Case Study: Fast-80 Setup and Hold Timings

Quantum Corporation - Duncan Penman, Farrokh Mottahedin,
Muhammad Nazir, Dennis Moore

Introduction

This report is a summary of timing studies done over the past several weeks using the Quantum Atlas IV disk drive attached to an Adaptec host adapter capable of Fast-80 operation.

Summary of Results

First, we believe our tests and measurements demonstrate that the timings specified in SPI-3 rev 2 are viable for Fast-80 operation. It is possible to assemble reliable configurations at the limits of permitted cable length and loads **provided** impedances are reasonably matched and twisted pair cable is used.

We have tested many configurations. The table below summarizes results from four of them we feel are pertinent.

- Point-to-point, 1 meter
- Point-to-point, 25 meters
- One initiator with 15 targets, 12 meters.
- One 6-slot backplane, 6 drives installed, with 10 meters of cable to the host adapter.

Measurements are normally repeatable to within a range of about 100 psec, so results have been rounded to the nearest .1 nsec.

An important caution: While many reliable Fast-80 configurations are possible, we have seen configurations that worked reliably at Fast-40 but did not work at Fast-80. We are not prepared at this time to offer any general guidelines beyond the requirements of SPI-3.

Details of Measurements

1. Skew

   When the drive is the data source, the difference between the earliest and latest data bits is on the order of 600 psec. This was measured at the drive connector while reading an alternating 1/0 pattern on all bits. Measurements were taken at the zero crossing level between all positive going edges, relative to each other, and between all negative going edges, relative to each other.

   Different bits were earliest and latest on 68 pin and SCA drives. For one type of drive the earliest and latest bits, and the timing ranges, were consistent across multiple drives.

2. Setup and Hold Times

   Using the earliest and latest bits determined in the skew measurement above, we took 4 setup and 4 hold measurements on each bit. DT clocking requires 4 measurements because each combination of positive going data and negative going data vs. positive going REQ and negative going REQ exhibits a different timing relationship.

   Timings were measured using the measurement points defined for DT data transfer in Figure 45 of SPI-3 rev 2.

   The table below presents the worstcase (shortest) time for setup and hold in several different configurations while executing READ commands to a disk drive with Fast-80 transfer rate negotiated.

Measurement Condition	Setup Time	Hold Time
Point-to-point, 1 meter cable Alternating 1/0 data, measured at the host adapter	5.6 nsec (see Figure 1)	5.9 nsec (see Figure 2)
Point-to-point, 25 meter cable Alternating 1/0 data, measured at the host adapter	4.8 nsec (see Figure 3)	4.6 nsec (see Figure 3)
1 host adapter with 15 targets on 12 meter cable, alternating 1/0 data, measured at host adapter	5.6 nsec (see Figure 4)	3.7 nsec (see Figure 5)
1 host adapter with 15 targets on 12 meter cable, random data, measured at host adapter	Example of ISI effect on setup timing. (see Figure 1) 5.5 nsec (vs 5.6 nsec above)	N/A - ISI only has a significant effect on setup time.
Backplane with 6 drives installed, alternating 1/0 pattern, measured at drive	6.3 nsec	5.8 nsec
Backplane with 6 drives installed, alternating 1/0 pattern, measured at host adapter	4.8 nsec Same setup as measurement at drive above (see Figure 7)	4.0 nsec Same setup as measurement at drive above (see Figure 8)

Configuration Details

- Manufacturer's specs for all cables meet SPI-3 requirements. Round cable is 30 ga Madison up to 12 meters; 28 ga Madison beyond 12 meters. Ribbon cable is Hitachi laminated twisted pair ribbon with connector mounting areas every 10 inches.
- Host adapter termination was provided by Dallas Semiconductor DS2118 multimode devices; target bus termination was provided by Unitrode or Dallas Semiconductor devices.
- The backplane used was an Intel SK6 LVD backplane. Power was supplied to it by a standard 200W PC power supply through a modified connector.
- The test environment was Windows NT 4.0, using the program SCSI PRO to generate controlled activity on the bus.

Test Equipment

- Oscilloscope: HP Infinium, 1.5 GHz, 8 GS
- Probes: Tektronix P6247 differential w/1103 power supply. 1.5 GHz, <1 pf

Appendix – Oscilloscope Traces

See following pages.

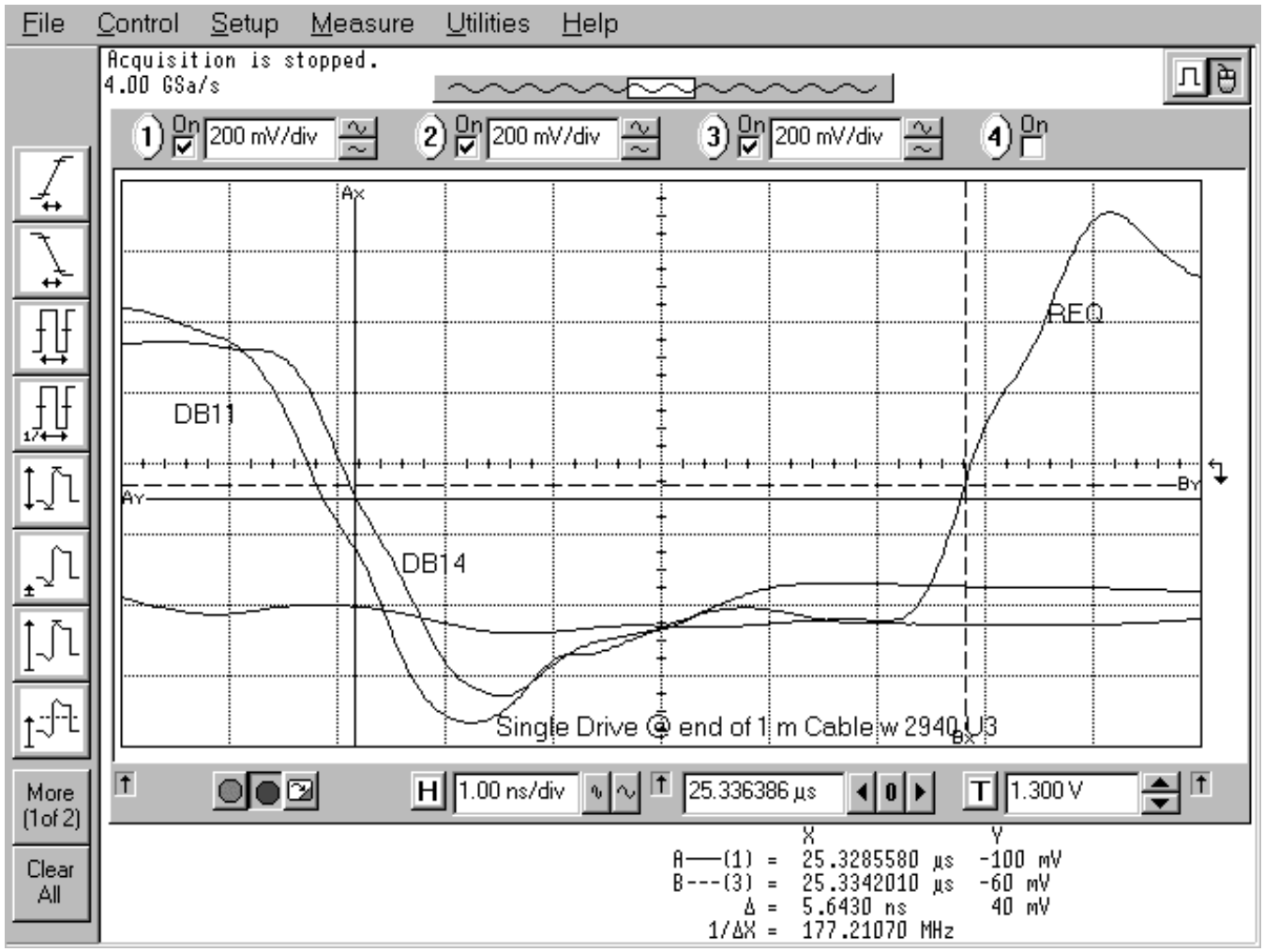

Figure 1: DB14 Setup time at HBA with 1 meter cable, 5.6 nsec

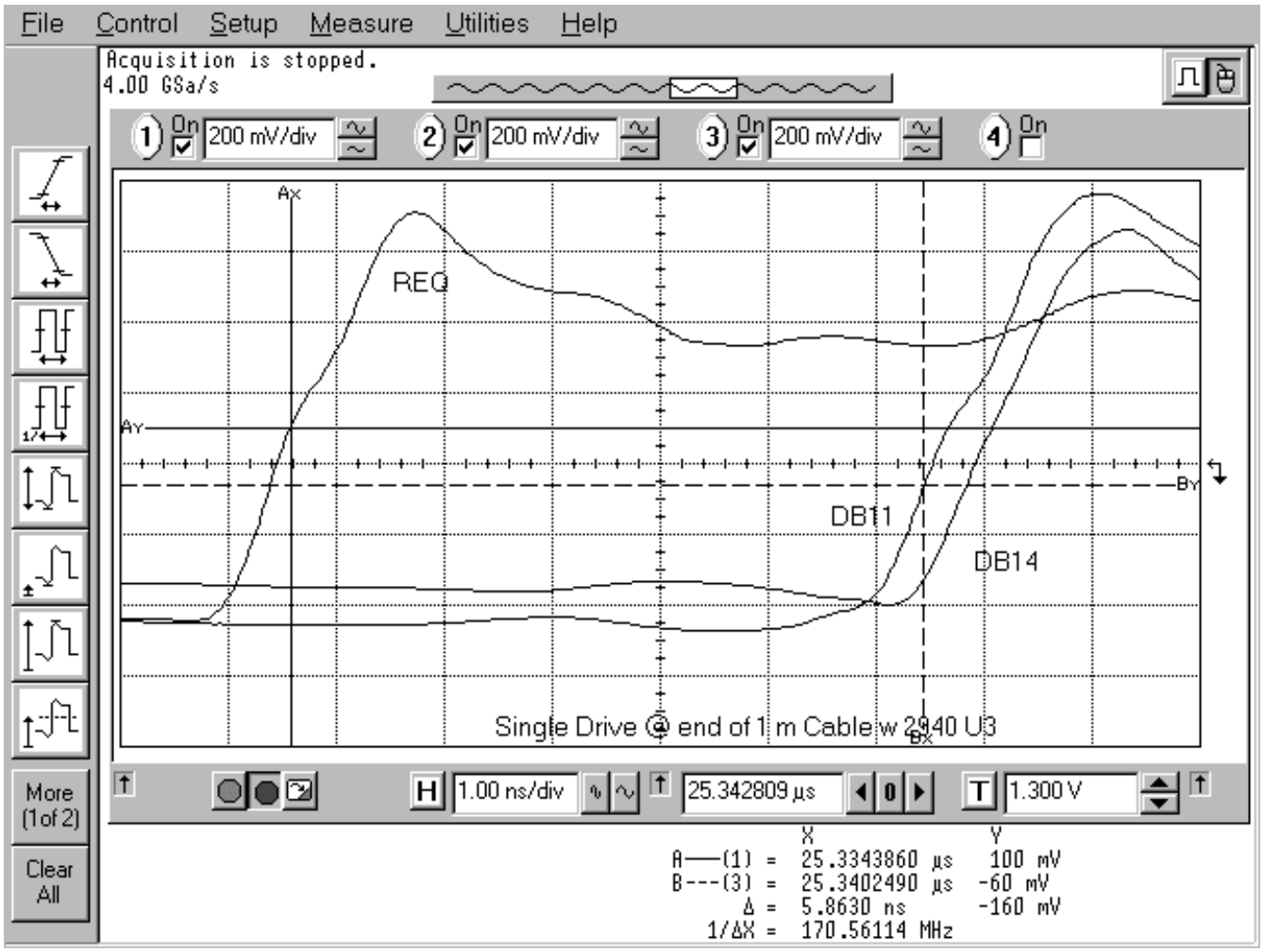

Figure 2: DB11 Hold time at HBA with 1 meter cable, 5.9 nsec

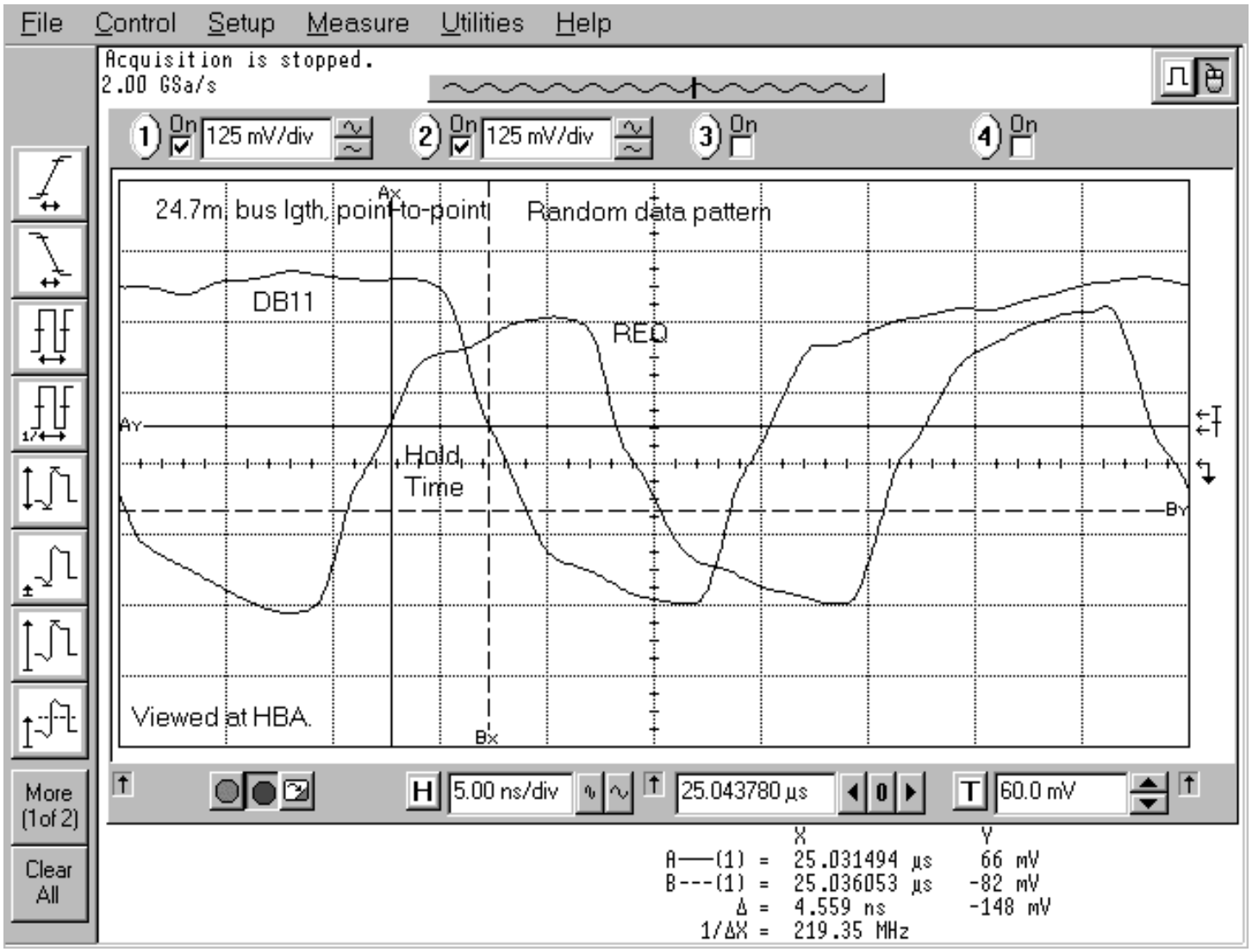

Figure 3: DB11 timing at HA, approximately 25 meters from source.
Hold = 4.6 nsec, Setup = 4.8 nsec

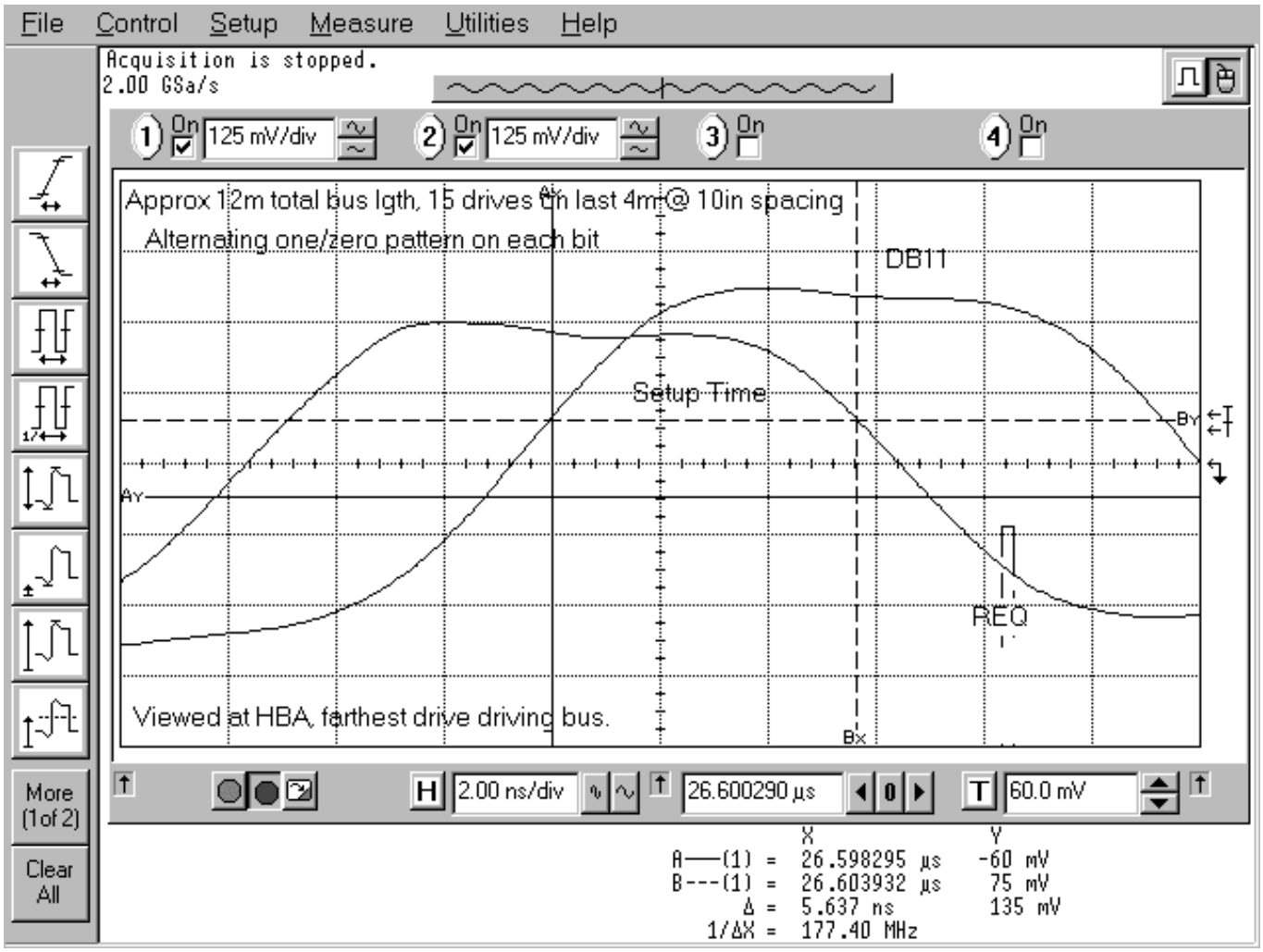

Figure 4: DB11 setup time at HBA, 15 drives on 12 meter cable, with farthest drive driving the bus, 5.6 nsec.

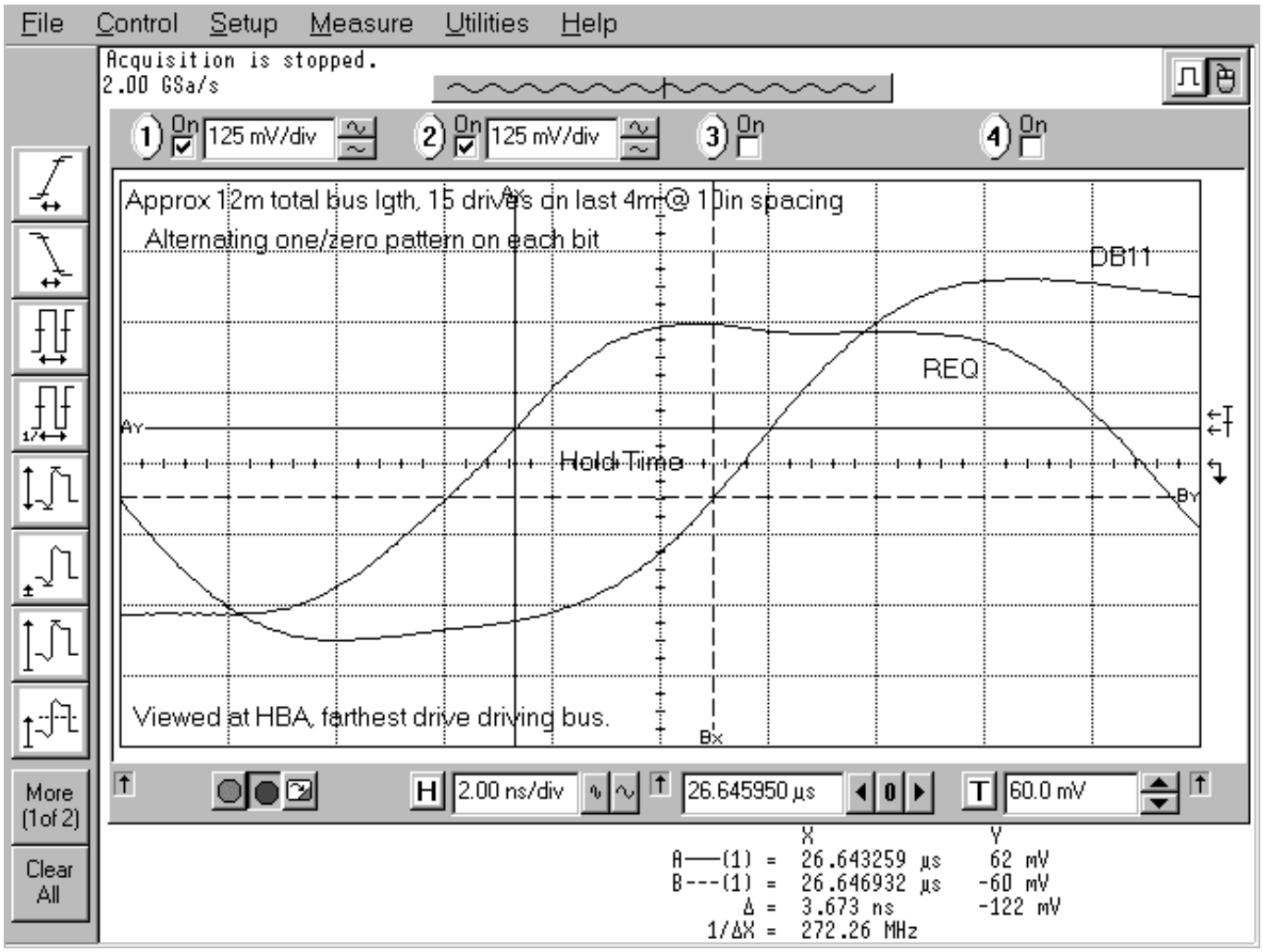

Figure 5: DB11 hold time at HBA, 15 drives on 12 meter cable, with farthest drive driving the bus, 3.7 nsec.

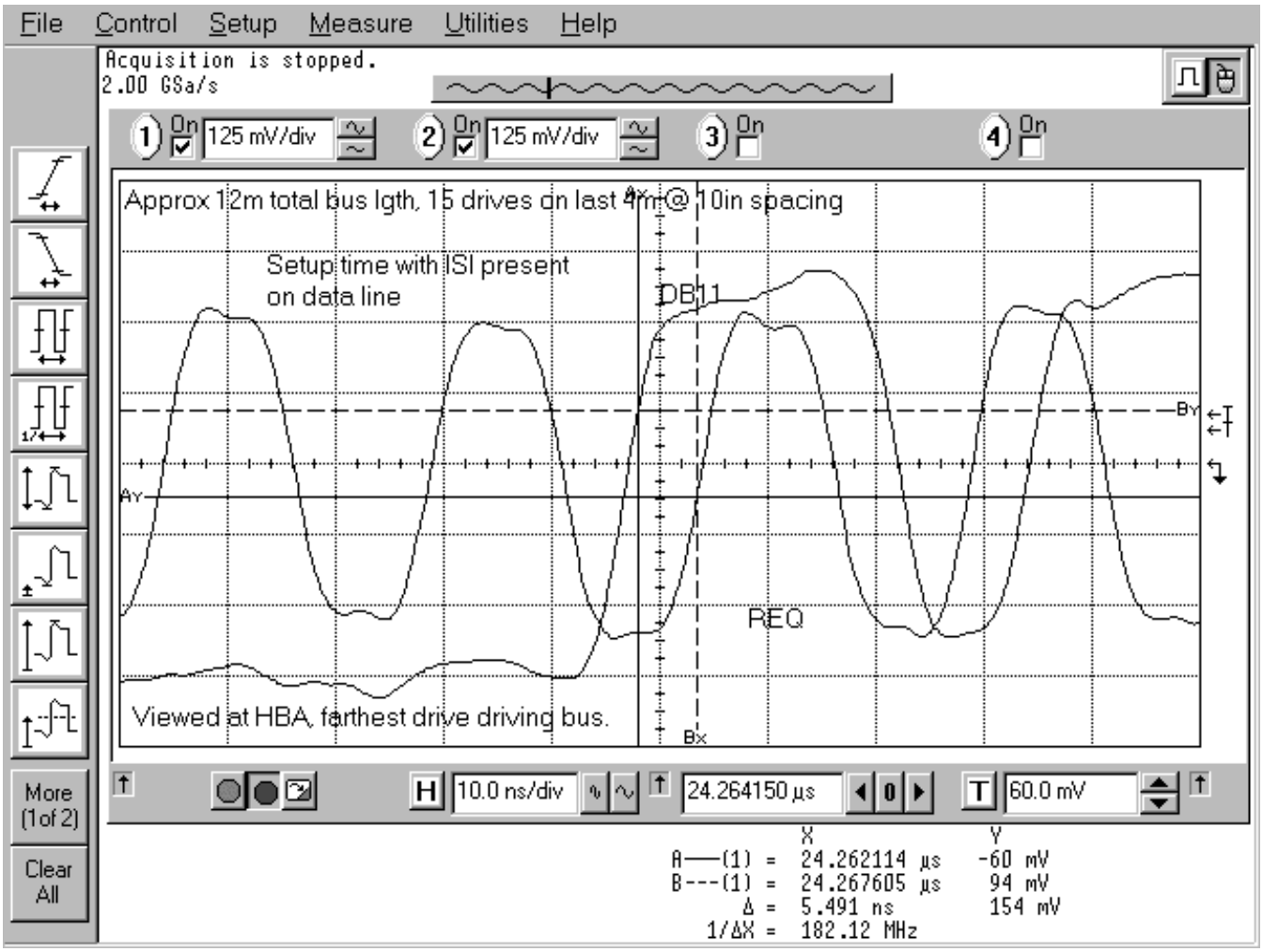

Figure 6: DB11 setup time at HBA, 15 drives on 12 meter cable, with farthest drive driving the bus, 5.5 nsec.
Example of ISI effect on Setup time

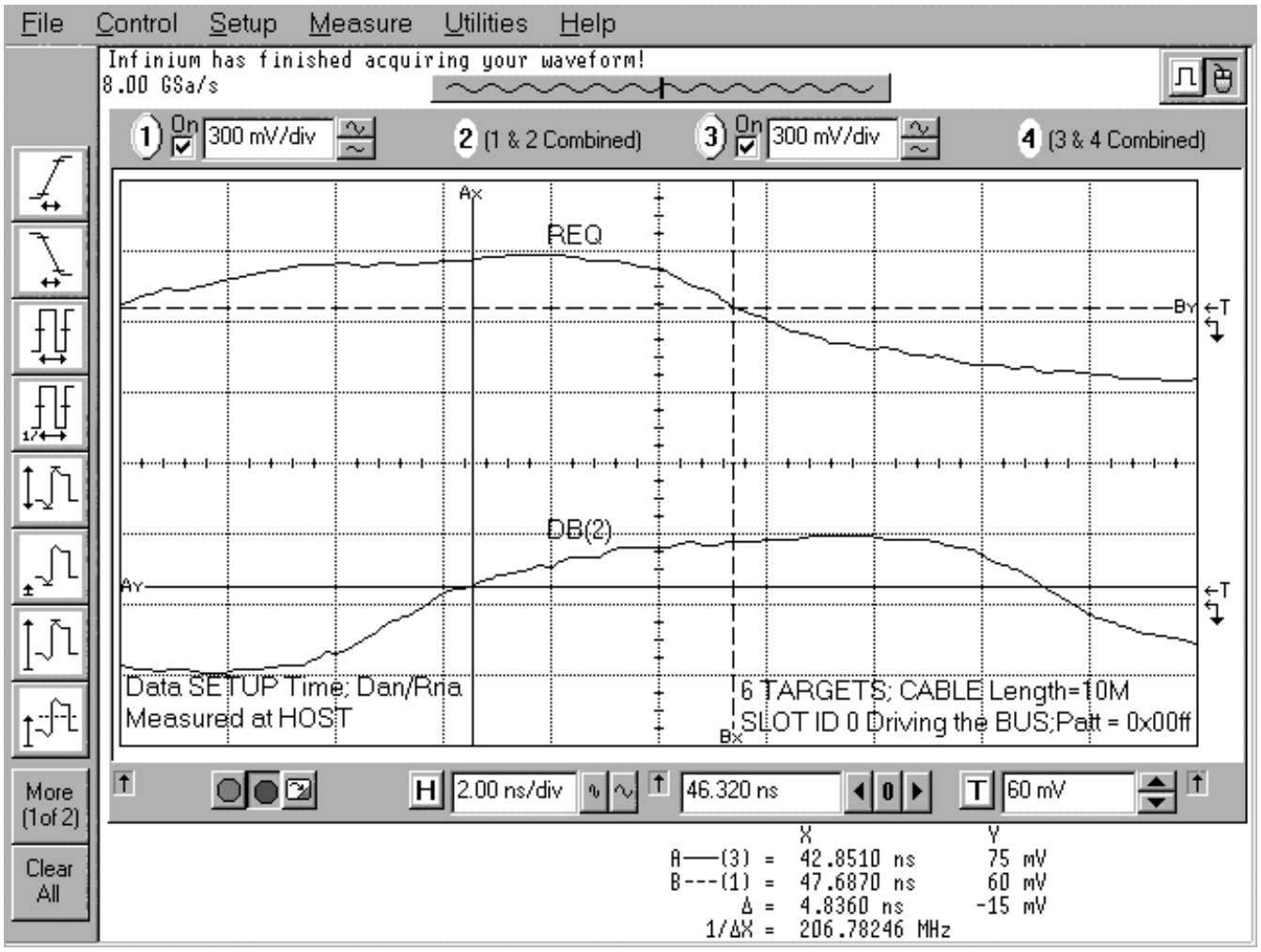

Figure 7: DB2 setup time at HBA, driven by farthest drive in 6 slot backplane 10 meters from host, 4.8 nsec.

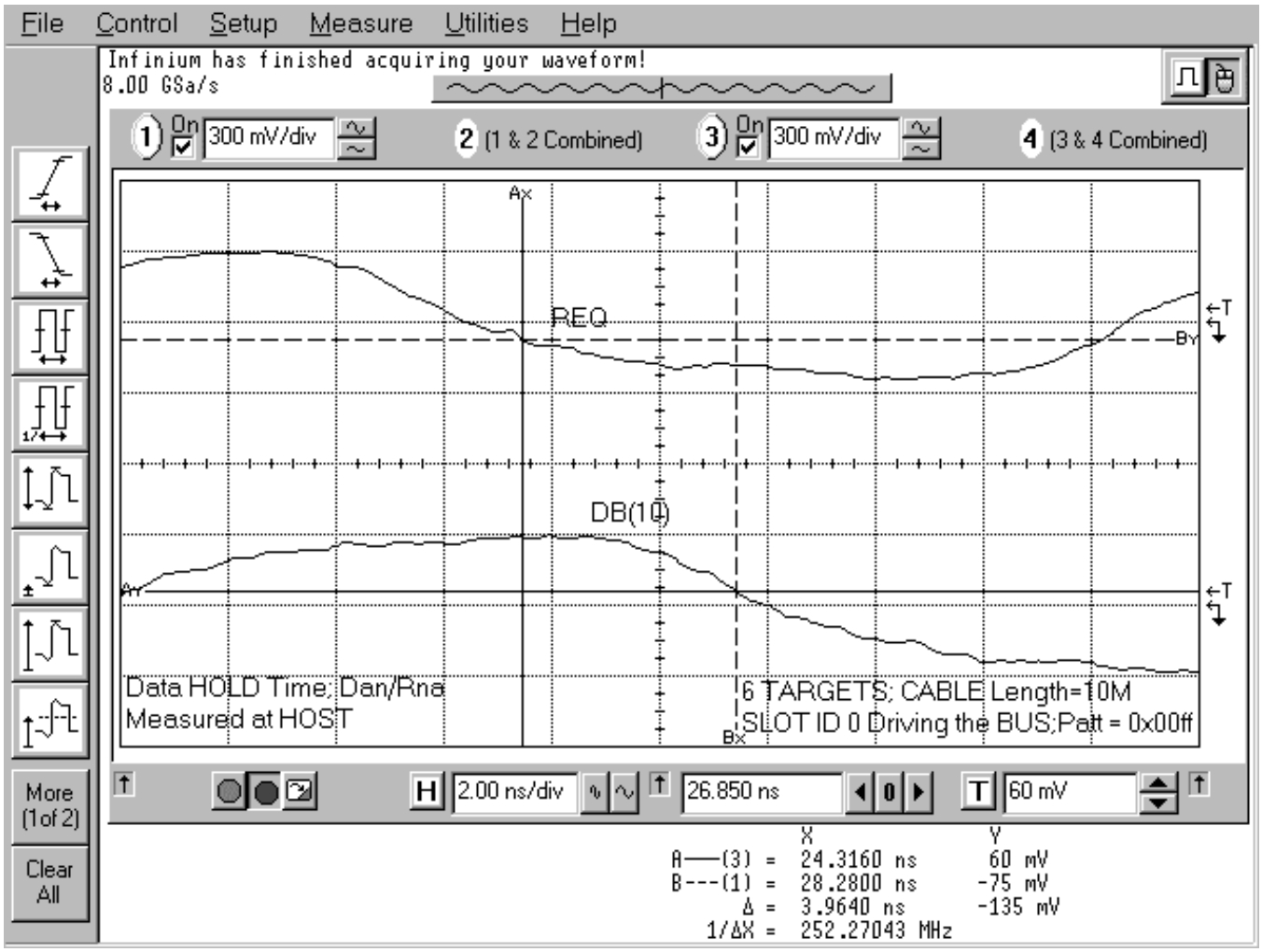

Figure 8: DB10 hold time at HBA, driven by farthest drive in 6 slot backplane 10 meters from host, 4.0 nsec.