Input and Output Characteristics of Digital Integrated Circuits

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Abstract

This report contains a comprehensive collection of the input and output characteristic curves of typical integrated circuits from various logic families. These curves go beyond the information given in data sheets by providing additional details regarding the characteristics of the components. This knowledge is particularly useful when, for example, a decision must be made as to which circuit should be used in a bus system, or when the waveforms that can be expected in a transmission system need to be predicted by using a Bergeron chart. In addition, the waveforms at the outputs of these components are shown when loaded with a 50-Ω coaxial line, which is open circuited at the end of the line. These oscillograms are of great assistance when generating models for simulation programs that analyze the dynamic behavior of the integrated circuits in a particular environment.

Introduction

The parameters given in the data sheets of integrated circuits can give only a limited indication of their actual behavior in a system. Data sheets generally give only information regarding the behavior over an input and output voltage range of 0 to 5 volts. The output currents specified over this range provide an incomplete picture of the actual performance that can be expected from the device. Often the behavior outside the usually accepted operating conditions is of interest. This is, for example, the situation when the characteristic curves need to be used to predict the signal waveforms resulting from line reflections.

For requirements of this kind, the most important input and output characteristic curves of logic circuits are shown in the figures that follow. In view of the wide range of integrated circuits that are available, it has been necessary to limit this information to typical characteristics only. As a result, the input and output characteristics of the following circuits have been shown as being representative of other components which have similar circuit behavior:

’00: The characteristic curves of this NAND gate are representative of all logic circuits having normal drive capability, such as gates, flip-flops, counters, multiplexers, etc.

’40: For a range of applications, gates are available in several logic families that have increased drive capability. Such components can supply about three times the output current, when compared with the normal drive-capability logic circuits mentioned above.

’1004: A special group of driver circuits was introduced into the ALS and AS family for applications requiring a very large output current. These components play a significant role in clock distribution systems.

’240: The output characteristics of these bus interface circuits are of particular importance when a decision must be made as to which circuit family should be used for a specific system requirement. The available output current has a decisive influence on the distortion of signals on bus lines.

’25240: The incident-wave-switching (IWS) driver was developed to meet the requirements imposed by fast bus systems and applications with exceptionally low-resistance lines. Since these components play a significant role in applications of this kind, their input and output characteristics have been included.

Table 1 provides an overall view of the input and output characteristics curves shown on the following pages.

Table 1. Typical Output Types in the Various Logic Families

FAMILY	TYPE				
	’00	’40	’240	’1004	’25240
SN74	✓	✓			
SN74LS	✓	✓	✓		
SN74S	✓	✓	✓		
SN74ALS	✓	✓	✓	✓	
SN74AS	✓		✓	✓	
SN74F	✓	✓	✓		
SN74HC	✓		✓		
SN74AC			✓†		
SN74BCT			✓		✓
SN74ABT			✓		
SN74LV	✓		✓		
SN74LVC			✓		
SN74ALCV			✓‡		
SN74LVT			✓		

† With the AC family, the device type is SN74AC11240.
‡ With the ALVC family, only the Widebus™ function SN74ALVC16240 is available.

Waveforms at the outputs of the integrated circuits in the above table are shown in Figures 60 through 88. For these measurements, the devices under test were loaded with a 1.3-m coaxial cable having a characteristic impedance of 50 Ω; the end of the line was open circuit. These waveforms provide good insight into the dynamic behavior of the components. In particular, the oscillograms provide information regarding drive capability with a low-resistance load, together with an indication of the line reflections that can be expected.

Acknowledgment

The author of this document is Peter Forstner.

Input Characteristics

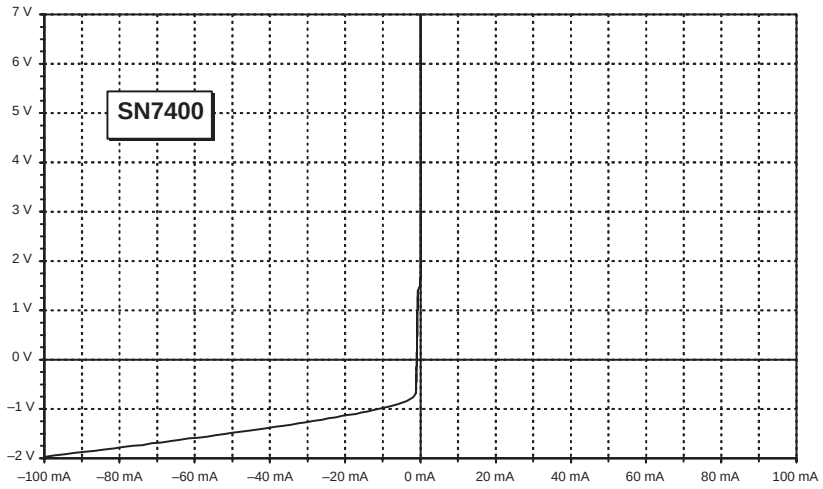

Figure 1. Input Characteristics of the SN7400

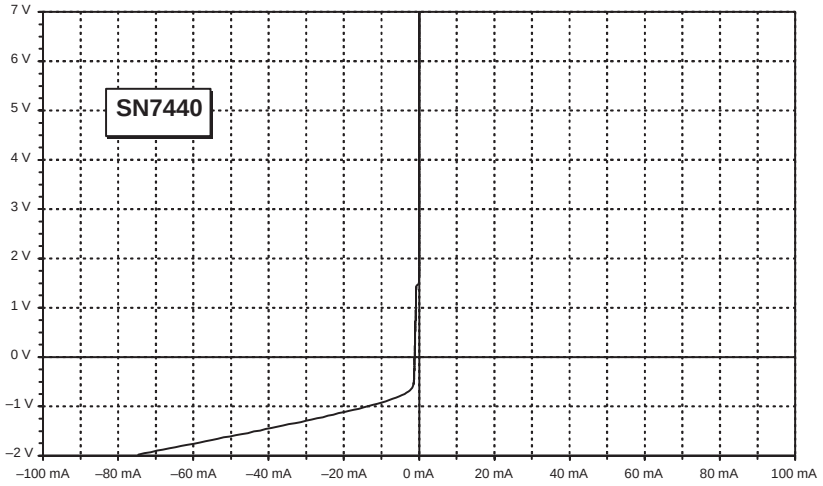

Figure 2. Input Characteristics of the SN7440

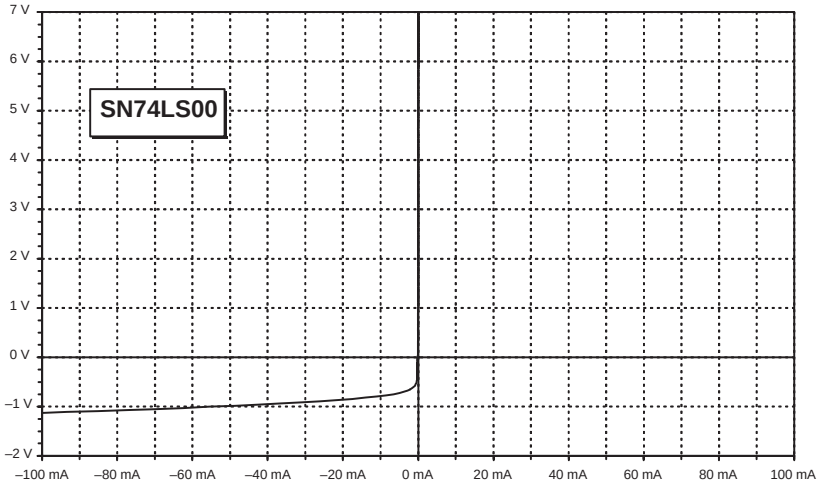

Figure 3. Input Characteristics of the SN74LS00

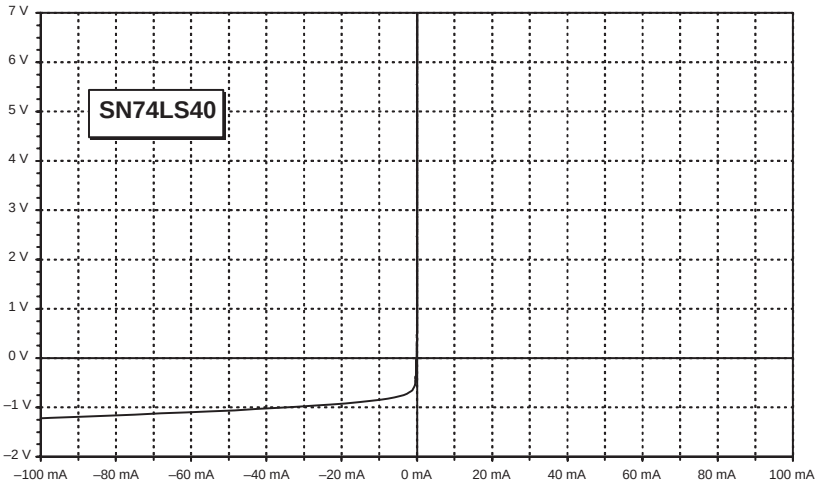

Figure 4. Input Characteristics of the SN74LS40

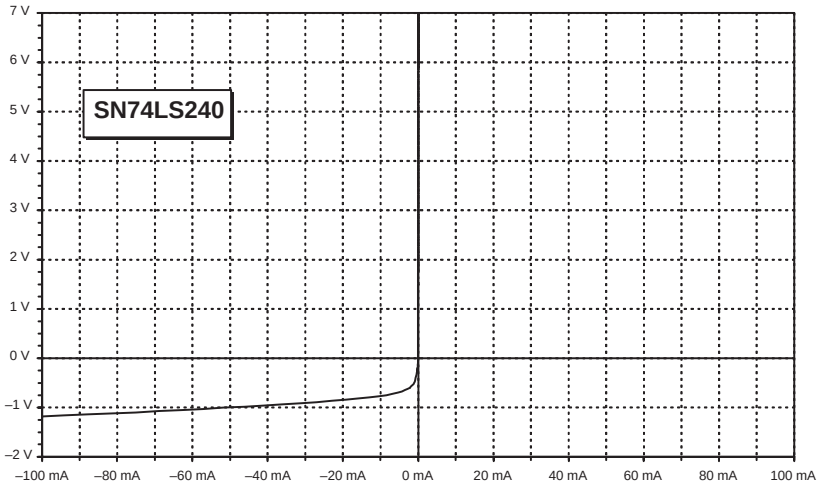

Figure 5. Input Characteristics of the SN74LS240

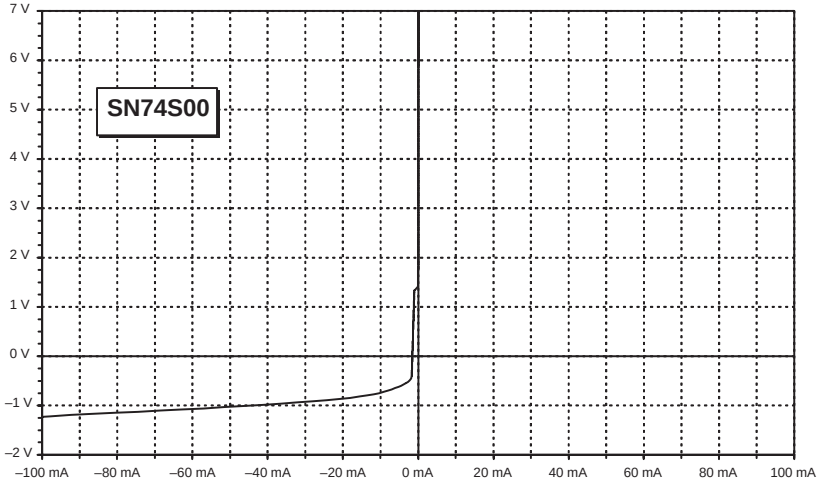

Figure 6. Input Characteristics of the SN74S00

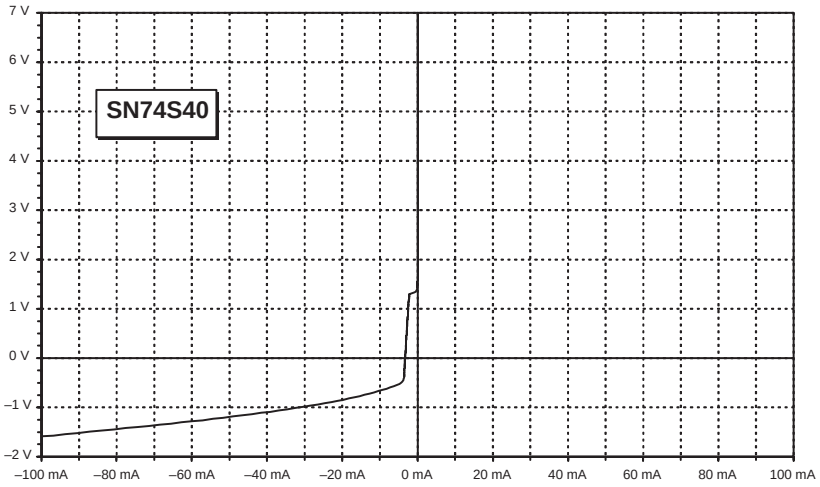

Figure 7. Input Characteristics of the SN74S40

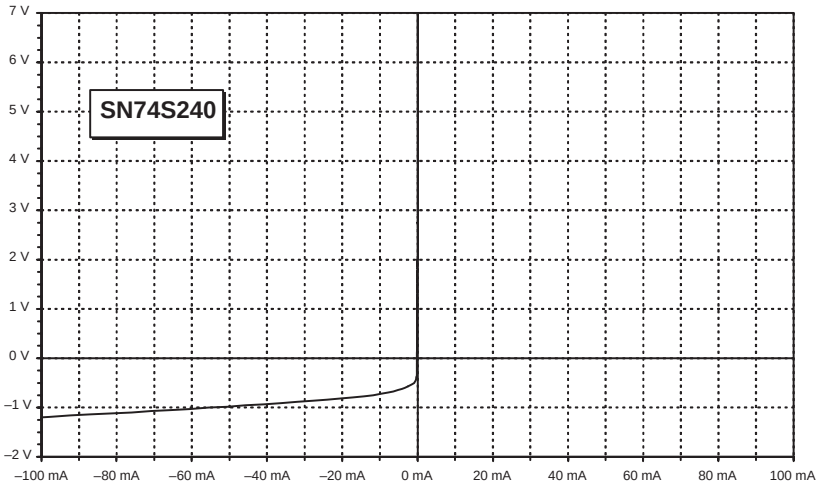

Figure 8. Input Characteristics of the SN74S240

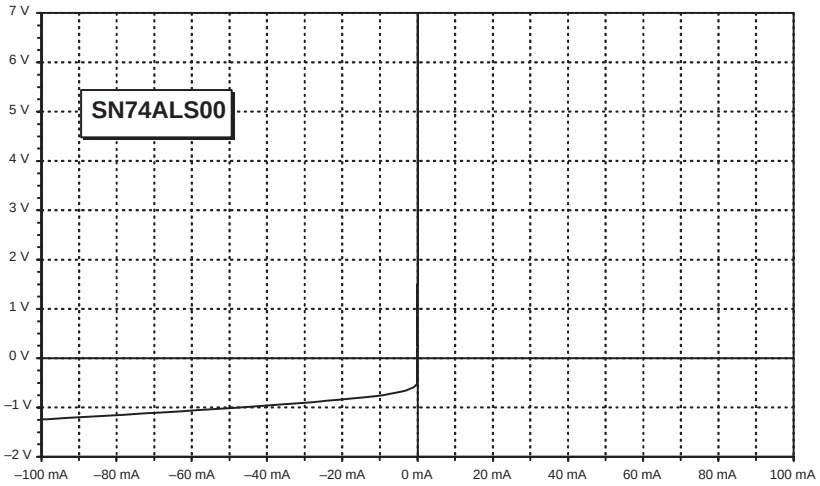

Figure 9. Input Characteristics of the SN74ALS00

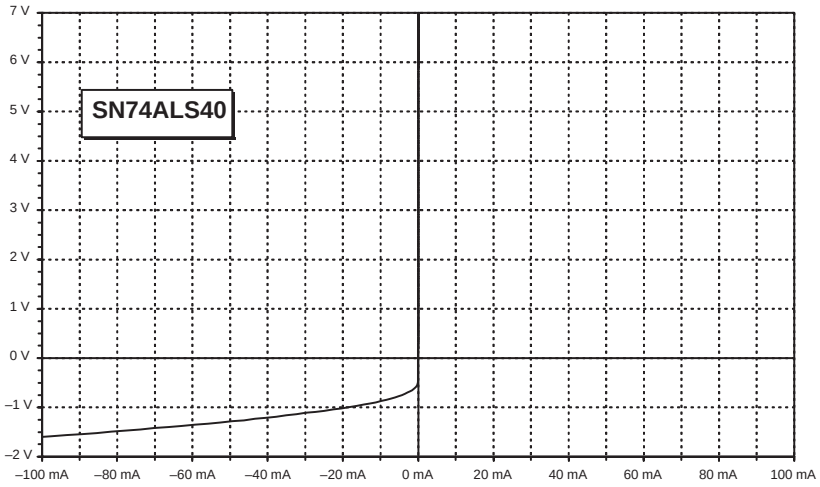

Figure 10. Input Characteristics of the SN74ALS40

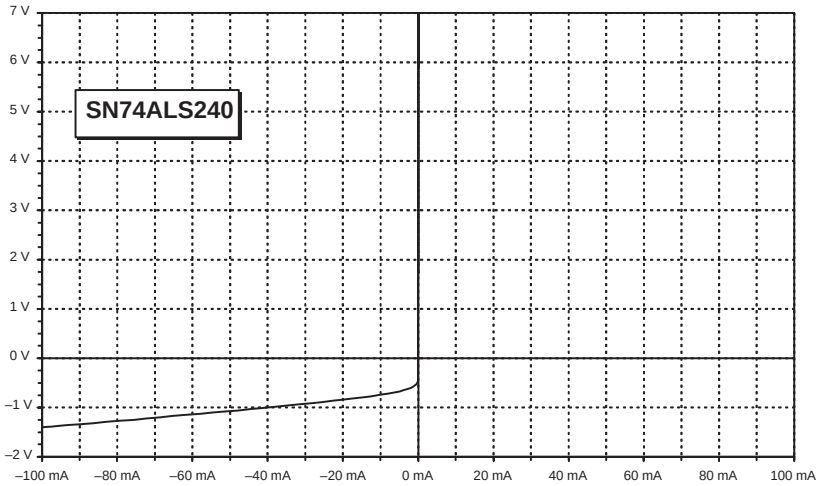

Figure 11. Input Characteristics of the SN74ALS240

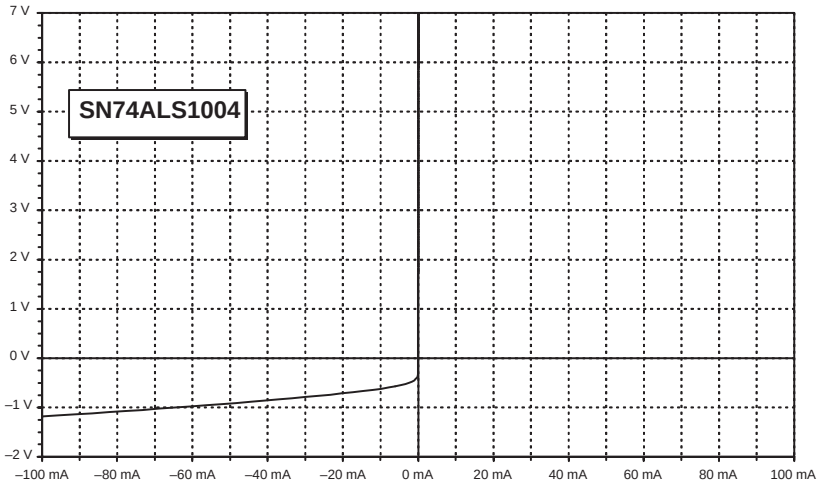

Figure 12. Input Characteristics of the SN74ALS1004

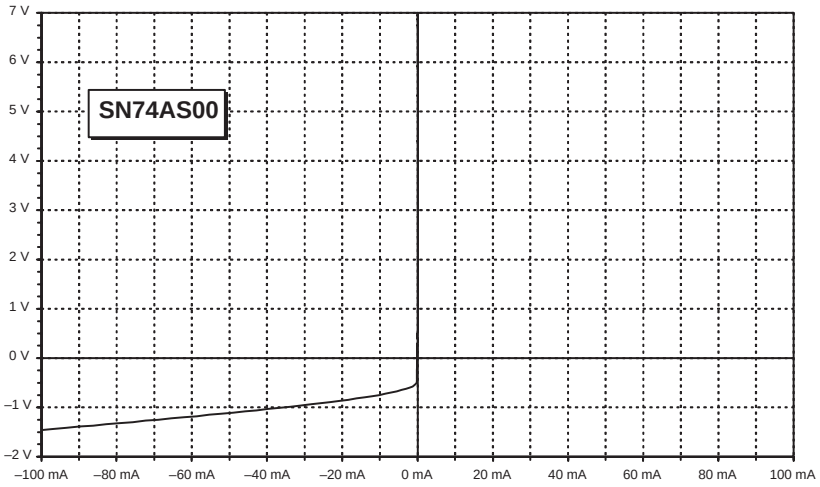

Figure 13. Input Characteristics of the SN74AS00

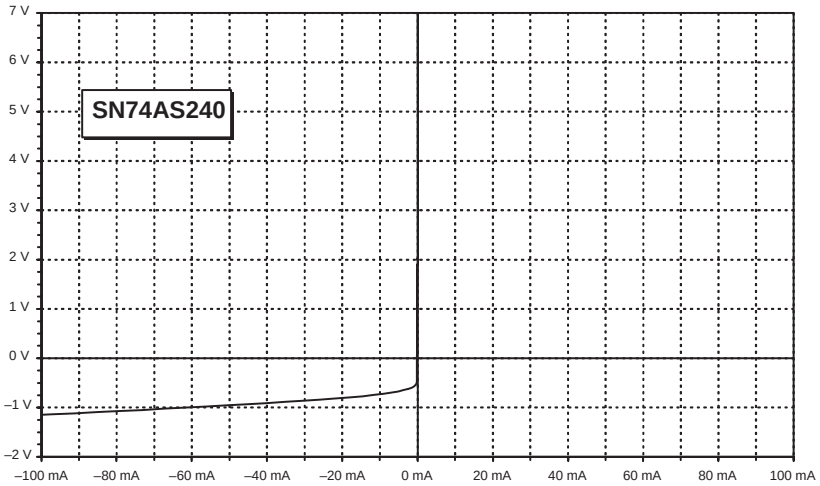

Figure 14. Input Characteristics of the SN74AS240

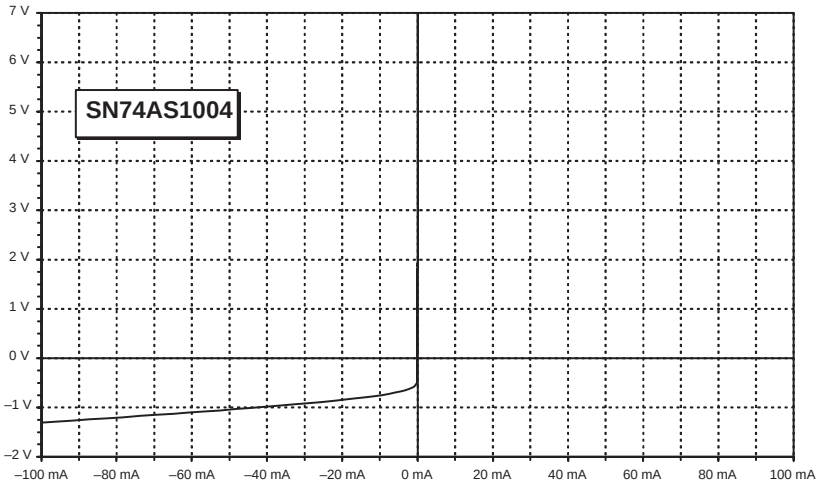

Figure 15. Input Characteristics of the SN74AS1004

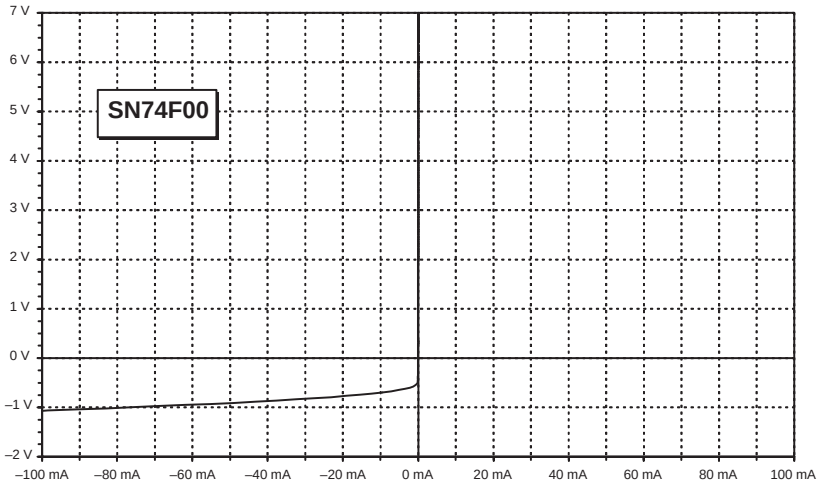

Figure 16. Input Characteristics of the SN74F00

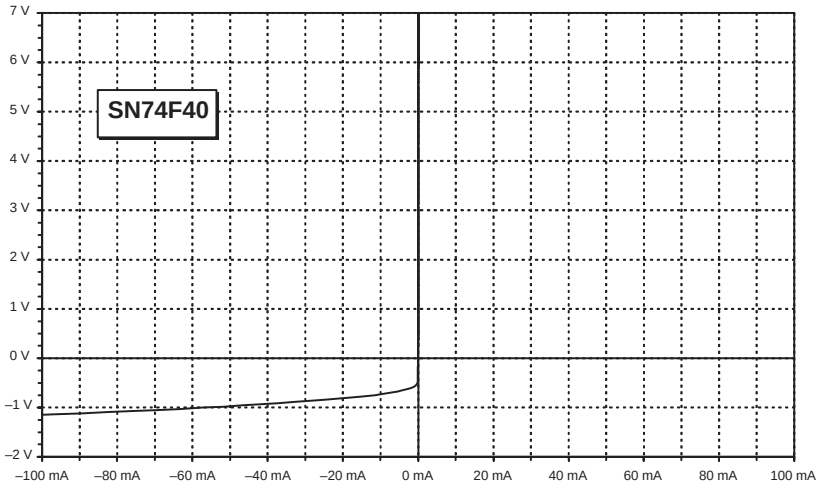

Figure 17. Input Characteristics of the SN74F40

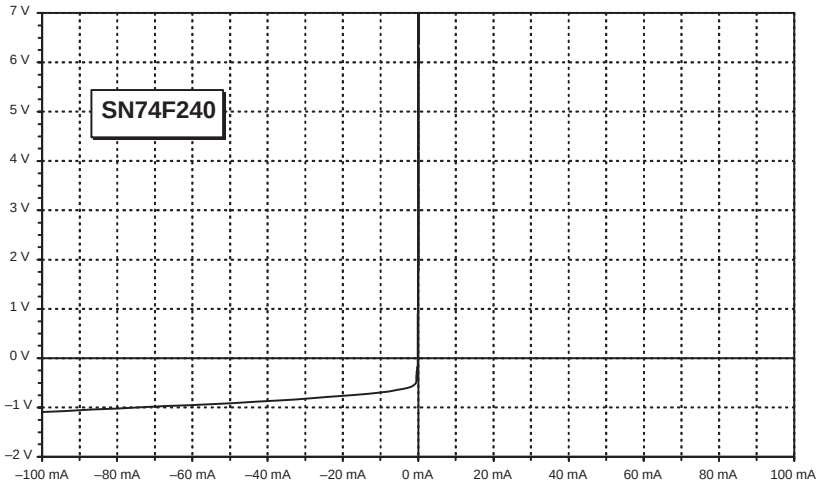

Figure 18. Input Characteristics of the SN74F240

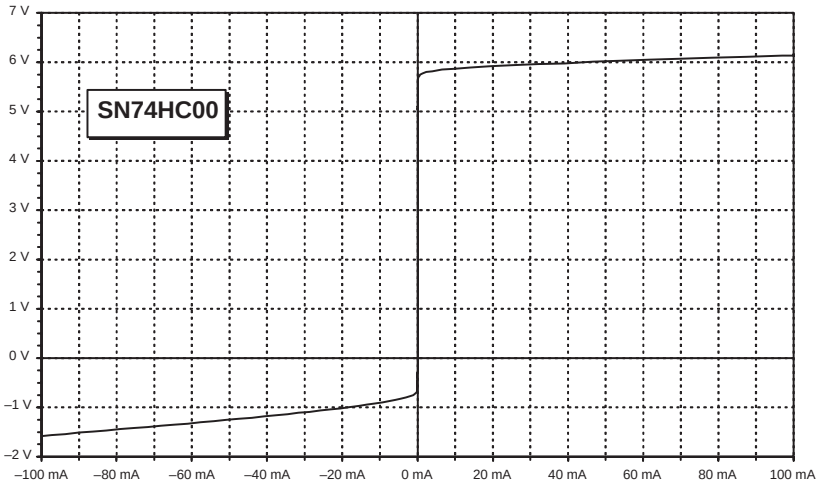

Figure 19. Input Characteristics of the SN74HC00

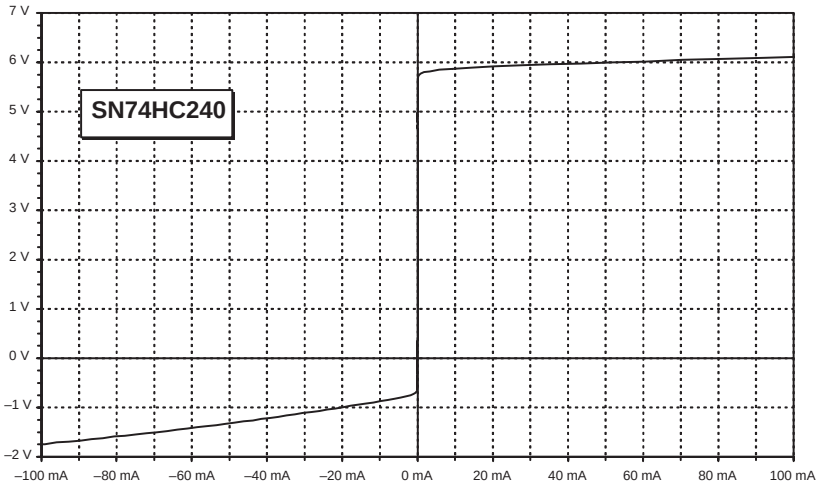

Figure 20. Input Characteristics of the SN74HC240

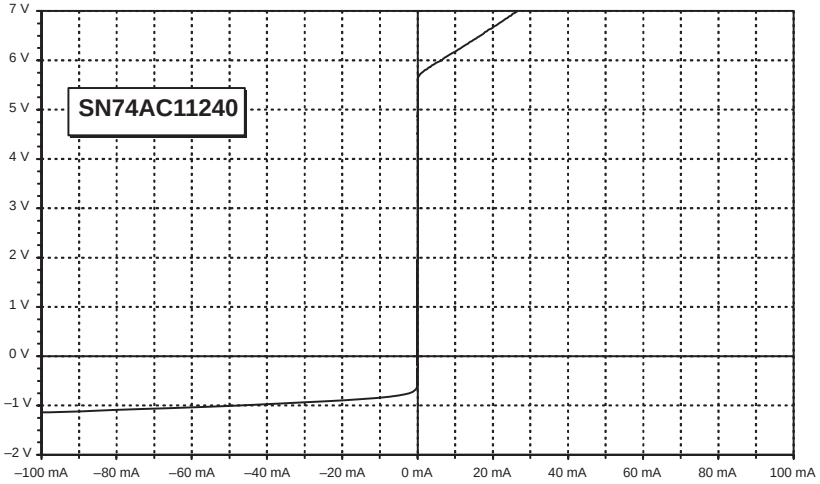

Figure 21. Input Characteristics of the SN74AC11240

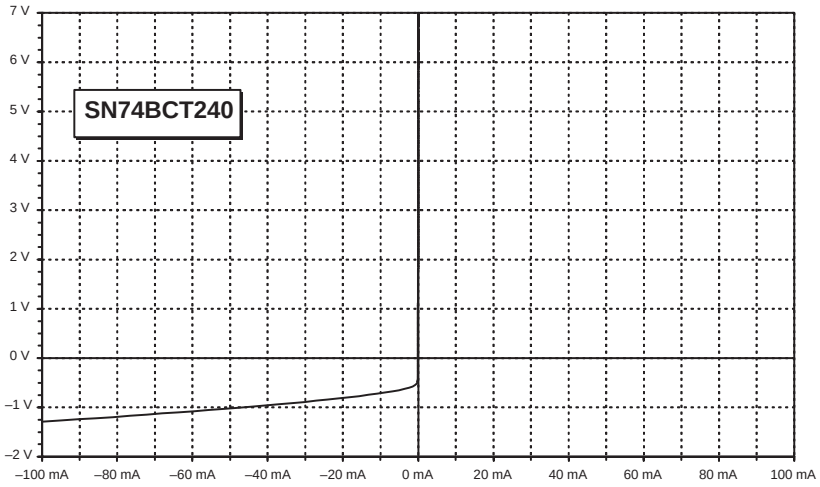

Figure 22. Input Characteristics of the SN74BCT240

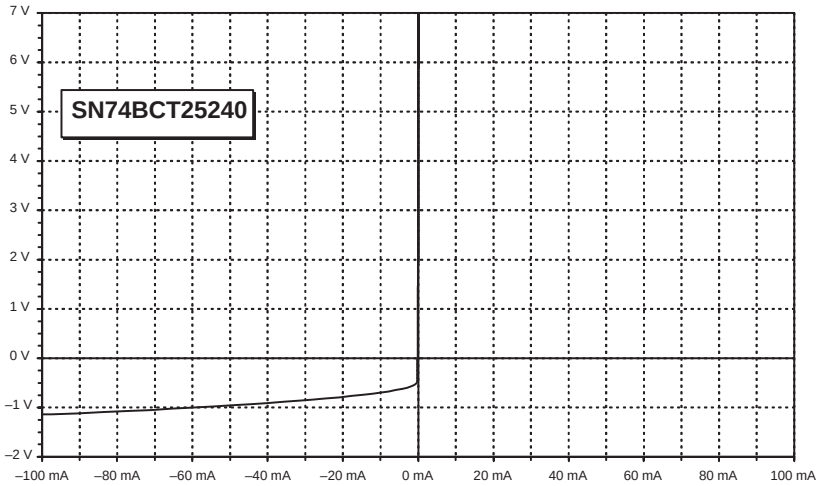

Figure 23. Input Characteristics of the SN74BCT25240

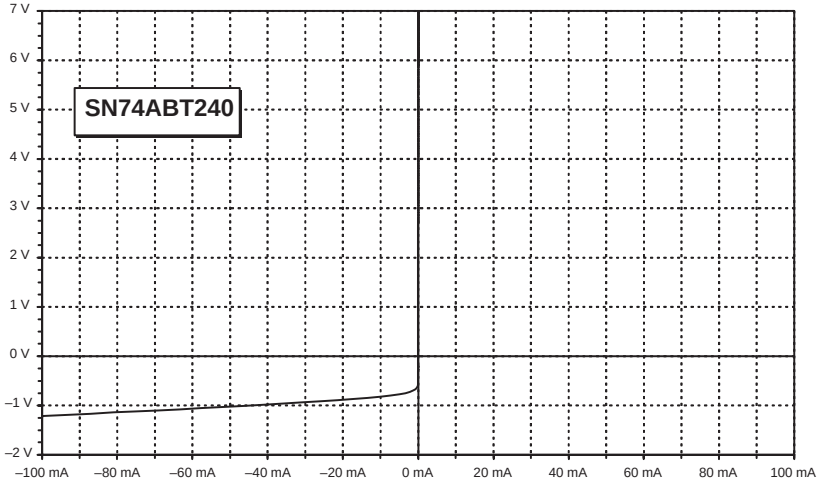

Figure 24. Input Characteristics of the SN74ABT240

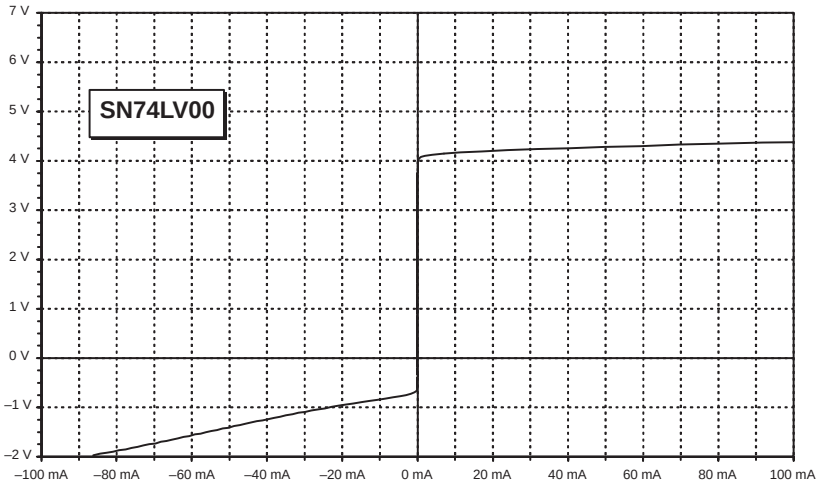

Figure 25. Input Characteristics of the SN74LV00

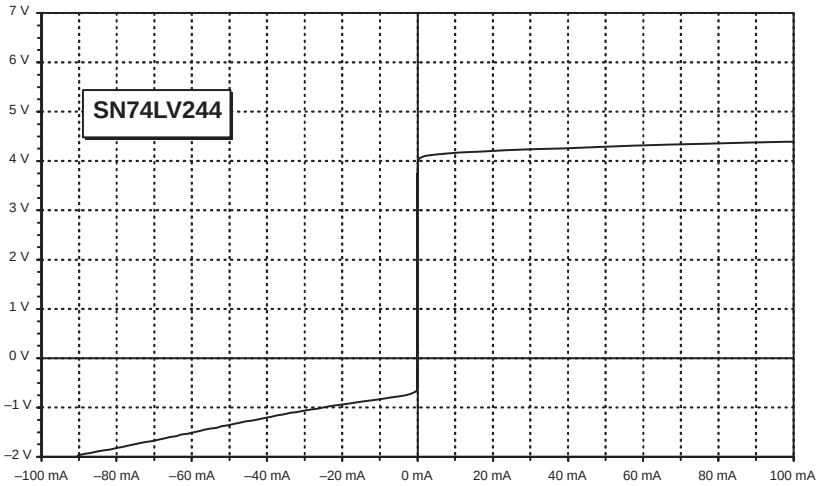

Figure 26. Input Characteristics of the SN74LV244

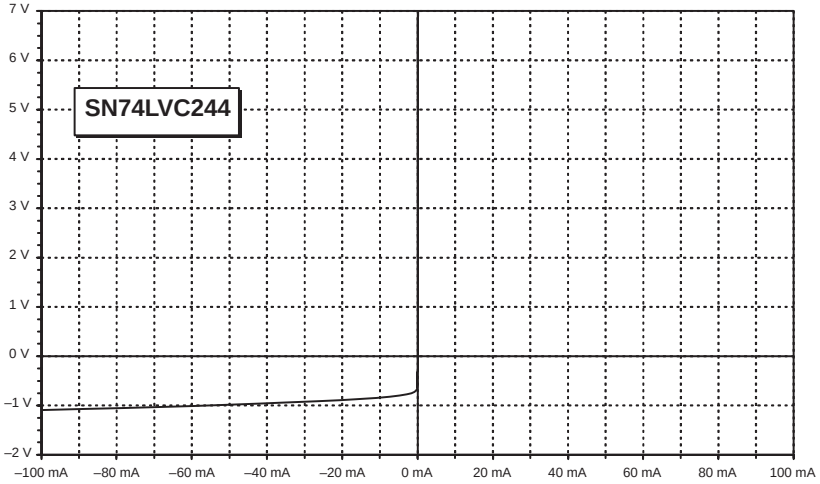

Figure 27. Input Characteristics of the SN74LVC244

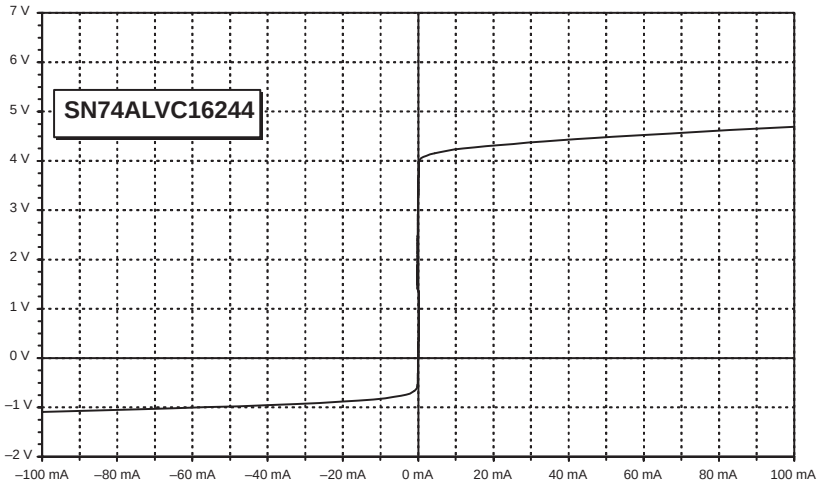

Figure 28. Input Characteristics of the SN74ALVC16244

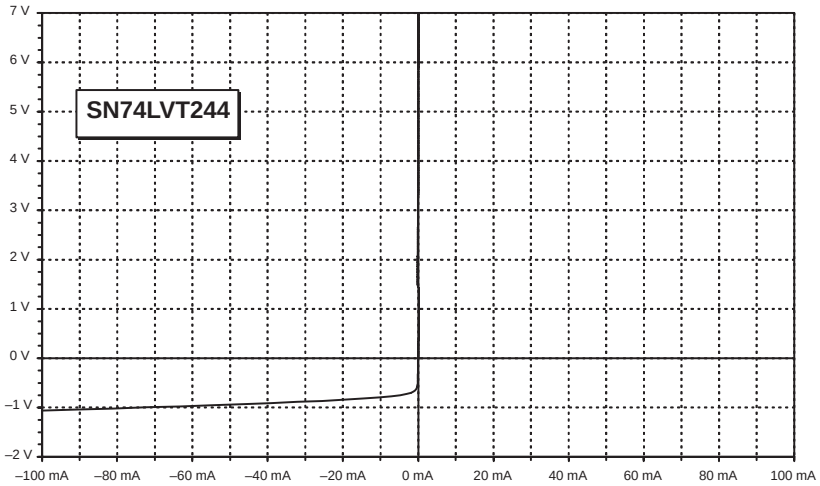

Figure 29. Input Characteristics of the SN74LVT244

Output Characteristics

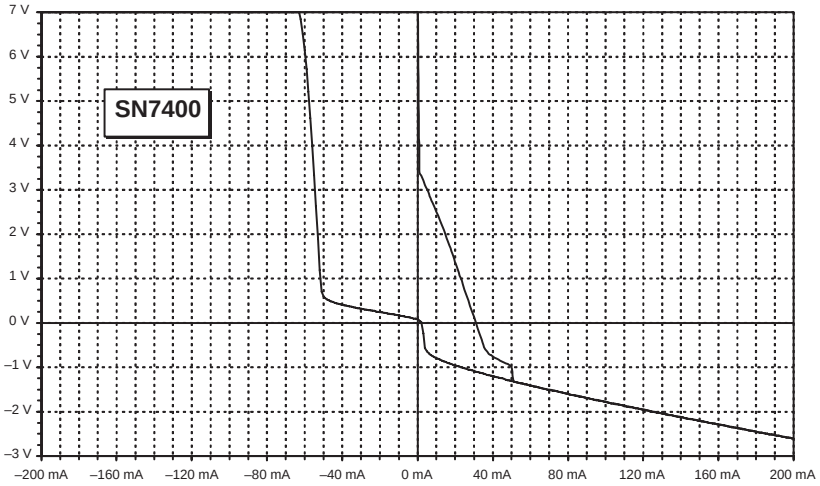

Figure 30. Output Characteristics of the SN7400

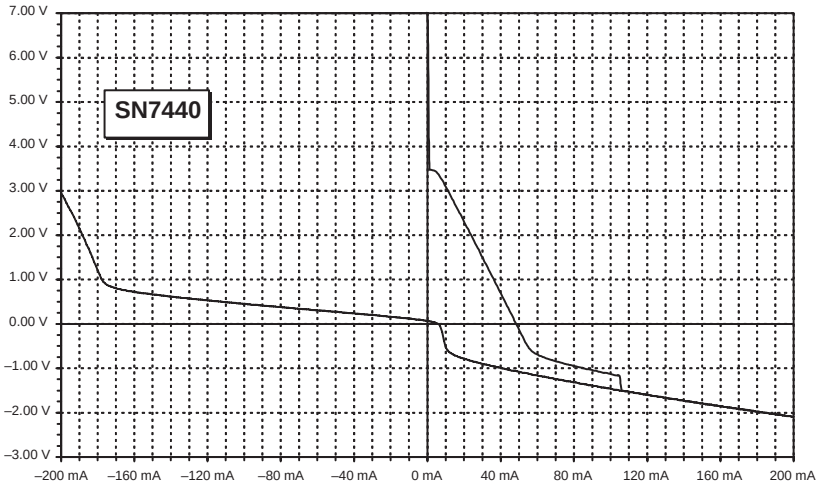

Figure 31. Output Characteristics of the SN7440

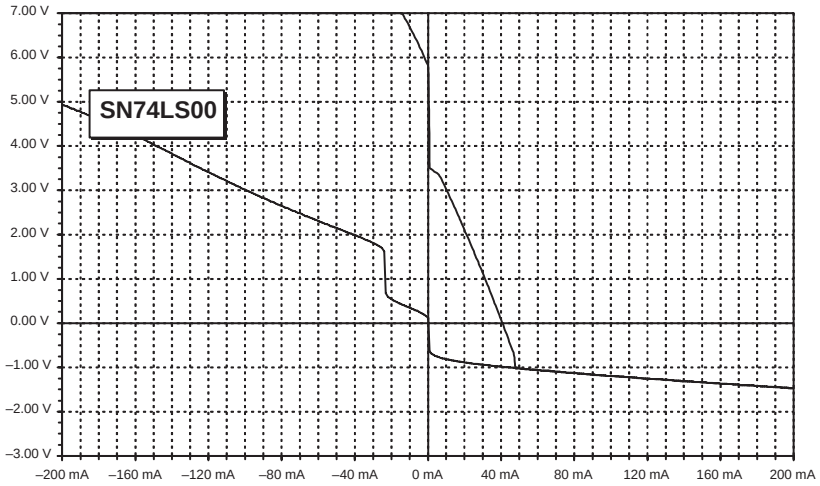

Figure 32. Output Characteristics of the SN74LS00

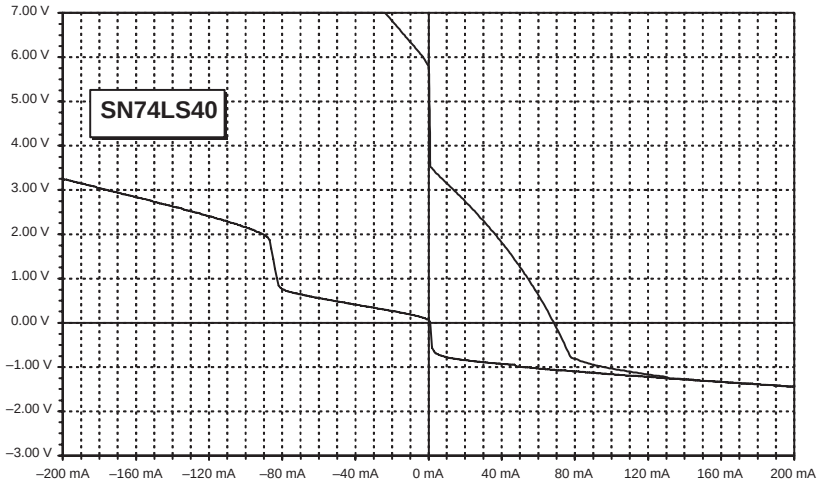

Figure 33. Output Characteristics of the SN74LS40

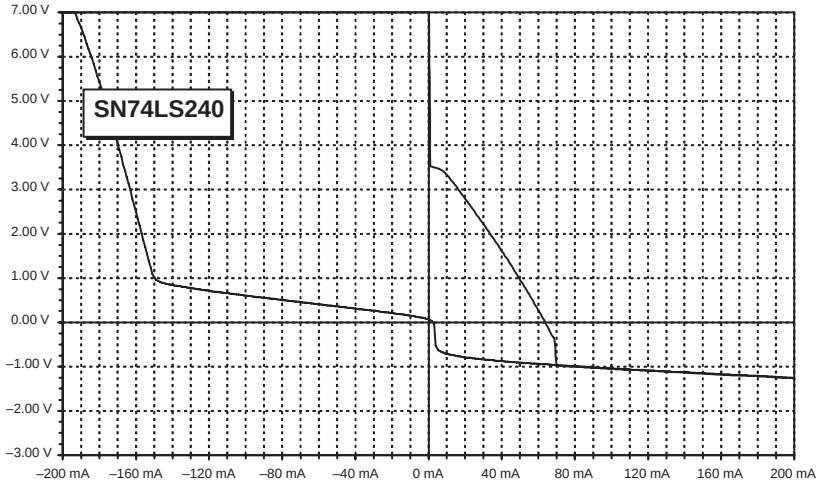

Figure 34. Output Characteristics of the SN74LS240

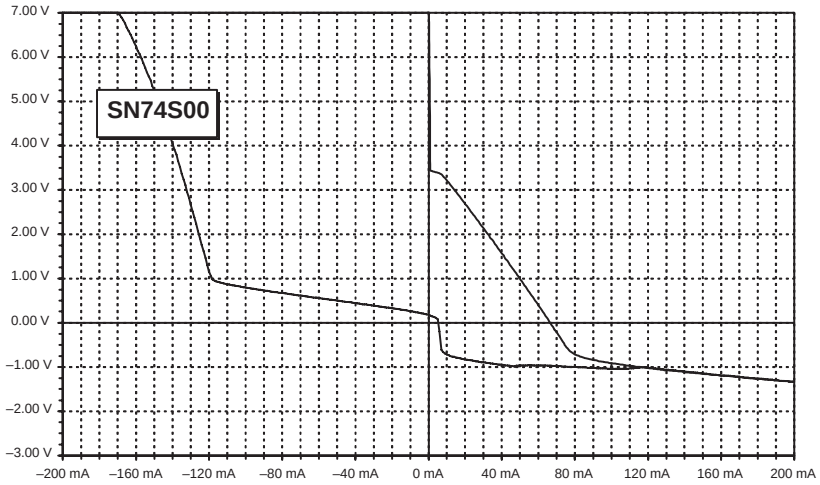

Figure 35. Output Characteristics of the SN74S00

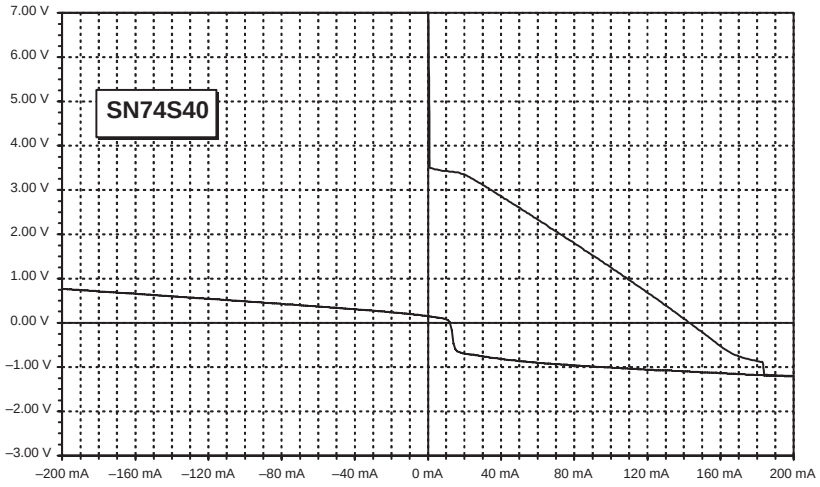

Figure 36. Output Characteristics of the SN74S40

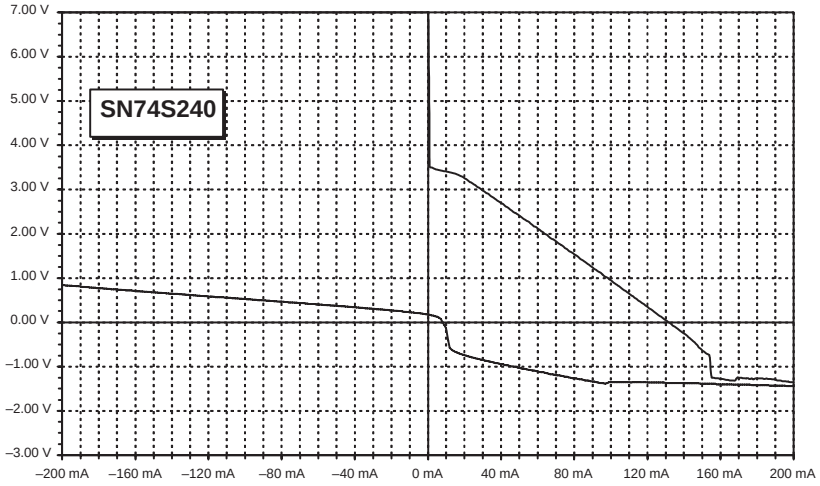

Figure 37. Output Characteristics of the SN74S240

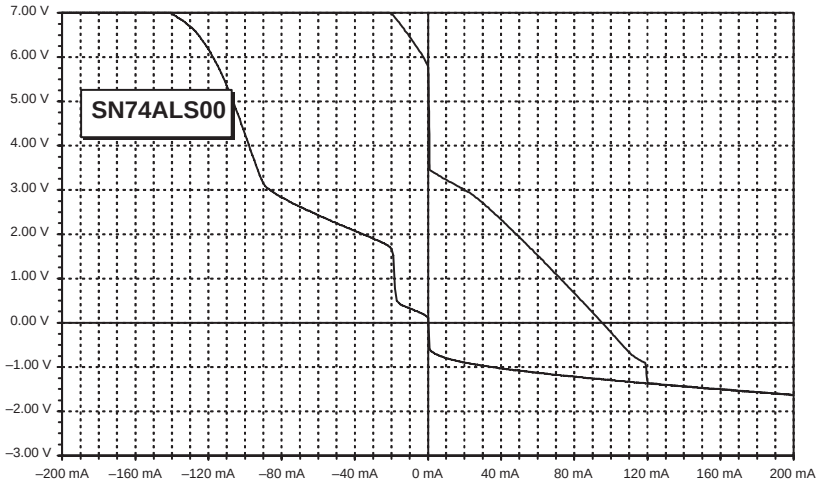

Figure 38. Output Characteristics of the SN74ALS00

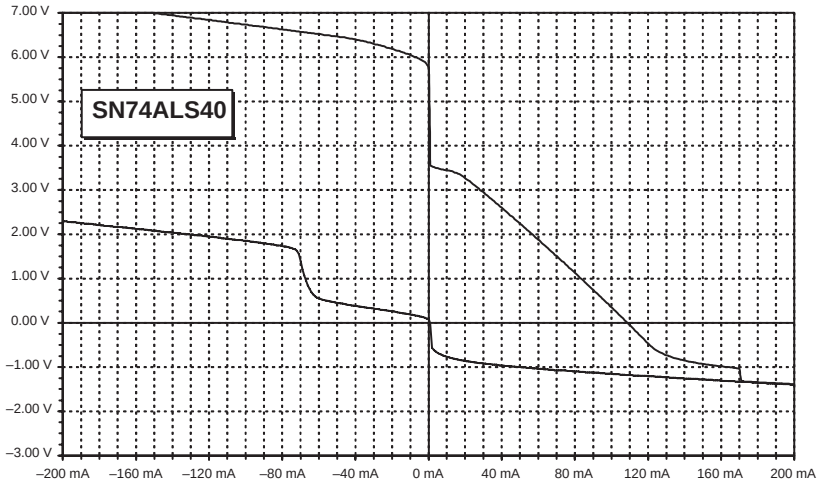

Figure 39. Output Characteristics of the SN74ALS40

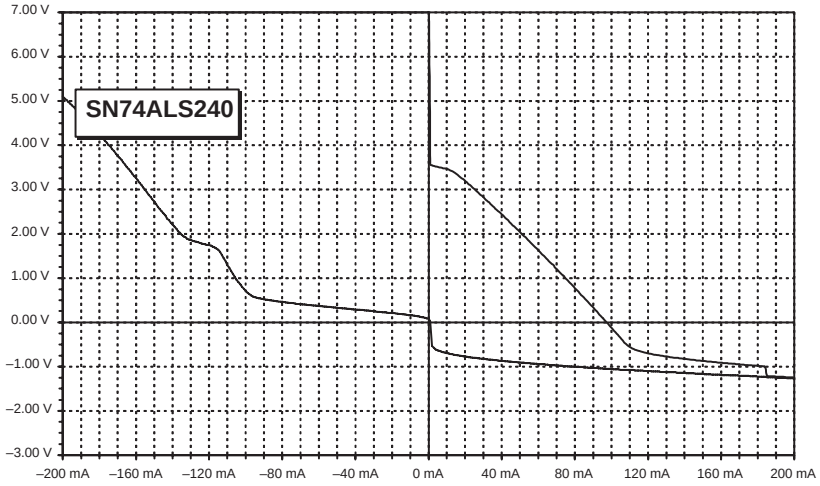

Figure 40. Output Characteristics of the SN74ALS240

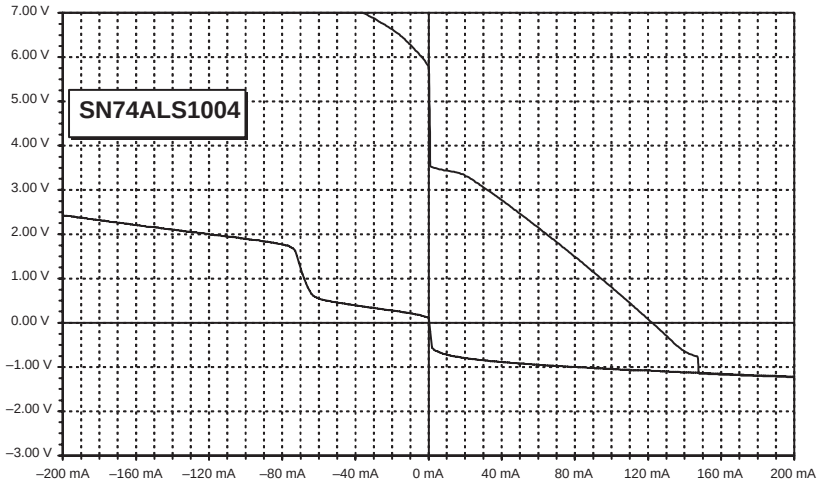

Figure 41. Output Characteristics of the SN74ALS1004

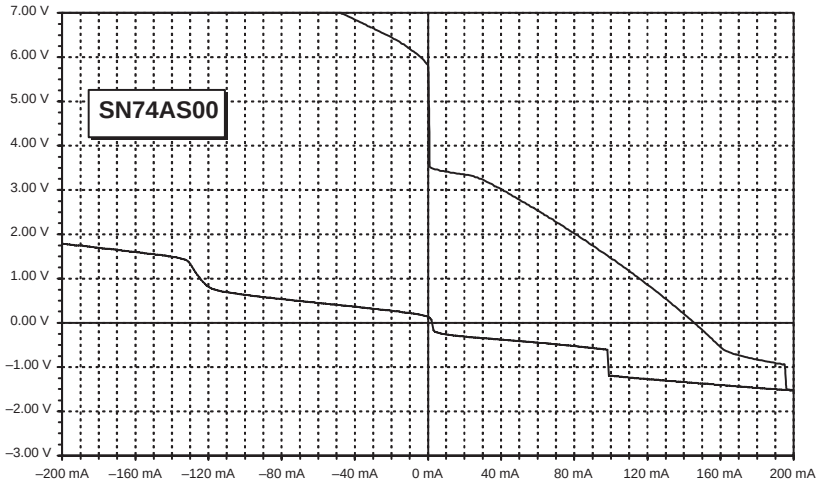

Figure 42. Output Characteristics of the SN74AS00

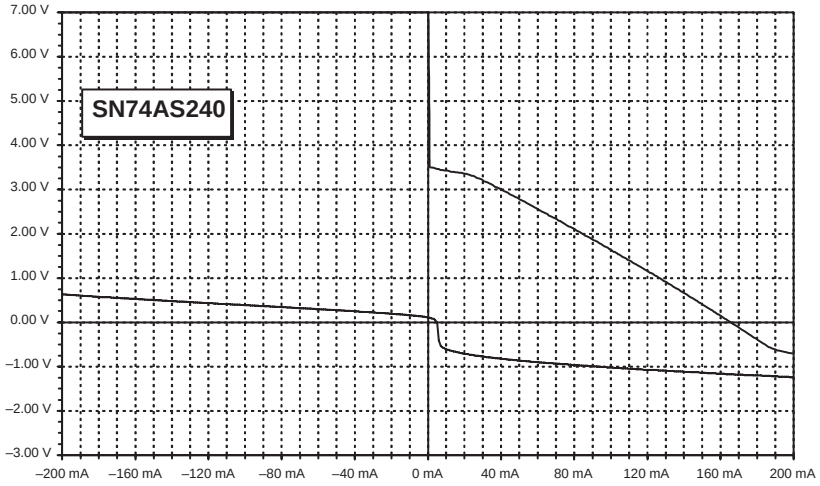

Figure 43. Output Characteristics of the SN74AS240

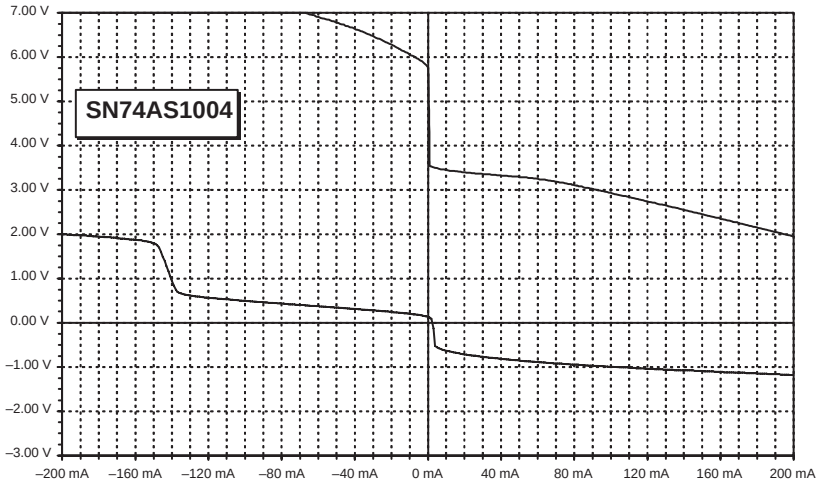

Figure 44. Output Characteristics of the SN74AS1004

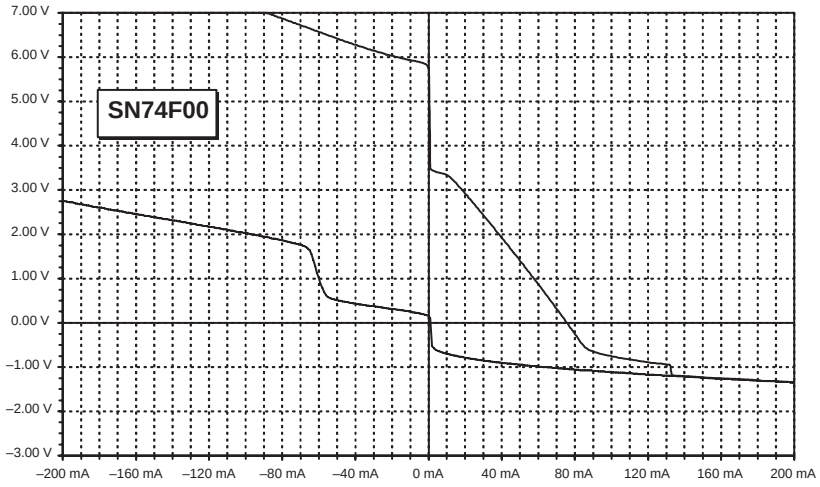

Figure 45. Output Characteristics of the SN74F00

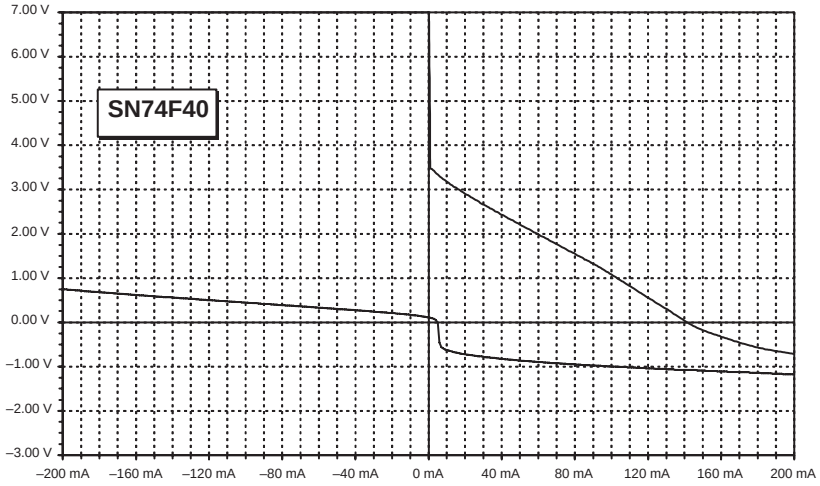

Figure 46. Output Characteristics of the SN74F40

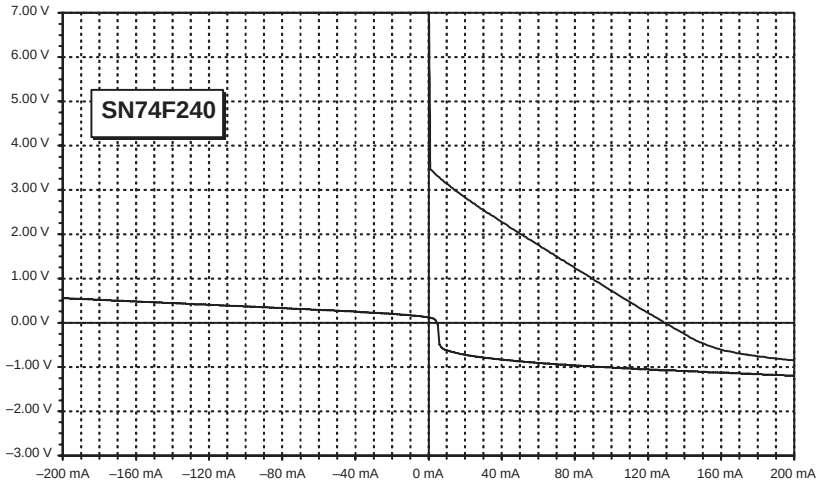

Figure 47. Output Characteristics of the SN74F240

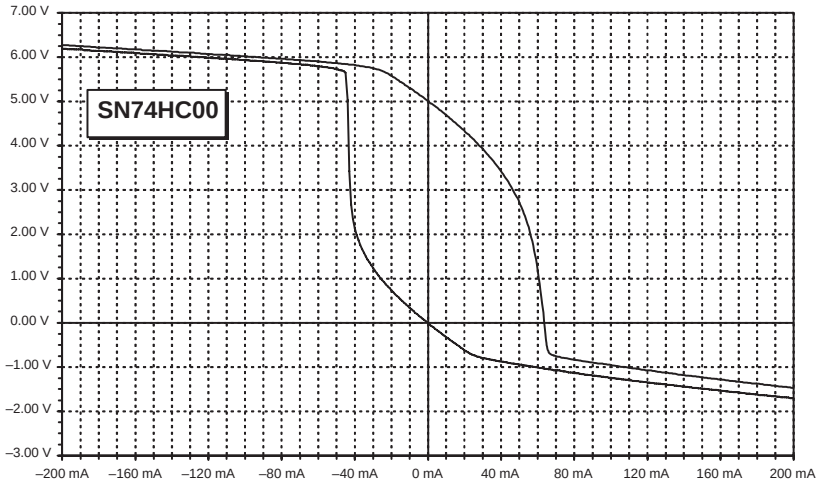

Figure 48. Output Characteristics of the SN74HC00

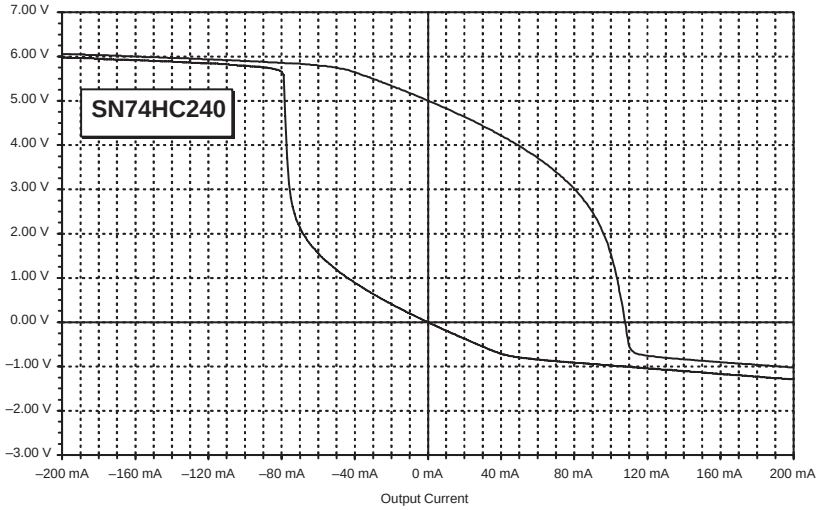

Figure 49. Output Characteristics of the SN74HC240

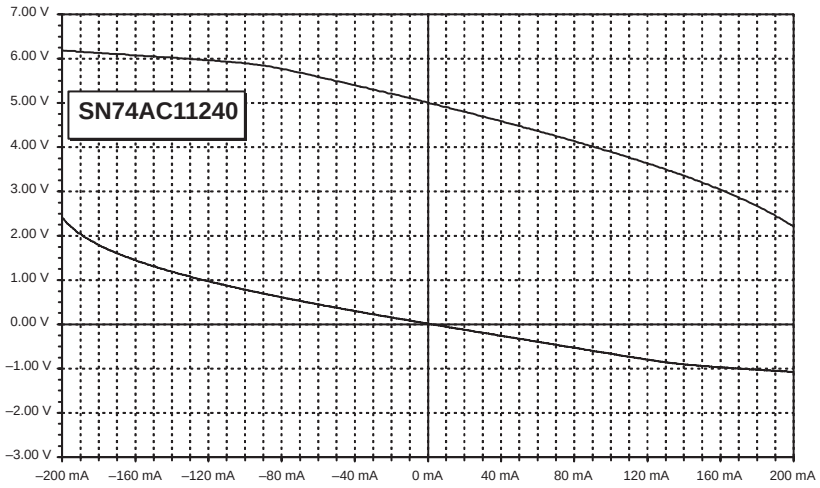

Figure 50. Output Characteristics of the SN74AC11240

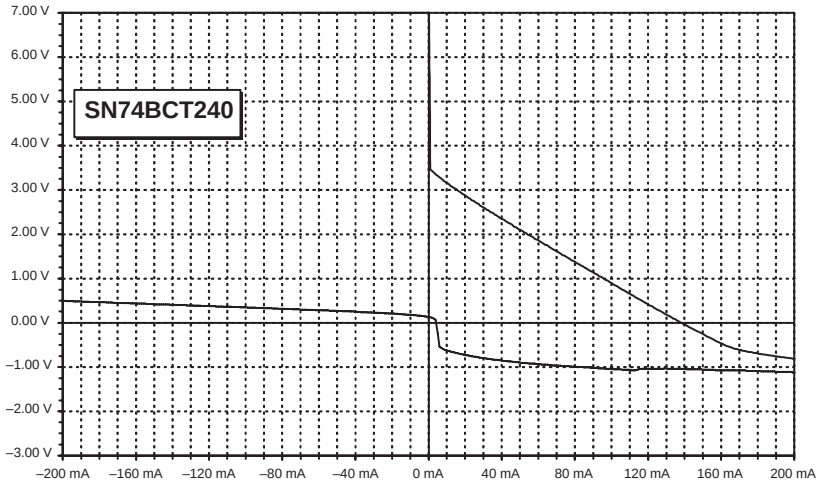

Figure 51. Output Characteristics of the SN74BCT240

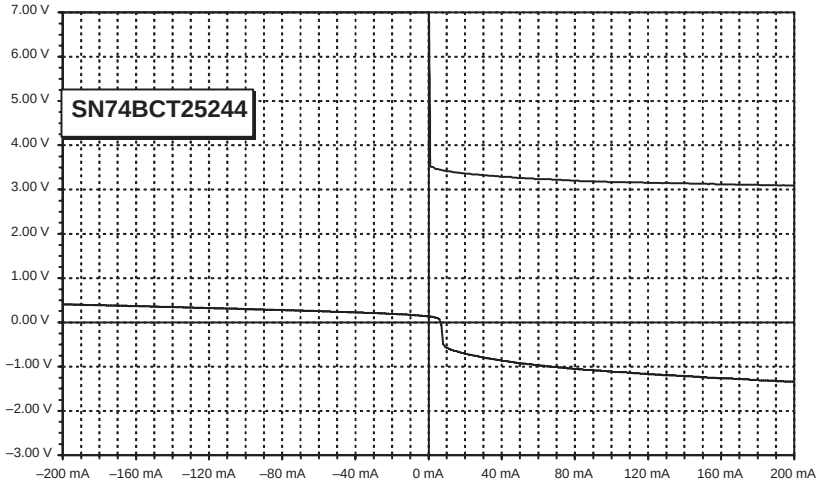

Figure 52. Output Characteristics of the SN74BCT25240

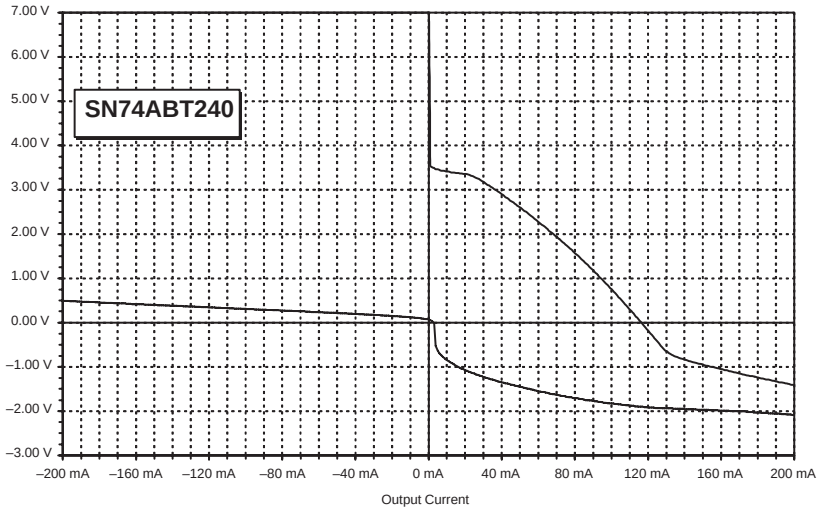

Figure 53. Output Characteristics of the SN74ABT240

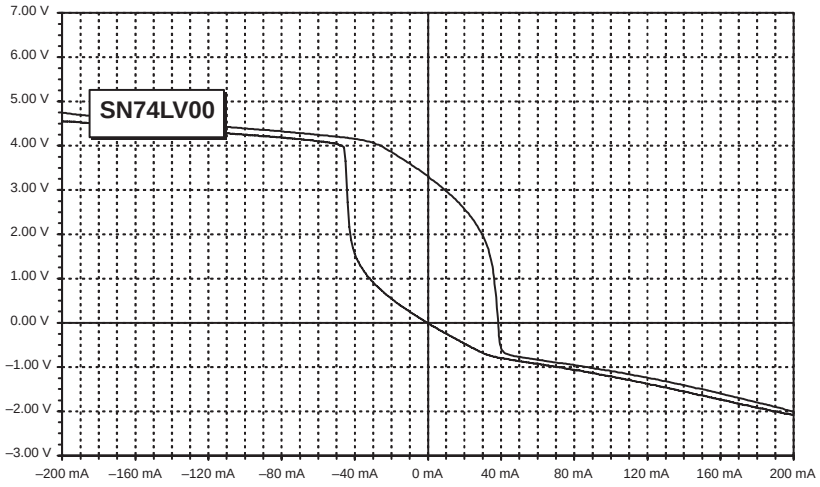

Figure 54. Output Characteristics of the SN74LV00

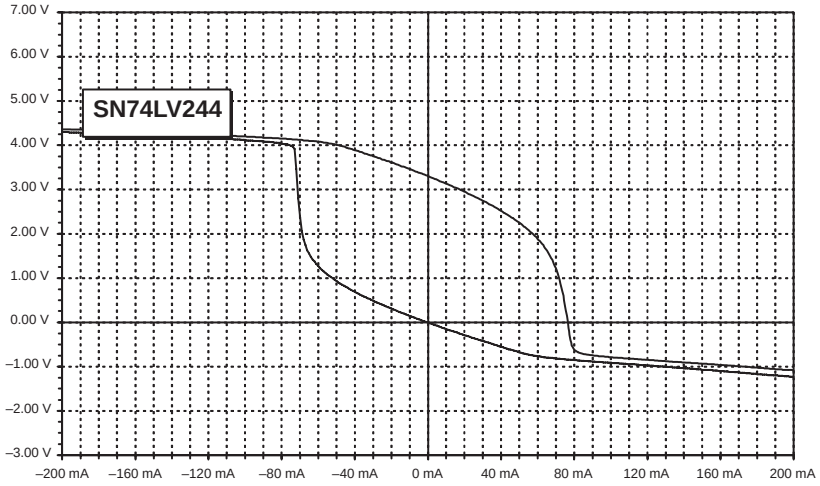

Figure 55. Output Characteristics of the SN74LV244

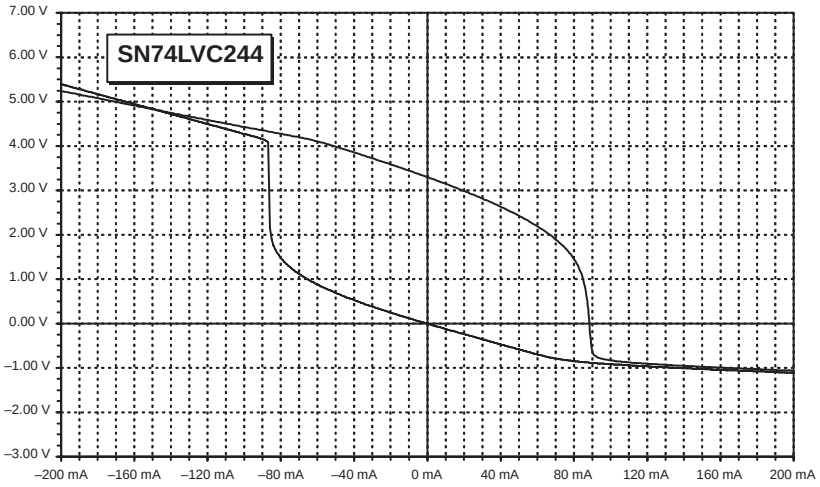

Figure 56. Output Characteristics of the SN74LVC244

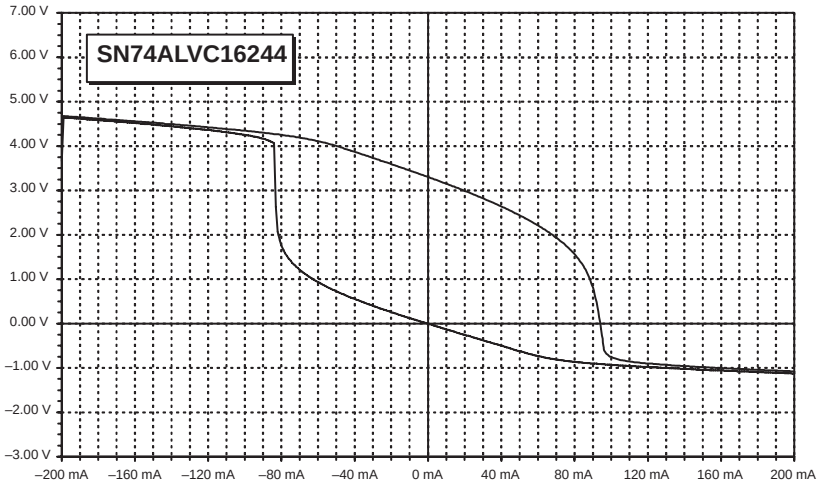

Figure 57. Output Characteristics of the SN74ALVC16244

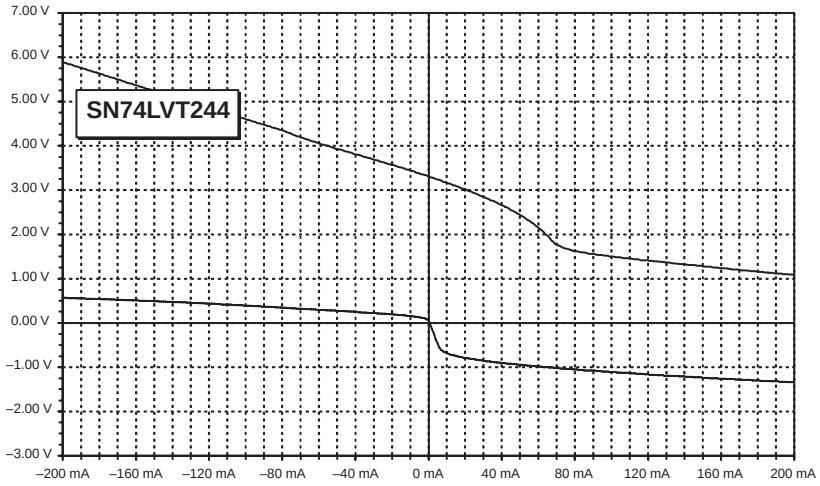

Figure 58. Output Characteristics of the SN74LVT244

Output Waveforms

The setup shown in Figure 59 was used to obtain voltage waveforms of typically representative output stages (see Figures 60 through 88).

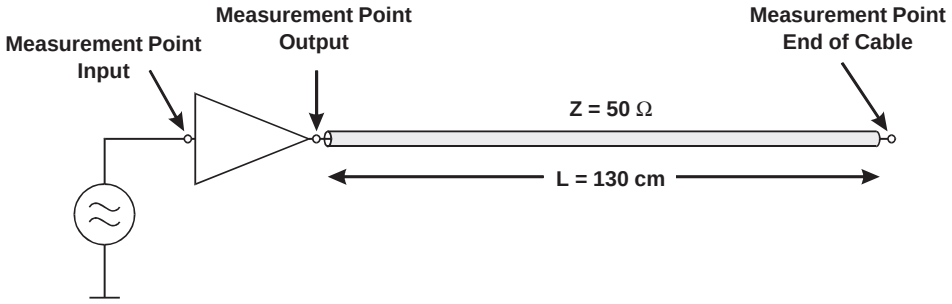

Figure 59. Setup for Obtaining Output Waveforms

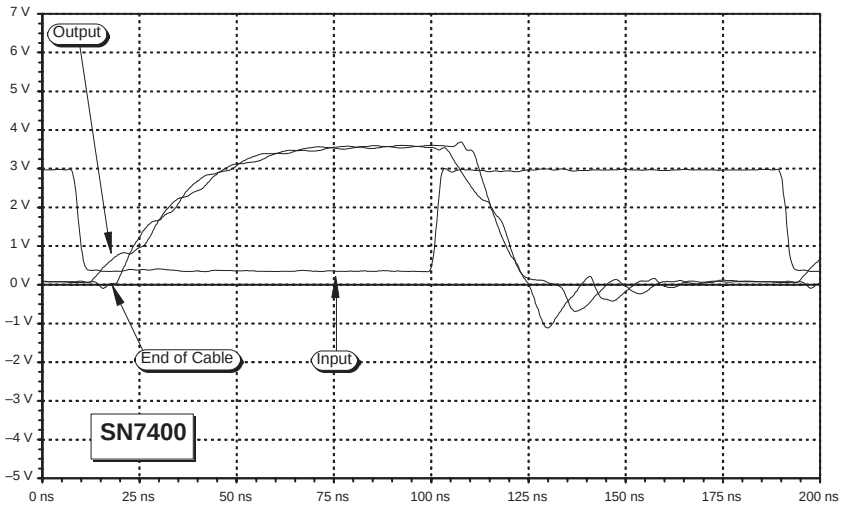

Figure 60. Waveforms of the SN7400

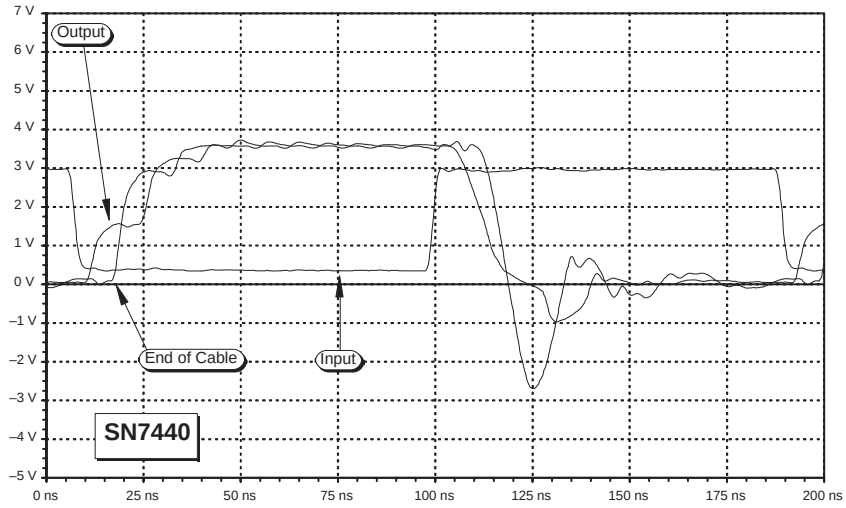

Figure 61. Waveforms of the SN7440

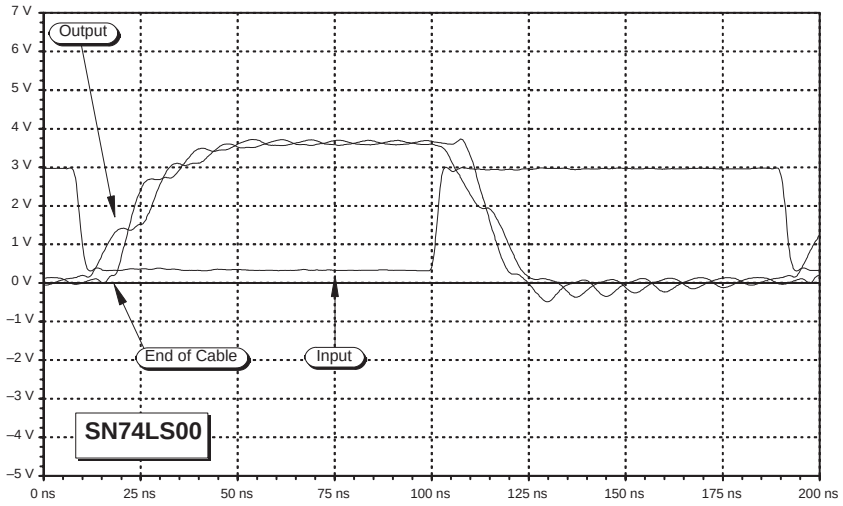

Figure 62. Waveforms of the SN74LS00

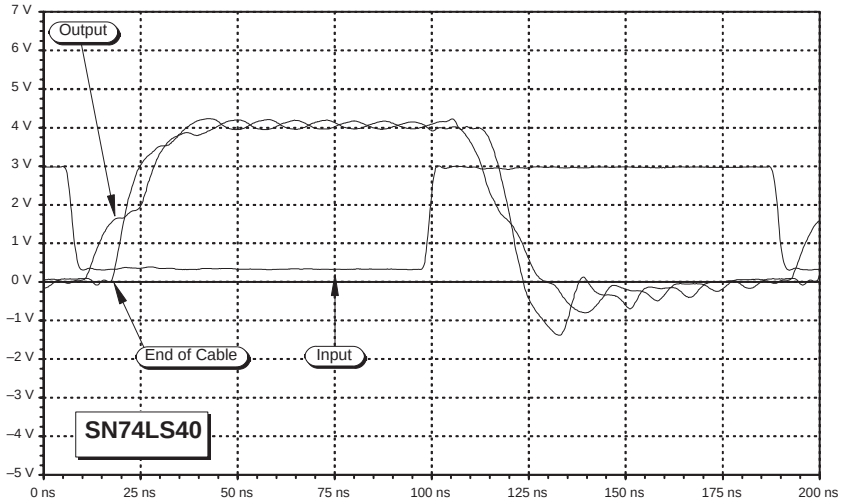

Figure 63. Waveforms of the SN74LS40

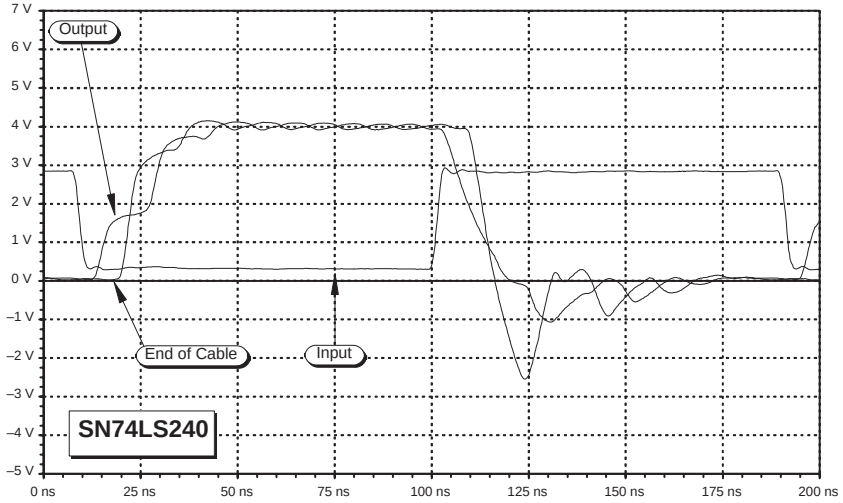

Figure 64. Waveforms of the SN74LS240

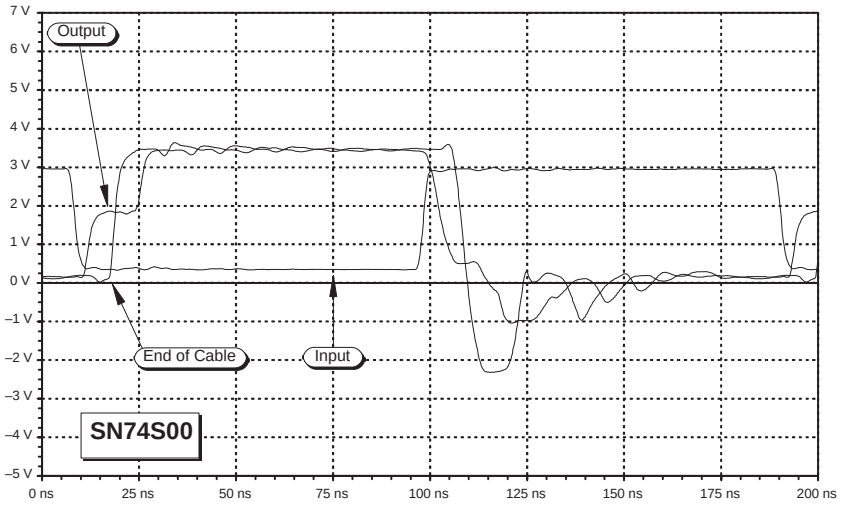

Figure 65. Waveforms of the SN74S00

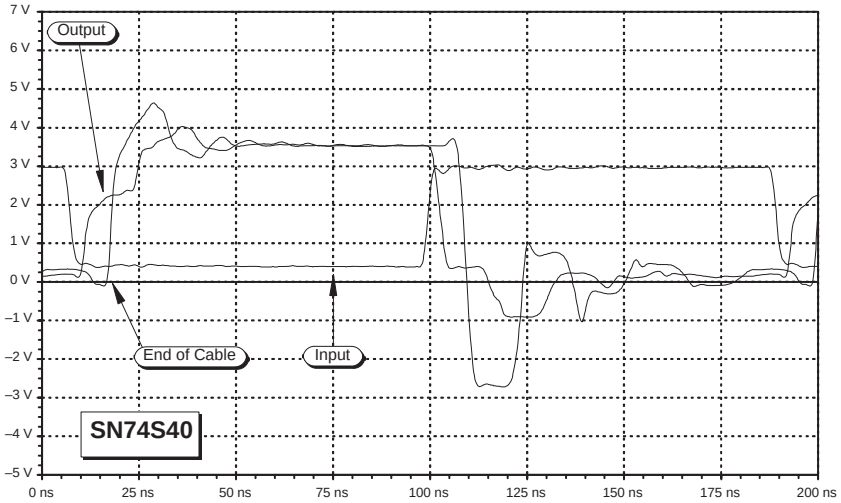

Figure 66. Waveforms of the SN74S40

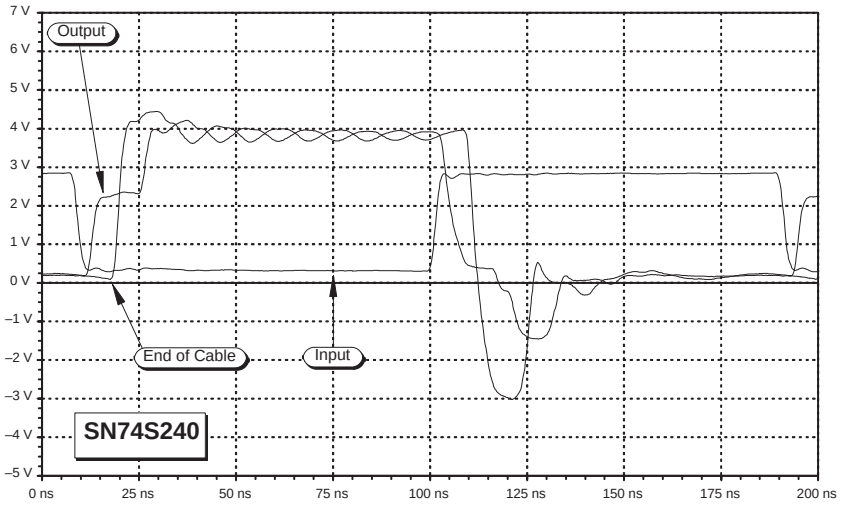

Figure 67. Waveforms of the SN74S240

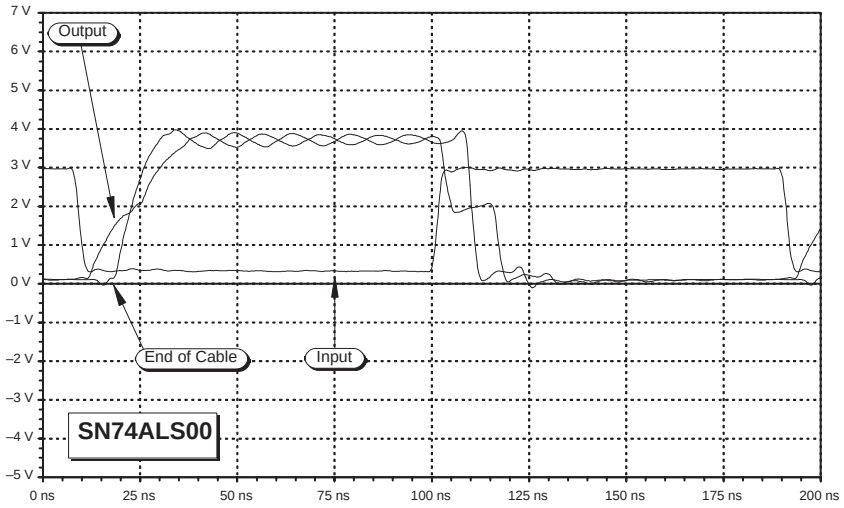

Figure 68. Waveforms of the SN74ALS00

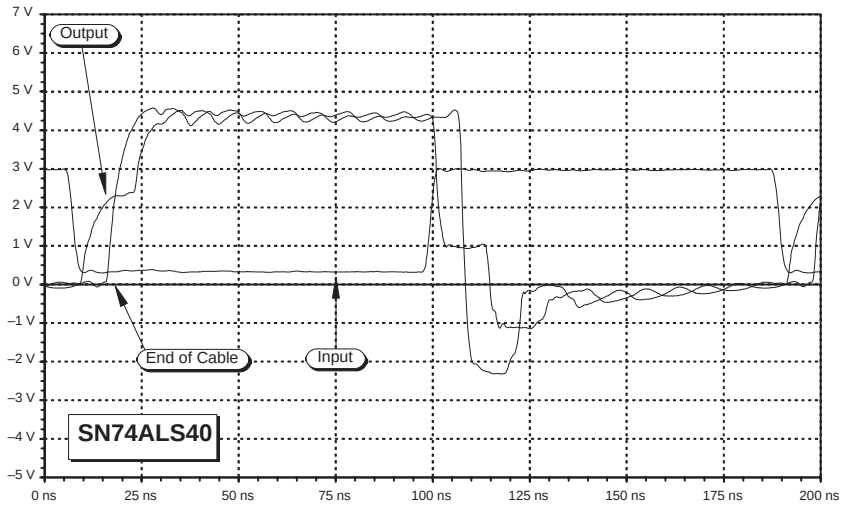

Figure 69. Waveforms of the SN74ALS40

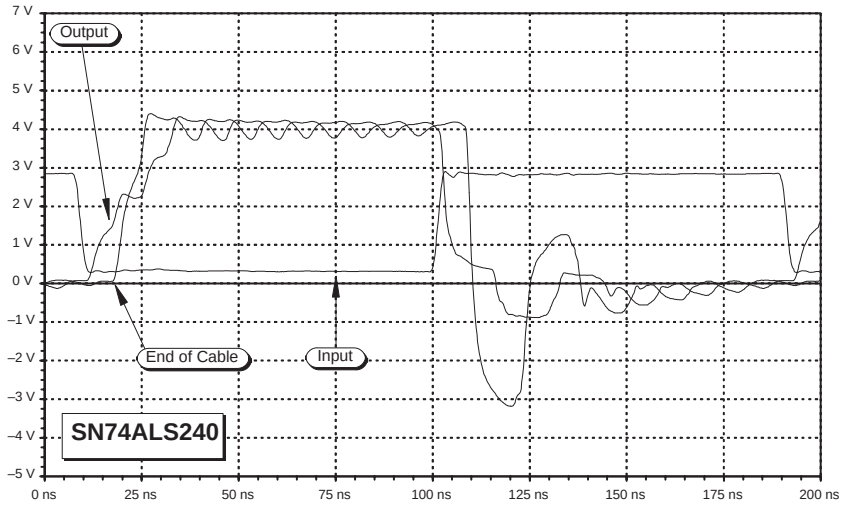

Figure 70. Waveforms of the SN74ALS240

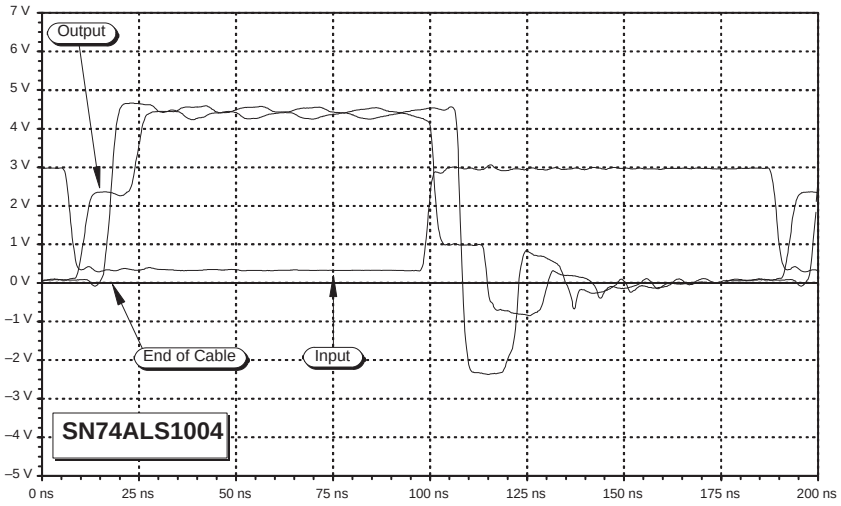

Figure 71. Waveforms of the SN74ALS1004

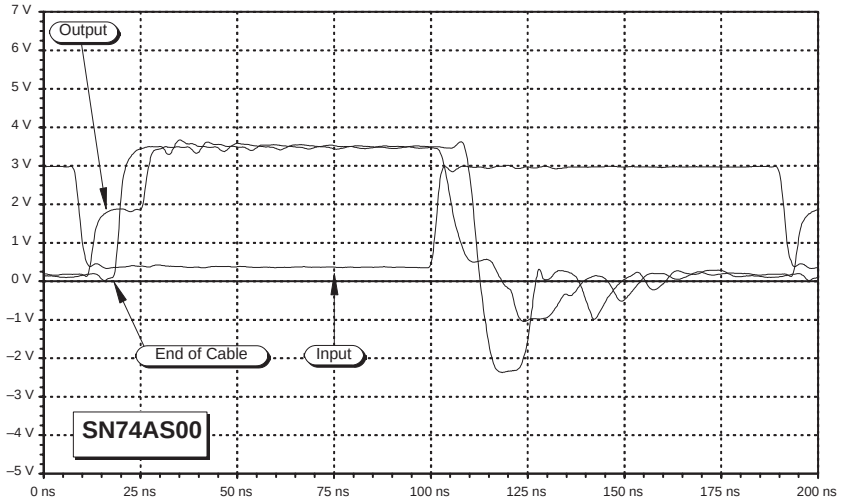

Figure 72. Waveforms of the SN74AS00

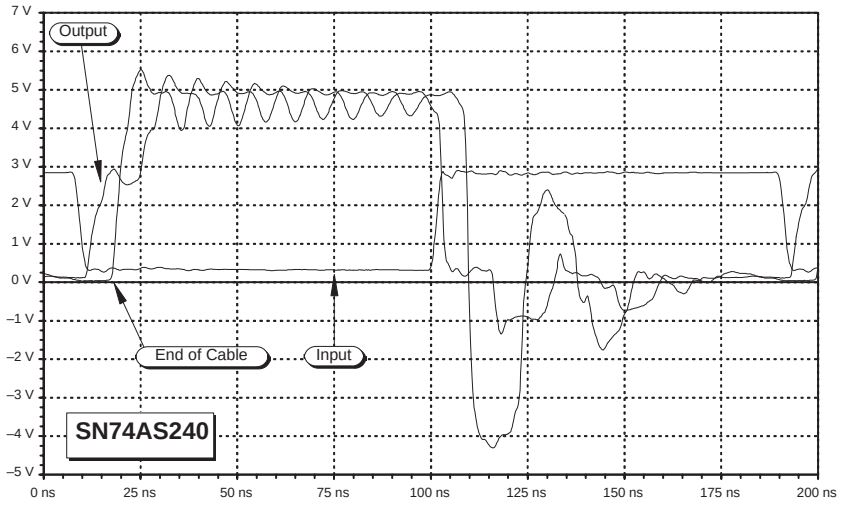

Figure 73. Waveforms of the SN74AS240

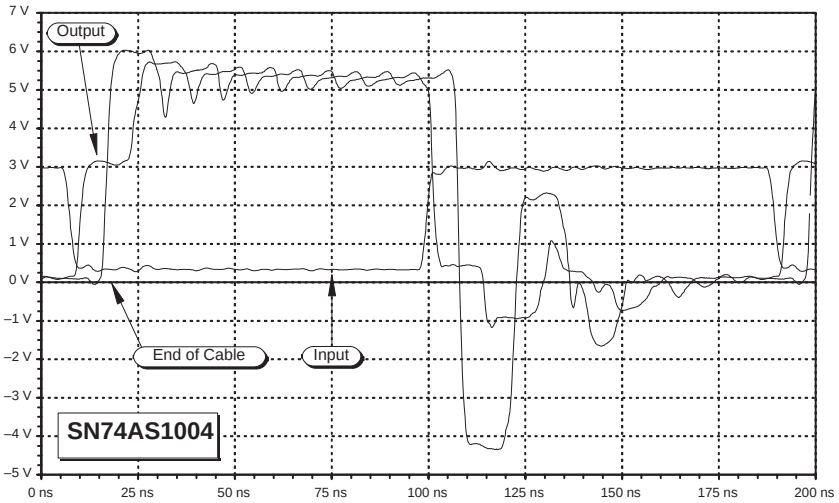

Figure 74. Waveforms of the SN74AS1004

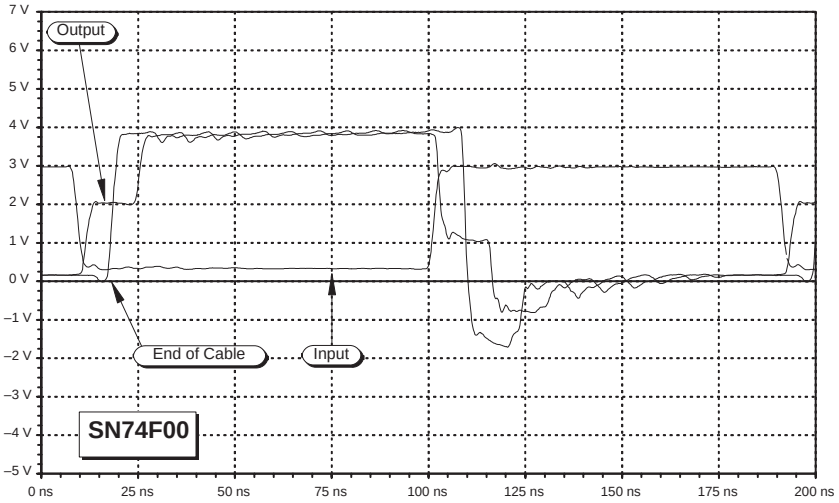

Figure 75. Waveforms of the SN74F00

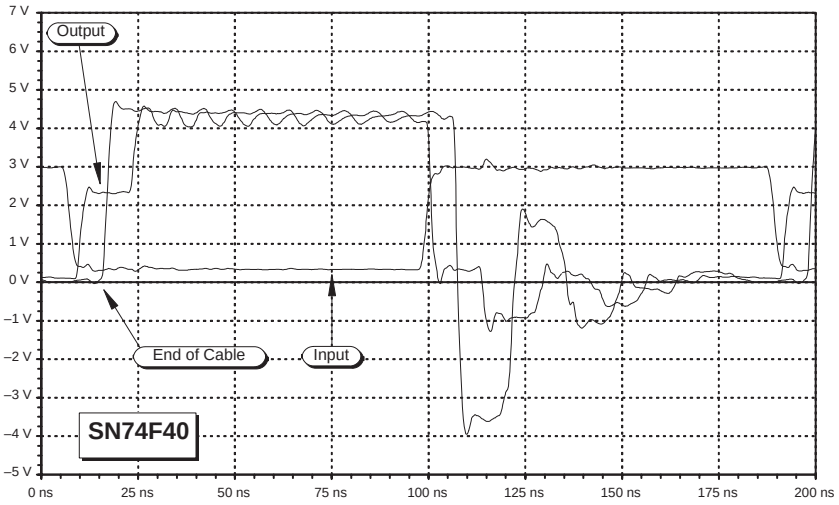

Figure 76. Waveforms of the SN74F40

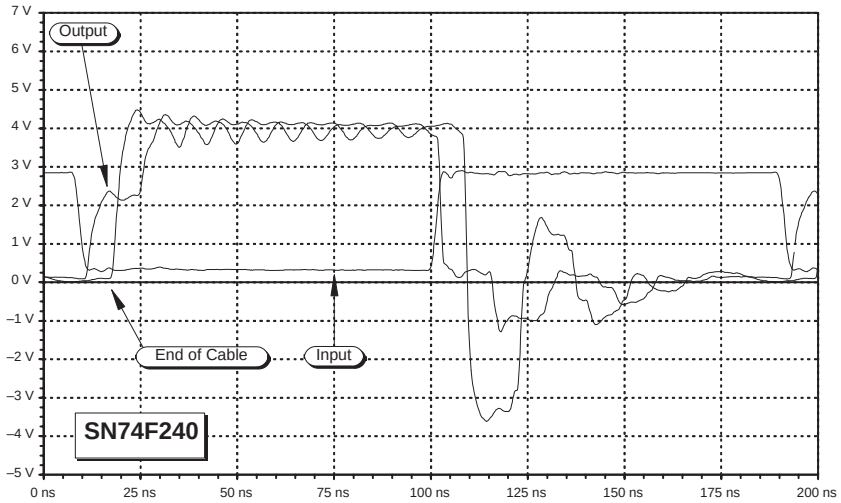

Figure 77. Waveforms of the SN74F240

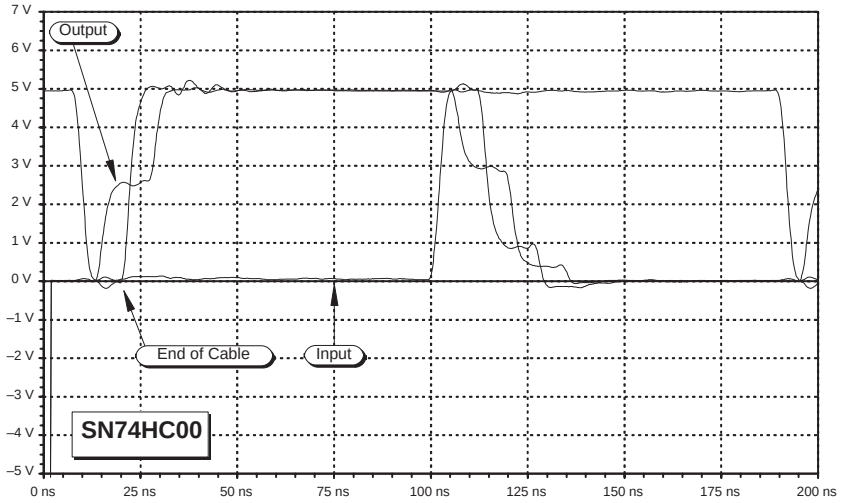

Figure 78. Waveforms of the SN74HC00

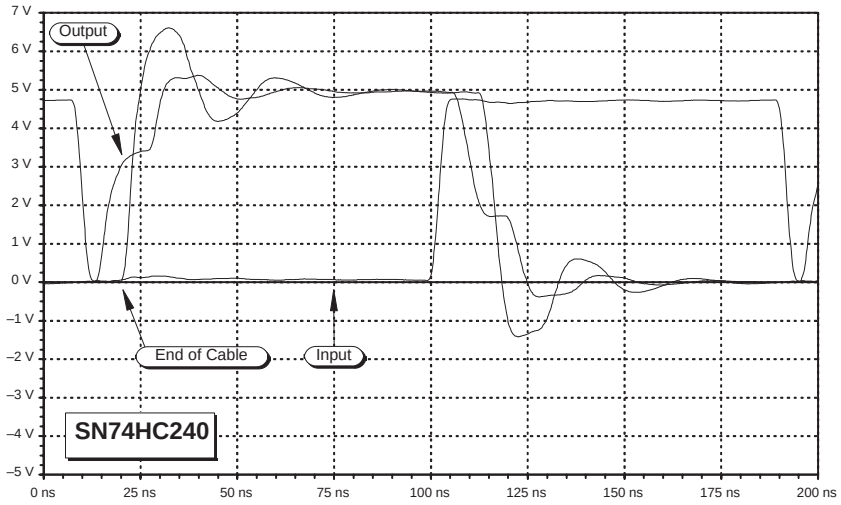

Figure 79. Waveforms of the SN74HC240

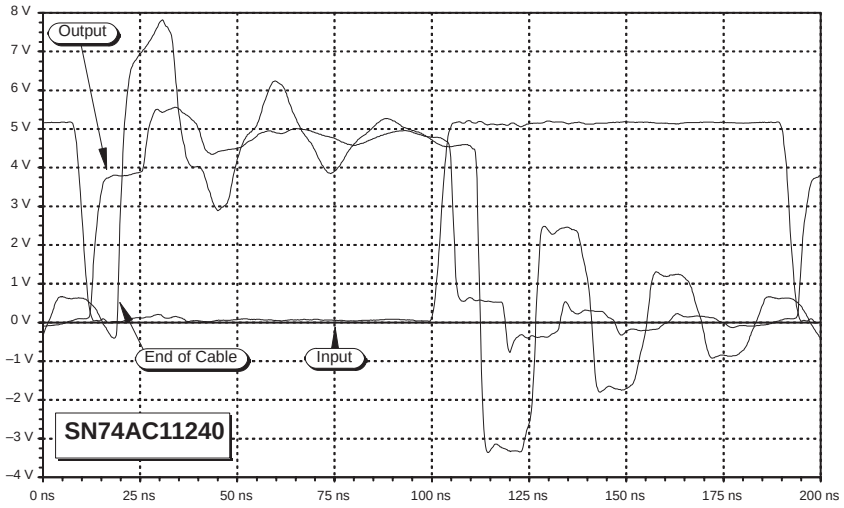

Figure 80. Waveforms of the SN74AC11240

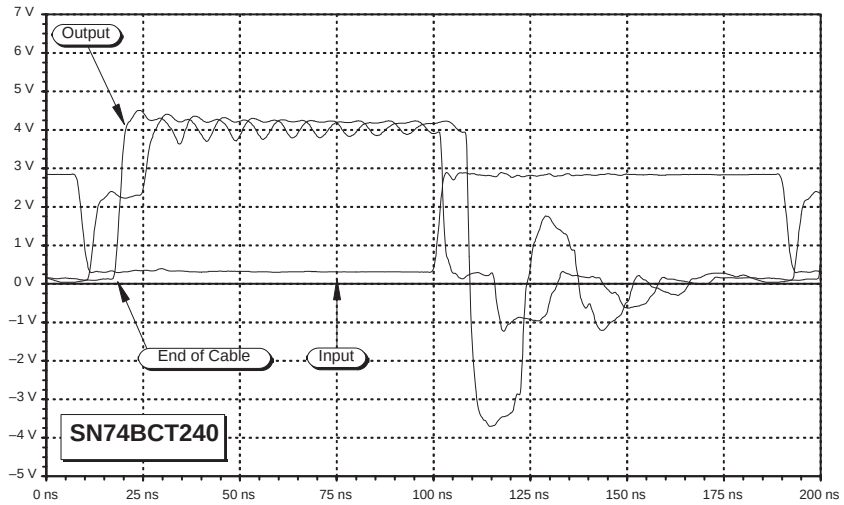

Figure 81. Waveforms of the SN74BCT240

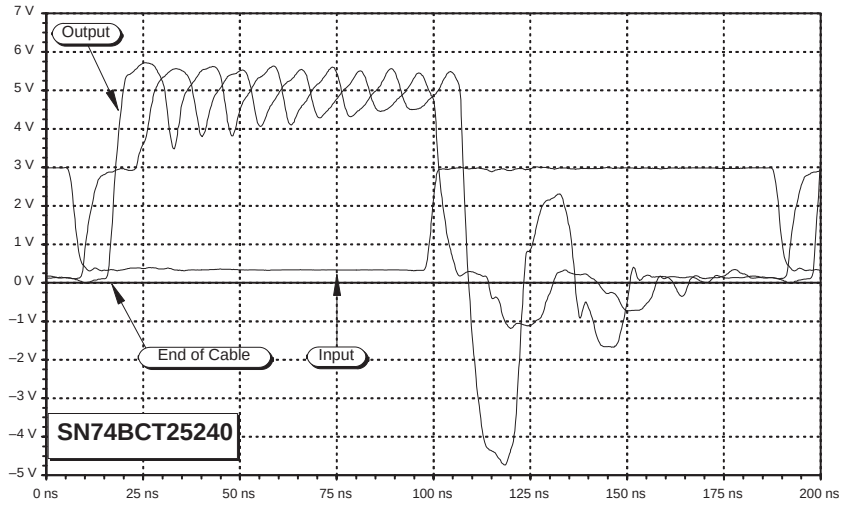

Figure 82. Waveforms of the SN74BCT25240

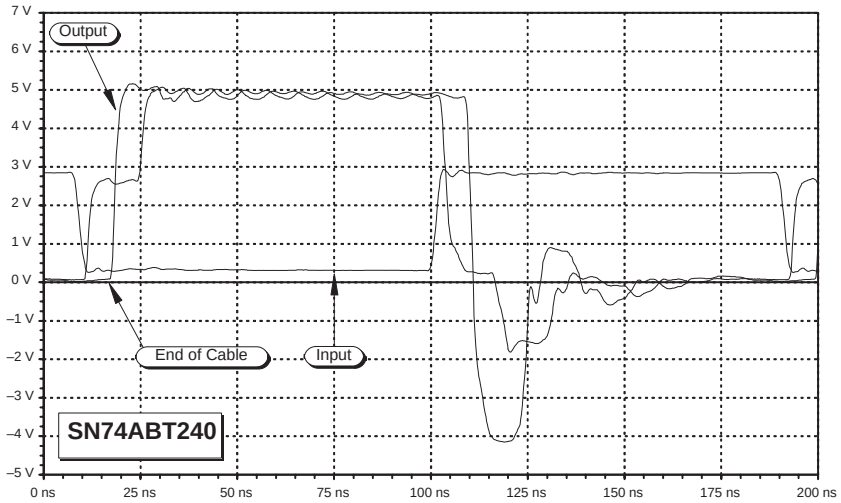

Figure 83. Waveforms of the SN74ABT240

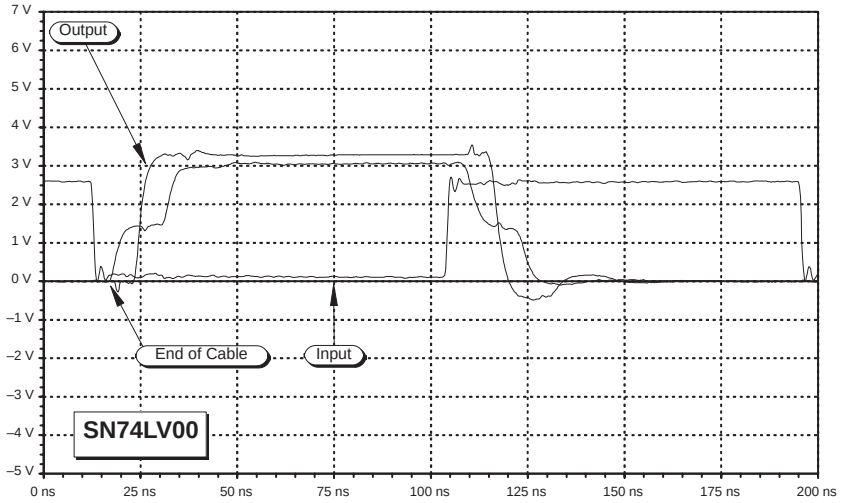

Figure 84. Waveforms of the SN74LV00

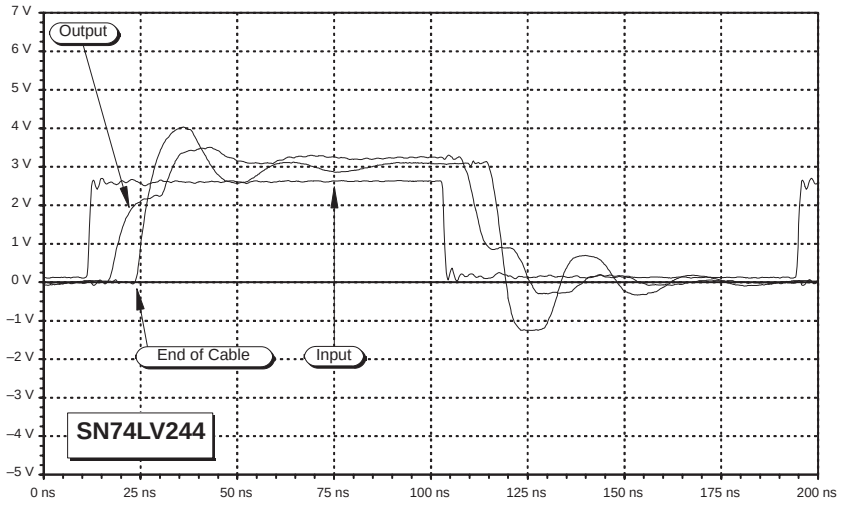

Figure 85. Waveforms of the SN74LV244

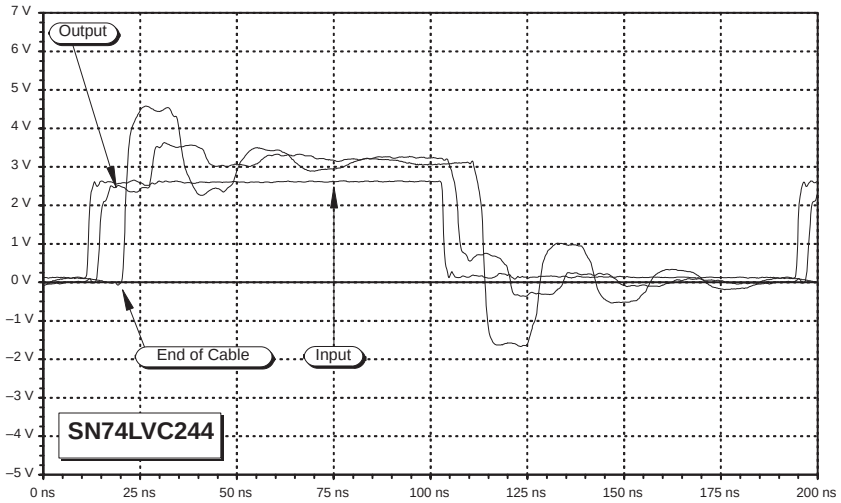

Figure 86. Waveforms of the SN74LVC244

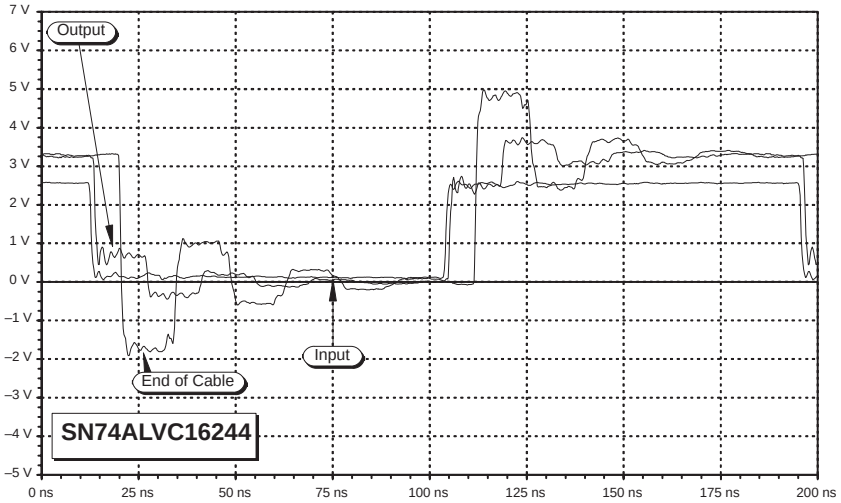

Figure 87. Waveforms of the SN74ALVC16244

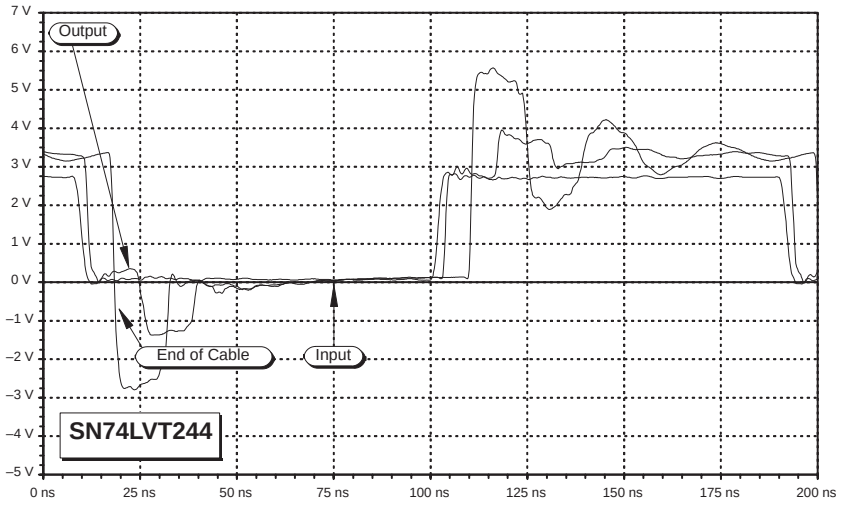

Figure 88. Waveforms of the SN74LVT244