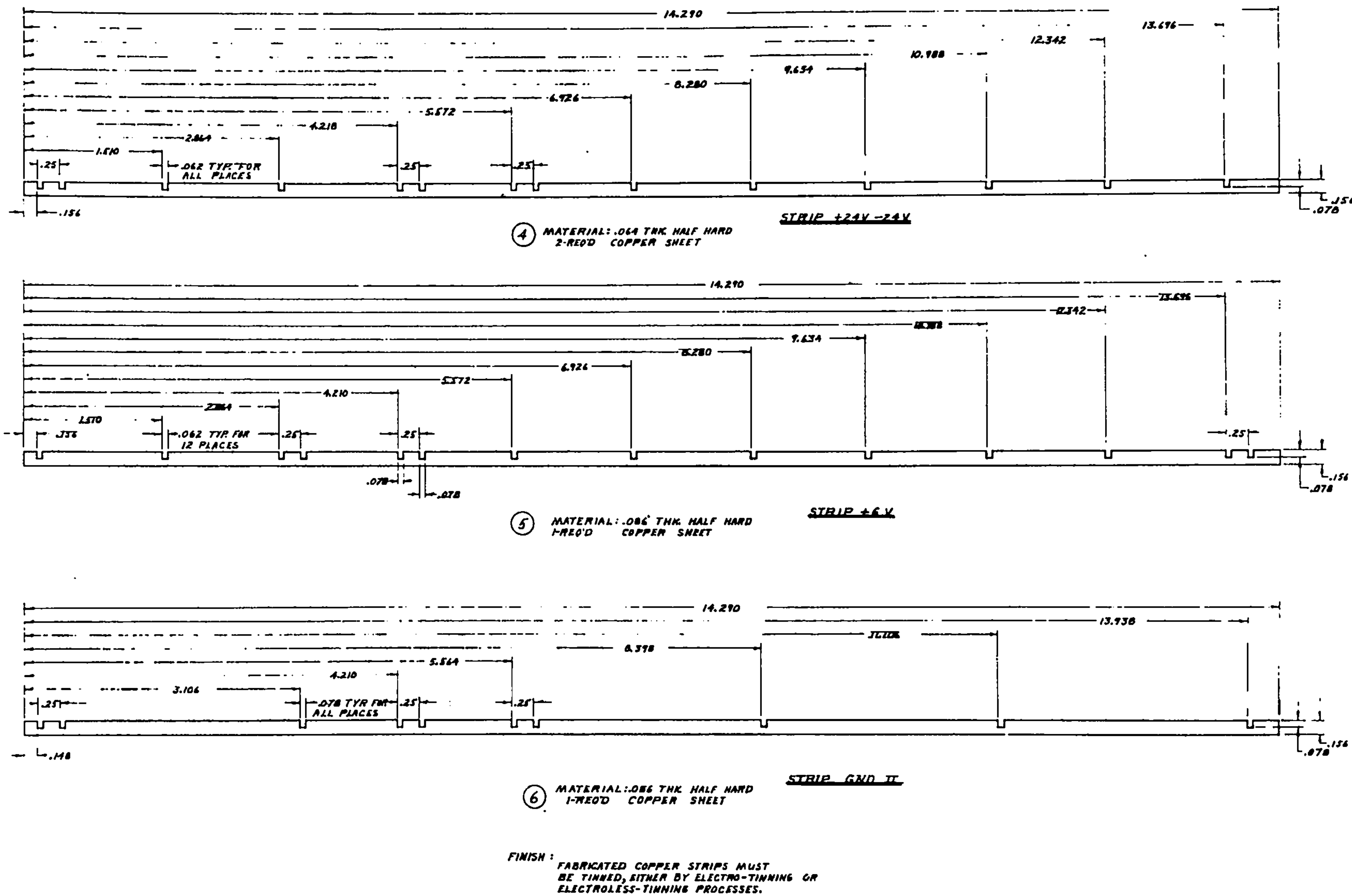


Fig. 3. 4Y-89726, D1 - Copper strips.

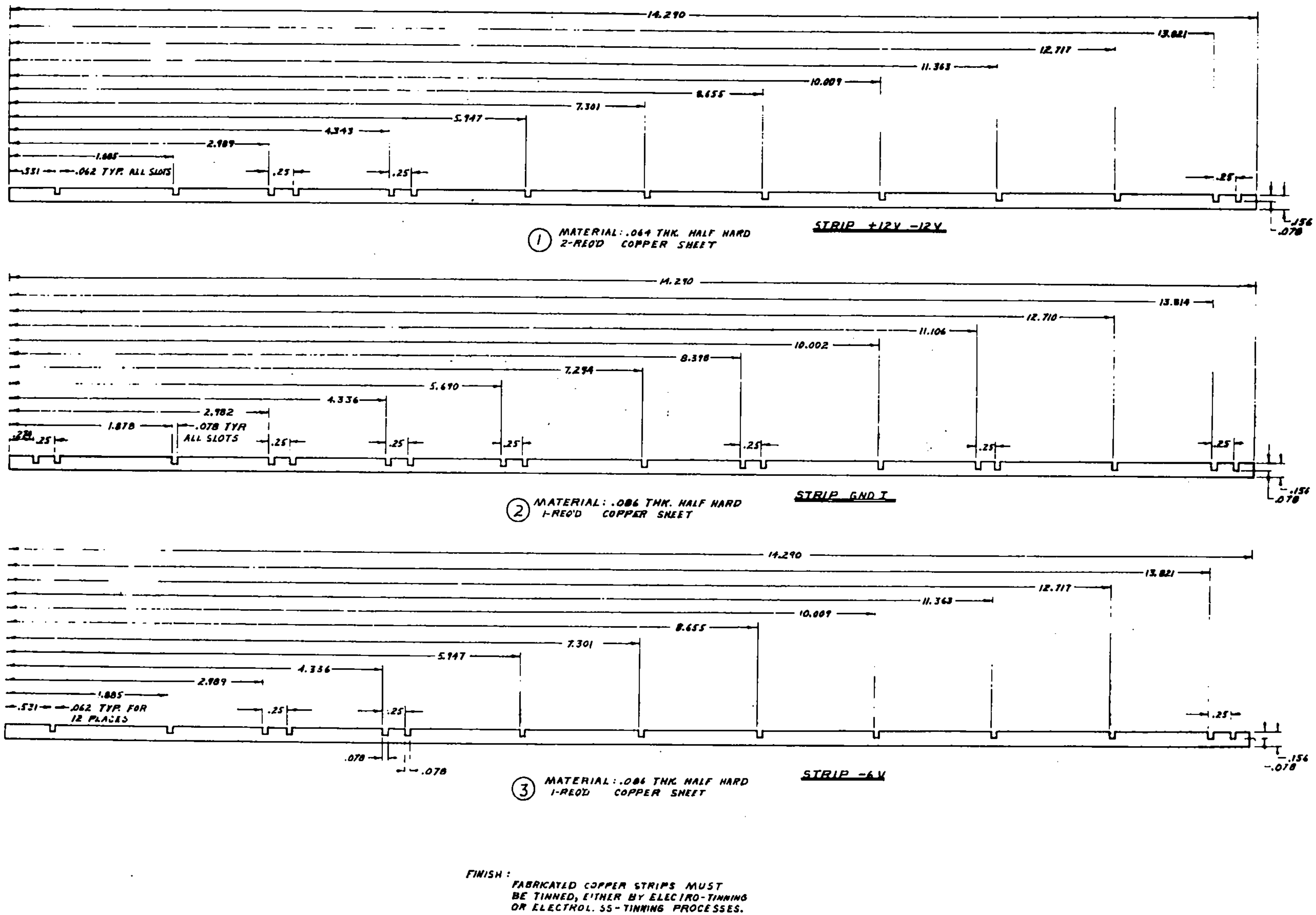


Fig. 4. 4Y-89726, D2 - Copper strips.

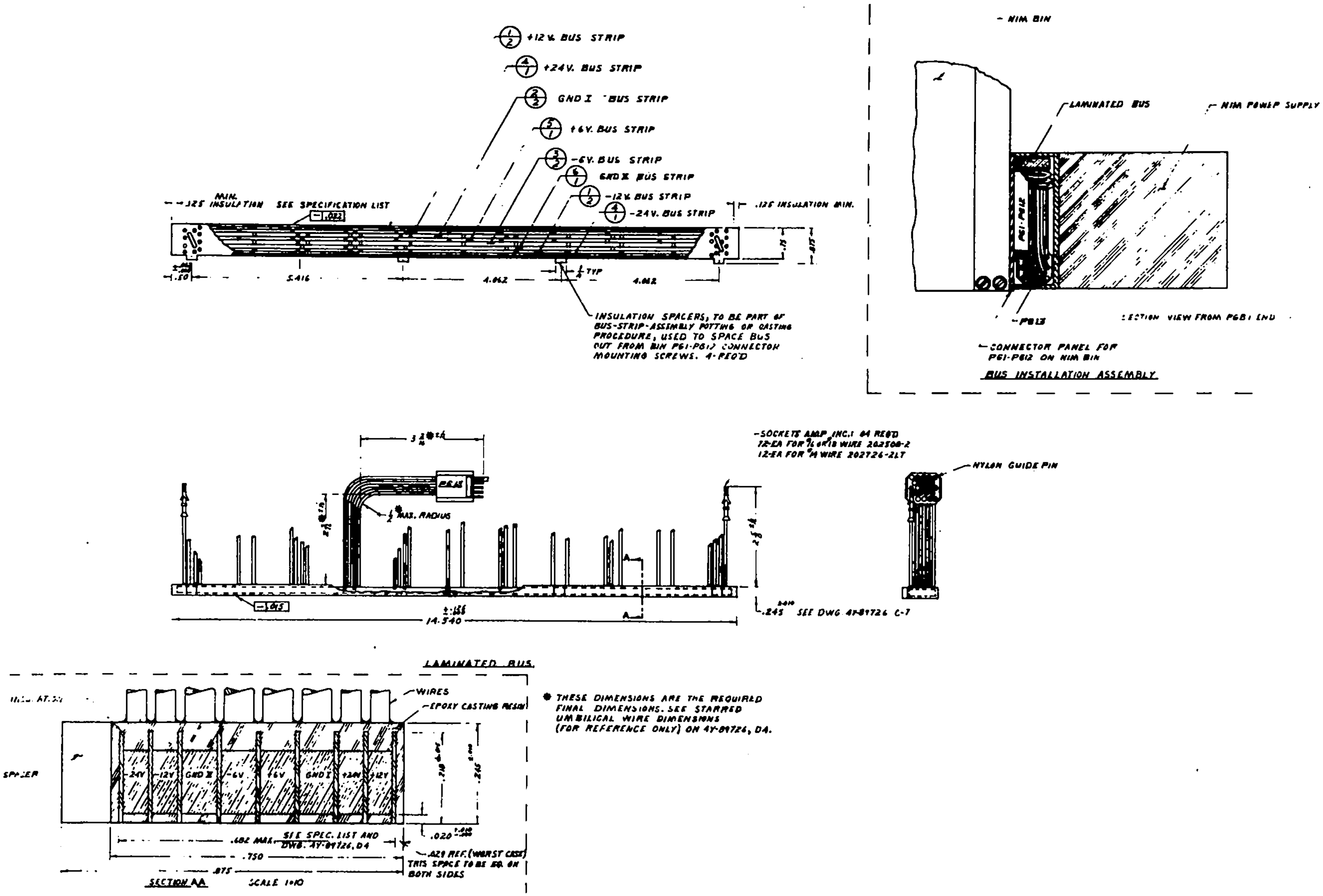


Fig. 5. 4Y-89726, D3 - Laminated bus assembly.

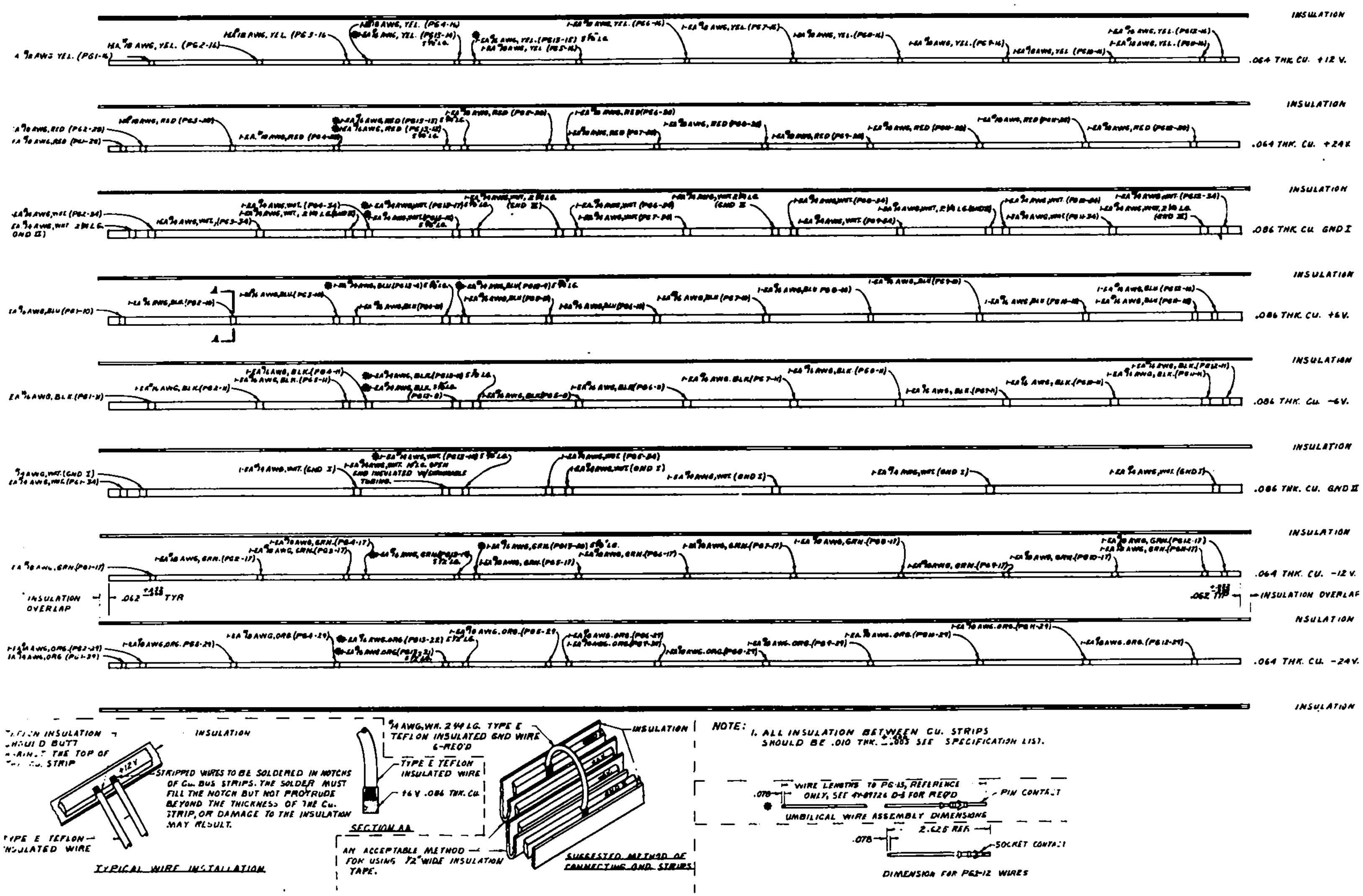
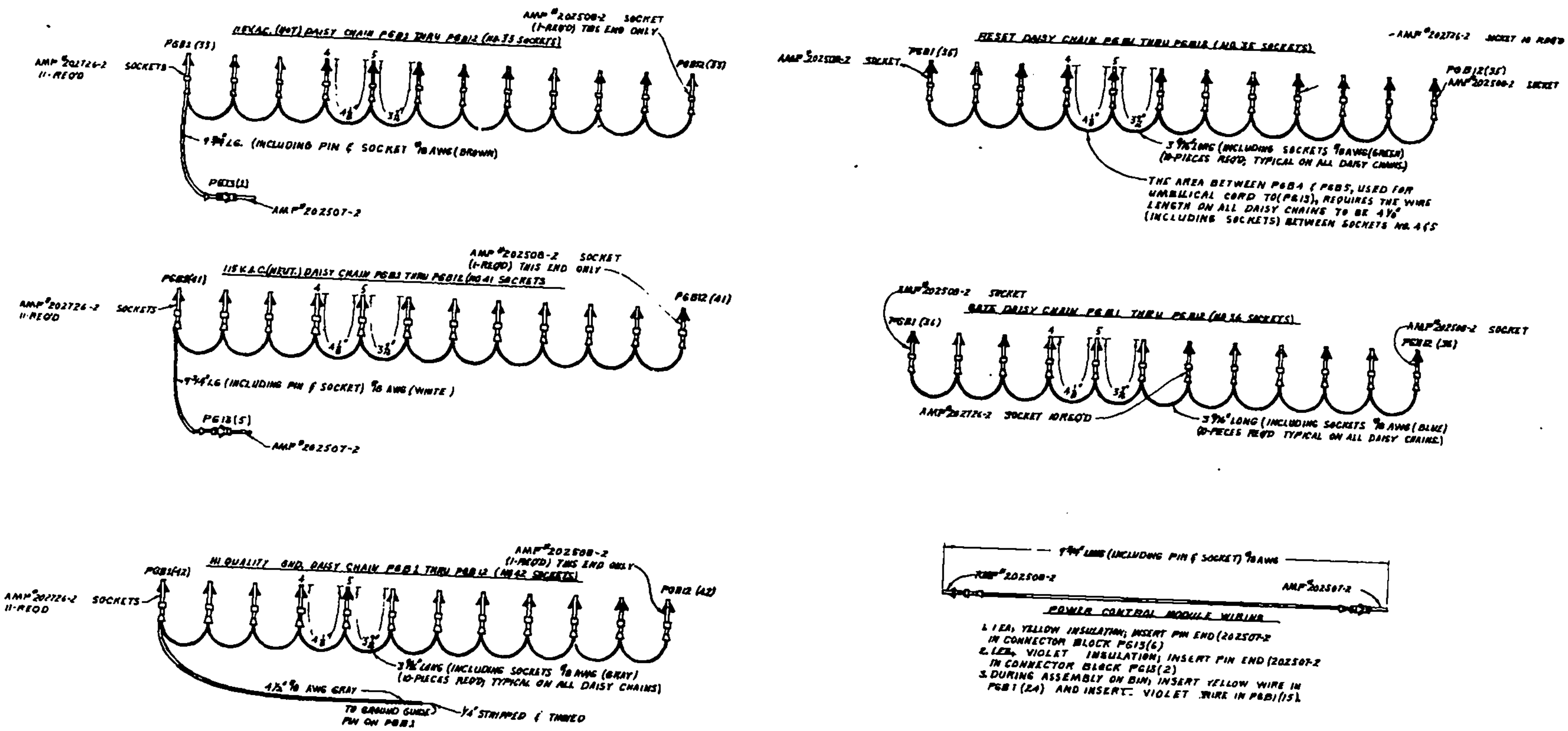


Fig. 6. 4Y-89726, D4 - Wire installation details.



SEE DWG. 4Y-89726 D6 FOR WIRING DIAGRAM

Fig. 7. 4Y-89726, D5 - Daisy chains.

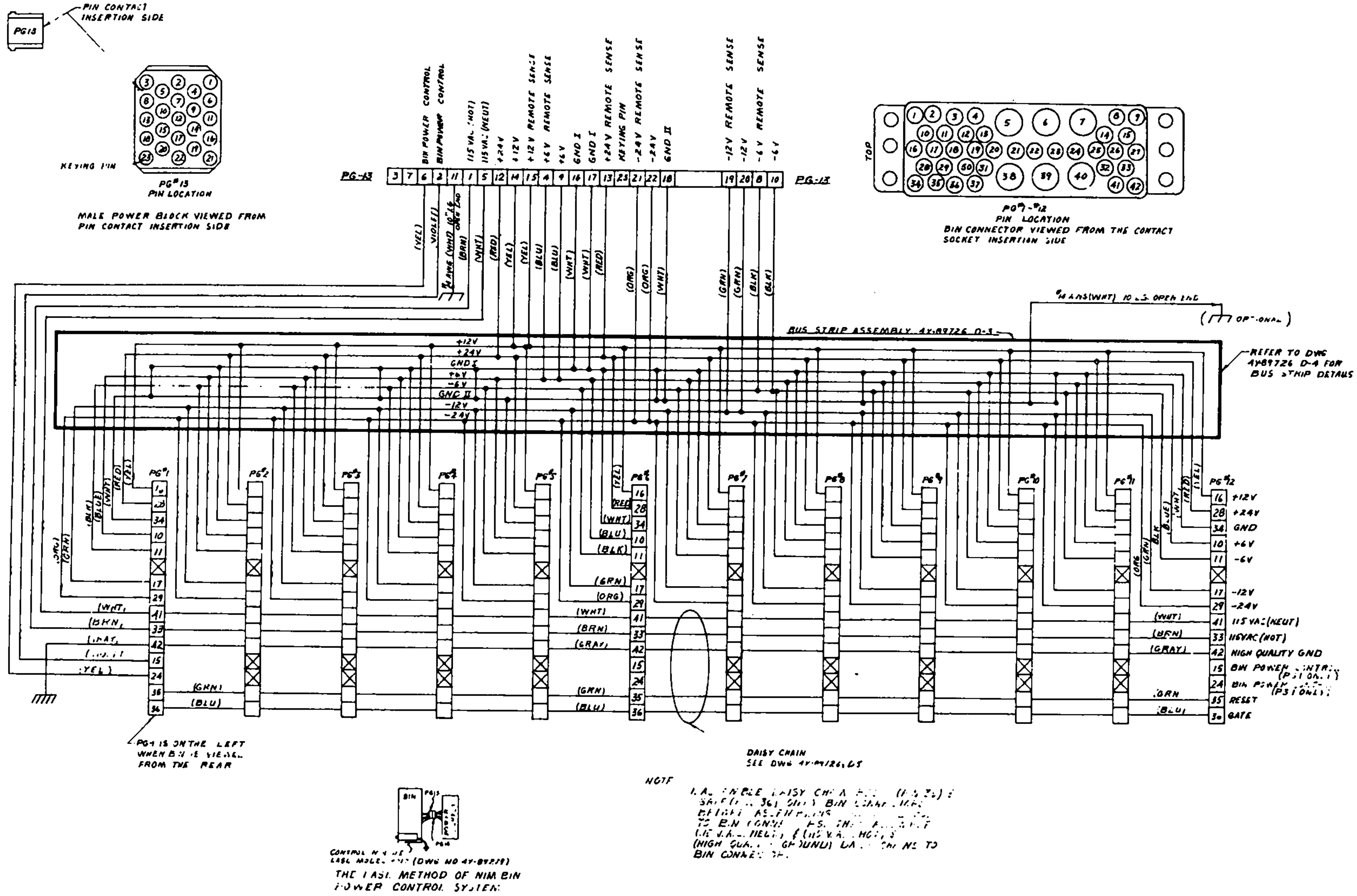


Fig. 8. 4Y-89726, D6 - Daisy chain and standard NIM bin wiring.

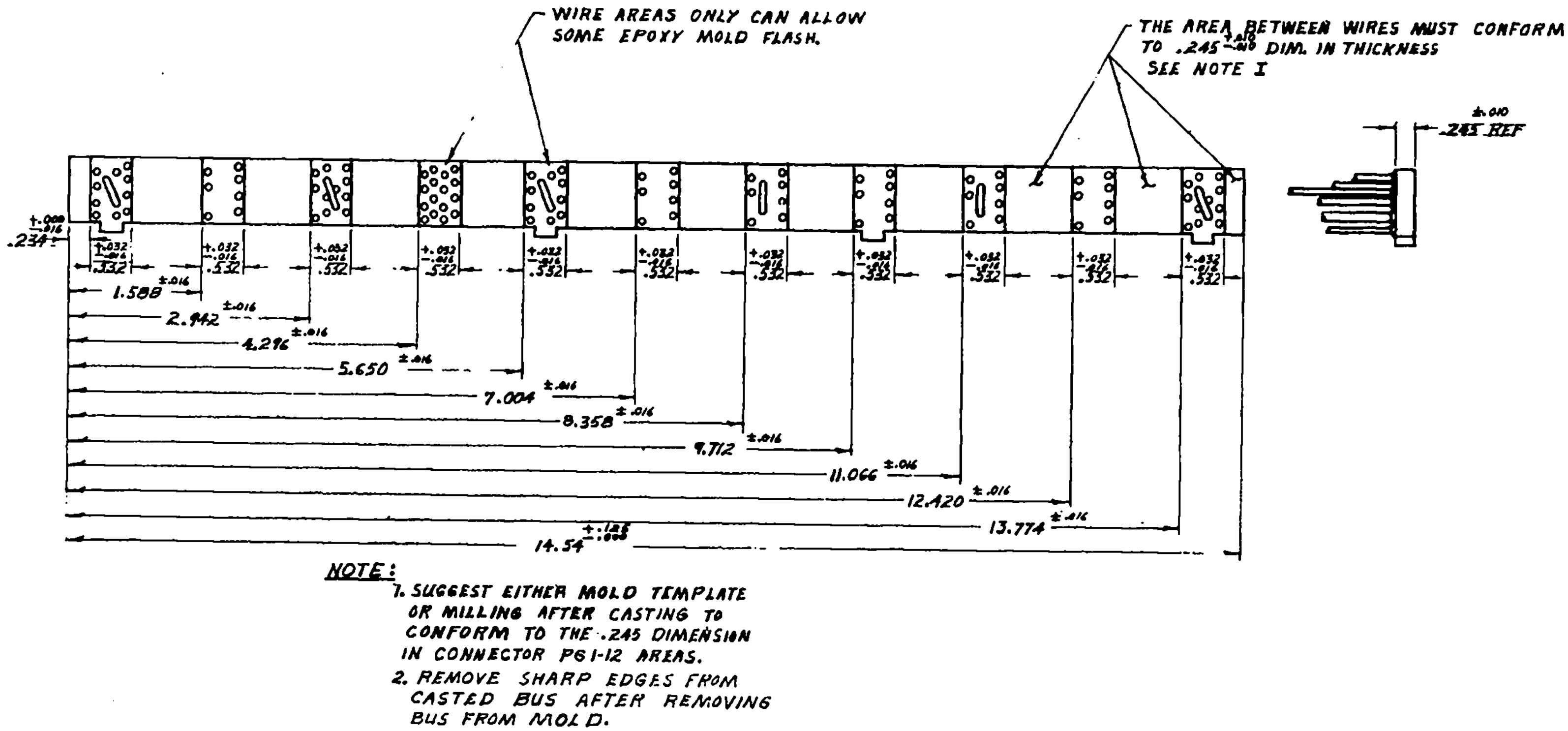


Fig. 9. 4Y-89726, C7 - Mold casting information.