Features

- Meet ISO11898 Standard
- Support CAN FD and data rates up to 5 Mbps
- Typical Loop Delay: 110 ns
- 5 V power supply, 3.0 V ~ 5.5 V IO interface
- Receiver Common Mode Input Voltage: ±30 V
- Bus Fault Protection: ±42 V
- Up to 110 Nodes in CAN network
- Junction Temperatures from −40°C to 150°C
- Latch-Up performance exceeds 500 mA
- BUS pin ESD Protection：
  - ±15 kV IEC-Contact ESD
  - ±15 kV Human-Body Model
  - ±1.5 kV Charged-Device Model

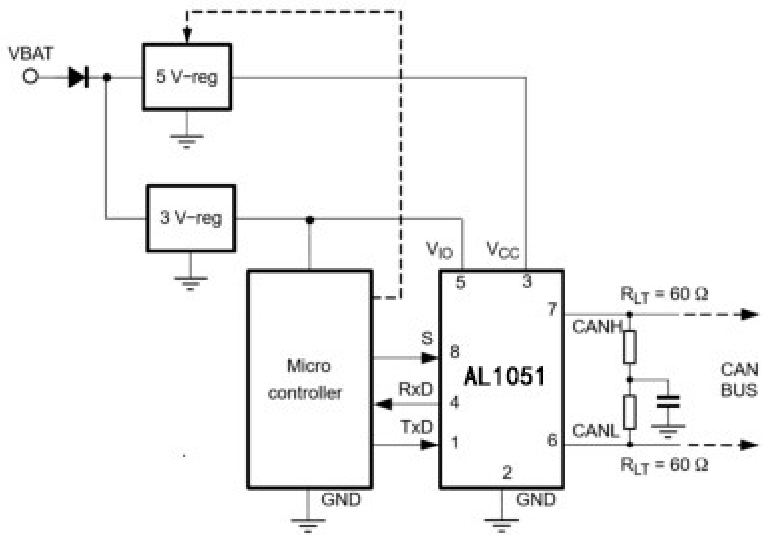
Applications

- All devices support highly loaded CAN networks
- Field Industrial Automation, Sensors and Drive Systems
- Building, Security Control Systems
- Energy Storage systems
- Telecom Base Station Status and Control

Description

The AL1051 device is a CAN transceiver which meets the ISO11898 High-speed CAN (Controller Area Network) physical layer standard. The device is designed to use in CAN FD networks up to 5 Mbps, and to enhance timing margin and higher data rates in long and high-loading networks. As design, the device features cross-wire, overvoltage and loss of ground protection from −42 V to +42 V, overtemperature shutdown, a −30 V to +30 V common-mode range. AL1051 has a secondary power supply input for I/O level shifting the input pin thresholds and RXD output level, and the device comes with silent mode which is also commonly referred as listen-only mode, and it includes many protection features to enhance device and network robustness.

Typical Application Circuit

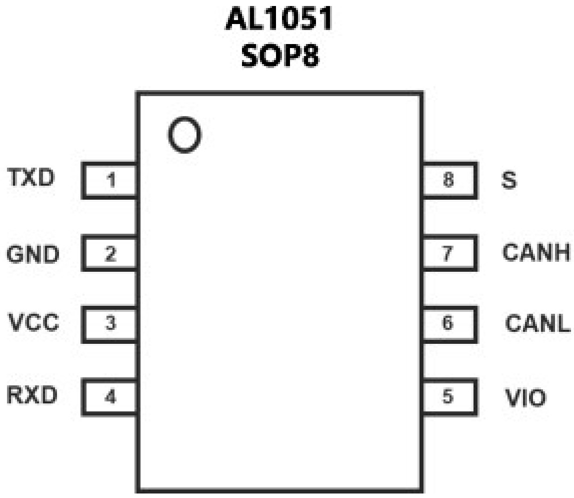


Product Family Table

Order Number	VCC (V)	VIO (V)	BUS Protection (V)	Package
AL1051N	5.0	NC	±42	SOP-8
AL1051	5.0	3.3, or 5	±42	SOP-8

Table of Contents

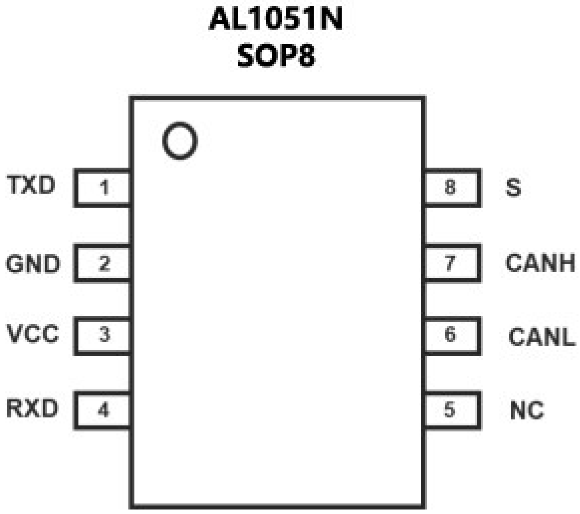
Pin Configuration and Functions – AL1051



AL1051 Pin Functions

Pin		I/O	Description
No.	Name		
1	TXD	I	CAN transmit data input
2	GND	GND	Ground
3	VCC	POWER	Transceiver 5V supply voltage
4	RXD	O	CAN receive data output
5	VIO	POWER	Transceiver I/O level shifting supply voltage
6	CANL	BUS I/O	Low level CAN bus input/output line
7	CANH	BUS I/O	High level CAN bus Input/output line
8	S	I	Silent Mode control input (active high)

Pin Configuration and Functions – AL1051N



AL1051N Pin Functions

Pin		I/O	Description
No.	Name		
1	TXD	I	CAN transmit data input
2	GND	GND	Ground
3	VCC	POWER	Transceiver 5V supply voltage
4	RXD	O	CAN receive data output
5	NC	-	Not Connection
6	CANL	BUS I/O	Low level CAN bus input/output line
7	CANH	BUS I/O	High level CAN bus input/output line
8	S	I	Silent Mode control input (active high)

Specifications

Absolute Maximum Ratings

Parameter		Min	Max	Unit
V_{CC}	5-V Bus Supply Voltage Range	−0.3	7	V
V_{IO}	I/O Level-Shifting Voltage Range	−0.3	7	V
V_{BUS}	CAN Bus I/O voltage range (CANH, CANL)	−42	42	V
V(Logic_Input)	Logic input terminal voltage range (TXD, S)	−0.3	7	V
V(Logic_Output)	Logic output terminal voltage range (RXD)	−0.3	7	V
IO(RXD)	RXD (Receiver) output current	−8	8	mA
T_J	Maximum junction temperature	−40	150	°C
T_{stg}	Storage temperature range	−65	150	°C

Note: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.
(1) This data was taken with the JEDEC low effective thermal conductivity test board.
(2) This data was taken with the JEDEC standard multilayer test boards.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
IEC	IEC Contact Discharge	IEC-61000-4-2, Bus Pin	±15	kV
	IEC Air-Gap Discharge	IEC-61000-4-2, Bus Pin	±15	kV
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001, Bus Pin	±15	kV
		ANSI/ESDA/JEDEC JS-001, All Pin Except Bus Pin	±6	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002, All Pin	±1.5	kV
LU	Latch Up	LU, per JESD78, All Pin	±500	mA

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Symbol	Description	Min	Max	Unit
V_{IO}	Input/output voltage TXD, RXD,S of AL1051	3.0	5.5	V
V_{CC}	Power supply	4.5	5.5	V
$I_{OH(RXD)}$	RXD terminal HIGH level output current	−2		mA
$I_{OL(RXD)}$	RXD terminal LOW level output current		2	mA
T_A	Operating ambient temperature	−40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
8-Pin SOIC	148	48	°C/W

Power Consumption

Parameter		Test Condition	Value	Unit
P_D	Average power dissipation (Dominant mode)	VCC = 5V, VIO = 3.3V, Ta = 25°C, RL = 60 Ω, S at 0 V, Input to TXD at 250 kHz, CL_RXD = 15 pF. Typical CAN operating conditions at 500 kbps with 25% transmission rate	63	mW
		VCC = 5.5V, VIO = 3.6V, Ta = 125°C, RL = 50 Ω, S at 0 V, Input to TXD at 0.5MHz, CL_RXD = 15 pF. Typical high load CAN operating conditions at 1 Mbps with 50% transmission rate and loaded network.	154	mW

Electrical Characteristics

V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = −40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{CC}	Normal mode (dominant)	TXD = 0 V, R_L = 60 Ω, C_L = open, R_{CM} = open, S = 0 V		50	70	mA
		TXD = 0 V, R_L = 50 Ω, C_L = open, R_{CM} = open, S = 0 V		52	80	mA
	Normal mode (dominant – bus fault)	TXD = 0 V, S = 0 V, CANH = CANL = -3 /+18V, R_L = open, C_L = open, R_{CM} = open		73	150	mA
	Normal mode (recessive)	TXD = V_{IO} , R_L = 50 Ω, C_L = open, R_{CM} = open, S = 0 V		1.2	2.5	mA
	Silent mode	TXD = V_{IO} , R_L = 50 Ω, C_L = open, R_{CM} = open, S = VCC		1.2	2.5	mA
I_{IO}	Normal and Silent modes	RXD Floating, TXD = S = 0 or V_{IO}		73	200	µA
UV_{VCC}	Rising undervoltage detection on V_{CC} for protected mode			4.0	4.4	V
	Falling undervoltage detection on V_{CC} for protected mode		3.6	3.9	4.2	
$V_{HYS(UVVCC)}$	Hysteresis voltage on U_{VVCC} (1)			200		mV
UV_{VIO}	Undervoltage detection on V_{IO} for protected mode	V_{IH} and V_{IL}	1.3		2.75	V
$V_{HYS(UVVIO)}$	Hysteresis voltage on U_{VVIO} for protected mode (1)			150		mV
Pin-S (mode select input)						
V_{IH}	High-level input voltage	AL1051	0.7 x V_{IO}			V
		AL1051N	2			
V_{IL}	Low-level input voltage	AL1051			0.3 x V_{IO}	
		AL1051N			0.8	
I_{IH}	High-level input leakage current	S = V_{CC} or V_{IO} = 5.5 V			30	µA
I_{IL}	Low-level input leakage current	S = 0 V, V_{CC} = V_{IO} = 5.5 V	−1	0	1	
$I_{lkg(OFF)}$	Unpowered leakage current	S = 5.5 V, V_{CC} = V_{IO} = 0 V	−1	0	1	
Pin-TXD (CAN transmit data input)						
V_{IH}	High-level input voltage	AL1051	0.7 x V_{IO}			V
		AL1051N	2			
V_{IL}	Low-level input voltage	AL1051			0.3 x V_{IO}	
		AL1051N			0.8	
I_{IH}	High-level input leakage current	S = V_{CC} or V_{IO} = 5.5 V	−2.5	0	1	µA
I_{IL}	Low-level input leakage current	S = 0 V, V_{CC} = V_{IO} = 5.5 V	−100	−63	−7	

$I_{lkg(OFF)}$	Unpowered leakage current	TXD = 5.5 V, V_{CC} = V_{IO} = 0 V	−1	0	1	
C_I	Input capacitance [(1)]			5		pF

(1). Test data is based on bench test and design simulation

Electrical Characteristics (Continued)

V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = –40°C to 125°C, unless otherwise noted.

Symbol	Parameter		Test Conditions	Min	Typ	Max	Unit
Pin- RXD (CAN Receive data output)							
V_{OH}	High-level output voltage		AL1051, I_O = −2 mA	0.8 × V_{IO}			V
			AL1051N, I_O = −2 mA	4	4.6		
V_{OL}	Low-level output voltage		AL1051, I_O = +2 mA			0.2 x V_{IO}	
			AL1051N, I_O = +2 mA		0.2	0.4	
$I_{lkg\ (OFF)}$	Unpowered leakage current		RXD = 5.5 V, V_{CC} = 0 V, V_{IO} = 0 V	−1	0	1	μA
Driver electrical characteristics							
$V_{O(DOM)}$	Bus output voltage (dominant)	CANH	TXD = 0 V, S = 0 V, 45 Ω ≤ R_L ≤ 65 Ω, C_L = open, R_{CM} = open	2.75		4.5	V
		CANL		0.5		2.25	V
$V_{O(REC)}$	Bus output voltage (recessive)	CANH CANL	TXD = V_{CC} , V_{IO} = V_{CC} , S = V_{CC} or 0 V[(2)] , R_L = open (no load), R_{CM} = open	2	0.5 x V_{CC}	3	V
$V_{OD(DOM)}$	Differential output voltage (dominant)	CANH CANL	TXD = 0 V, S = 0 V, 45 Ω ≤ R_L < 50 Ω, C_L = open, R_{CM} = open	1.4		3	V
			TXD = 0 V, S = 0 V, 50 Ω ≤ R_L ≤ 65 Ω, C_L = open, R_{CM} = open	1.5		3	V
			TXD = 0 V, S =0 V, R_L = 2240 Ω, C_L = open, RCM = open, V_{CC} = 4.5 V~5.25 V	1.5		5	V
$V_{OD(REC)}$	$V_{OD(REC)}$	$V_{OD(REC)}$	TXD = V_{CC} , S = 0 V, R_L = 60 Ω, C_L = open, R_{CM} = open	−120		12	mV
			TXD = V_{CC} , S = 0 V, R_L = open (no load), C_L = open, R_{CM} = open	−50		50	mV
V_{SYM}	Transient symmetry (dominant or recessive), ($V_{O(CANH)}$ + $V_{O(CANL)}$) / V_{CC} [(1)]		S at 0 V, R_{term}= 60 Ω, C_{split} = 4.7 nF, C_L = open, R_{CM} = open, T_{XD} = 250 kHz, 1 MHz		1.0		V/V
V_{SYM_DC}	DC Output symmetry (dominant or recessive), (V_{CC} – $V_{O(CANH)}$ – $V_{O(CANL)}$) [(1)]		S = 0 V, R_L = 60 Ω , C_L = open, R_{CM} = open	−0.4		0.4	V
$I_{OS(SS\_DOM)}$	Short-circuit steady-state output current, dominant		S at 0 V, V_{CANH} = −5 V to 40 V, CANL = open, TXD = 0 V	−100			mA
			S at 0 V, V_{CANL} = −5 V to 40 V, CANH = open, TXD = 0 V			100	

$I_{OS(SS\_REC)}$	Short-circuit steady-state output current, recessive	−27 V ≤ V_{BUS} ≤ 32 V, Where V_{BUS} = CANH = CANL, TXD = V_{CC}	−5		5	mA

(1). Test data based on bench test and design simulation, Vsym = 0.9 ~ 1.1 V/V at 250 kbps

Electrical Characteristics (Continued)

V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = –40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Receiver electrical characteristics						
V_{CM}	Common mode range, normal mode	S = 0 or V_{CC} or V_{IO}	−30		+30	V
V_{IT+}	Positive-going input threshold voltage, all modes	S = 0 or V_{CC} or V_{IO}, −20 V ≤ V_{CM} ≤ +20 V			900	mV
V_{IT-}	Negative-going input threshold voltage, all modes		500			
V_{IT+}	Positive-going input threshold voltage, all modes	S = 0 or V_{CC} or V_{IO}, −30 V ≤ V_{CM} ≤ +30 V			1000	mV
V_{IT-}	Negative-going input threshold voltage, all modes		400			
V_{HYS}	Hysteresis voltage (V_{IT+} − V_{IT-}) (1)	S = 0 or V_{CC} or V_{IO}		120		mV
$I_{lkg(IOFF)}$	Power-off (unpowered) bus input leakage current	CANH = CANL = 5 V, V_{CC} = V_{IO} = 0 V			3	μA
C_I	Input capacitance to ground (CANH or CANL) (1)			25		pF
C_{ID}	Differential input capacitance (1)			2		pF
R_{ID}	Differential input resistance	TXD = V_{CC} = V_{IO} = 5 V, S = 0 V, −30 V ≤ V_{CM} ≤ +30 V	30		80	kΩ
R_{IN}	Input resistance (CANH or CANL)		15		40	kΩ
$R_{IN(M)}$	Input resistance matching: [1 − $R_{IN(CANH)}$ / $R_{IN(CANL)}$] × 100%	V_{CANH} = V_{CANL} = 5 V	−1%		+1%	

(1). Test data is based on bench test and design simulation

AC Timing Requirements

V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = −40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
DEVICE SWITCHING CHARACTERISTICS						
$t_{PROP(LOOP1)}$	Total loop delay, driver input (TXD) to receiver output (RXD), recessive to dominant	S = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF		100	160	ns
$t_{PROP(LOOP2)}$	Total loop delay, driver input (TXD) to receiver output (RXD), dominant to recessive			110	175	
t_{MODE}	Mode change time, from Normal to Silent or from Silent to Normal			0.15	10	μs
DRIVER SWITCHING CHARACTERISTICS						
t_{pHR}	Propagation delay time, high TXD to driver recessive (dominant to recessive) (1)	S = 0 V, R_L = 60 Ω, C_L = 100 pF, R_{CM} = open		70		ns
t_{pLD}	Propagation delay time, low TXD to driver dominant (recessive to dominant) (1)			40		
$t_{sk(p)}$	Pulse skew (|t_{pHR} - t_{pLD} |) (1)			20		
t_R	Differential output signal rise time (1)			27		
t_F	Differential output signal fall time (1)			35		
t_{TXD_DTO}	Dominant timeout	S = 0 V, R_L = 60 Ω, C_L = open	1.2		3.8	ms
RECEIVER SWITCHING CHARACTERISTICS						
t_{pRH}	Propagation delay time, bus recessive input to high output (Dominant to Recessive) (1)	S = 0 V, $C_{L(RXD)}$ = 15 pF		76		ns
t_{pDL}	Propagation delay time, bus dominant input to low output (Recessive to Dominant) (1)			59		
t_R	RXD Output signal rise time (1)			12		
t_F	RXD Output signal fall time (1)			7		
FD Timing Parameters						
$t_{BIT(BUS)}$	Bit time on CAN bus output pins with $t_{BIT(TXD)}$ = 500 ns, all devices	S = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF, Δt_{REC} = $t_{BIT(RXD)}$ − $t_{BIT(BUS)}$	435		530	ns
	Bit time on CAN bus output pins with $t_{BIT(TXD)}$ = 200 ns, G device variants only		155		210	
$t_{BIT(RXD)}$	Bit time on RXD output pins with $t_{BIT(TXD)}$ = 500 ns, all devices		400		550	
	Bit time on RXD output pins with $t_{BIT(TXD)}$ = 200 ns, G device variants only		120		220	
Δt_{REC}	Receiver timing symmetry with $t_{BIT(TXD)}$ = 500 ns, all devices		−65		40	
	Receiver timing symmetry with $t_{BIT(TXD)}$ = 200 ns, G device variants only		−45		15	

(1). Test data is based on bench test and design simulation

Detailed Description

Overview

The AL1051 device is a CAN transceiver which meets the ISO11898 High-speed CAN (Controller Area Network) physical layer standard. The device is designed to use in CAN FD networks up to 5 Mbps, and enhanced timing margin and higher data rates in long and high-loading networks. As design, the device features cross-wire, overvoltage and loss of ground protection from −42 V to +42 V, overtemperature shutdown, a −30V to +30V common-mode range. AL1051 have a secondary power supply input for I/O level shifting the input pin thresholds and RXD output level, and the pin5 of AL1051N is NC. The devices come with silent mode which is also commonly referred to as listen-only mode, and it includes many protection features to enhance device and network robustness.

Functional Block Diagram

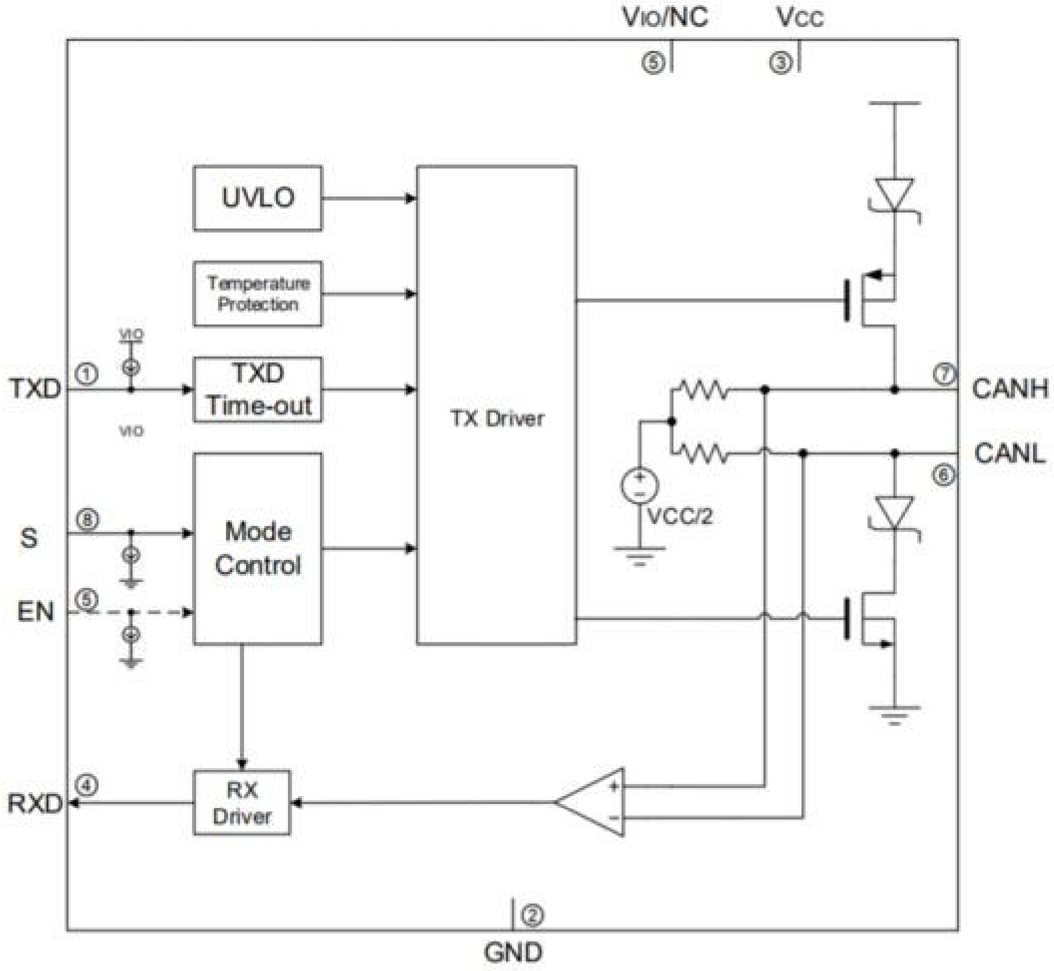


Figure 1 Functional Block Diagram

Feature Description

Under-voltage Lockout (UVLO)

The AL1051 uses an under-voltage lockout circuit to keep the device in shutdown mode until the supply voltage is higher than UVLO threshold.

Over Temperature Protection (OTP)

The AL1051 integrates Foldback circuit and over-temperature protection to prevent device from over-heated and damage. When the junction temperature is higher than T_{OTP}, 150°C, a current thermal Foldback circuit starts to work and decrease the device output charge current gradually with T_J rise. If T_J still rises and reaches 180°C, the device will shut down charging loop until T_J drops below 100°C.

Driver Function Table

Device	Inputs		Outputs		Driven BUS State
	S	TXD	CANH	CANL	
All Devices	L or open	L	H	L	Dominant
		H or Open	Z	Z	Recessive
	H	X	Z	Z	Recessive

Receiver Function Table

Device Mode	CAN Differential Inputs $V_{ID} = V_{CANH} - V_{CANL}$	BUS State	RXD Terminal
Normal or Silent	$V_{ID} \geq V_{IT+(MAX)}$	Dominant	L
	$V_{IT-(MIN)} < V_{ID} < V_{IT+(MAX)}$	Indeterminate	Indeterminate
	$V_{ID} \leq V_{IT-(MIN)}$	Recessive	H
	Open ($V_{ID} \approx 0$ V)	Open	H

Normal mode

A LOW level on pin S selects Normal mode. In this mode, the transceiver will transmit and receive data via the bus lines CANH and CANL. The differential receiver converts the analog data on the bus lines into digital data which is output to pin RXD. The slopes of the output signals on the bus lines are controlled internally and are optimized in a way that guarantees the lowest possible Electro Magnetic Emission (EME).

Silent mode

A HIGH level on pin S selects Silent mode. In Silent mode the transmitter is disabled, releasing the bus pins to recessive state. All other IC functions, including the receiver, continue to operate as in Normal mode, just like listen-only mode. Silent mode can be used to prevent a faulty CAN controller from disrupting all network communications.

Typical Characteristics

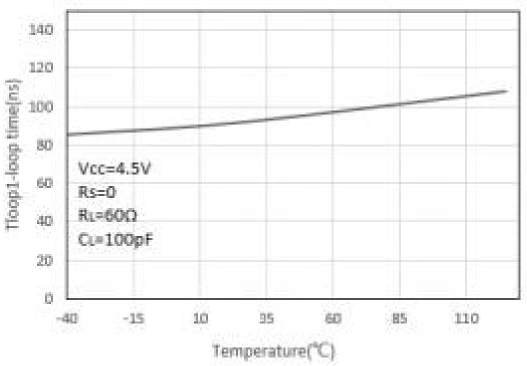


Figure1.Recessive to Dominant Loop Delay Vs Temperature

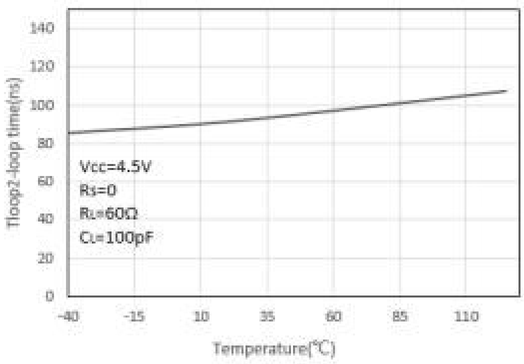


Figure2. Dominant to Recessive Loop Delay Vs Temperature

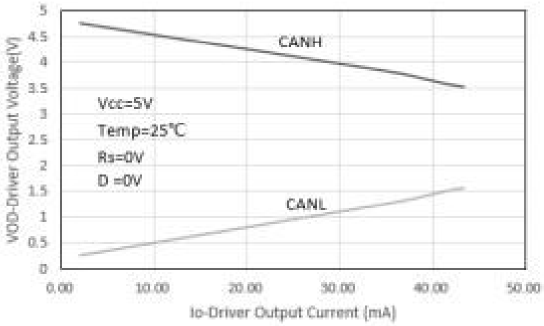


Figure3.Driver Output Voltage Vs Output Current

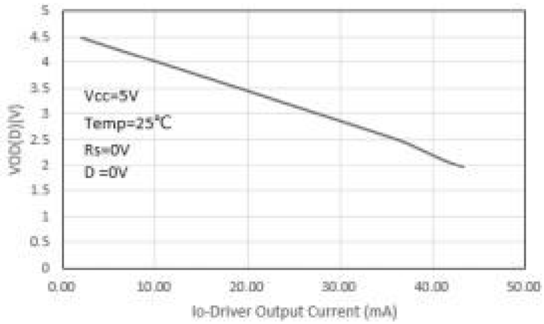


Figure4. Driver Differential Output Voltage Vs Output Current

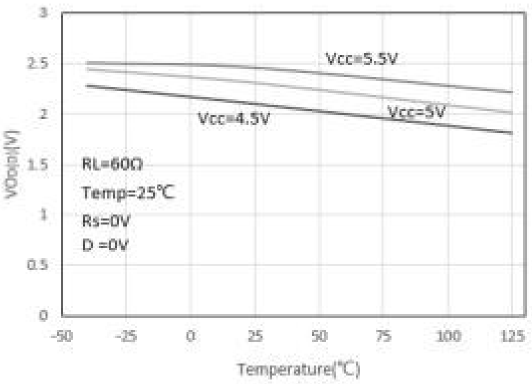


Figure5. Driver Differential Output Voltage Vs Temperature

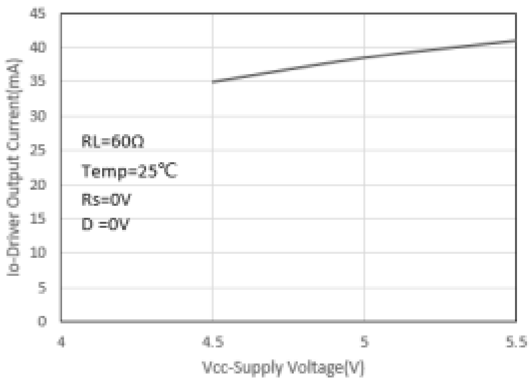


Figure6. Driver Output Current Vs Supply Voltage

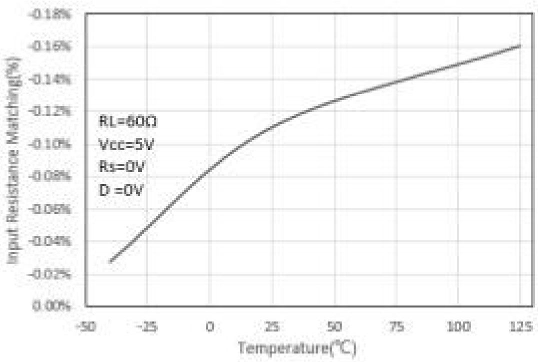


Figure7. Input Resistance Matching Vs Temperature

Application Information

The AL1051 device is a CAN transceiver to support CAN FD function up to 5 Mbps, with BUS protection voltage from –42 V to +42 V, overtemperature shutdown, a −30 V to +30 V common-mode range. The VIO of AL1051 can support the voltage level of TXD and RXD from 3.3 V to 5.0 V, and pin5 of AL1051N is NC which means it can only support 5V I/O voltage.

The following sections show a typical application of the AL1051 and AL1051N.

Typical Application

Figure 2 shows the typical application schematic of the AL1051.

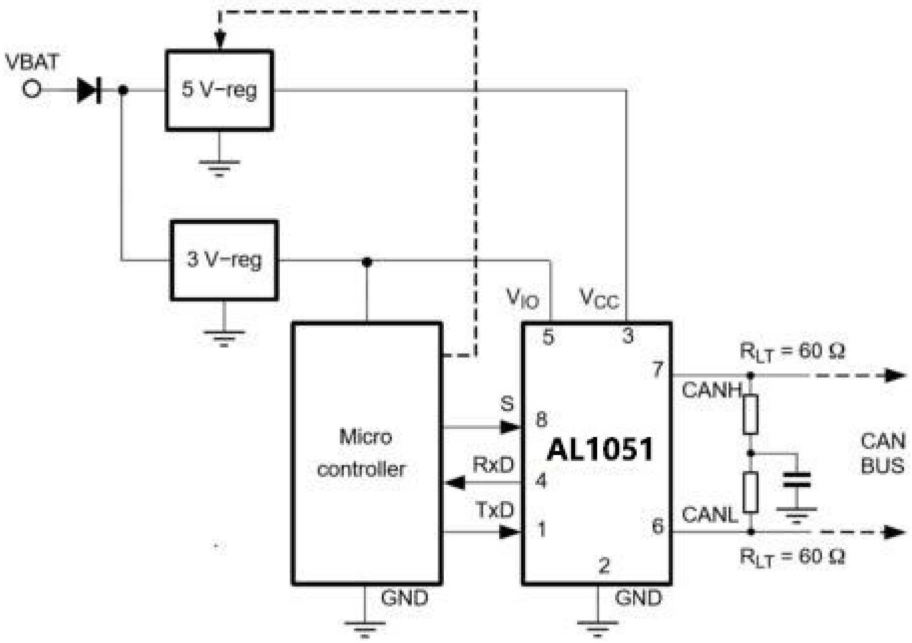


Figure 2 AL1051 Typical Application Circuit

Figure 2shows the typical application schematic of the AL1051N.

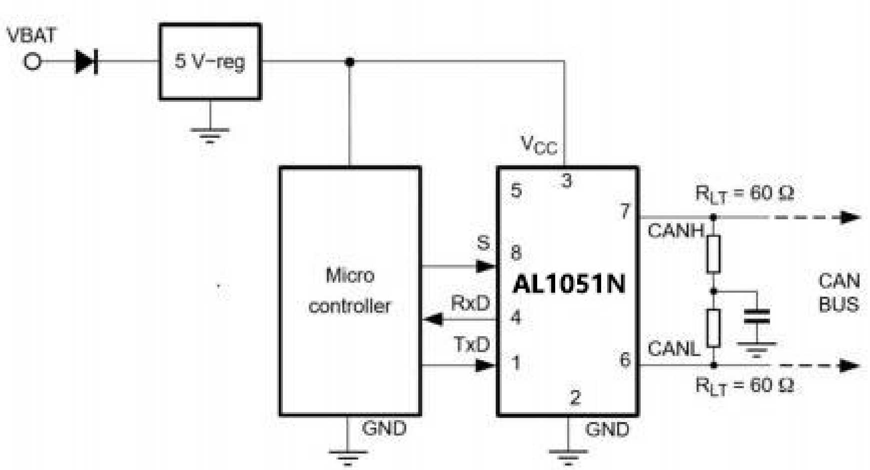


Figure 3 AL1051N Typical Application Circuit

Power Dissipation and Thermal Consideration

During normal operation, junction temperature limitation is 150°C. When junction temperature exceeds 150°C, the charge current decreases with the temperature value. Using Equation 2 and Equation 3 to calculate the power dissipation and estimate the junction temperature.

The maximum power dissipation can be calculated usingEquation 2.

$$P_D = (V_{IN} - V_{BAT}) \times I_{BAT} = \frac{T_{J,max} - T_A}{\theta_{JA}} \quad (2)$$

Where,

$T_{J,max}$ is the junction temperature limitation, 150°C,

T_A is the ambient temperature, θ_{JA} is the junction-to-ambient thermal resistance (See ThermalInformation).

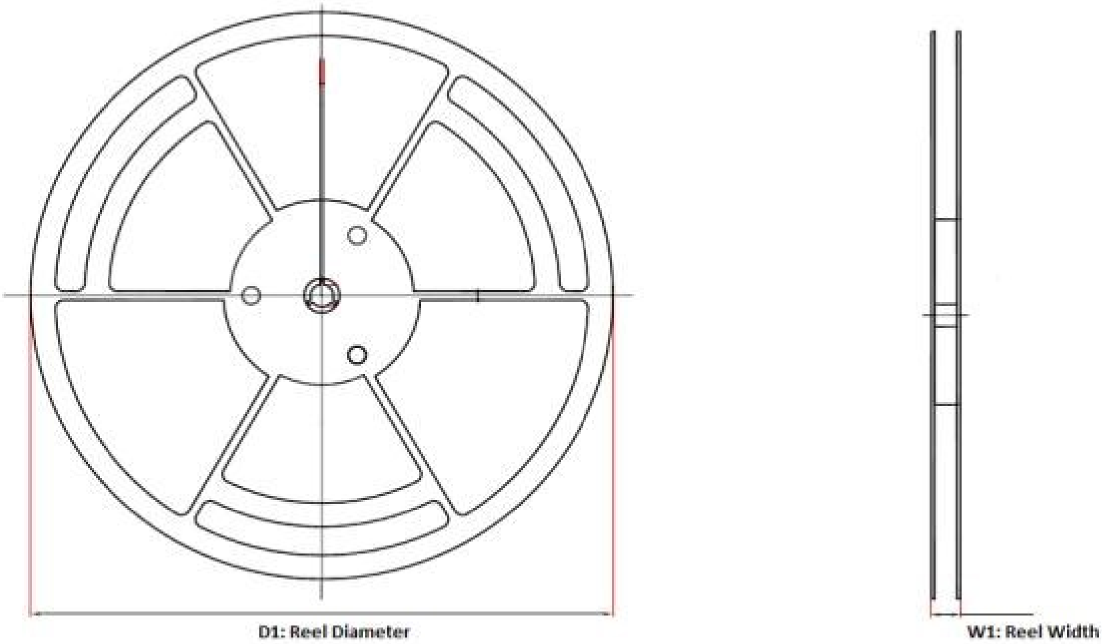
SolveEquation 2, the constant charge current value is calculated inEquation 3.

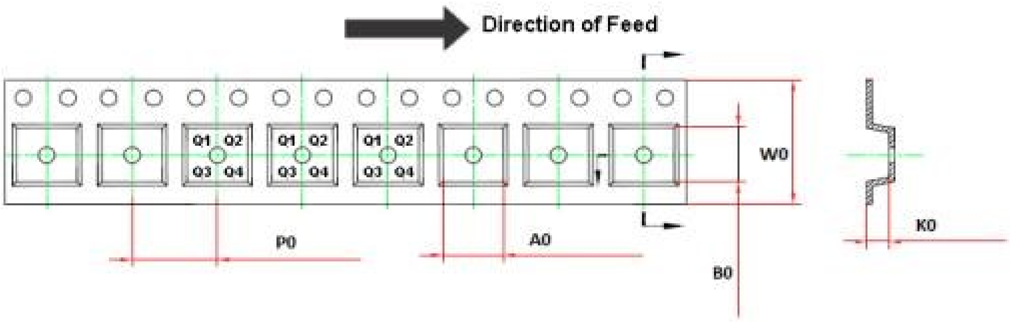
$$I_{BAT} = \frac{150°C - T_A}{(V_{IN} - V_{BAT}) \times \theta_{JA}} \quad (3)$$

Power Consumption

Parameter		Test Condition	Value	Unit
P_D	Average power dissipation (Dominant mode)	VCC = 5V, VIO = 3.3V, Ta = 25°C, RL = 60 Ω, S at 0 V, Input to TXD at 250 kHz, CL_RXD = 15 pF. Typical CAN operating conditions at 500 kbps with 25% transmission rate	63	mW
		VCC = 5.5V, VIO = 3.6V, Ta = 125°C, RL = 50 Ω, S at 0 V, Input to TXD at 0.5MHz, CL_RXD = 15 pF. Typical high load CAN operating conditions at 1 Mbps with 50% transmission rate and loaded network.	154	mW

Tape and Reel Information



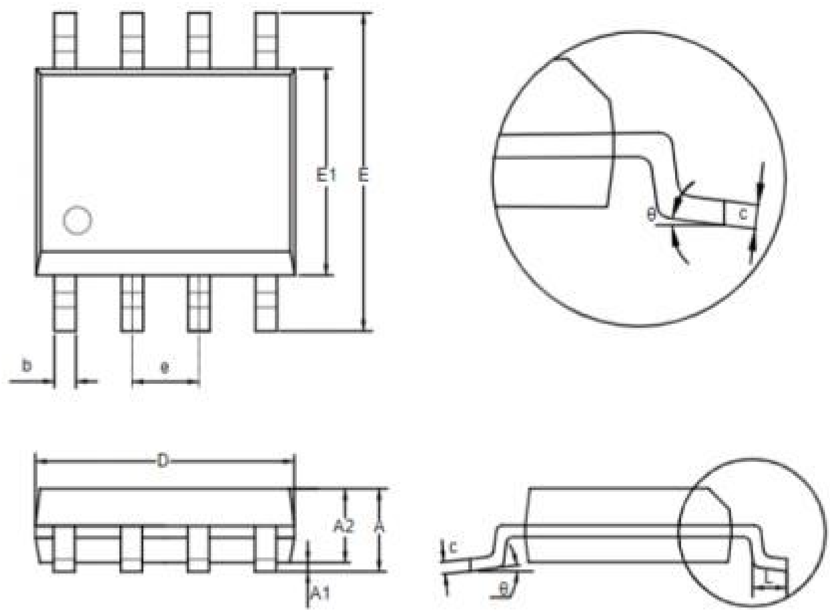


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
AL1051N	8-Pin SOP	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL1051	8-Pin SOP	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1

Package Outline Dimensions

(SOP-8)

Package Outline Dimensions SO1(SOP-8-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
AL1051N	-40 to 125°C	8-Pin SOP	AL1051N	MSL3	Tape and Reel, 4000	Green
AL1051	-40 to 125°C	8-Pin SOP	AL1051	MSL3	Tape and Reel, 4000	Green