

Single-Ended Bus Transceiver

DESCRIPTION

The Si9241AEY is a monolithic bus transceiver designed to provide bidirectional serial communication in automotive diagnostic applications.

The device incorporates protection against overvoltages and short circuits to V_{BAT} . The transceiver pin is protected and can be driven beyond the V_{BAT} voltage.

The Si9241AEY is built on the Vishay Siliconix BiC/DMOS process. An epitaxial layer prevents latchup.

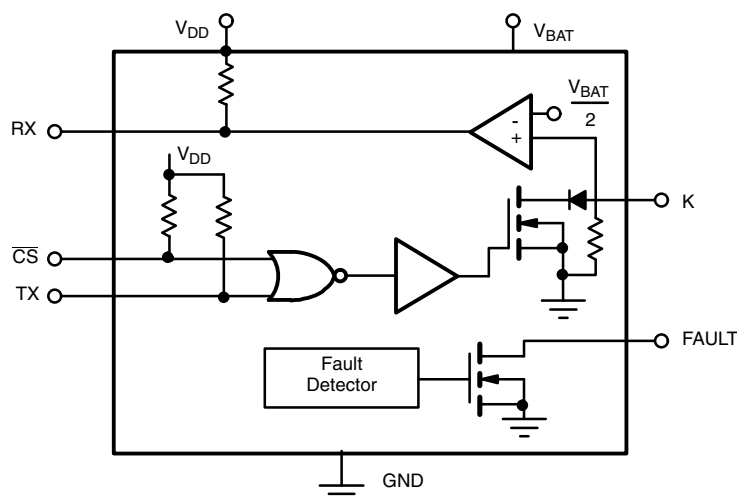
The RX output is capable of driving CMOS or 1 x LSTTL load.

The Si9241AEY is available in a space efficient 8-pin SO package. It operates reliably over the automotive temperature range (- 40 to 125 °C). The Si9241AEY is available in both standard and lead (Pb)-free packages.

FEATURES

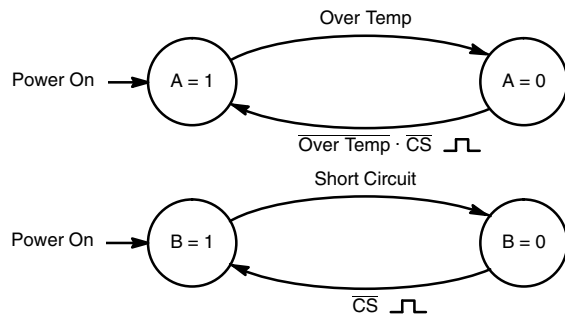
- Operating Power Supply Range
 $6\text{ V} \leq V_{BAT} \leq 36\text{ V}$
- Reverse Battery Protection Down to $V_{BAT} \geq -24\text{ V}$
- Standby Mode With Very Low Current Consumption
 $I_{BAT(SB)} = 1\text{ }\mu\text{A}$ at $V_{DD} = 0.5\text{ V}$
- Low Quiescent Current in OFF Condition
 $I_{BAT} = 120\text{ }\mu\text{A}$ and $I_{DD} \leq 10\text{ A}$
- ISO 9141 Compatible
- Overtemperature Shutdown Function For K Output
- Defined K Output OFF for Open GND
- Defined Receive Output Status for Open K Input
- Defined K Output OFF for TX Input Open
- Open Drain Fault Output
- 2 kV ESD
- Typical Transmit Speeds of 200 kBaud

PIN CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM



Si9241A

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**OUTPUT TABLE AND STATE DIAGRAMS**

Note: Over Temp is an internal condition, not meant to be a logic signal.

INPUTS		STATE VARIABLE		OUTPUT TABLE			Comments
$\overline{CS}$	TX	A	B	RX	K	$\overline{FAULT}$	
0	0	1	1	0	0	1	Over Temp Short Circuit
0	1	1	1	1	1	1	
X	X	0	1	K	HiZ	0	
0	X	1	0	K	HiZ	0	Receive Mode
1	X	1	1	0	0	1	
1	X	1	1	1	1	1	

X = "1" or "0"
HiZ = High Impedance State

ABSOLUTE MAXIMUM RATINGS

Parameter	Limit	Unit
Voltages Referenced to Ground		
Voltage On V_{BAT}	- 24 to 45	V
Voltage K	- 16 to ($V_{BAT} + 1$)	
Voltage Difference $V_{(VBAT, K)}$	55	
Voltage or Max. Current On Any Pin (Except V_{BAT} , K)	- 0.3 to ($V_{DD} + 0.3$ V) or 10	mA
Voltage on V_{DD}	7	V
K Pin Only, Short Circuit Duration (to V_{BAT} or GND)	Continuous	
Operating Temperature (T_A)	- 40 to 125	°C
Junction and Storage Temperature	- 55 to 150	
Thermal Impedance (Θ_{JA})	125	°C/W

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING RANGE

Parameter	Limit	Unit
Voltages Referenced to Ground		
V_{DD}	4.5 to 5.5	V
V_{BAT}	6 to 36	
K	6 to 36	
Digital Inputs	0 to V_{DD}	



SPECIFICATIONS

Parameter	Symbol	Test Conditions Unless Specified V _{DD} = 4.5 V to 5.5 V V _{BAT} = 6 V to 36 V		Temp. ^a	Limits - 40 to 125 °C			Unit
					Min. ^b	Typ. ^c	Max. ^b	
Transmitter and Logic Levels								
$\overline{CS}$, TX Input Low Voltage	V _{ILT}			Full			1.5	V
$\overline{CS}$, TX Input High Voltage	V _{IHT}			Full	3.5			
TX Input Capacitance ^d	C _{INT}			Full			10	pF
$\overline{CS}$, TX Input Pull-up Resistance	R _{TX}	V _{DD} = 5.5 V, TX or $\overline{CS}$ = 1.5 V, 3.5 V		Full	10	20	40	kΩ
K Transmit								
K Output Low Voltage	V _{OLK}	R _L = 510 Ω ± 5 %, V _{BAT} = 6 to 18		Full			0.2 V _{BAT}	V
		R _L = 1 kΩ ± 5 %, V _{BAT} = 16 to 36		Full			0.2 V _{BAT}	
		R _L = 510 Ω ± 5 %, V _{BAT} = 4.5		Full			1.2	
K Output High Voltage	V _{OHK}	R _L = 510 Ω ± 5 %, V _{BAT} = 4.5 to 18		Full	0.95 V _{BAT}			
		R _L = 1 kΩ ± 5 %, V _{BAT} = 16 to 36		Full	0.95 V _{BAT}			
K Rise, Fall Times	t _{r, f}	See Test Circuit		Full			9.6	μs
K Output Sink Resistance	R _{si}	$\overline{CS}$ = 0 V, TX = 0 V		Full			110	Ω
K Output Capacitance ^d	C _O			Full			20	pF
Receiver								
K Input Low Voltage	V _{ILK}			Full			0.35 V _{BAT}	V
K Input High Voltage	V _{IHK}			Full	0.65 V _{BAT}			
K Input Hysteresis ^{c, d}	V _{HYS}			Full		0.05 V _{BAT}		
K Input Currents	I _{IHK}	$\overline{CS}$ = 4	V _{IHK} = V _{BAT}	Full			20	μA
RX Output Low Voltage	V _{OLR}		V _{ILK} = 0.35 V _{BAT} I _{OLR} = 1 mA	Full			0.4	V
RX Pull-up Resistance	R _{RX}			Full	5		20	kΩ
RX Turn On Delay	t _{d(on)}	R _L = 510 Ω ± 5 %, V _{BAT} = 6 V to 18 V C _L = 10 nF, See Test Circuit		Full		3	10	μs
		R _L = 1 kΩ ± 5 %, V _{BAT} = 16 V to 36 V C _L = 4.7 nF, See Test Circuit		Full		3	10	
RX Turn Off Delay	t _{d(off)}	R _L = 510 Ω ± 5 %, V _{BAT} = 6 V to 18 V C _L = 10 nF, See Test Circuit		Full		3	10	
		R _L = 1 kΩ ± 5 %, V _{BAT} = 16 V to 36 V C _L = 4.7 nF, See Test Circuit		Full		3	10	
Supplies								
Bat Supply Current On	I _{BAT(on)}	$\overline{CS}$ = TX = 0 V, V _{BAT} ≤ 16 V		Full		1.2	3	mA
Bat Supply Current Off	I _{BAT(off)}	$\overline{CS}$ = High, V _{BAT} ≤ 12 V, TX = High ^f		Full		120	220	μA
Bat Supply Current Standby	I _{BAT(SB)}	V _{DD} ≤ 0.5 V, V _{BAT} ≤ 12 V		Full		< 1	10	
Logic Supply Current On	I _{DD(on)}	V _{DD} ≤ 5.5 V, TX = 0 V		Full		1.4	2.3	mA
Logic Supply Current Off	I _{DD(off)}	$\overline{CS}$ = High, V _{BAT} ≤ 12 V, TX = High ^f		Full			10	μA
Miscellaneous								
TX Transmit Baud Rate	BR _T	R _L = 510 Ω, C _L = 10 nF		Full	10.4			kBaud
RX Receive Baud Rate ^c	BR _R	6 V < V _{BAT} < 16 V, C _{RX} = 20 pF		Full		200		
Transmission Frequency	f _{K-RXK}	6 V < V _{BAT} < 16 V, R _K = 510 Ω, C _K ≤ 1.3 nF		Full	50	200		kHz
Fault Output Low Voltage	V _{OLF}	$\overline{CS}$ = TX = 0, K = V _{BAT} , I _{OLF} = 1 mA		Full			0.4	V
$\overline{CS}$ Minimum Pulse Width ^{d, e}	t _{cs}			Full	1			μs
Over Temperature Shutdown ^d	T _{SHUT}	Temperature Rising			160	180		°C
Temperature Shutdown Hysteresis ^c	T _{HYST}					30		

Notes:

a. Room = 25 °C, Cold and Hot = as determined by the operating temperature suffix.

b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.

c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

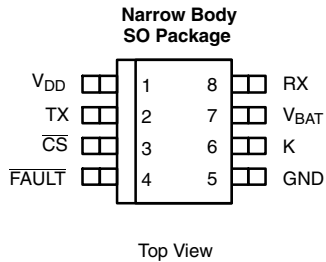
d. Guaranteed by design, not subject to production test.

e. Minimum pulse width to reset a fault condition.

f. High refers to Logic High and Low refers to Logic Low.

Si9241A

Vishay Siliconix

**PIN CONFIGURATION****ORDERING INFORMATION**

Part Number	Temperature Range
Si9241AEY-T1	- 40 °C to 125 °C
Si9241AEY-T1-E3 (Lead (Pb)-free)	

PIN DESCRIPTION

Pin Number	Symbol	Description
1	V_{DD}	Positive Power Supply
2	TX	Transmit, Input
3	$\overline{CS}$	Chip Select, Input
4	$\overline{FAULT}$	Fault, Open Drain Output
5	GND	Ground Connection
6	K	Transmit/Receive, Bidirectional
7	V_{BAT}	Battery Power Supply
8	RX	Receiver, Output

FUNCTIONAL DESCRIPTION

The Si9241AEY can be either in transmit or receive mode and it contains over temperature, and short circuit V_{BAT} fault detection circuits.

The voltage on K is internally compared to $V_{BAT/2}$. If the voltage on the K pin is less than $V_{BAT/2}$ then RX output will be "low". If the voltage on the K pin is greater than $V_{BAT/2}$ then RX output will be "high".

In order to be in transmit mode, $\overline{CS}$ must be set "low". When $\overline{CS}$ and TX are set "low" the internal MOSFET will turn on, causing the K pin to be "low". In the transmit mode, the processor monitors RX and TX. When the two mirror each other there is no fault. In the event of over temperature, or short circuit to V_{BAT} , the Si9241AEY will turn off the K output to protect the IC and the external open drain FAULT pin will

be asserted. The K pin will stay in high impedance and RX will follow the K pin. The fault will be reset when $\overline{CS}$ is toggled high. RX, $\overline{CS}$ and TX pins have an internal pull up resistor to V_{DD} while the K pin has internal pull down resistors. When any one of the TX, V_{BAT} or GND pins is open the K output is off.

When $\overline{CS}$ is set "high" the Si9241AEY is in receive mode and the internal MOSFET for the K pin is turned off. The RX output will follow the K pin. If $\overline{CS}$ is "low" while the IC is receiving data, an incorrect fault signal will occur.

To inhibit the short detect, tie $\overline{CS}$ and TX together.

The schematic diagram of the Si9241AEY shows the internal circuitry. The RX input is connected to an input buffer. The TX output is connected to a differential driver. The K output is connected to a level shifter. The timing diagram shows the relationship between RX, TX, and K signals. The RX signal has a delay $t_{d(off)}$ and $t_{d(on)}$. The TX signal has a minimum pulse width TX_{min} . The K signal is a voltage level that transitions between V_K and V_{BAT} with a rise time t_r and fall time t_f . The voltage levels are defined as V_{DD} , V_{BAT} , and V_K .

Timing parameters:

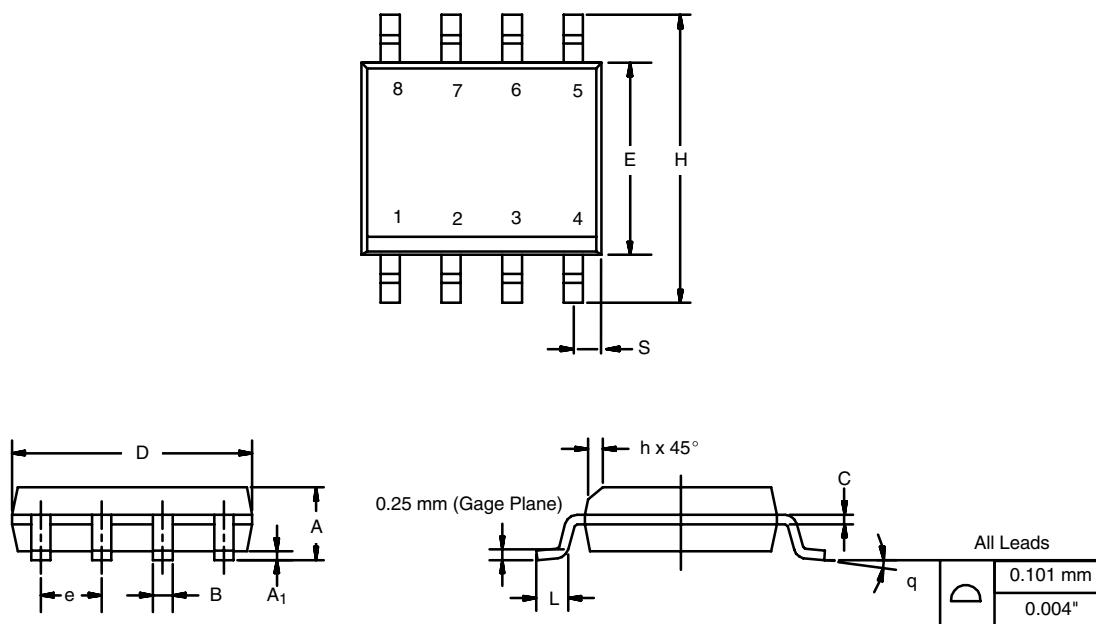
- $R_L = 510 \Omega$, $C_L = 10 \text{ nF}$, $V_{BAT} = 6 \text{ V to } 18 \text{ V}$
- $R_L = 1 \text{ k}\Omega$, $C_L = 4.7 \text{ nF}$, $V_{BAT} = 16 \text{ V to } 36 \text{ V}$

The diagram illustrates the electrical connections for a CAN bus system. On the left, the **ECU** (Electronic Control Unit) contains a **Microcontroller** with three I/O lines. It also includes two identical **Si9241AEY** transceiver chips. Each transceiver is powered by V_{DD} and has a pull-up resistor to V_{DD} . The ECU's power supply is derived from V_{BAT} through a $0.1\ \mu\text{F}$, $50\ \text{V}$ capacitor ($C1$), and the transceivers are powered by a V_{DD} supply also connected to a $0.1\ \mu\text{F}$, $50\ \text{V}$ capacitor ($C1$). The transceivers convert the microcontroller's signals into CAN bus signals, labeled **K-Line** and **L-Line**. On the right, the **Diagnostic Tester** is connected to the bus. It features a $510\ \Omega$ resistor and a switch connected to a $0.4\ \Omega$ resistor, which is then connected to the **Bus**. The bus is represented by a dashed line.

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SOIC (NARROW): 8-LEAD

JEDEC Part Number: MS-012



DIM	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A ₁	0.10	0.20	0.004	0.008
B	0.35	0.51	0.014	0.020
C	0.19	0.25	0.0075	0.010
D	4.80	5.00	0.189	0.196
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.020
L	0.50	0.93	0.020	0.037
q	0°	8°	0°	8°
S	0.44	0.64	0.018	0.026

ECN: C-06527-Rev. I, 11-Sep-06
DWG: 5498



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