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COMPARATIVE PULSE RESPONSE OF RG-58C/U AND RG-174/U OVER SHORT DISTANCES

I. Introduction

Due to the increased emphasis on miniaturization there is increasing interest in subminiature coaxial connectors (the LEMO connector for example is the standard coaxial connector for the CAMAC system of modular electronics). Consequently there is a new need for pulse response data on miniature coaxial cable, such as RG-174/U, which might be used to transmit fast pulses between high speed electronic modules.

The primary purpose of this note is to compare the pulse characteristics of RG-174/U with the "standard" RG-58C/U coax presently used to cable up high-speed electronic modules. This comparison was suggested by C. Sinclair of the Spectrometer Facilities Group who also suggested that a good cable length to use for the comparison was 20 feet, corresponding to a typical length when cabling up one or two racks of equipment. Note therefore that longer distances, such as from a phototube to a discriminator, are not covered in this note. In the latter case,cable risetimes for the particular distances involved should be carefully evaluated in terms of amplitude loss, timing errors, etc. Several good reports on cable risetime are available to assist in such an evaluation,[1,2,3] although these do not contain actual measurements on RG-174/U.

It should also be pointed out that the influence of the connectors was not studied in this note — both cables were terminated in BNC standard connectors.

II. General Comparison of the Cables

Both cables are 50 Ω having a solid polyethelene dielectric with a velocity of .659c. Outer diameter of RG-58C/U is 0.195" and RG-174/U is 0.100". At the present time (October, 1971) the SLAC Stores cost is 3.2 cents/foot for RG-58C/U and 1.8 cents/foot for RG-174/U.

The dc resistance of the center conductor is a significant difference between the cables. Twenty feet of RG-58C/U has a center conductor resistance of about 0.25 Ω , while the RG-174/U has approximately 1.8 Ω resistance.

This means that for a "long" pulse there is inherently a 4% amplitude error when using RG-174/U in a 50 Ω terminated system of 20 feet length.

Attenuation at 100 MHz is 6 db/100 feet for RG58C/U and 8.9 db/100 feet for RG-174/U.

III. Results

Pictures of all results are shown in Figs. 1 through 3. In all cases the pulse generator was a Tektronix Type 109 mercury pulser having a risetime $\leq$ .25 nsec. The oscilloscope was a Tektronix 661 with a 4S1, 50 Ω plug-in having a risetime $\leq$ .35 nsec.

Figures 1a, 1b, 1c show the leading edge of a long pulse. The final values are shown at the side of the photo. Note that the RG-174/U shows a dc loss as expected. The waveforms show the classical error function shape. The measured 10% - 50% risetime of RG58C/U is about .35 nsec whereas the corresponding risetime of the RG-174 is about .4 nsec. These measurements are of course limited by the scope risetime and only indicate that the cable risetime is somewhat less than .4 nsec.[4] Due to the shape of the pulse it is very difficult to measure an accurate 10% - 90% risetime. Instead it is more informative to measure the output pulse amplitude for "short" input pulses.

In Fig. 2a, a 3 nsec pulse is injected into the cables. Figure 2b and Figure 2c show the output of the RG-58C/U and RG-174/U. The shapes are quite similar, but the RG-58C/U shows about 7% loss at the peak while the RG-174/U shows about 10% loss at the peak.

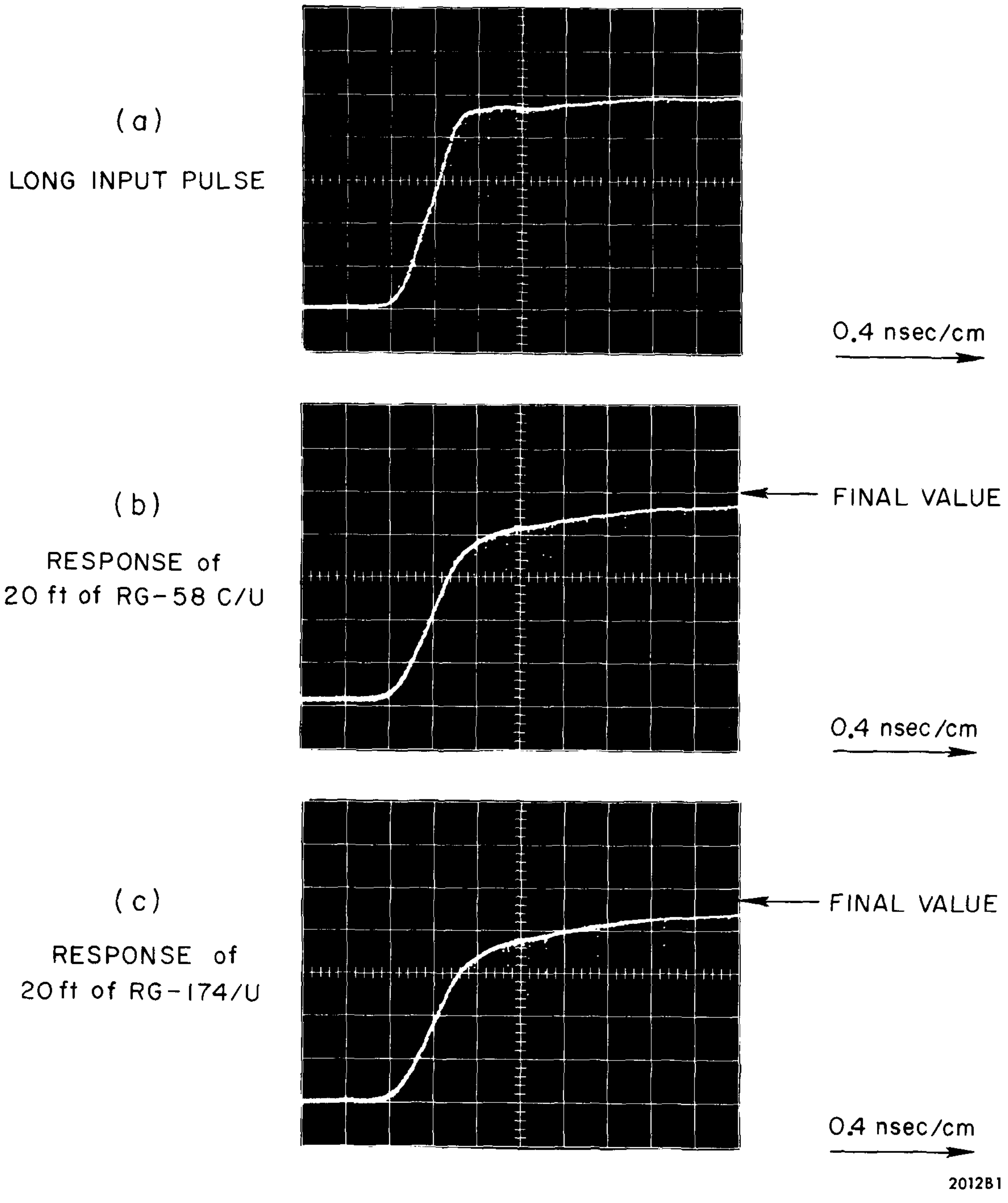
Figures 3a, 3b, 3c show the results for a 1 nsec input pulse. In this case the RG-58C/U shows a 20% loss, while the RG-174/U shows a 25% loss.

IV. Conclusion

While the RG-174/U does show slightly degraded performance compared to RG-58C/U for 20 feet it is hard to see where this difference would be of significance. In fact, for 100 MHz NIM logic where the minimum output pulse width is about 3 nsec, and the output signals are standardized at 0, -700 mV the 10% amplitude loss results in a -630 mV input level, which is greater than the input minimum of -600 mV, specified by the NIM standards.[5]

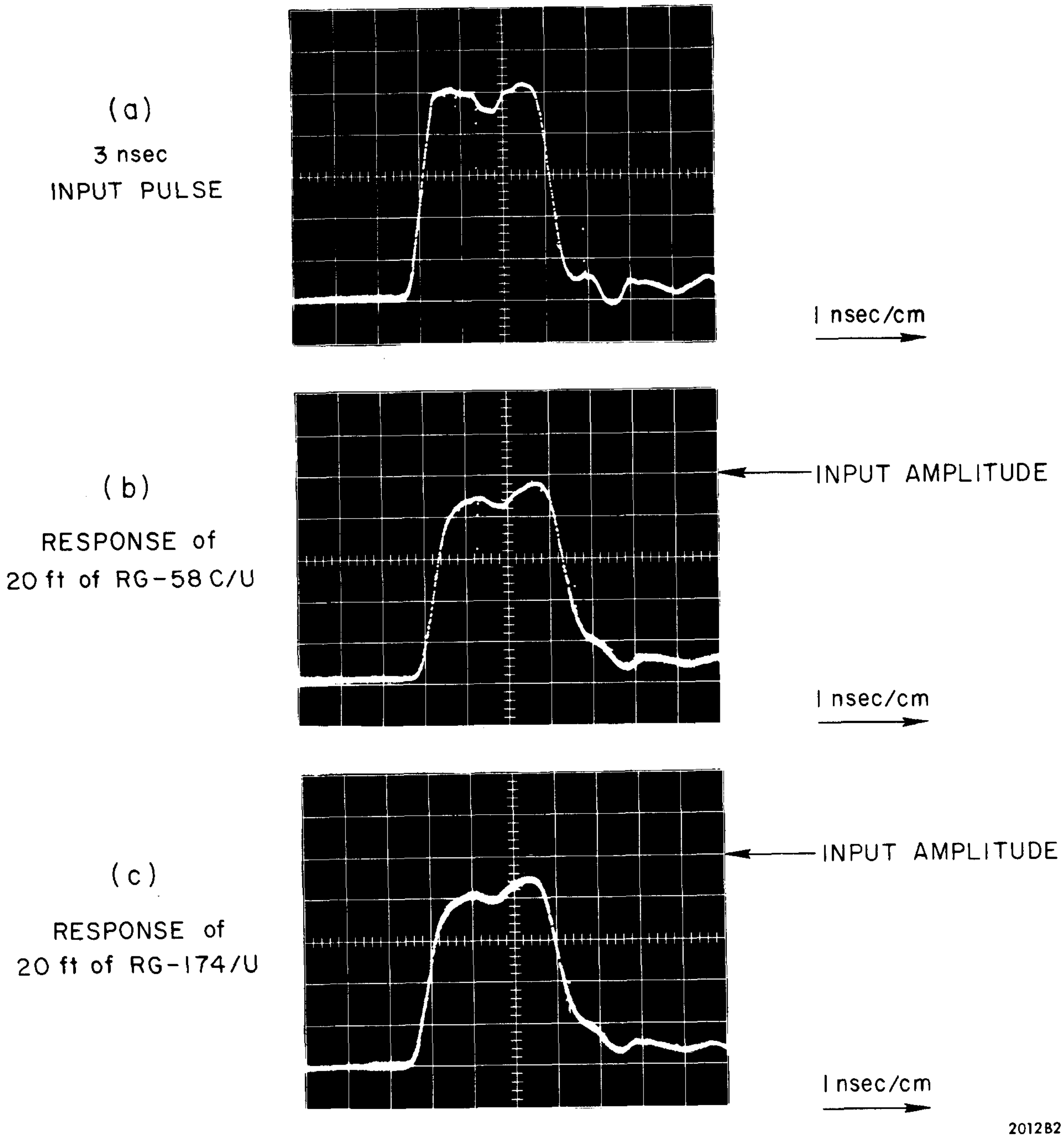
REFERENCES

1. Wigington and Nahman, "Transient Analysis of Coaxial Cables Considering Skin Effect," Proc. IRE, Vol. 45, pp. 166-174 (February 1957).
2. LRL Counting Note No. CC2-1B, "Pulse Response of Coaxial Cables."
3. LRL Counting Note No. CC2-2C, "Physical Characteristics of Coaxial Cables."
4. Calculated 10% - 50% risetime for RG-174/U is about .15 nsec, and for RG-58C/U is about .08 nsec for 20 feet of cable.
5. "Standard Nuclear Instrument Modules," USAEC TID-20893 (Rev. 3); Section D7.



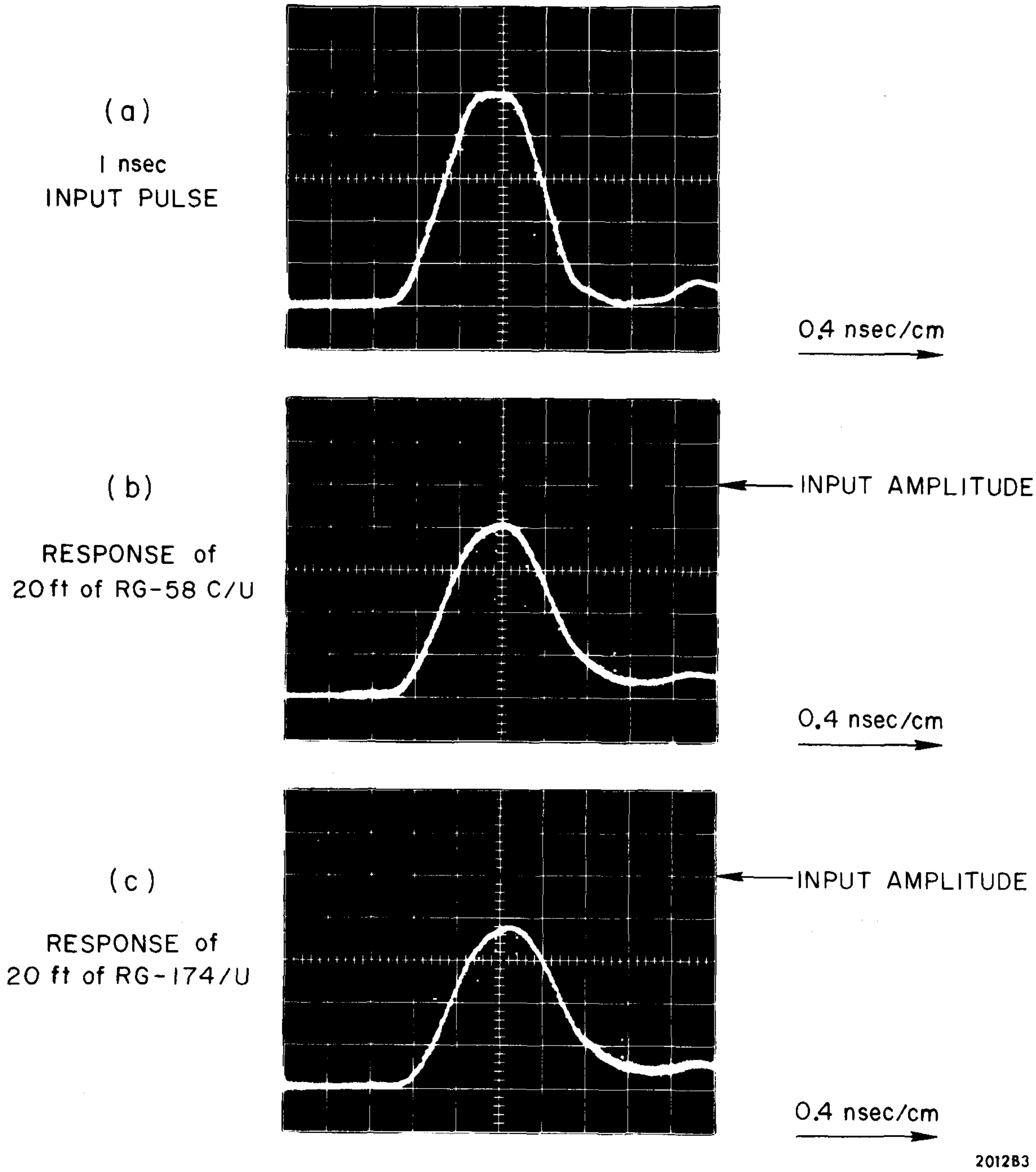
All Photos taken with TEKTRONIX 109 PULSER ($\leq$.25 nsec), TEKTRONIX 661 SCOPE, and TEKTRONIX 4S1 PLUG-IN ($\leq$.35 nsec)

Fig. 1



All Photos taken with TEKTRONIX 109 PULSER ($\leq$.25 nsec), TEKTRONIX 661 SCOPE, and TEKTRONIX 4S1 PLUG-IN ($\leq$ .35 nsec)

Fig. 2



All Photos taken with TEKTRONIX 109 PULSER ($\leq .25$ nsec), TEKTRONIX 661 SCOPE, and TEKTRONIX 4S1 PLUG-IN ($\leq .35$ nsec)

Fig. 3