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AND8363/D

AMIS-42665 CAN Transceiver

Immunity Against ESD

Prepared by:
ON Semiconductor

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APPLICATION NOTE

Introduction

The AMIS-42665 high-speed CAN transceiver was ESD stressed without voltage supply and used a test PCB in four configurations:

- No termination resistors
- Termination 2 x 30 Ω, tap to Vsplit, Vsplit decoupled with 47 nF
- Termination 2 x 60 Ω, tap to Vsplit, Vsplit decoupled with 22 nF
- Termination 2 x 1300 Ω, tap to Vsplit, Vsplit decoupled with 4.7 nF

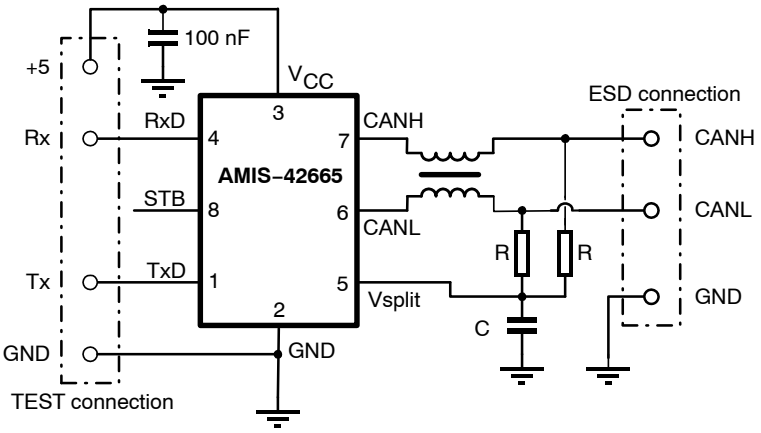


Figure 1. Schematic Diagram used for ESD Stress and Functional Verification

After stress, the system ESD results were judged on:

- Shift in I/V characteristic on CANH and/or CANL
- Functional communication (Tx / Rx) / correct levels on CAN bus

Table 1. RESISTOR AND CAPACITOR VALUES FOR THE FOUR USED CONFIGURATIONS

Configuration	R	C
1	∞	0
2	30 Ω	47 nF
3	60 Ω	22 nF
4	1.3 kΩ	4.7 nF

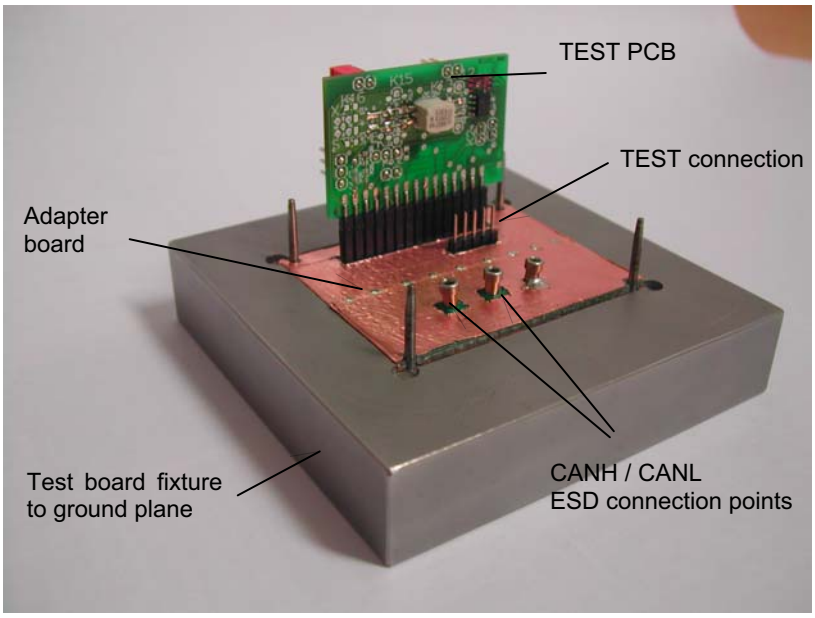


Figure 2. Test Set−up

Figure 3. Test Set−up for ESD Measurements

Used Equipment

- ESD simulator KeyTek Minizap (serial nr. 9105261)
- Contact discharge module KeyTek MZ TPC-2 (serial nr. 9105188)
- Pattern generator Agilent 33210A
- DSO Tektronix
- Curve tracer Tektronix / Sony A370

Test Procedure

Start level: Vesd = 1 kV

Step level: Vstep =1 kV

After stress, the system ESD results were judged on:

- Shift in I/V characteristic on CANH and/or CANL to ground
- Functional communication (Tx / Rx) / correct levels on CAN bus. The DUT is supplied via the test connection. A pattern generator drives the Tx input with a 250 kHz square wave. With an oscilloscope the signals on Tx, Rx, CANL, and CANH are measured.

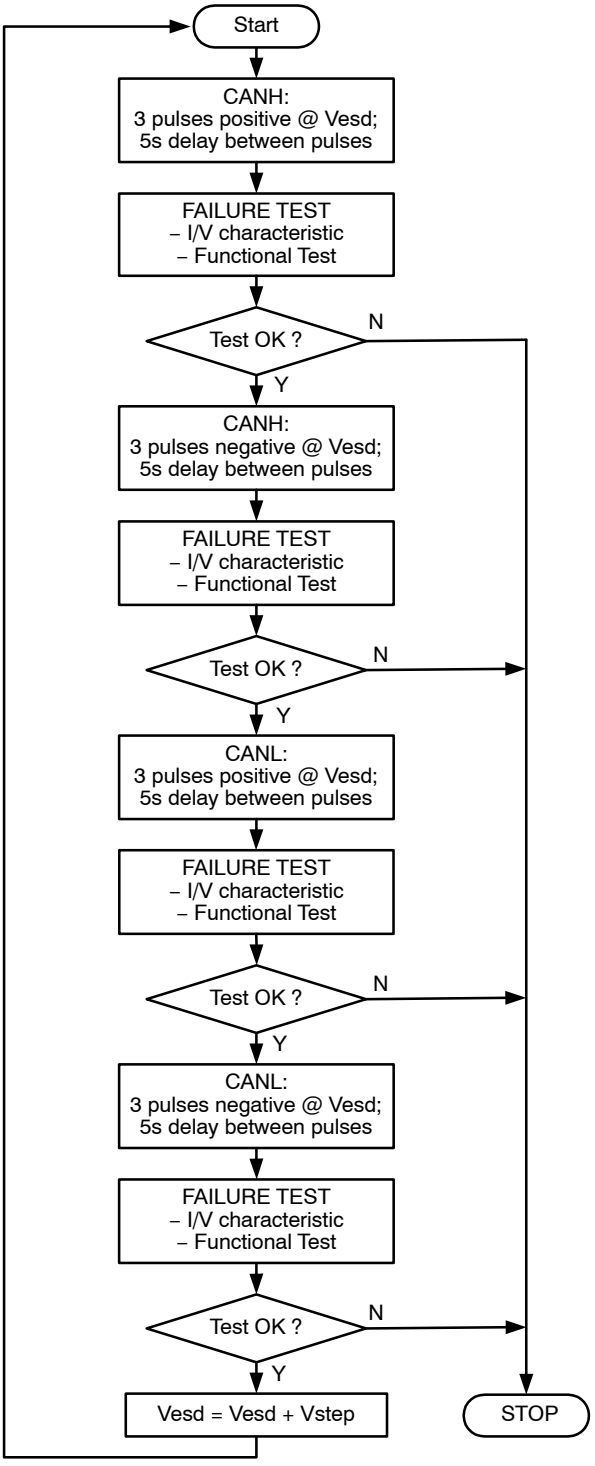


Figure 4. Test Flow for ESD Measurements

Test Results

Table 2. CONFIGURATION 1

Configuration 1	AMIS-42665		Competition	
	Result	Reference	Result	Reference
I/V pass	±4 kV		±1 kV	
I/V fail	-5 kV CANL		-2 kV CANH	
Func pass	±10 kV		±2 kV	
Func fail	+11 kV CANL		+3 kV CANH	

Table 3. CONFIGURATION 2

Configuration 2	AMIS-42665	
	Result	Reference
I/V pass	±3 kV	
I/V fail	+4 kV CANH	
Func pass	±3 kV	
Func fail	+4 kV CANH	

Table 4. CONFIGURATION 3

Configuration 3	AMIS-42665		Competition	
	Result	Reference	Result	Reference
I/V pass	±2 kV		±1 kV	
I/V fail	+3 kV CANL		-2 kV CANH	
Func pass	±2 kV		±2 kV	
Func fail	+3 kV CANL		+3 kV CANH	

Table 5. CONFIGURATION 4

Configuration 4	AMIS-42665	
	Result	Reference
I/V pass	±4 kV	
I/V fail	-5 kV CANL	
Func pass	±11 kV	
Func fail	+12 kV CANL	

Conclusion

The AMIS-42665 performs better for system ESD compared with the major competitor for any of the four tested configurations.

Best results are for Configurations 1 and 4:

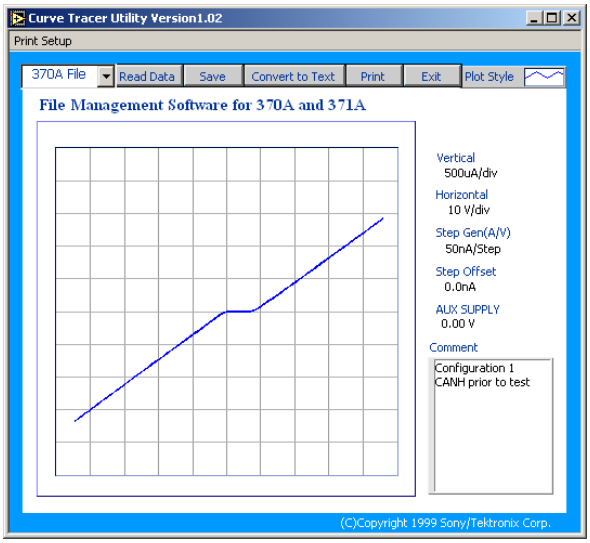
- AMIS: pass 4 kV I/V and 10 kV functional
- Competitor: Pass 1 kV I/V and 2 kV functional

Worst result is for Configuration 3:

- AMIS: pass 2 kV both I/V as functional
- Competitor: pass 1 kV I/V and 2 kV functional

Addendum: Measurement Details

Configuration 1



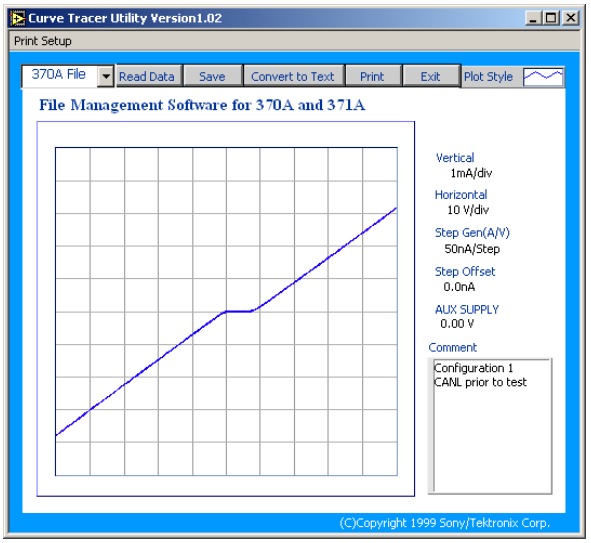


Figure 5. CANH and CANL I/V Characteristics of the AMIS−42665 in Configuration 1 Prior to Test

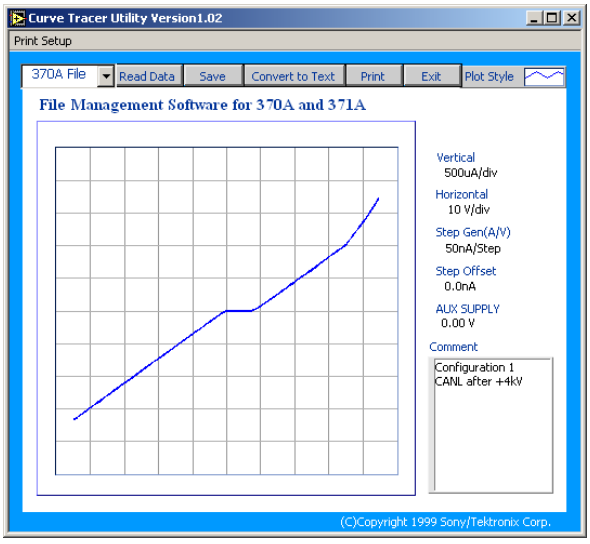


Figure 6. CANL of the AMIS−42665 after +4 kV

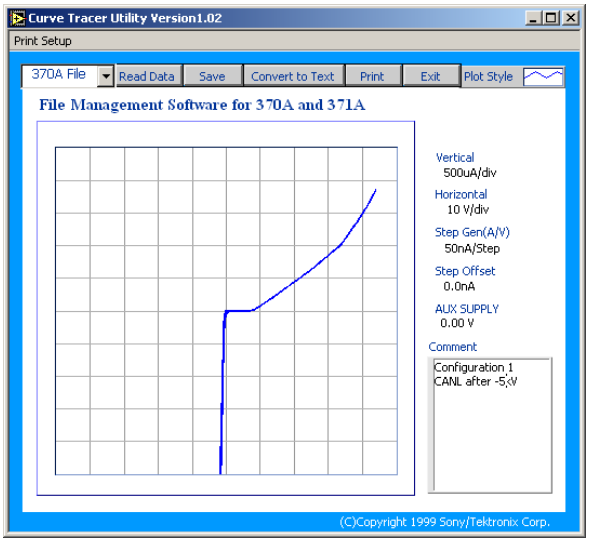
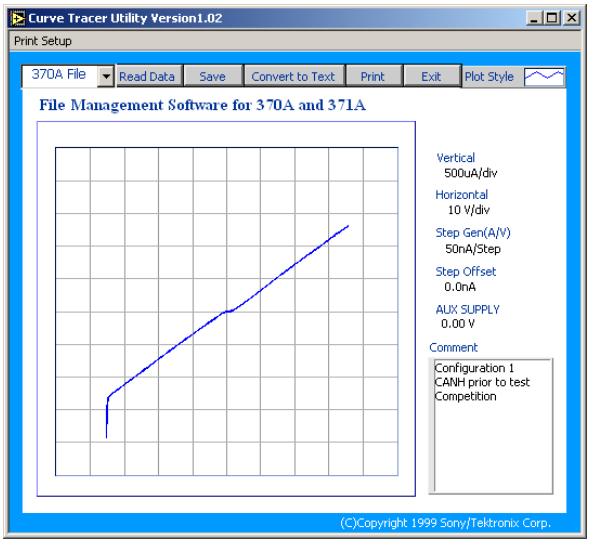


Figure 7. CANL of the AMIS−42665 after −5 kV



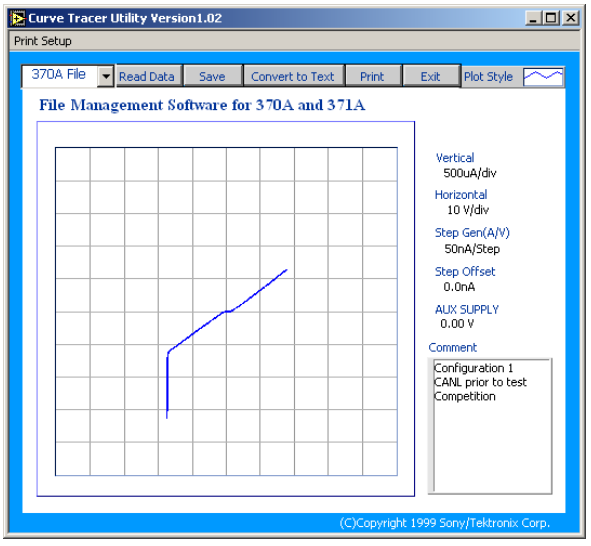


Figure 8. CANH and CANL I/V Characteristics of Competitor in Configuration 1 Prior to Test

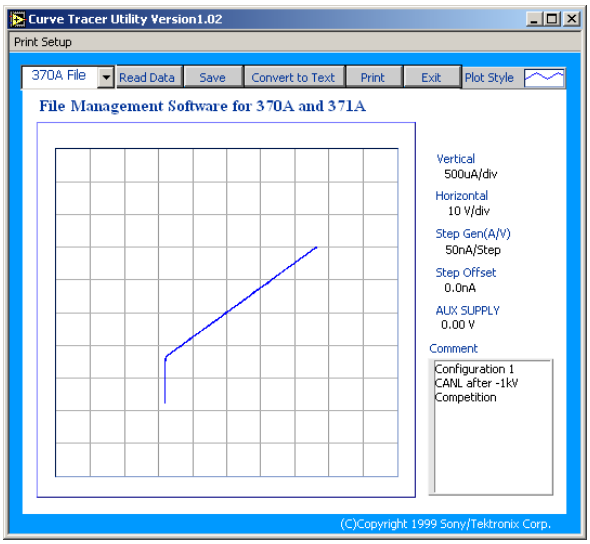


Figure 9. CANL of Competitor after −1 kV

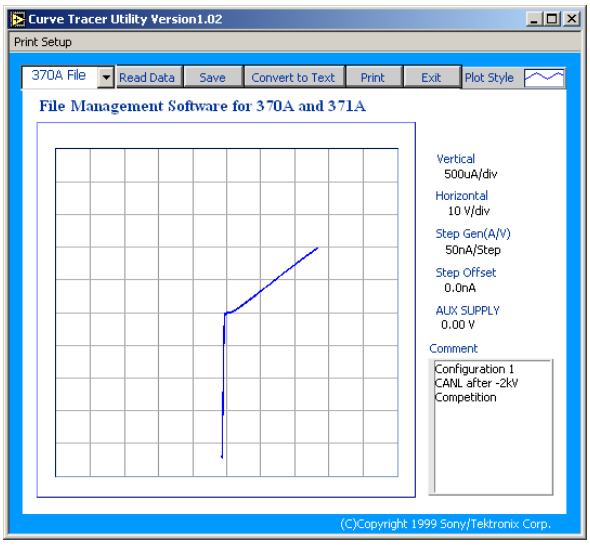


Figure 10. CANL of Competitor after −2 kV

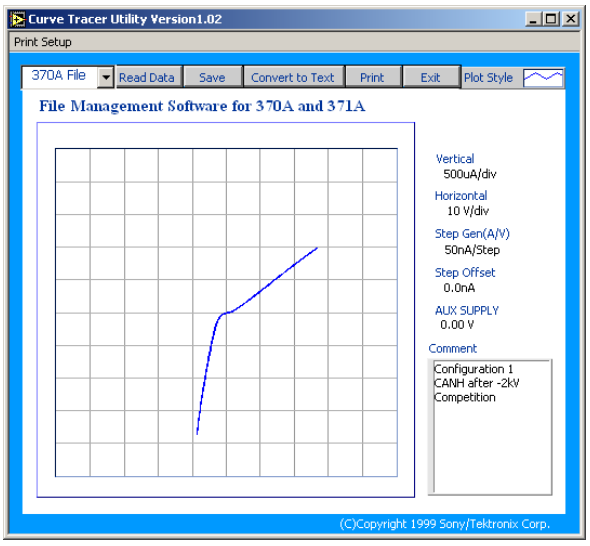


Figure 11. CANH of Competitor after −2 kV

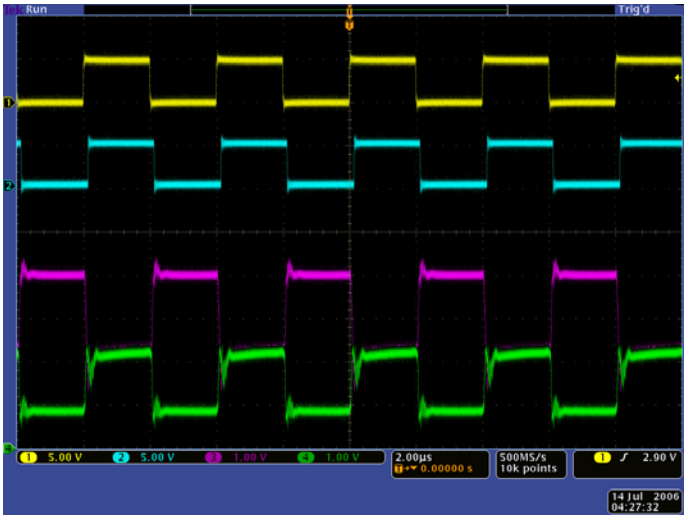


Figure 12. Functional behavior of the AMIS−42665 in Configuration 1 prior to test. Measured with 200 Ω termination resistor between CANH and CANL. CH1 (yellow) Tx; CH2 (blue); CH3 (purple) CANH; CH4 (green) CANL.

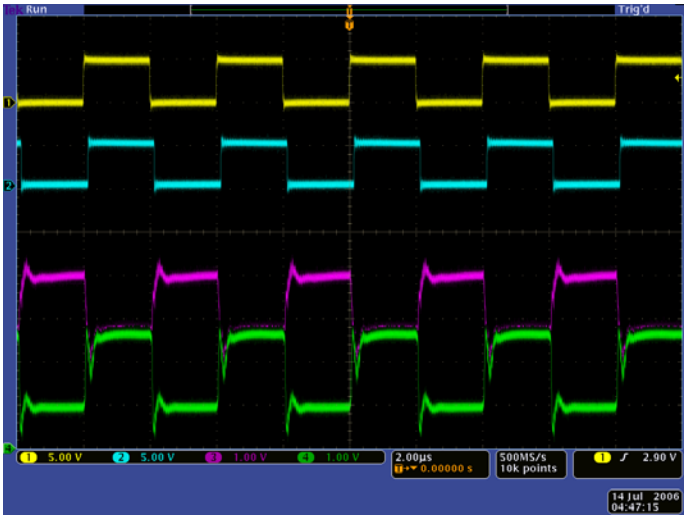


Figure 13. Functional behavior of the AMIS−42665 in Configuration 1 after test. CANL was stressed with ±5 kV pulse and fails on curve tracer (shift). Transceiver is still functional (under normal conditions). Measured with 200 Ω termination resistor between CANH and CANL.

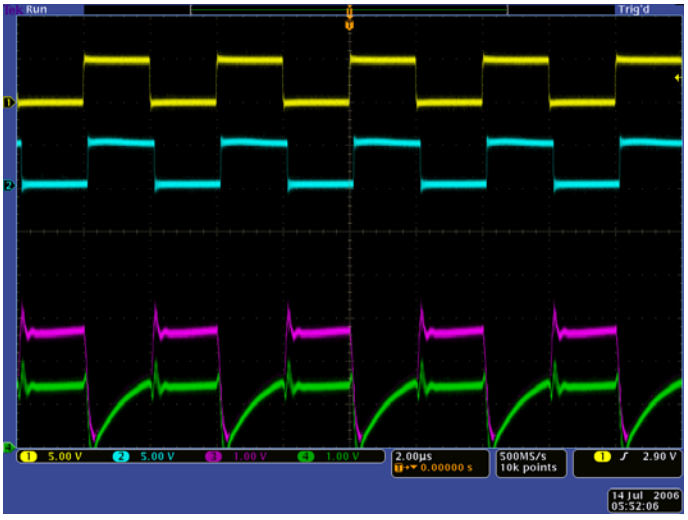


Figure 14. Functional behavior of the AMIS−42665 in Configuration 1 after test. CANL was stressed with ±11 kV pulse and fails functional (bus levels). Set−up 2: measured with 200 Ω termination resistor between CANH and CANL.

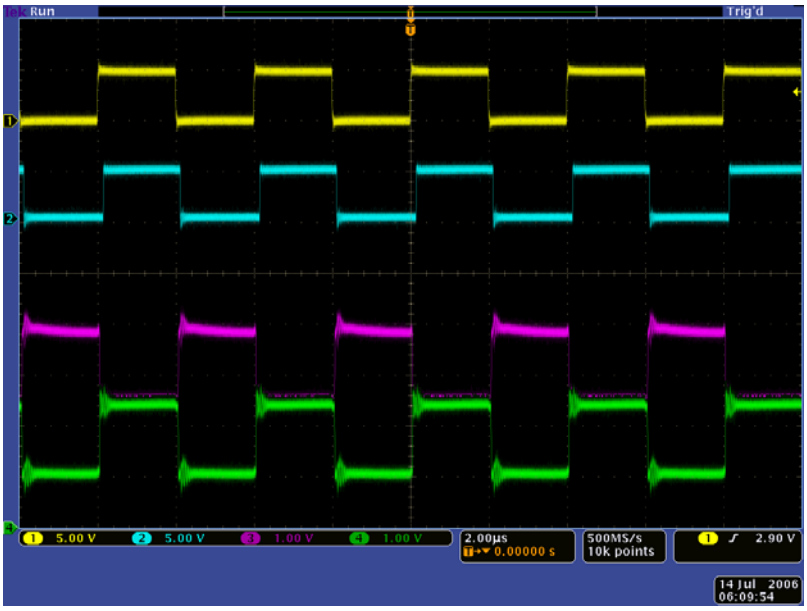


Figure 15. Functional behavior of the AMIS−42665 in Configuration 1 prior to test. Measured with 200 Ω termination resistor between CANH and CANL. CH1 (yellow) Tx; CH2 (blue); CH3 (purple) CANH; CH4 (green) CANL.

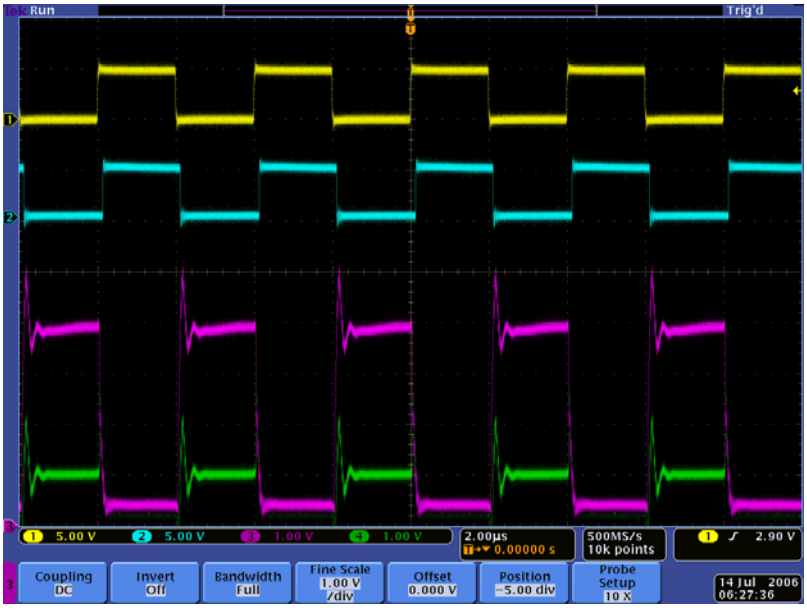


Figure 16. Functional behavior of the AMIS−42665 in Configuration 1 after test. CANL was stressed with ±5 kV pulse and fails on curve tracer (shift). Transceiver is still functional (under normal conditions). Measured with 200 Ω termination resistor between CANH and CANL.

Configuration 2

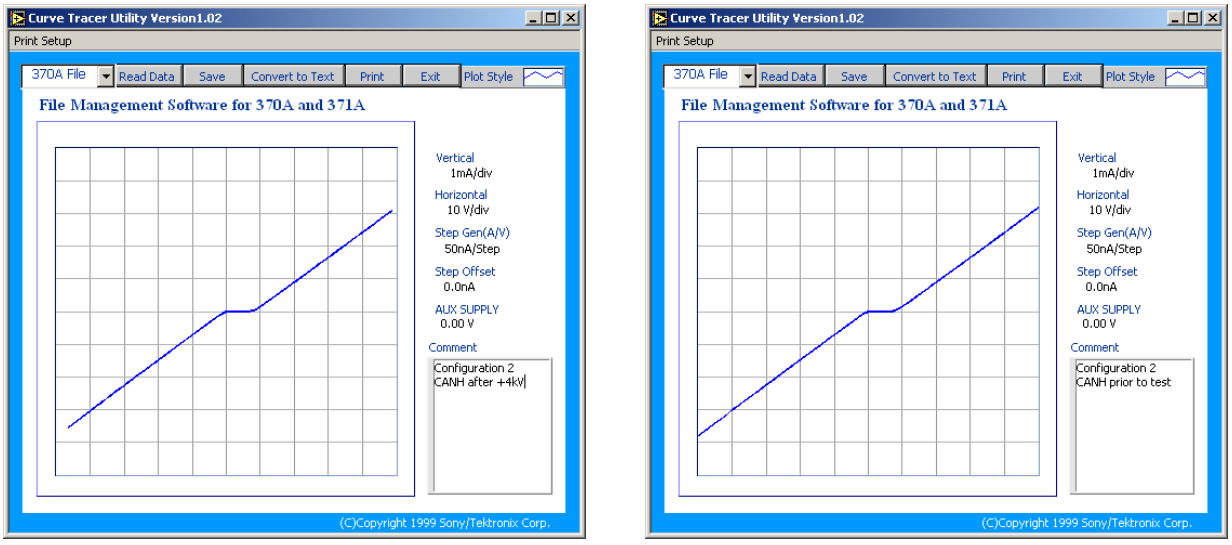


Figure 17. CANH and CANL I/V Characteristics of the AMIS−42665 in Configuration 2 Prior to Test

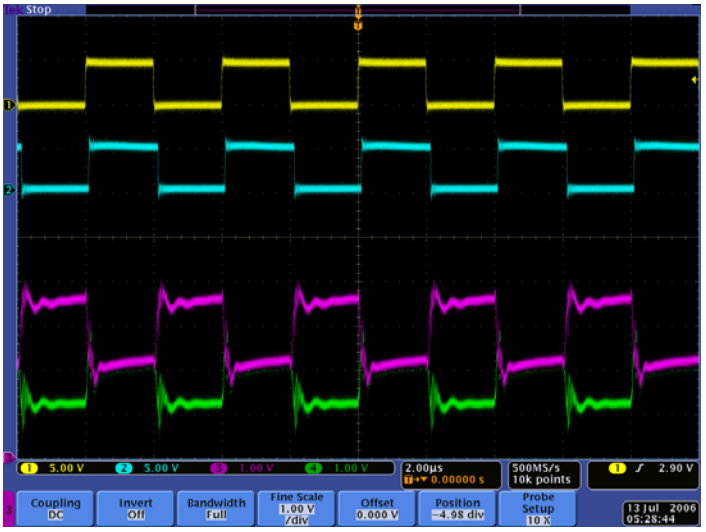


Figure 18. Functional behavior of the AMIS−42665 in Configuration 2 prior to test. CH1 (yellow) Tx; CH2 (blue) Rx; CH3 (purple) CANH; CH4 (green) CANL.

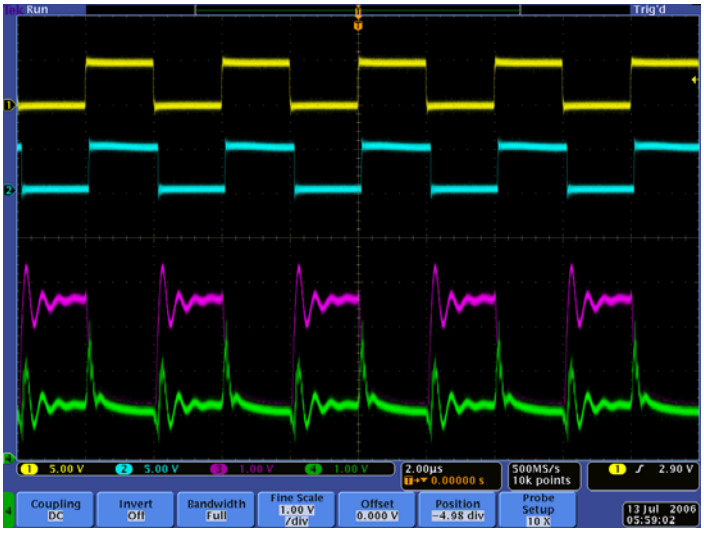
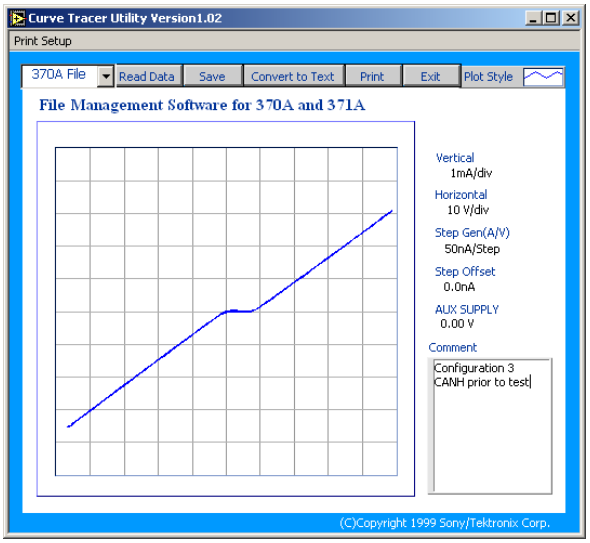


Figure 19. Functional behavior of the AMIS−42665 in Configuration 2 after test. CANH was stressed with 4 kV positive pulse. CANL pin fails. The dominant levels are reached but in recessive mode the bus voltage is pulled to 0V.

Configuration 3



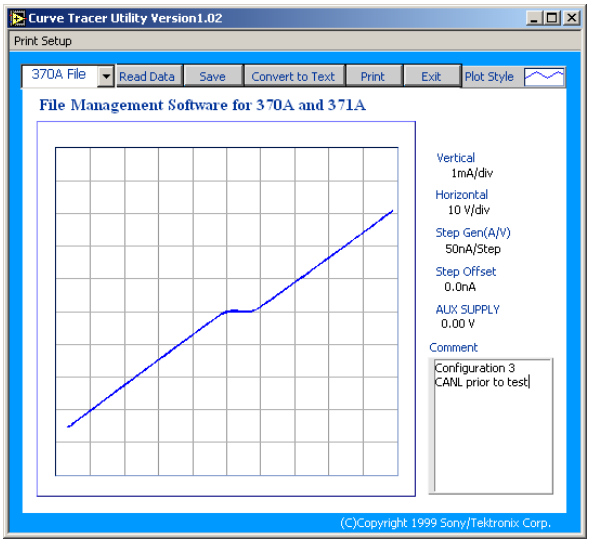


Figure 20. CANH and CANL I/V Characteristics of the AMIS−42665 in Configuration 3 Prior to Test

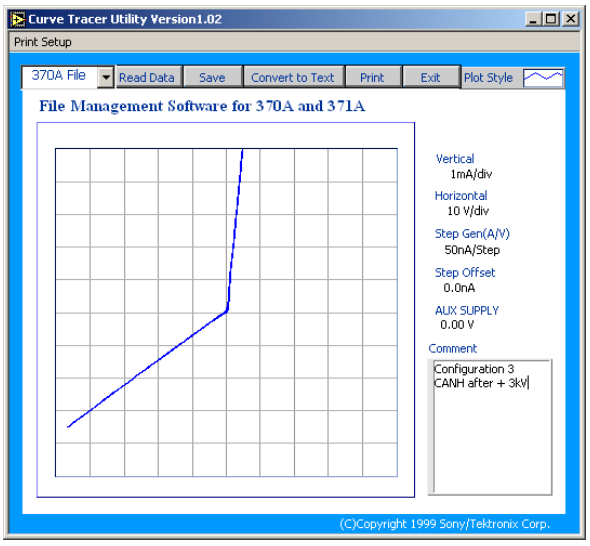


Figure 21. CANH of the AMIS−42665 after +3 kV

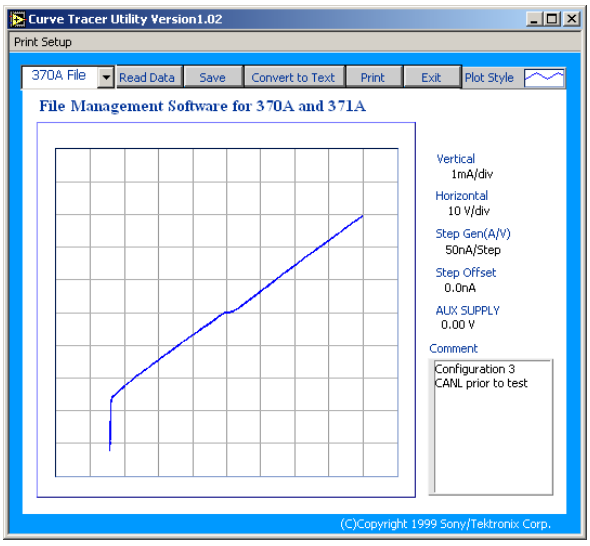


Figure 22. CANL I/V Characteristics of Competitor in Configuration 3 Prior to Test

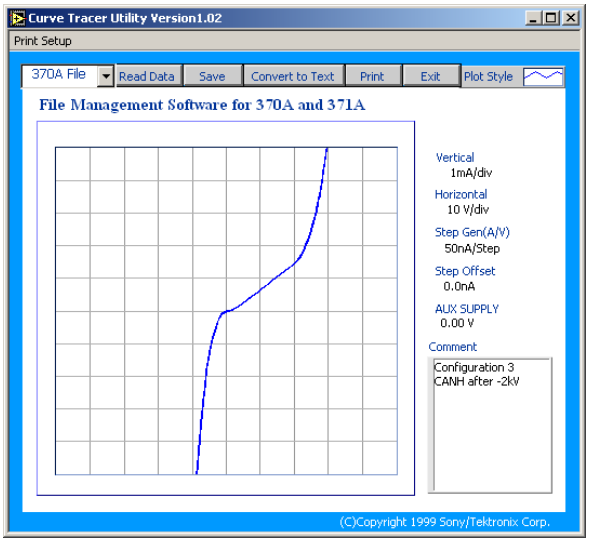


Figure 23. CANH of Competitor after −2 kV

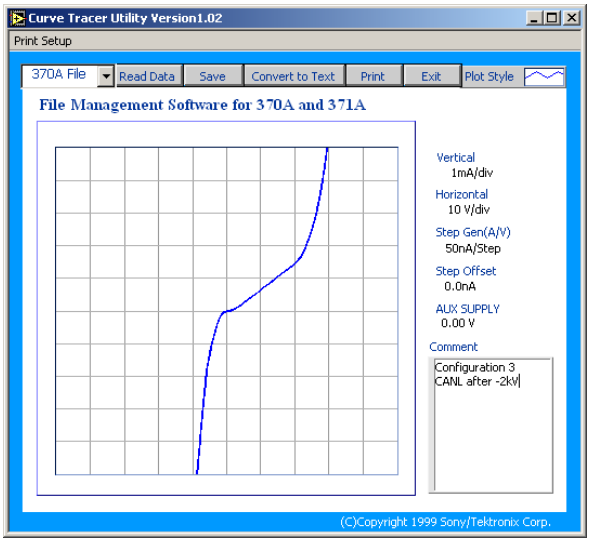


Figure 24. CANL of Competitor after −2 kV

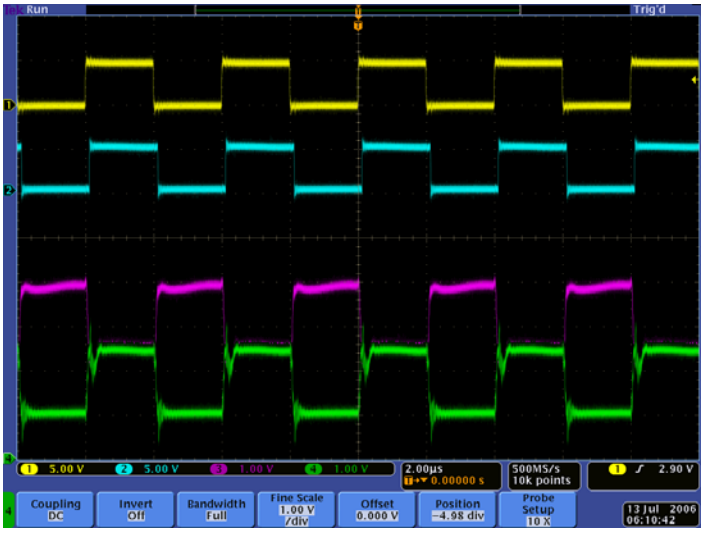


Figure 25. Functional behavior of the AMIS−42665 in Configuration 3 prior to test. CH1 (yellow) Tx; CH2 (blue) Rx; CH3 (purple) CANH; CH4 (green) CANL.

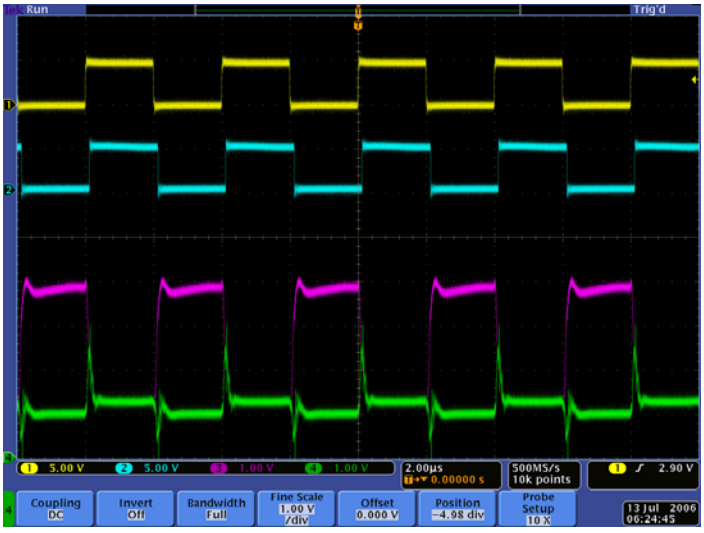


Figure 26. Functional behavior of the AMIS−42665 in Configuration 3 after test. CANH was stressed with 3 kV positive pulse. CANL pin fails. The dominant levels are reached but in recessive mode the bus voltage is pulled to 0V.

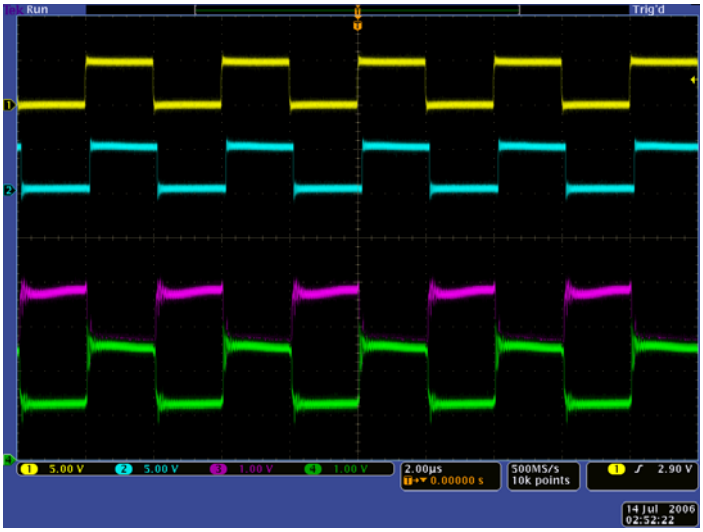


Figure 27. Functional behavior of competitor in Configuration 3 after test. CH1 (yellow) Tx; CH2 (blue) Rx; CH3 (purple) CANH; CH4 (green) CANL.

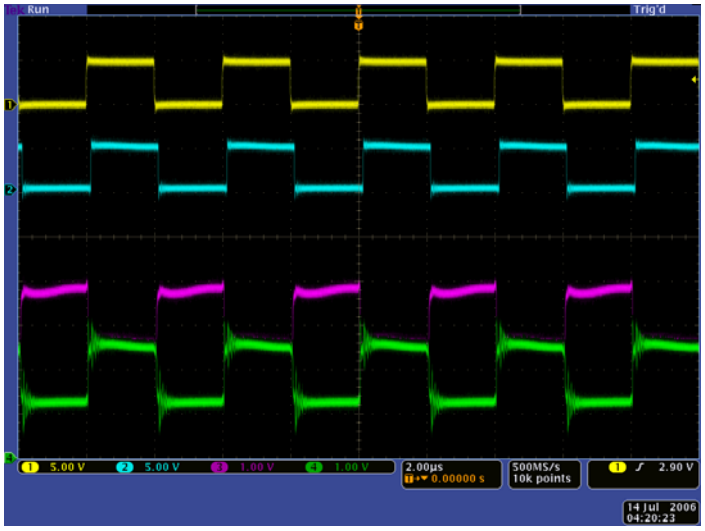


Figure 28. Functional behavior of competitor in Configuration 3 after test. CANH was stressed with −2 kV pulse and fails on curve tracer. Transceiver is still functional (under normal conditions).

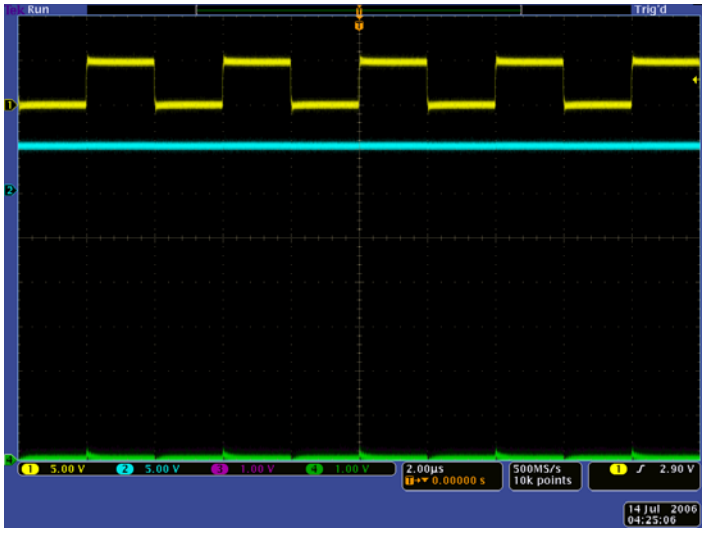
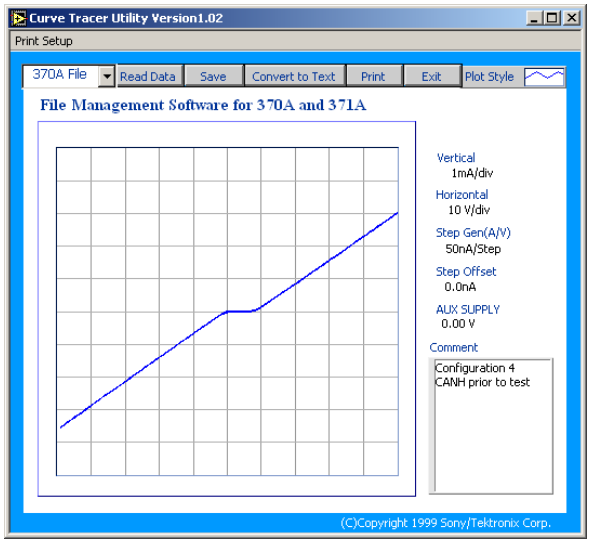


Figure 29. Functional behavior of competitor in Configuration 3 after test. CANH was stressed with +3 kV pulse and fails functional (bus levels and receiver).

Configuration 4



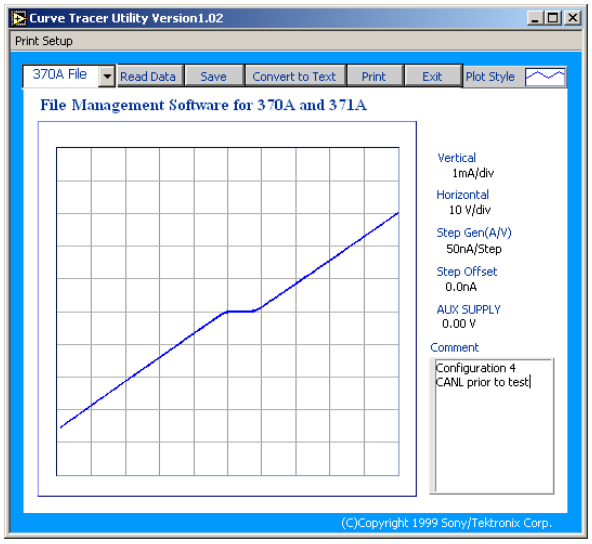


Figure 30. CANH and CANL I/V Characteristics of the AMIS−42665 in Configuration 4 Prior to Test

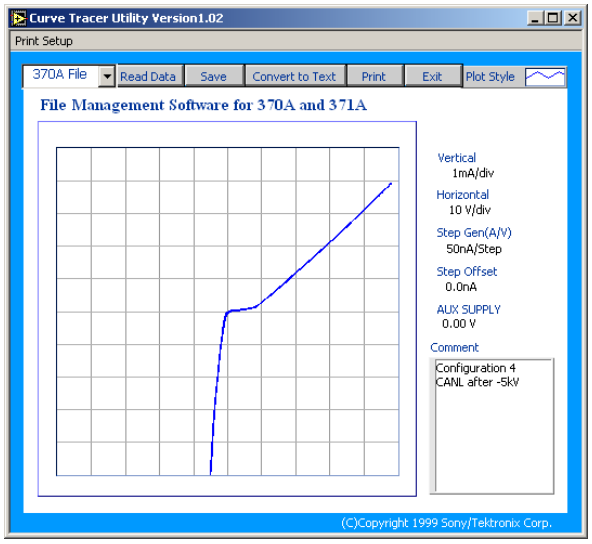


Figure 31. CANL of the AMIS−42665 after −5 kV

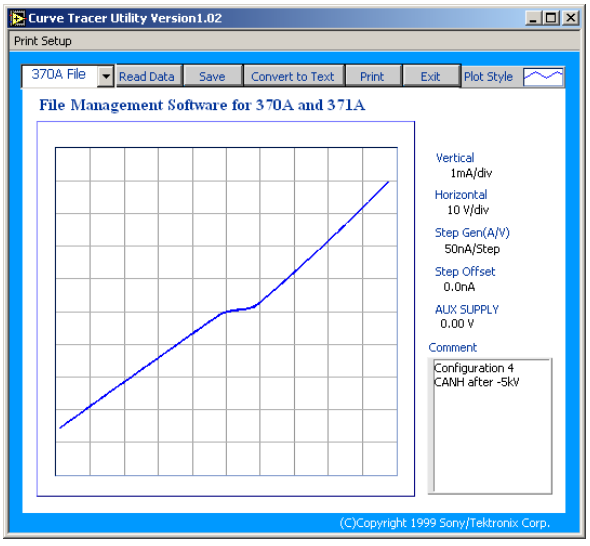


Figure 32. CANH of the AMIS−42665 after −5 kV

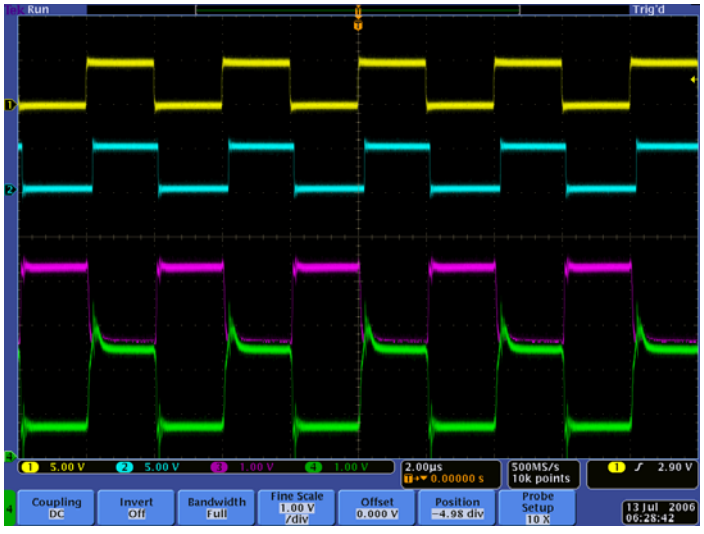


Figure 33. Functional behavior of the AMIS−42665 in Configuration 4 prior to test.
CH1 (yellow) Tx; CH2 (blue) Rx; CH3 (purple) CANH; CH4 (green) CANL.

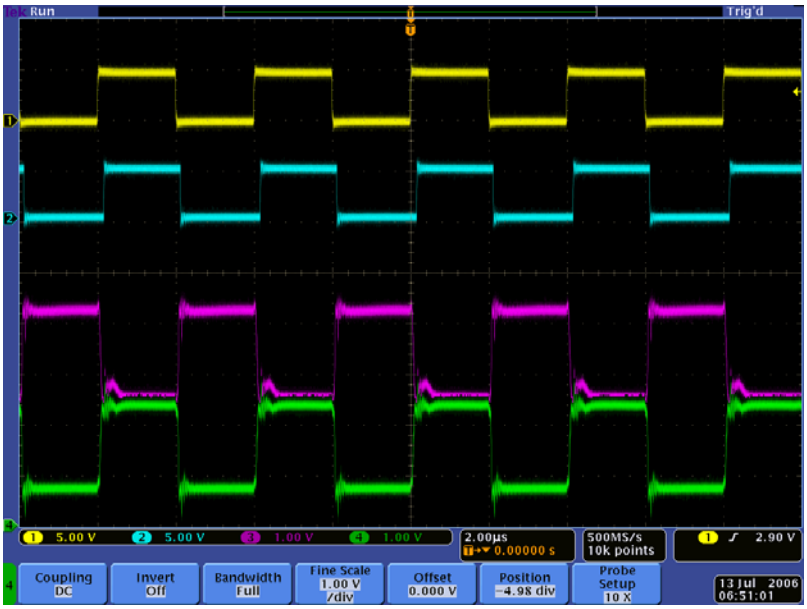


Figure 35. Functional behavior of the AMIS−42665 in Configuration 4 after test. CANL was stressed with −5 kV pulse and fails on curve tracer. Transceiver is still 100 percent functional (under normal conditions).

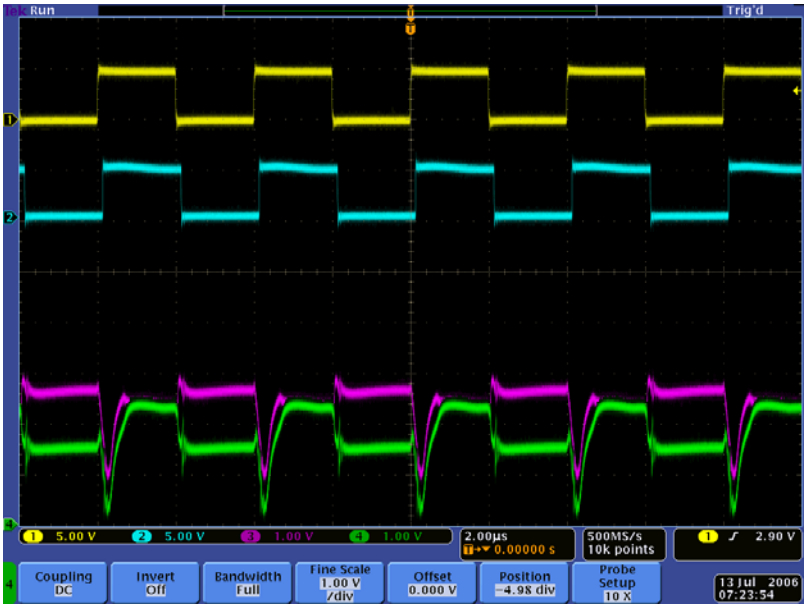


Figure 34. Functional behavior of the AMIS−42665 in Configuration 4 after test. CANL was stressed with +12 kV pulse and fails functional (bus levels).

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