Technical Note: Coaxial Jumper Cable SPICE Model

D20-2012-01

Picture-1 TDR / TDT Test Board
Test Sample: Straight termination, AWG#28 L=500mm

Fig.-1 shows simulation model designed based on the actual TDR / TDT test result shown in Fig.-2. Fig.-3 shows simulation result using SPICE.

Comparing Fig.-1 and Fig.-2, TDR waveform of incident portion well matches with actual TDR/TDT measurement. TDT waveform and TDR reflected waveform however shows differences. Even though “LOSSY TRANSMISSION LINE” (LTRA) model is used for Jumper cable, Simulated TDT waveform rise time (Tr=75pS) is faster than actual test result (Tr=136pS). This is due to the fact the LTRA model does not incorporates “SKIN EFFECT” of the center conductor but series resistance at given frequency (DC in this case). The simulated reflected waveform(toward right of the screen) shows larger magnitude than actual measurement due to the faster simulated TDT signal rise time.

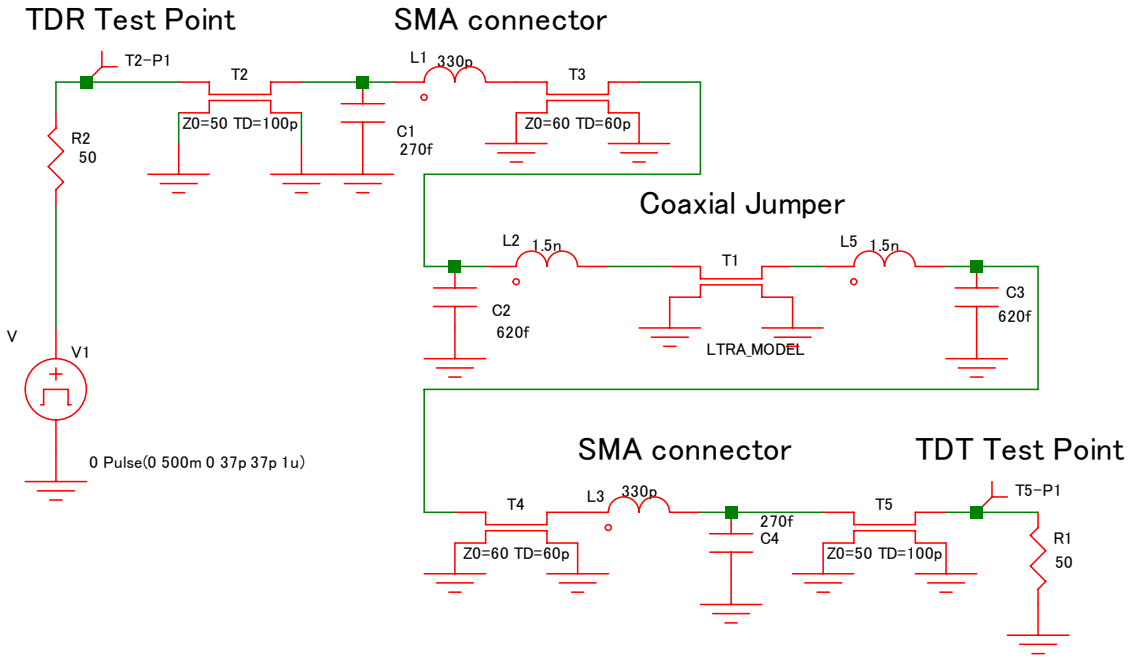
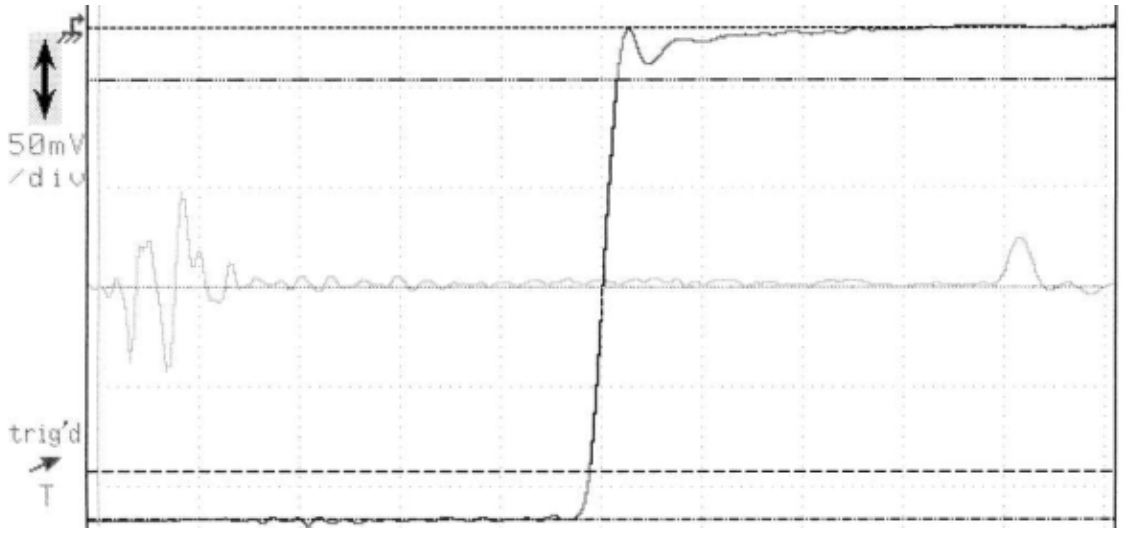


Fig.-1 Coaxial Jumper Cable SPICE MODEL

TDR/TDT test result

Equipment:TEKTORONIX 11801B / SD-24 Digital Sampling Oscilloscope



36.59nS 500pS / div 41.59nS

Fig.-2 TDR/TDT Test data AWG#28 Coax Jumper L=500mm Tr=136pS

Simulation Result

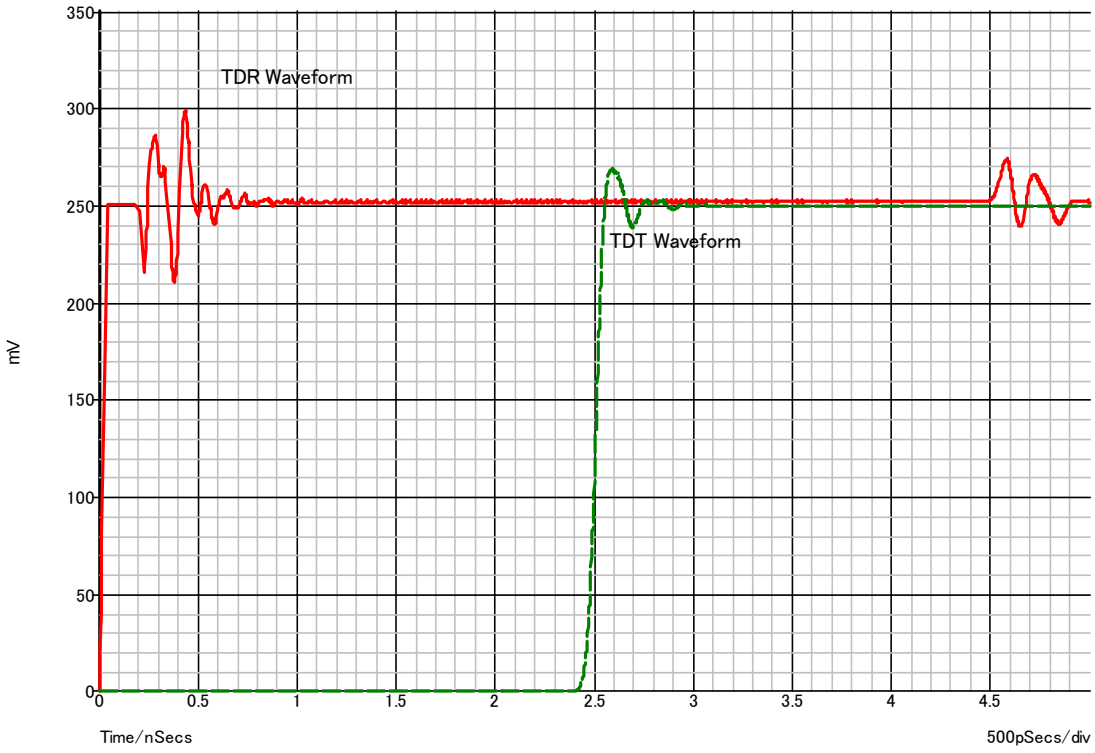


Fig.-3 Simulation Result Coax Jumper L= 500mm Tr=75pS

Effect of incident waveform rise time variation

Following is simulation result with incident waveform varied as 100pS, 500pS, 1nS .

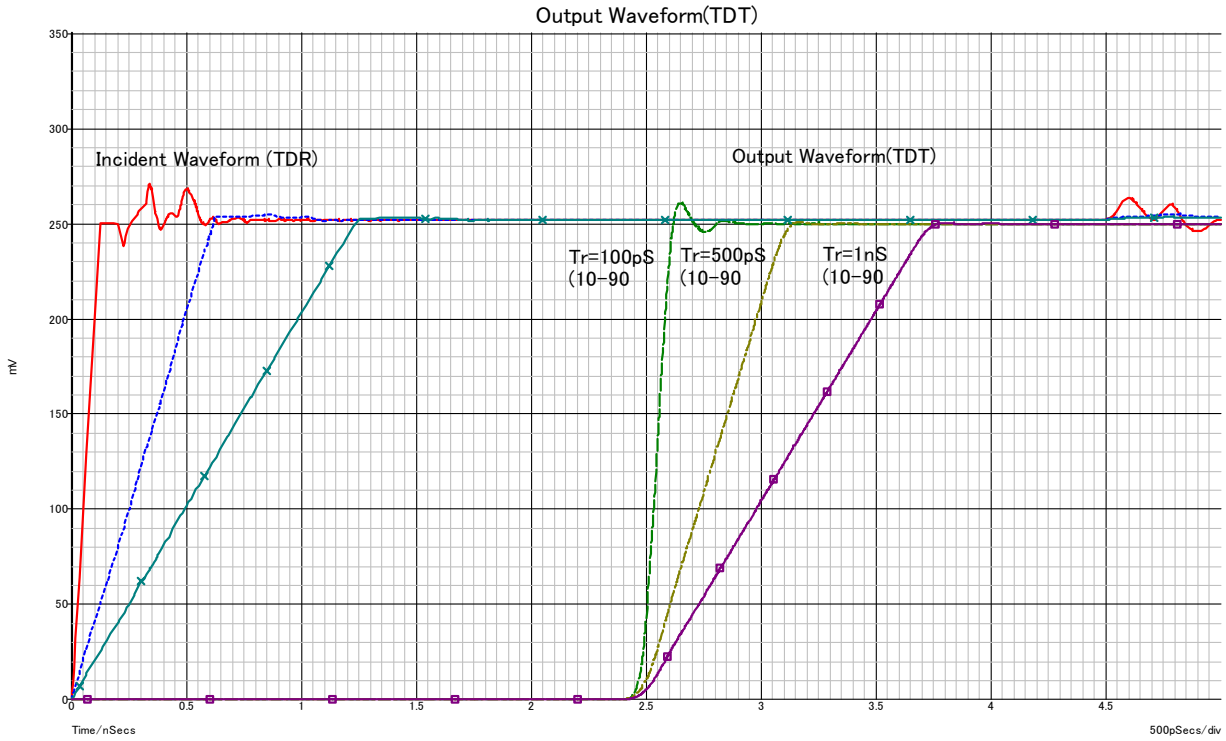


Fig.-4 Simulated result with varied incident waveform rise time

Spice Model Circuit File

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* C:¥My Documents¥spice data¥Coax Jumper¥Coaxial_Jumper.sxsch
*#SIMETRIX
O$T1 L2_N 0 T1_P2 0 LTRA$T1
.MODEL LTRA$T1 LTRA R=0.25 C=8.2e-011 L=2.1e-007 LEN=0.5 REL=1 ABS=1
T2 R2_P 0 T2_P2 0 Z0=50 TD=100p
T3 T3_P1 0 T3_P2 0 Z0=60 TD=60p
T4 L5_N 0 L3_P 0 Z0=60 TD=60p
T5 L3_N 0 T5_P2 0 Z0=50 TD=100p
V1 R2_N 0 0 Pulse(0 500m 0 37p 37p 1u)
L1 T2_P2 T3_P1 330p
L2 T3_P2 L2_N 1.5n
L3 L3_P L3_N 330p
L5 T1_P2 L5_N 1.5n
.graph T5_P2 curveLabel="T5-P1" nowarn=true ylog=auto
.graph R2_P curveLabel="T2-P1" nowarn=true ylog=auto
C4 L3_N 0 270f
C2 T3_P2 0 620f
C3 L5_N 0 620f
C1 T2_P2 0 270f
R1 T5_P2 0 50
R2 R2_P R2_N 50

.TRAN 5n
```

Cable rise time measurement with multiple cable lengths

Test result of 4”(inches),7”,8”,10” and 500mm,1m cable are super imposed on scope screen.
Test setup rise time was determined as 30pS by measuring SMA-SMA through adapter in place of test board. Cable Tr are calculated by Tr (cable) = SQRT(Tr(measured)**2 – (30e-12)**2)

Waveform rise time and F3dB(Note 1) has following relationship for gaussian pulse.

F3dB ≃ 0.338 / Tr (10-90%)

(Note 1) F3dB: frequency at which impulse response rolls off by 3-dB

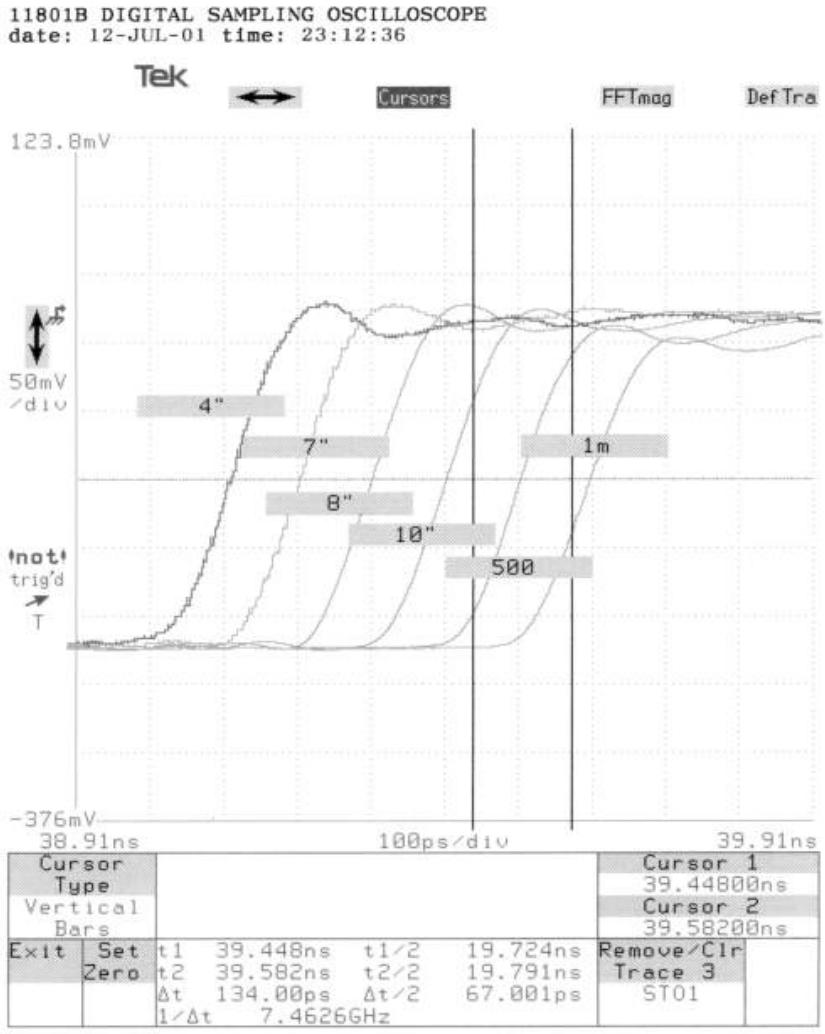

Fig.-5 AWG#28 Coax Jumper cable rise time measurement

Test Result

Cable length	Tr (measured)	Tr (cable)	F3dB
4”	126pS	122.5pS	2.76GHz
7”	124pS	120.4pS	2.81GHz
8”	124pS	120.4pS	2.81GHz
10”	130pS	126.6pS	2.67GHz
500mm	134pS	130.0pS	2.60GHz
1m	150pS	147.0pS	2.25GHz