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1 Introduction

This technical note defines the operation of the ZSSC3154 under varying supply voltage and load conditions. If not stated otherwise, the specified parameters and behavior are valid for the full specified temperature range.

2 Protection Functions

The ZSSC3154 provides short-pin protection, lost-pin detection, and over-voltage protection for the external connections in the application circuit: VCC (VDDE pin), AOUT1, AOUT2, and GND (VSSE pin). The components and configuration of the basic application circuit shown Figure 2.1 or Figure 2.2 (also given in section 3 of the *ZSSC3154 Data Sheet*) are required in order to guarantee these protection parameters.

Figure 2.1 Application Circuit with Two Analog Outputs and Diagnostic Fault Band Level Low

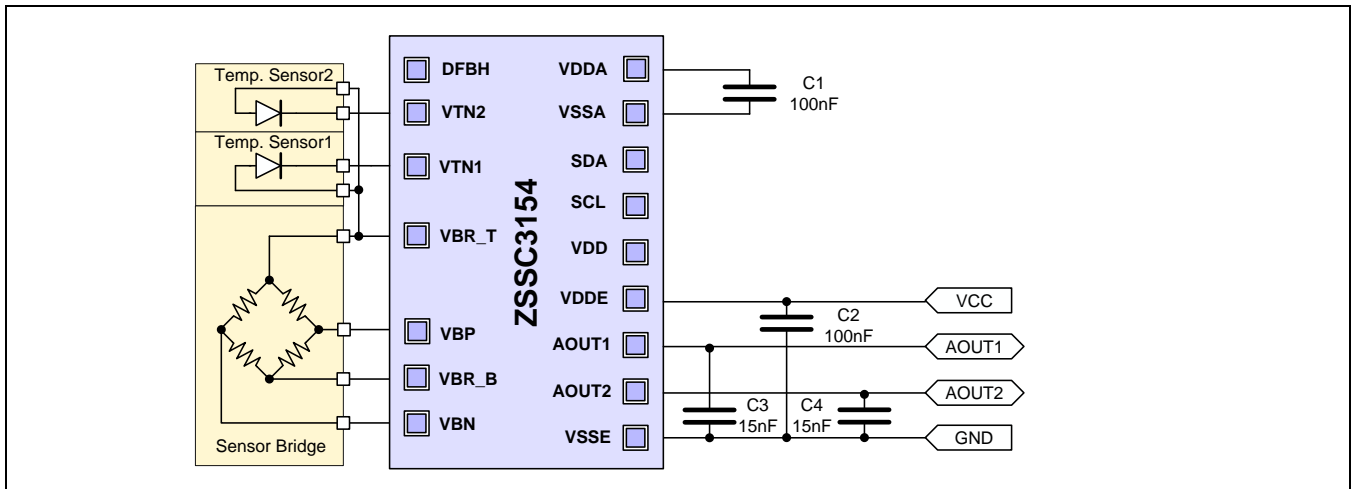
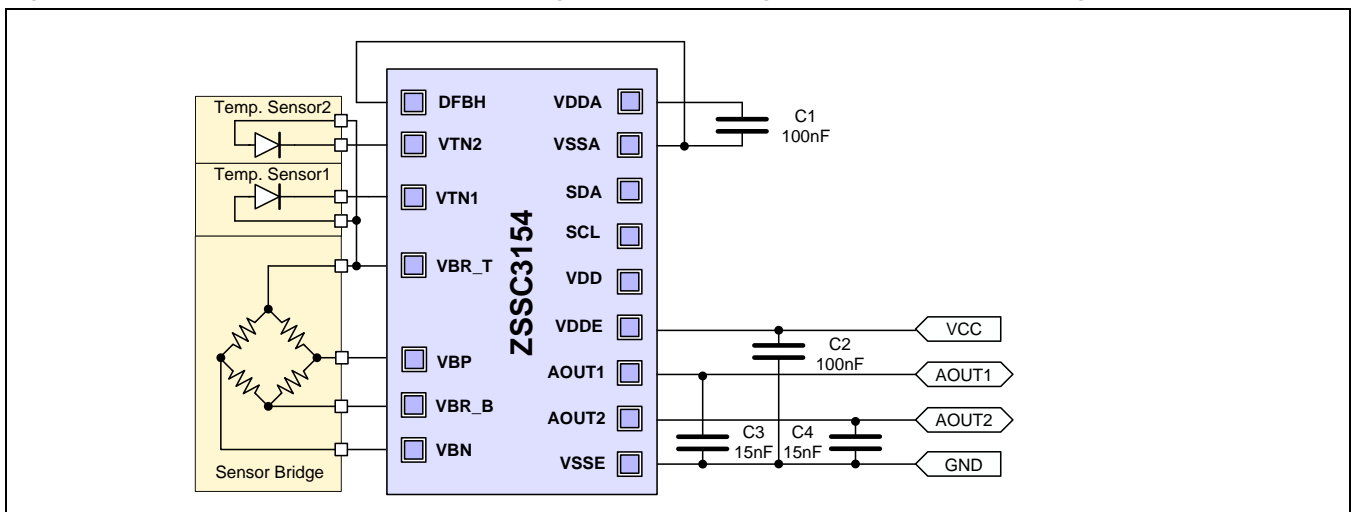


Figure 2.2 Application Circuit with Two Analog Outputs and Diagnostic Fault Band Level High



3 Values and Purpose of the External Components

Table 3.1 gives the typical values, ratings, and purpose for the required external components shown in Figure 2.1 and Figure 2.2. The purpose for C1, C2, C3, and C4 is to reduce the positive and negative voltage spikes and reduce the RF emission.

Note: The capacitor values are must be adapted to the requirements of the specific application, in particular to the EMC requirements.

V_N is the manufacturer's maximum voltage rating for the capacitor.

Table 3.1 External Components for Protection

	Component	SYMBOL	Parameter
3.1.	Capacitor (VDDA to VSSA)	C1	Typical 100nF, $V_N \geq 10V$
3.2.	Capacitor (VDDE to VSSE)	C2	Typical 100nF, $V_N \geq 16V$
3.3.	Capacitor (AOUT1 to VSSE) ^{1,2}	C3	Typical 15nF, $V_N \geq 16V$
3.4.	Capacitor (AOUT2 to VSSE) ^{2,3}	C4	Typical 15nF, $V_N \geq 16V$
<p>1. C3 is the sum of the load capacitance and the cable capacitance; refer to the ZSSC3154 Data Sheet for additional requirements.</p> <p>2. Requirements for external capacitance on these pins are not tested in mass production but are guaranteed by design and/or quality monitoring.</p> <p>3. C4 is the sum of the load capacitance and the cable capacitance; refer to the ZSSC3154 Data Sheet for additional requirements.</p>			

4 Behavior when Supply Voltage < $V_{DDE_{MIN}}$

Table 4.1 Behavior when Supply Voltage < $V_{DDE_{MIN}}$

	Condition	Behavior	ZSSC3154 Function
	$V_{DDE}=V_{CC}$, $V_{SSE}=GND$		
4.1.	$V_{VSSE} = 0V$, $0V < V_{VDDE} < 1.5V$ $V_{AOUT1} = 0$ to V_{VDDE} $V_{AOUT2} = 0$ to V_{VDDE}	Output not specified.	Not specified.
4.2.	$V_{VSSE} = 0V$, $1.5V \leq V_{VDDE} < V_{switch_on}$ ¹ $V_{AOUT1} = 0$ to V_{VDDE} $V_{AOUT2} = 0$ to V_{VDDE}	AOUT1 and AOUT2 switches to high impedance state. ²	ZSSC3154 is in the reset condition.
4.3.	$V_{VSSE} = 0V$ $V_{AOUT1} = 0$ to V_{VDDE} $V_{AOUT2} = 0$ to V_{VDDE} $V_{switch_on} < V_{VDDE} < 4.5V$ ¹	Internal current and voltage limitation.	ZSSC3154 is in the Normal Operation Mode (NOM); parameters are not guaranteed.

1. V_{switch_on} depends on the Power-On-Reset (POR) level voltage:
Internal POR_off threshold = 3.3 V to 4.1 V ($V_{DDA} \rightarrow V_{SSA}$), internal POR_on threshold = 3.0 V to 3.8 V ($V_{DDA} \rightarrow V_{SSA}$)
Hysteresis POR_off - POR_on = 300mV (minimum), delay POR_off = 0.4ms to 2.5ms, delay POR_on = 0.2ms to 1.2ms.

2. High impedance state: $-40\mu A \leq I_{OUTLEAKAGE} \leq +40\mu A$; $I_{OUTLEAKAGE_{typ}} = \pm 13\mu A$ (at 25°C), where $I_{OUTLEAKAGE}$ is the leakage current of the AOUT1 and AOUT2 pins.

5 Behavior at Nominal Supply Voltage

Table 5.1 Behavior when $4.5V \leq (V_{DDE}-V_{SSE}) \leq 5.5V$

	Condition	Behavior	ZSSC3154 Mode
	$V_{DDE}=V_{CC}$, $V_{SSE}=GND$		
5.1.	$V_{VSSE} = 0V$ $V_{AOUT1} = 0$ to V_{VDDE} $V_{AOUT2} = 0$ to V_{VDDE} $4.5V \leq (V_{DDE}-V_{SSE}) \leq 5.5V$	Internal current and voltage limitation.	Normal Operation Mode (NOM); parameters are guaranteed.
5.2.	$V_{VSSE} = 0V$ $V_{AOUT1} = 0$ to V_{VDDE} $V_{AOUT2} = 0$ to V_{VDDE} $V_{VDDE} = 4.5V$ to $5.5V$	Internal current and voltage limitation.	Internal EEPROM programming is possible when ZSSC3154 functions in Command Mode. The AOUT1 pin is used as the one-wire interface (OWI) pin.

6 Behavior during Short Circuit or Overvoltage (Maximum: 7.7V)

Figure 6.1 illustrates the possible short or overvoltage conditions using the following switches to represent the fault condition possibilities: swvcc, swaout1, swaout2, and swgnd. Possible fault conditions represented are a direct short high to Vsupp (4.5V to 5.5V), a connection to Vsupp through a resistance Ry, a direct short to ground, a connection to ground through a resistance Rx, and an overvoltage condition of >5.5V up to 7.7V maximum (labeled 7.7V). See Table 6.1 for the effects of the various combinations of these conditions on the external connection lines.

Figure 6.1 Short or Overvoltage Conditions

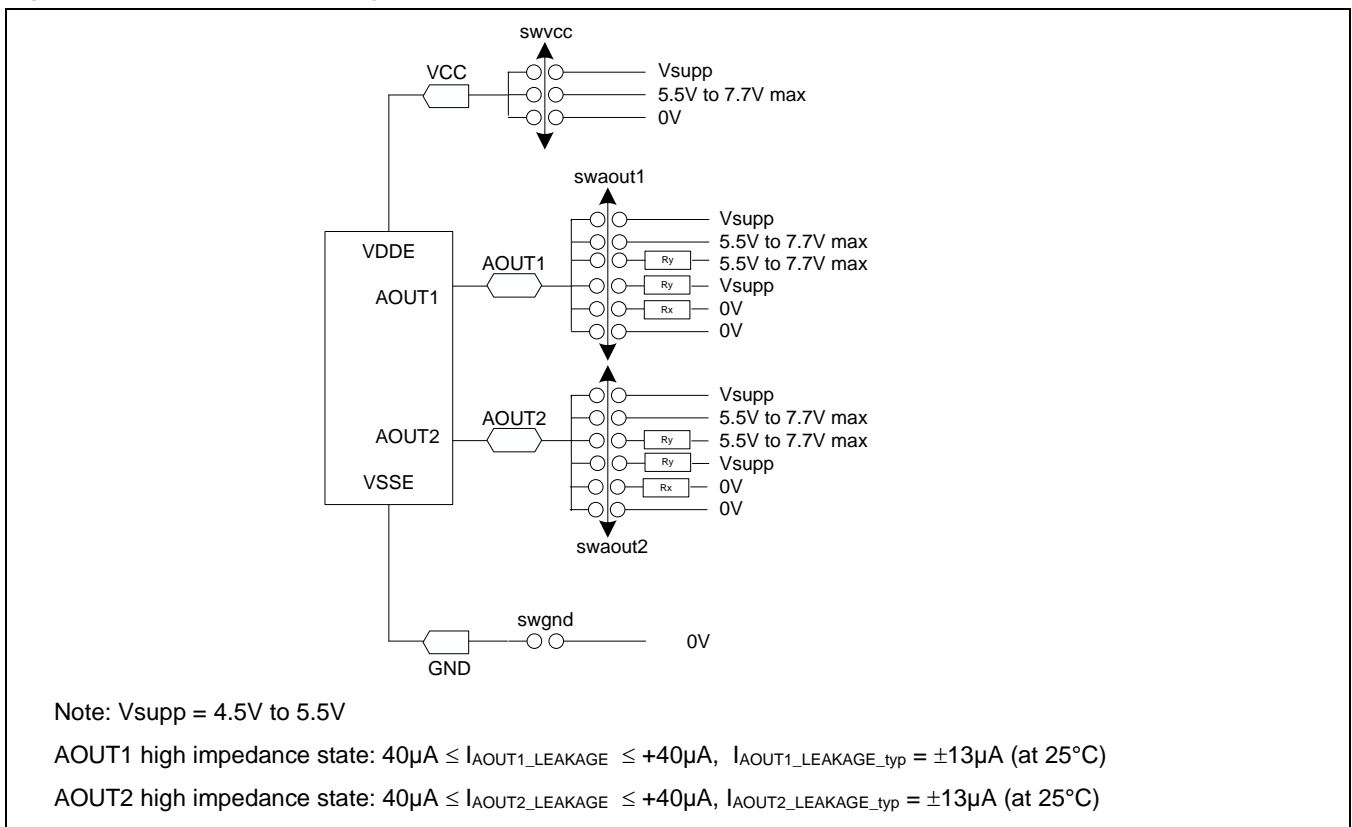


Table 6.1 Short Circuit or Overvoltage Conditions (Maximum: 7.7V)

An asterisk (*) indicates a current assumption at AOUT1 or AOUT2 of 25mA (max.).

	Condition		ZSSC3154 Behavior	ZSSC3154 Function
	VDDE=VCC, VSSE=GND, swgnd = 0V			
	swvcc	swaout1 or swaout2		
6.1.	+5.5 to +7.7V	Ry → +5.5 to +7.7V	Internal current and voltage limitation.	IC active → output signal in extended tolerance range *
6.2.	+5.5 to +7.7V (VDDE=AOUT1)	+5.5 to +7.7V (VDDE=AOUT1)	Internal current and voltage limitation.	No output signal on AOUT 1 and AOUT2
6.3.	+5.5 to +7.7V (VDDE=AOUT2)	+5.5 to +7.7V (VDDE=AOUT2)	Internal current and voltage limitation.	No output signal on AOUT 1 and AOUT2
6.4.	+5.5 to +7.7V	Ry → Vsupp	Internal current and voltage limitation.	IC active → output signal in extended tolerance range *
6.5.	+5.5 to +7.7V	Vsupp	Internal current and voltage limitation.	No output signal on AOUT 1 and AOUT2
6.6.	Vsupp	Ry → 5.5 to +7.7V	Internal current and voltage limitation.	IC active → output signal in extended tolerance range *
6.7.	Vsupp	+5.5 to +7.7V	Internal current and voltage limitation.	No output signal on AOUT 1 and AOUT2*
6.8.	+5.5 to +7.7V	Rx → 0V	Internal current and voltage limitation.	IC active → output signal in extended tolerance range *
6.9.	+5.5 to +7.7V	0V	Internal current and voltage limitation.	No output signal on AOUT 1 and AOUT2*

7 Behavior for Open or Short Circuit Conditions (VDDE - VSSE = 4.5V to 5.5V)

Figure 7.1 illustrates the possible open or short conditions when the supply is within specifications. It uses the following switches to represent the fault condition possibilities: swvcc, swaout1, swaout2, and swgnd. Possible fault conditions represented in this case are an open on the supply to VDDE, an open on the connection to AOUT1 or AOUT2, an open on the GND connection to VSSE, a direct short to Vsupp (4.5V to 5.5V) on AOUT1 or AOUT2, a short to Vsupp through a resistance Ry on AOUT1 or AOUT2, a direct short to ground on AOUT1 or AOUT2, or a short to ground through a resistance Rx on AOUT1 or AOUT2. See Table 7.1 for the effects of the various combinations of these conditions on the external connection lines.

Figure 7.1: Lost Connection (Open) or Short Conditions (VDDE – VSSE = 4.5V to 5.5V)

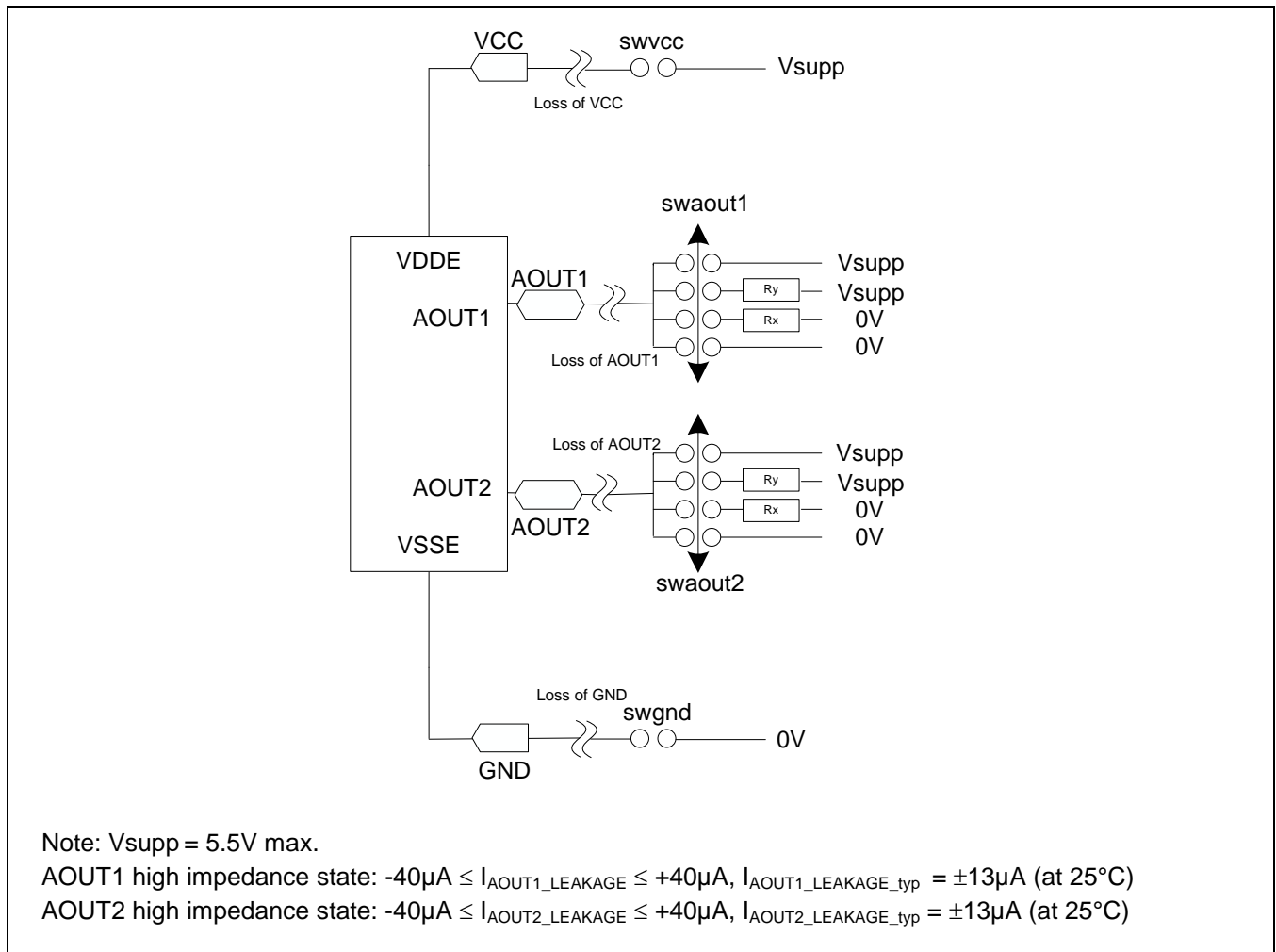


Table 7.1 Effects of Lost Connections (Open) and/or Short Conditions (VDDE - VSSE = 4.5V to 5.5V)

	Condition			Function	Behavior
	VDDE=VCC, VSSE=GND, swgnd=0V, swvcc=Vsupp				
	Loss of or Shorted	swaout1	swaout2		
7.1.	VCC	Rx→0V	Not used	AOUT1 signal in DFB (diagnostic fault band).	AOUT1 switch is high impedance.
			Rx→0V	AOUT1 and AOUT2 signal in DFB.	AOUT1 and AOUT2 switch are high impedance.
			Ry→Vsupp		
7.2.	AOUT1	Rx→0V	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.3.	AOUT2	Rx→0V	Rx→0V	AOUT1 signal in normal range; no AOUT2 signal.	
			Ry→Vsupp		
7.4.	GND	Rx→0V	Not used	AOUT1 signal in DFB.	AOUT1 switch is high impedance.
			Rx→0V	AOUT1 and AOUT2 signal in DFB.	AOUT1 and AOUT2 switch are high impedance.
			Ry→Vsupp		
7.5.	VCC	Ry→Vsupp	Not used	AOUT1 signal in DFB.	AOUT1 switch is high impedance.
			Rx→0V	AOUT1 and AOUT2 signal in DFB.	AOUT1 and AOUT2 switch are high impedance.
			Ry→Vsupp		
7.6.	AOUT1	Ry→Vsupp	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.7.	AOUT2	Ry→Vsupp	Rx→0V	AOUT1 signal in normal range; no AOUT2 signal.	
			Ry→Vsupp		
7.8.	GND	Ry→Vsupp	Not used	AOUT1 signal in DFB.	AOUT1 switch is high impedance.
			Rx→0V	AOUT1 and AOUT2 signal in DFB.	AOUT1 and AOUT2 switch are high impedance.
			Ry→Vsupp		
7.9.	AOUT1 →VCC	Rx→0V	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.10.	AOUT2 →VCC	Rx→0V	Rx→0V	AOUT1 signal in normal	

	Condition			Function	Behavior
	VDDE=VCC, VSSE=GND, swgnd=0V, swvcc=Vsupp				
	Loss of or Shorted	swaout1	swaout2		
			Ry→Vsupp	range; no AOUT2 signal.	
7.11.	AOUT1 →GND	Rx→0V	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.12.	AOUT2 →GND	Rx→0V	Rx→0V	AOUT1 signal in normal range; no AOUT2 signal.	
			Ry→Vsupp		
7.13.	VCC →GND	Rx→0V	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 and no AOUT2 signal.	
			Ry→Vsupp	No AOUT1 signal; AOUT2 signal in DFB.	
7.14.	AOUT1 →VCC	Ry→Vsupp	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.15.	AOUT2 →VCC	Ry→Vsupp	Rx→0V	AOUT1 signal in normal range; no AOUT2 signal.	
			Ry→Vsupp		
7.16.	AOUT1 →GND	Ry→Vsupp	Not used	No AOUT1 signal.	
			Rx→0V	No AOUT1 signal; AOUT2 signal in normal range.	
			Ry→Vsupp		
7.17.	AOUT2 →GND	Ry→Vsupp	Rx→0V	AOUT1 signal in normal range; no AOUT2 signal.	
			Ry→Vsupp		
7.18.	VCC →GND	Ry→Vsupp	Not used	AOUT1 signal in DFB.	AOUT switches to high impedance state.
			Rx→0V	AOUT1 signal and AOUT2 signal in DFB.	
			Ry→Vsupp		

8 Overvoltage Protection

The ZSSC3154 pins VDDE, VSSE, AOUT1 and AOUT2 are protected against overvoltage $\leq 7.7V$. This is only guaranteed if external components are used as shown in the application circuits.

9 Output Current Limitation for PIN AOUT1 and AOUT2

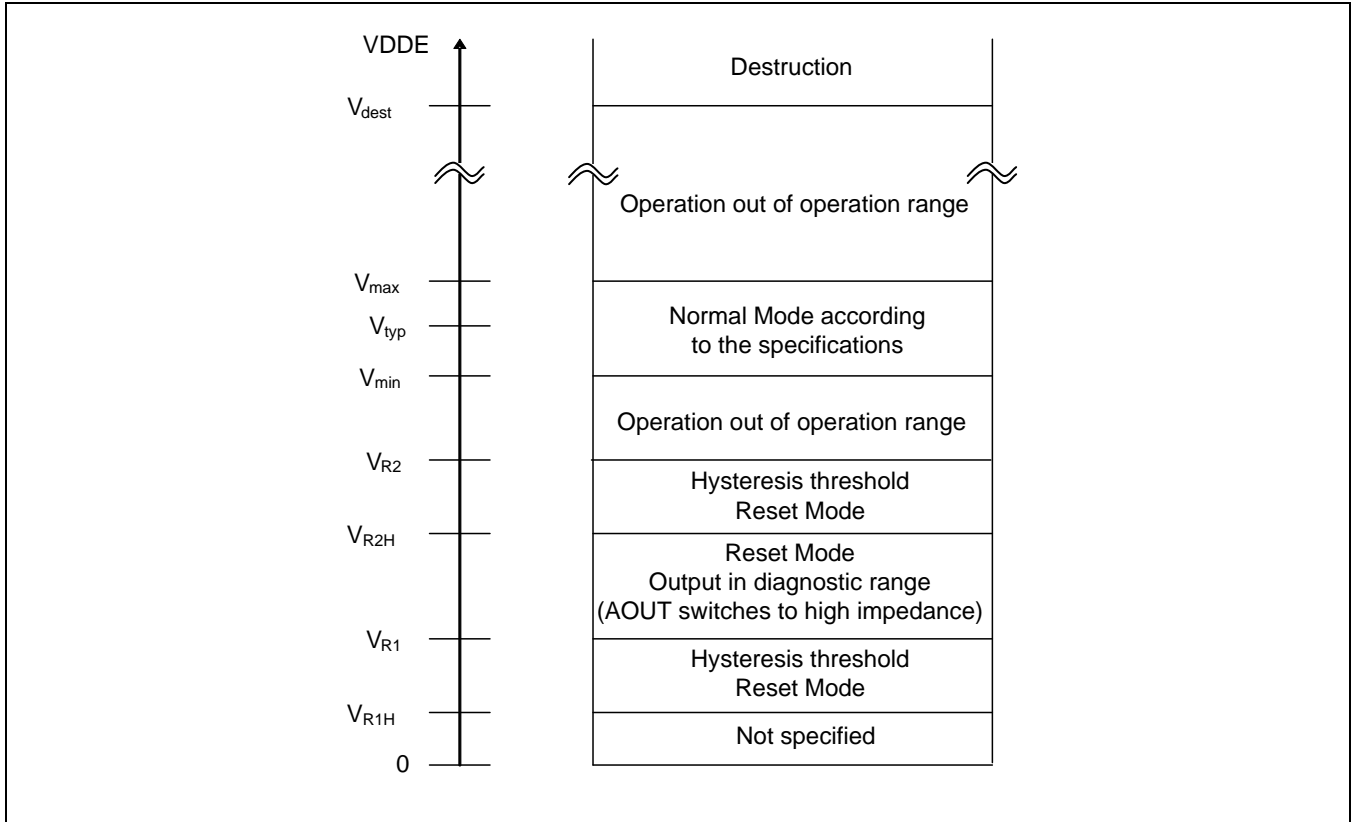
In the event of a short to the external supply pins VCC or GND, every output current is limited to 15mA (typical) at pins AOUT1 and AOUT2. In the event of overvoltage at VDDE ($VDDE > 5.5V$; 7.7V max), the current is limited to less than 50mA.

10 Supply Voltage Behavior (without Time Limits)

Table 10.1 Supply Voltage Behavior

	Voltage Range ¹	Sensor Behavior	Limits (Typical Values)
10.1.	↗ 0 to V_{R1}	Not specified	$V_{R1} < 1.5V$
10.2.	↗ V_{R1} to V_{R2}	Reset Mode; output in diagnostic range	$V_{R2} = 3.7V$
10.3.	↗ V_{R2} to V_{min}	Normal Mode; extended tolerance range	$V_{min} = 4.5V$
10.4.	↗ V_{min} to V_{typ}	Normal Mode according to specifications	$V_{typ} = 5V$
10.5.	↗ V_{typ} to V_{max}	Normal Mode according to specifications	$V_{max} = 5.5V$
10.6.	↗ V_{max} to V_{dest}	Normal Mode; extended tolerance range	$V_{dest} > 7.7V$
10.7.	↗ V_{dest} to V_{∞}	Destruction	$V_{dest} > 7.7V$
10.8.	↘ V_{dest} to V_{max}	Normal Mode; extended tolerance range	$V_{dest} > 7.7V$, $V_{max} = 5.5V$
10.9.	↘ V_{max} to V_{typ}	Normal Mode according to specifications	$V_{typ} = 5V$
10.10.	↘ V_{typ} to V_{min}	Normal Mode according to specifications	$V_{min} = 4.5V$
10.11.	↘ V_{min} to V_{R2H}	Normal Mode; extended tolerance range	$V_{R2H} < V_{R2} - 0.3V$
10.12.	↘ V_{R2H} to V_{R1H}	Reset Mode; output in diagnostic range	$V_{R1H} < V_{R1}$
<p>1. In this column, the symbol ↗ indicates a rise in the supply voltage (voltage increases from V_x to V_y). The symbol ↘ indicates a downward slope for the supply voltage (voltage decreases from V_x to V_y).</p>			

Figure 10.1 Behavior over Full Supply Voltage Range



11 EMC Specification

11.1. Behavior during Applications of Test Pulses

The required application circuit (see *ZSSC3154_DataSheet_Rev_X_xx.pdf*, section 3) prevents irreversible damage to the ZSSC3154 during application of test pulses.

The integrated reset circuit with sufficient hysteresis prevents an out-of-specification switch between different working modes. The functional mode of the pressure sensor (IC and application) is mainly determined by external components.

The customer must verify the functions of the total system. If necessary, the customer must adjust the application circuit and the dimensions of the external components respectively.

Negative voltage pulses at the supply line cause an interruption of the ZSSC3154 power supply that must be compensated for with suitable steps.

11.2. Strength against Test Pulses (DIN 40839 Part1)

When testing the total system, the following parameters apply:

- Functional State A:
The device fulfills the complete functionality according to the specification during and after the application of test pulses.
- Functional State B:
The device fulfills the complete functionality according to the specification during the application of test pulses, but one or more functions might be out of the range of the operational tolerances. After the test pulse application, all functions are fulfilled according to the specification again. Memory functions must stay in the state A.

Table 11.1 Test Pulses 3a, 3b Severity IV according to DIN 40839 Part 1, Capacitive Coupling AOUT1 or AOUT2 Pin

Test-Pulse	Pulse-Amplitude Vs [V]	Ri [Ω]	td [μs]	tr [ns]	t1 [μs]	t4 [ms]	t5 [ms]	Functional State of the Device	Duration
3a	-150	50	0.1	5	100	10	90	B	1h
3b	+100	50	0.1	5	100	10	90	B	1h

11.3. Electromagnetic Emission

The wired emission of externally connected pins of the device is measured according to the following standard:

IEC 61967_4:2002 + A1:2006

Measurements must be performed with the application circuit described in the *ZSSC3154 Data Sheet*.

For the pins VDDE, AOUT1, and AOUT2, the spectral power measured with the 150Ω method must not exceed the limits according to IEC code H10kN. For the VSSE pin, the spectral power measured with the 1Ω method must not exceed the limits according to IEC code 15KmO.

12 Related Documents

Document
ZSSC3154 Data Sheet

Visit www.IDT.com/ZSSC3154 or contact your nearest sales office for the latest version of these documents.

13 Glossary

Term	Description
AOUT	Analog Output
DFB	Diagnostic Fault Band
EMC	Electromagnetic Compatibility
IC	Integrated Circuit
POR	Power-on-Reset
SSC	Sensor Signal Conditioner

14 Document Revision History

Revision	Date	Description
1.00	October 21, 2013	First release.
	April 1, 2016	Changed to IDT branding.

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