High-speed CAN Transceiver with ±58V Bus Fault Protection

UMCAN1051CVS8 *SOP8*

1 Description

The UMCAN1051C is a high-speed CAN transceiver that provides an interface between a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed CAN applications in the automotive industry, providing differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

The UMCAN1051C offers improved ElectroMagnetic Compatibility (EMC) and ElectroStatic Discharge (ESD) performance, and also features:

- Ideal passive behavior to the CAN bus when the supply voltage is off.
- UMCAN1051CVS8 can be interfaced directly to microcontrollers with 3.3V or 5V supply voltage.

The UMCAN1051C implements the CAN physical layer as defined in ISO 11898-2:2024 and SAE J2284-1 to SAE J2284-5. This implementation enables reliable communication in the CAN FD fast phase at data rates up to 5 Mbit/s. These features make the UMCAN1051C an excellent choice for all types of HS-CAN networks, in nodes that do not require a standby mode with wake-up capability via the bus.

2 Applications

- Automotive Industry
- Industrial Control
- Wireless Infrastructure

3 Features

- ISO 11898-2:2024 and SAE J2284-1 to SAE J2284-5 compliant
- Timing guaranteed for data rates up to 5 Mbit/s in the CAN FD fast phase
- Suitable for 12V and 24V systems
- V_{IO} input on UMCAN1051CVS8 allows for direct interfacing with 3.3V or 5V microcontrollers
- Transceiver disengages from the bus when not powered up (zero load)
- High ElectroStatic Discharge (ESD) handling capability on the bus pins
- Transmit Data (TXD) dominant time-out function
- Undervoltage detection on pins V_{CC} and V_{IO}
- Thermally protected

4 Ordering Information

Part Number	Marking Code	Package Type	Shipping Qty
UMCAN1051CVS8	1051CVS8	SOP8	3000pcs/13Inch Tape & Reel

5 Pin Configuration and Function

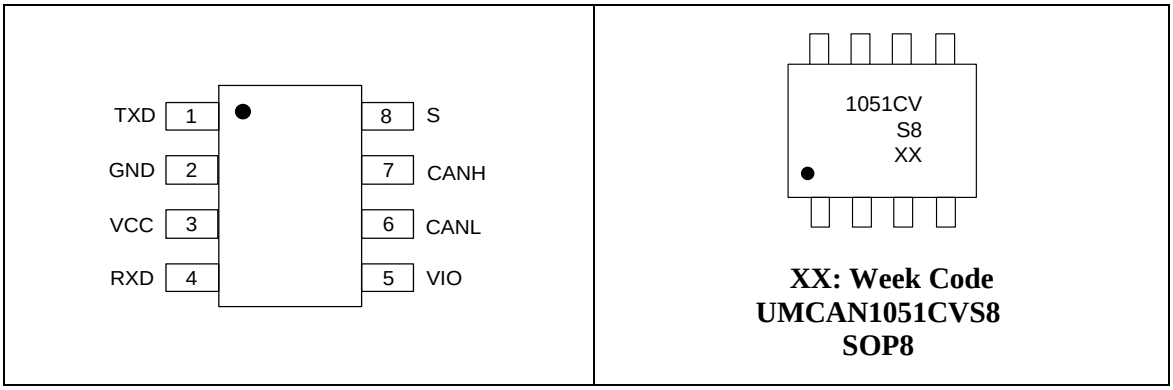


Table 5-1. Pin Functions

Pin No.	Symbol	Description
1	TXD	Transmit data input
2	GND	Ground
3	VCC	Supply voltage
4	RXD	Receive data output; reads out data from the bus lines
5	V_{IO}	Supply voltage for I/O level adapter
6	CANL	Low-level CAN bus line
7	CANH	High-level CAN bus line
8	S	Silent mode control input

6 Specifications

6.1 Recommended Operating Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	Bus supply voltage		4.5		5.5	V
V_{IO}	Supply voltage I/O level shifter		2.9		5.5	V
T_A	Operating ambient temperature		-40		125	℃

6.2 Absolute Maximum Ratings (Note 1, 2, 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_I	Voltage range on CANH, CANL		-58		+58	V
	Voltage range on V_{CC}, V_{IO}		-0.3		+7	V
	Voltage range on any other pin	Note 4	-0.3		V_{IO}+0.3	V
V_{DIF}	Voltage range between CANH and CANL		-40		+40	V
V_{trt}	Transient voltage on CANH, CANL pins (Note 5)	pulse 1	-100			V
		pulse 2a			+75	V
		pulse 3a	-150			V
		pulse 3b			+100	V
V_{ESD}	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	All pins		±8		kV
	Contact discharge, per IEC 61000-4-2	Bus pins		±8		kV
I_{LU}	Latch up, per JEDEC JESD78	Class II		200		mA
T_{VJ}	Virtual junction temperature		-40		150	℃
T_{STG}	Storage temperature		-55		150	℃

Note 1: Operation outside the Absolute Maximum Ratings may cause permanent device damage. Absolute Maximum Ratings do not imply functional operation of the device at these or any other conditions beyond those listed under Recommended Operating Conditions. If used outside the Recommended Operating Conditions but within the Absolute Maximum Ratings, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
Note 2: All voltage values, except differential I/O bus voltages, are with respect to ground terminal.
Note 3: V_{IO} = V_{CC} in non-VIO product variants.
Note 4: Maximum voltage should never exceed 7 V.
Note 5: Verified by an external test house according to IEC TS 62228, Section 4.2.4; parameters for standard pulses defined in ISO 7637.

6.3 Electrical Characteristics (Static) (Note 1)

T_J = -40℃ to +150℃; V_{CC} = 4.5V to 5.5V; V_{IO} = 2.9V to 5.5V; R_L = 60Ω; C_L = 100pF unless otherwise noted; Typical values are at V_{CC} = 5 V, V_{IO} = 3.3 V, T_A = 25℃.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply; pin VCC						
V_{CC}	Supply voltage		4.5		5.5	V
V_{UVD}	Undervoltage detection voltage on pin VCC		3	3.6	4.5	V
I_{CC}	Supply current	Silent mode		0.8	2.5	mA
		Normal mode; TXD = V_{IO}		4.5	10	mA
		Normal mode; TXD = 0 V	20	45	60	mA
		Normal mode; TXD = 0 V; short circuit on bus lines; -3V< (CANH=CANL)<18V		73	110	mA
I/O level adapter supply; pin VIO						
V_{IO}	Supply voltage on pin VIO		2.9		5.5	V
V_{UVD}	Undervoltage detection voltage on pin VIO		1.2	1.5	2.5	V
I_{IO}	Supply current on pin VIO	Normal mode; TXD = 0V		80	300	uA
		Normal mode; TXD = V_{IO}		15	50	uA
		Silent mode		15	50	uA
Mode control input; pins S						
V_{IH}	High-level input voltage		0.7V_{IO}			V
V_{IL}	Low-level input voltage				0.3V_{IO}	V
I_{IH}	High-level input current	V_{IN} = V_{IO}	1		10	uA
I_{IL}	Low-level input current	V_{IN} = 0 V	-1		-1	uA

6.3 Electrical Characteristics (Static)---continued

T_J = -40℃ to +150℃; V_{CC} = 4.5V to 5.5V; V_{IO} = 2.9V to 5.5V; R_L = 60Ω; C_L = 100pF unless otherwise noted; Typical values are at V_{CC} = 5 V, V_{IO} = 3.3 V, T_A = 25℃.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CAN transmit data input; pin TXD						
V_{IH}	High-level input voltage		0.7V_{IO}			V
V_{IL}	Low-level input voltage				0.3V_{IO}	V
I_{IH}	High-level input current	V_{IN} = V_{IO}	-5		5	uA
I_{IL}	Low-level input current	V_{IN} = 0 V	-270	-60	-30	uA
C_I	Input capacitance			5	10	pF
CAN receive data output; pin RXD						
I_{OH}	High-level output current	RXD = V_{IO} - 0.4 V	-9	-3	-1	mA
I_{OL}	Low-level output current	RXD = 0.4 V	1	3	12	mA
Driver						
$V_{O(DOM)}$	Dominant output voltage	S = 0 V; TXD = 0 V; t < $t_{TO(DOM)TXD}$; V_{CC} = 4.75V to 5.25V				
		50 Ω ≤ R_L ≤ 65 Ω; pin CANH	2.75	3.5	4.5	V
		50 Ω ≤ R_L ≤ 65 Ω; pin CANL	0.5	1.5	2.25	V
$V_{OD(DOM)}$	Dominant differential output voltage	S = 0 V; TXD = 0 V; t < $t_{TO(DOM)TXD}$; V_{CC} = 4.75V to 5.25V				
		50 Ω ≤ R_L ≤ 65 Ω;	1.5		3	V
		45 Ω ≤ R_L ≤ 70 Ω;	1.4		3.3	V
		R_L = 2240 Ω;	1.5		5	V
$V_{O(REC)}$	Recessive output voltage	Normal or silent mode; TXD = V_{IO}; R_L = open	2	0.5V_{CC}	3	V
$V_{OD(REC)}$	Recessive differential output voltage	Normal or silent mode; TXD = V_{IO}; R_L = open	-50		50	mV
$V_{SYM(DOM)}$	Dominant output voltage symmetry, V_{CC}-CANH-CANL	TXD = 0 V; t < $t_{TO(DOM)TXD}$; R_L = 60 Ω	-400		400	mV

6.3 Electrical Characteristics (Static)---continued

T_J = -40℃ to +150℃; V_{CC} = 4.5V to 5.5V; V_{IO} = 2.9V to 5.5V; R_L = 60Ω; C_L = 100pF unless otherwise noted; Typical values are at V_{CC} = 5 V, V_{IO} = 3.3 V, T_A = 25℃.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{SYM(TX)}$	Transmitter output voltage symmetry, (CANH+CANL)/V_{CC}	TXD = 250 kHz, 1 MHz, 2.5MHz; R_L = 60 Ω; C_{SPLIT} = 4.7 nF; see Figure 7-2	0.9V_{CC}		1.1V_{CC}	V
$I_{OS(DOM)}$	Dominant short-circuit output current	TXD = 0 V; t < $t_{TO(DOM)TXD}$; V_{CC} = 5 V; CANH = -15 V to 40 V; pin CANH	-100	-70		mA
		TXD = 0 V; t < $t_{TO(DOM)TXD}$; V_{CC} = 5 V; CANL = -15 V to 40 V; pin CANL		70	100	mA
$I_{OS(REC)}$	Recessive short-circuit output current	Normal mode; TXD = V_{IO}; –27 V≤ CANH = CANL ≤ 32 V	-5		5	mA
Receiver						
V_{TH}	Differential receiver threshold voltage	Normal or silent mode; -30 V≤ CANH, CANL ≤ 30 V	0.5		0.9	V
$V_{ID(REC)}$	Receiver recessive voltage	Normal or silent mode; -30 V ≤ CANH, CANL ≤ 30 V	-4		0.5	V
$V_{ID(DOM)}$	Receiver dominant voltage	Normal or silent mode; -30 V ≤ CANH, CANL ≤ 30 V	0.9		9	V
V_{HYS}	Differential receiver hysteresis voltage	Normal or silent mode; -30 V ≤ CANH, CANL ≤ 30 V	50		300	mV
$I_{LKG(PD)}$	Unpowered Leakage current	V_{CC} = V_{IO} = 0 V or shorted to GND via 47 kΩ; CANH = CANL = 5 V	-5		5	uA
R_I	Input resistance	-2 V ≤ CANH, CANL ≤ 7 V	15	30	40	kΩ
ΔR_I	Input resistance deviation, [1 – ($R_{IN(CANH)}$ / $R_{IN(CANL)}$)] × 100 %	0 V ≤ CANH, CANL ≤ 5 V	-3		3	%
R_{ID}	Differential input resistance	-2 V ≤ CANH, CANL ≤ 7 V	30	60	80	kΩ
C_{IN}	Common-mode input capacitance to ground				20	pF

6.3 Electrical Characteristics (Static)---continued

T_J = -40℃ to +150℃; V_{CC} = 4.5V to 5.5V; V_{IO} = 2.9V to 5.5V; R_L = 60Ω; C_L = 100pF unless otherwise noted; Typical values are at V_{CC} = 5 V, V_{IO} = 3.3 V, T_A = 25℃.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_{ID}	Differential input capacitance				10	pF
Thermal Protection						
$T_{J(SD)}$	Shutdown junction temperature			185		℃

6.4 Electrical Characteristics (Dynamic)

T_J = -40℃ to +150℃; V_{CC} = 4.5V to 5.5V; V_{IO} = 2.9V to 5.5V; R_L = 60Ω; C_L = 100pF unless otherwise noted; Typical values are at V_{CC} = 5 V, V_{IO} = 3.3 V, T_A = 25℃.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
CAN timing characteristics; $t_{BIT(TXD)}$ ≥ 200 ns; see Figure 7-1, Figure 7-3						
$t_{D(TXD-BUSDOM)}$	Delay time from TXD to bus dominant	Normal mode; R_L = 60 Ω, C_L = 100 pF		51	90	ns
$t_{D(TXD-BUSREC)}$	Delay time from TXD to bus recessive	Normal mode; R_L = 60 Ω, C_L = 100 pF		48	90	ns
$t_{D(BUSDOM-RXD)}$	Delay time from bus dominant to RXD	Normal mode; $C_{L(RXD)}$ = 15 pF		51	100	ns
$t_{D(BUSREC-RXD)}$	Delay time from bus recessive to RXD	Normal mode; $C_{L(RXD)}$ = 15 pF		56	110	ns
$t_{D(TXDL-RXDL)}$	Delay time from TXD LOW to RXD LOW	Normal mode; R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF	50		195	ns
$t_{D(TXDH-RXDH)}$	Delay time from TXD HIGH to RXD HIGH	Normal mode; R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF	50		195	ns
CAN FD timing characteristics according to ISO 11898-2:2024 parameter set B ($t_{BIT(TXD)}$) ⩾ 200 ns, up to 5 Mbit/s); See figure 7-1 and figure 7-3						
$\Delta t_{BIT(BUS)}$	Transmitted recessive bit width deviation	$\Delta t_{BIT(BUS)} = t_{BIT(BUS)} - t_{BIT(TXD)}$	-45		10	ns
Δt_{REC}	Receiver timing symmetry	$\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(BUS)}$	-45		15	ns
$\Delta t_{BIT(RXD)}$	Received recessive bit width deviation	$\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(TXD)}$	-80		20	ns
CAN FD timing characteristics according to ISO 11898-2:2024 parameter set A ($t_{BIT(TXD)}$) ⩾ 500 ns, up to 2 Mbit/s); See figure 7-1 and figure 7-3						
$\Delta t_{BIT(BUS)}$	Transmitted recessive bit width deviation	$\Delta t_{BIT(BUS)} = t_{BIT(BUS)} - t_{BIT(TXD)}$	-65		30	ns
Δt_{REC}	Receiver timing symmetry	$\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(BUS)}$	-65		40	ns
$\Delta t_{BIT(RXD)}$	Received recessive bit width deviation	$\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(TXD)}$	-100		50	ns
$t_{TO(DOM)TXD}$	TXD dominant time-out time	Normal mode; TXD = 0V (Note 1)	0.8	2.6	6.5	ms

Note 1: Time-out occurs between the min and max values. Time-out is guaranteed not to occur below the min value; time-out is guaranteed to occur above the max value.

7 Parameter Measurement Information

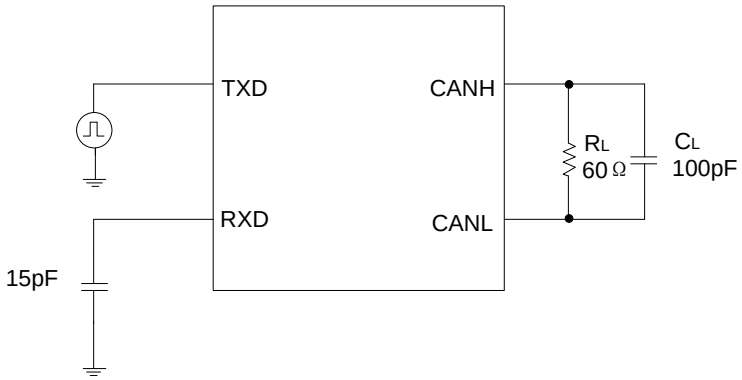


Figure 7-1. CAN transceiver timing test circuit

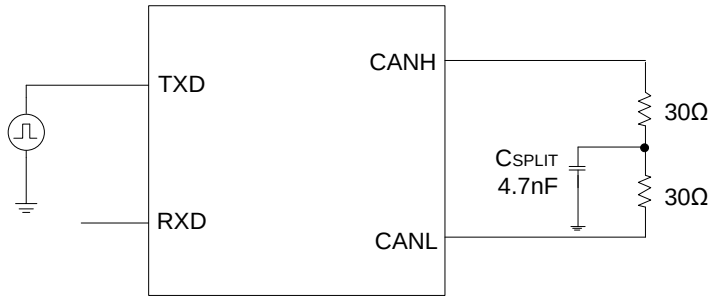


Figure 7-2. Test circuit for measuring transceiver transmitter driver symmetry

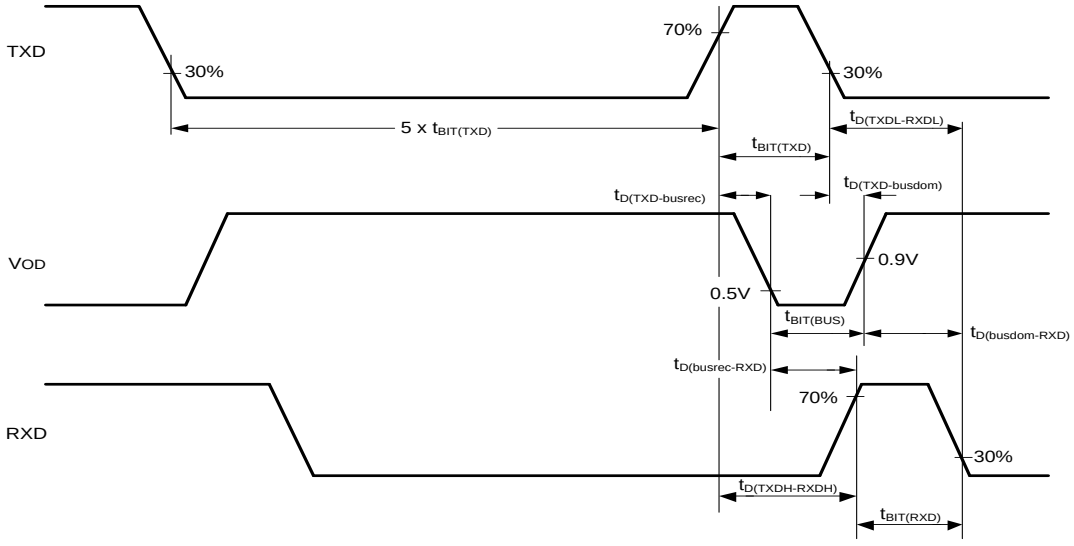


Figure 7-3. CAN FD timing definitions according to ISO 11898-2:2024

8 Block diagram

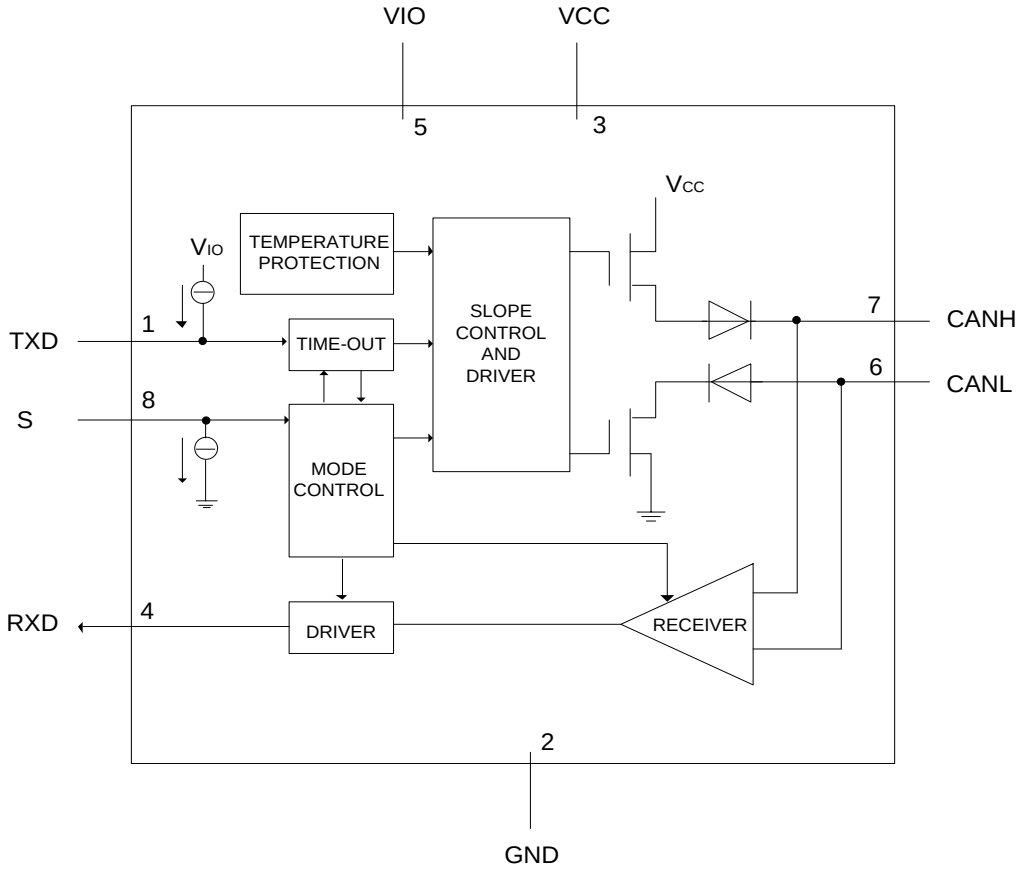


Figure 8-1. Block diagram

9 Detailed Description

9.1 Functional Description

The UMCAN1051C is a high-speed CAN stand-alone transceiver with Silent mode. It combines the functionality of transceiver with improved EMC and ESD handling capability. Improved slope control and high DC handling capability on the bus pins provides additional application flexibility.

9.2 Operating modes

The UMCAN1051C supports two operating modes, Normal and Silent, which are selected via pin S. See Table 9-1 for a description of the operating modes under normal supply conditions.

9.2 Operating modes (continued)

Table 9-1. Operating modes

Mode	Inputs		Outputs	
	Pin S	Pin TXD	CAN driver	Pin RXD
Normal	LOW	LOW	dominant	Active (Note 1)
	LOW	HIGH	recessive	Active (Note 1)
Silent	HIGH	X (Note 2)	recessive	Active (Note 1)

Note 1: LOW if the CAN bus is dominant, HIGH if the CAN bus is recessive.
Note 2: 'X' = Don't care.

9.2.1 Normal mode

A LOW level on pin S selects Normal mode. In this mode, the transceiver is able to transmit and receive data via the bus lines CANH and CANL (see Figure 8-1 for the block diagram). 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 ElectroMagnetic Emission (EME).

9.2.2 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. Silent mode can be used to prevent a faulty CAN controller from disrupting all network communications.

9.3 Fail-Safe Features

9.3.1 TXD dominant time-out function

A 'TXD dominant time-out' timer is started when pin TXD is set LOW. If the LOW state on pin TXD persists for longer than $t_{TO(DOM)TXD}$, the transmitter is disabled, releasing the bus lines to recessive state. This function prevents a hardware and/or software application failure from driving the bus lines to a permanent dominant state (blocking all network communications). The TXD dominant time-out timer is reset when pin TXD is set HIGH.

9.3.2 Internal biasing of TXD and S input pins

Pin TXD has an internal pull-up to V_{IO} and pins S have internal pull-downs to GND. This ensures a safe, defined state in case one or more of these pins is left floating.

9.3.3 Undervoltage detection on pins VCC and VIO

Should V_{CC} or V_{IO} drop below their respective undervoltage detection levels ($V_{UVD(VCC)}$ and $V_{UVD(VIO)}$), the transceiver will switch off and disengage from the bus (zero load) until V_{CC} and V_{IO} have recovered.

9.3.4 Overtemperature protection

The output drivers are protected against overtemperature conditions. If the operating junction temperature exceeds the shutdown junction temperature, $T_{J(SD)}$, the output drivers will be disabled until the operating junction temperature falls below $T_{J(SD)}$ and TXD becomes recessive again. Including the TXD condition ensures that output driver oscillations due to temperature drift are avoided.

9.3.5 VIO supply pin

Pin V_{IO} should be connected to the microcontroller supply voltage (see Figure 10-1). This will adjust the signal levels of pins TXD, RXD and S to the I/O levels of the microcontroller.

10 Application Information

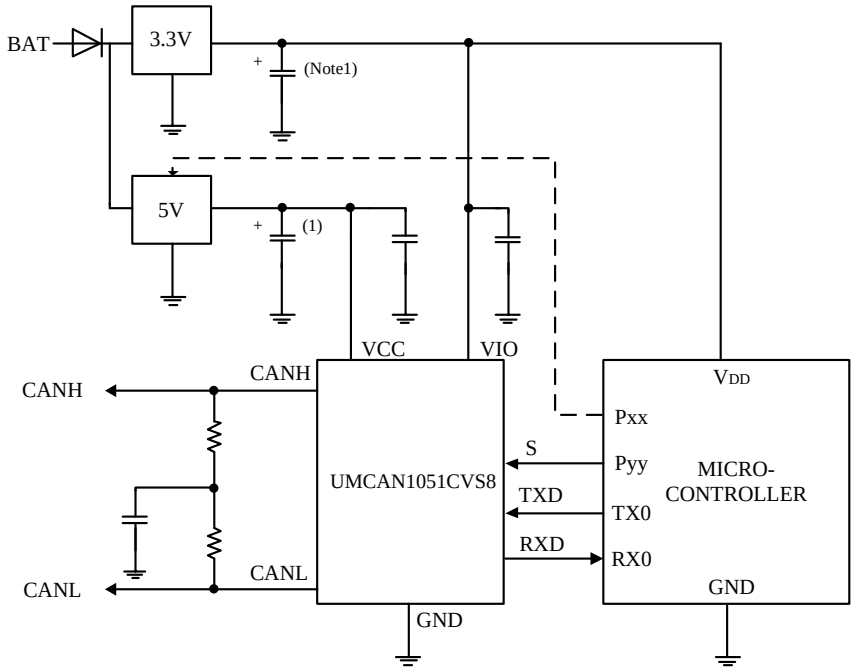


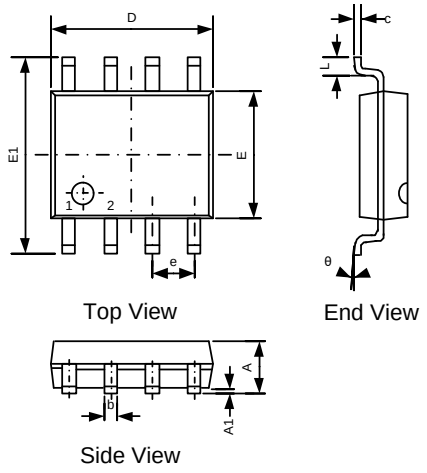
Figure 10-1. Typical application of the UMCAN1051CVS8

Note1: Optional, depends on regulator

Package Information

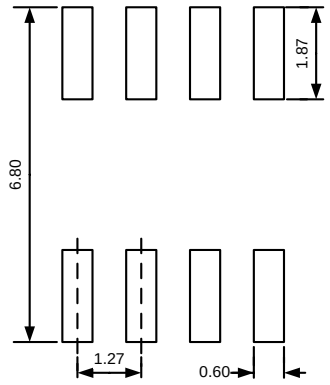
SOP8

Outline Drawing



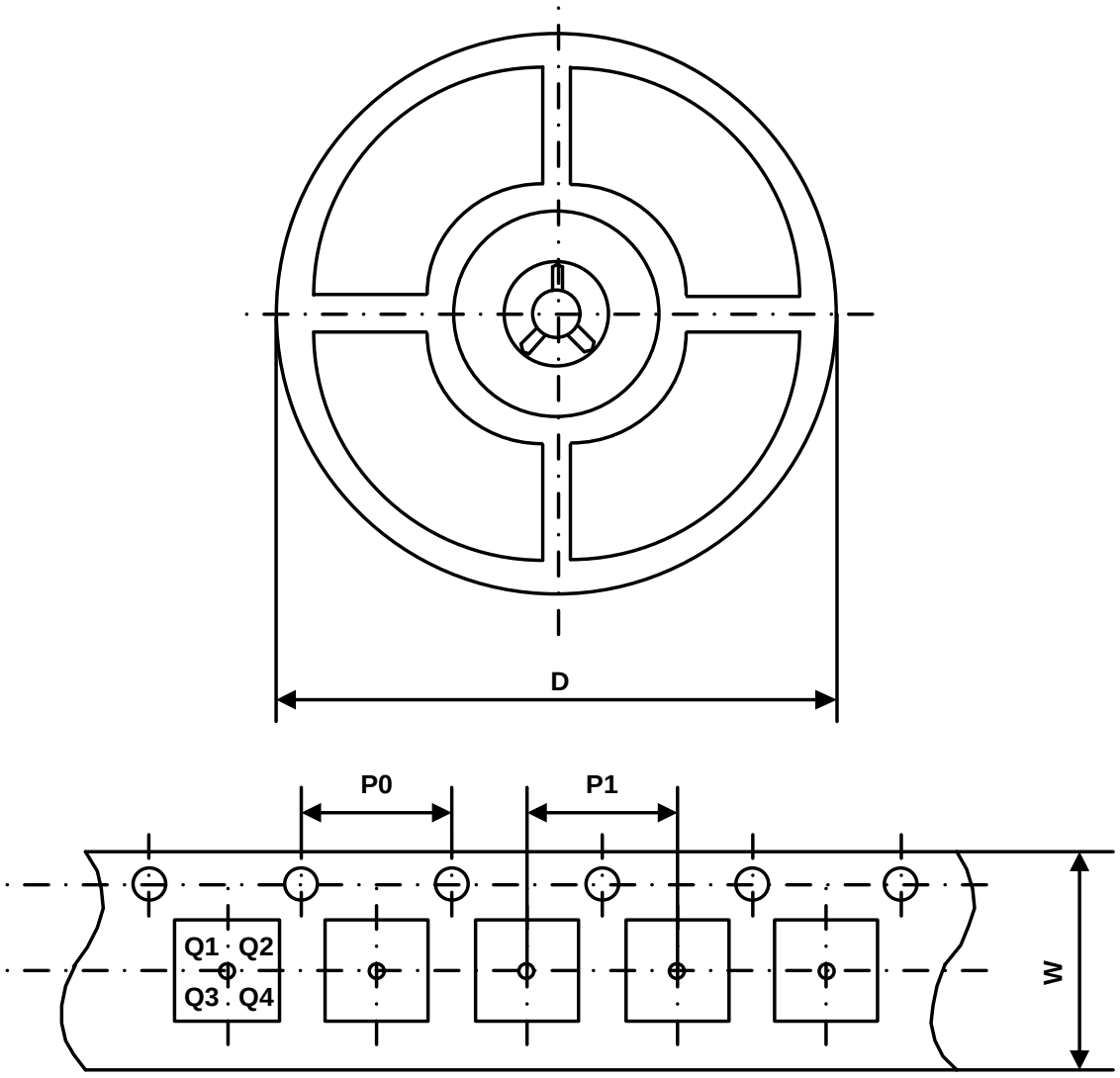
DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.75	-	-	0.069
A1	0.00	-	0.25	0.000	-	0.010
b	0.30	-	0.51	0.012	-	0.020
c	0.15	-	0.25	0.006	-	0.010
D	4.70	4.90	5.10	0.185	0.193	0.200
E	3.70	3.90	4.10	0.148	0.154	0.164
E1	5.80	-	6.25	0.228	-	0.250
e	1.27BSC			0.050 BSC		
L	0.40	-	1.27	0.016	-	0.050
θ	0 °	-	8 °	0 °	-	8 °

Land Pattern



NOTES:
1. Compound dimension: 4.90×3.90;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Packing Information



Part Number	Package Type	Carrier Width (W)	Pitch (P0)	Pitch (P1)	Reel Size (D)	PIN 1 Quadrant
UMCAN1051CVS8	SOP8	12 mm	4 mm	8 mm	330 mm	Q1

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