User's Guide

TCAN1462-Q1 Evaluation Module With SIC Network

ABSTRACT

This user guide details the TCAN1462 CAN (Controller Area Network) EVM transceiver operation in a signal improved capable (SIC) network. The TCAN1462 CAN EVM is configurable for use with the TCAN1042(V)/51(V), TCAN1044(A)(V)/57(A)(V), and TCAN1462(V) 8-pin CAN transcievers by replacing the transceiver and setting jumpers on the EVM as outlined in this document. This user guide explains the EVM configurations for basic CAN evaluation, SIC network configuration, and various load and termination settings.

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Trademarks

1 Introduction

1.1 Overview

TI offers a broad portfolio of high speed (HS) CAN, CAN FD, and CAN SIC transceivers compatible with the ISO11898-2 high speed CAN standards. These include 5-V V_{CC} only, 3.3-V V_{CC} only, 5-V V_{CC} with I/O level shifting and galvanic-isolated CAN transceivers. These CAN transceiver families include product mixes with varying features such as low-power standby modes with and without wake up, silent modes, loop back, and diagnostic modes.

The TI CAN EVM helps designers evaluate the operation and performance of various TI CAN transceivers in normal and SiC networks in accordance with CIA 601-4. It also provides bus termination, bus filtering, and protection concepts. The CAN transceivers are easily configured by the customer for the TCAN1042/51, TCAN1044(A)/57(A), and TCAN1462. Jumper settings, simple soldering tasks, and replacement of standard components are configured as needed. A separate EVM is available for the galvanic-isolated CAN transceiver family.

1.2 CAN EVM

The CAN EVM has simple connections to all necessary pins of the CAN transceiver device, and jumpers where necessary to provide flexibility for device pin and CAN bus configuration. There are test points (loops) for all main points where probing is necessary for evaluation such as GND, V_{CC}, TXD, RXD, CANH, CANL, pin 8 (mode pin), or pin 5 (V_{IO} or NC). The EVM supports many options for CAN bus configuration. It is pre-configured with two 120-Ω resistors that are connected on the bus via jumpers: a single resistor is used with the EVM as a terminated line end (CAN is defined for 120-Ω impedance twisted pair cable) or both resistors in parallel for electrical measurements representing the 60-Ω load the transceiver *detects* in a properly terminated network (that is, 120-Ω termination resistors at both ends of the cable). If the application requires “split” termination, TVS diodes for protection, or Common Mode (CM) Choke, the EVM has footprints available for this via customer installation of the desired components.

This EVM also has the ability to connect a SiC network, as defined in CIA601-4, to the CAN bus lines via J7 and J8. Connecting the SIC network to CANH and CANL simulates a noisy CAN bus by adding more reflections and ringing to the signals. This can be used to test the reliability of the transceiver in a very noisy environment.

Figure 1-1 shows the EVM board image.

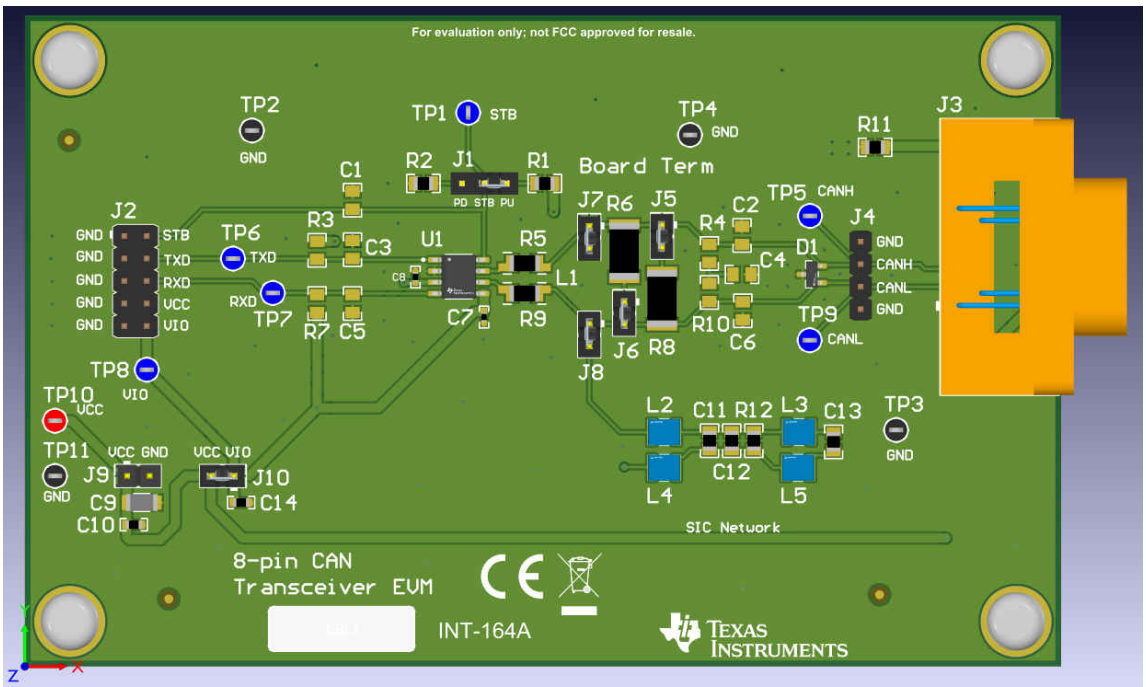

Figure 1-1. EVM PC Board

Figure 1-2 shows the EVM schematic.

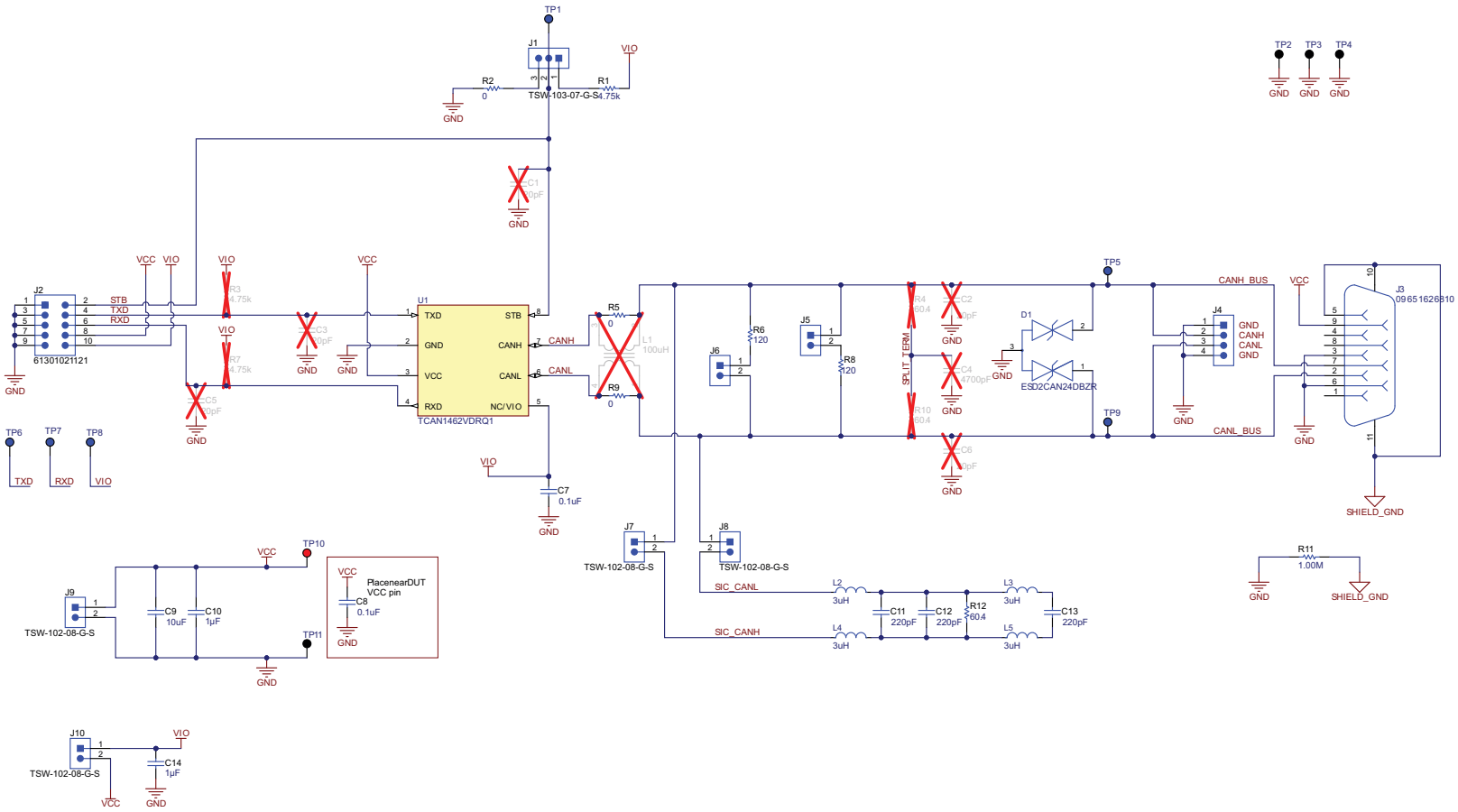

Figure 1-2. EVM Schematic

Table 1-1 lists the jumper connections for the EVM.

Table 1-1. Jumper Connections

Connection	Type	Description
J1	3-pin jumper	Used for mode selection on pin 8 (4.7-kΩ pullup to V_{IO}, 0-Ω pulldown to GND, customer-installable pulldown for devices with slew rate control R_S pin).
J2	10-pin header	Connection for access to all critical digital I/O, supply, and GND for driving the CAN transceiver externally with test equipment or interfaced to a processor EVM
J3	9-pin DB9 connector	Provides an optional way to connect CANH, CANL, V_{CC}, and GND all through a standard DB9 CAN pinout rather than through a regular header.
J4	4-pin jumper	CAN bus connection (CANH, CANL) and GND
J5	2-pin jumper	Connect 120-Ω CAN termination to the bus. Used separately for a single termination if EVM is at end of the CAN bus and termination is not in the cable. Used in combination with JMP5 to get to second CAN termination to represent the combined 60-Ω load for CAN transceiver parametric measurement.
J6	2-pin jumper	Connect 120-Ω CAN termination to the bus. Used in combination with JMP4 to get to second CAN termination to represent the combined 60-Ω load for CAN transceiver parametric measurement.
J7	2-pin jumper	Connect SIC network to CANH. Must be used in combination with J8.
J8	2-pin jumper	Connect SIC network to CANL. Must be used in combination with J7.
J9	2-pin jumper	V_{CC} supply and GND connection for the EVM
J10	2-pin jumper	V_{IO} and V_{CC} suuply connection. Provides ability to short Vcc and VIO together.
TP1	Test Point	Device pin 8 test point
TP2		GND test point
TP3		
TP4		
TP5		CANH (bus) test point
TP6		TXD, Device pin 1 test point
TP7		RXD, Device pin 4 test point
TP8		VIO, Device pin 5 test point
TP9		CANL (bus) test point
TP10		V_{CC} test point
TP11		GND test point

1.2.1 Bill of Materials

Table 1-2. Bill of Materials

Designator	Quantity	Value	Description	PartNumber	Manufacturer
C7, C8	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X5R, 0402	GRM155R61E104KA87D	MuRata
C9	1	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X7R, 1206_190	TMK316B7106KL-TD	Taiyo Yuden
C10, C14	2	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	C1608X7R1C105K080AC	TDK
C11, C12, C13	3	220pF	CAP, CERM, 220 pF, 100 V, +/- 5%, C0G/NP0, 0805	C0805C221J1GACTU	Kemet
D1	1		24-V, 2-Channel ESD Protection Diode for In-Vehicle Networks	ESD2CAN24DBZR	Texas Instruments
J1	1		Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	Samtec
J2	1		Header, 2.54 mm, 5x2, Gold, TH	61301021121	Wurth Elektronik
J3	1		D-Sub-9, 11Pos, Male, TH	09 65 162 6810	Harting
J4	1		Header, 2.54 mm, 4x1, Gold, TH	61300411121	Wurth Elektronik
J5, J6, J7, J8, J9, J10	6		Header, 2.54mm, 2x1, Gold, TH	TSW-102-08-G-S	Samtec
L2, L3, L4, L5	4	3uH	Ind Chip Wirewound 3uH 5% 7.9MHz 20Q-Factor Ceramic 300mA 1210 T/R	AISC-1210-3R0J-T	Abracon
R1	1	4.75k	RES, 4.75 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERJ-6ENF4751V	Panasonic
R2	1	0	RES, 0, 5%, 0.125 W, 0805	RC0805JR-070RL	Yageo America
R5, R9	2	0	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	CRCW12060000Z0EA	Vishay-Dale
R6, R8	2	120	RES, 120, 1%, 1 W, AEC-Q200 Grade 0, 2512	CRCW2512120RFKEG	Vishay-Dale
R11	1	1.00Meg	RES, 1.00 M, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERJ-6ENF1004V	Panasonic
R12	1	60.4	RES, 60.4, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	CRCW080560R4FKEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	6		Shunt, 2.54mm, Gold, Black	60900213421	Wurth Elektronik
TP1, TP5, TP6, TP7, TP8, TP9	6		Test Point, Miniature, Blue, TH	5117	Keystone

Table 1-2. Bill of Materials (continued)

Designator	Quantity	Value	Description	PartNumber	Manufacturer
TP2, TP3, TP4, TP11	4		Test Point, Miniature, Black, TH	5001	Keystone
TP10	1		Test Point, Miniature, Red, TH	5000	Keystone
U1	1		Fault-Protected CAN FD Transceiver with Signal Improvement Capability (SIC) and Standby Mode	TCAN1462VDRQ1	Texas Instruments
C1, C2, C3, C5, C6	0	20pF	CAP, CERM, 20 pF, 100 V, +/- 5%, C0G/NP0, 0805	08051A200JAT2A	AVX
C4	0	4700pF	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805	GRM219R72A472KA01D	MuRata
L1	0	100uH	Inductor, Ferrite, 100 uH, 0.15 A, 2 ohm, SMD	ACT45B-101-2P-TL003	TDK
R3, R7	0	4.75k	RES, 4.75 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERJ-6ENF4751V	Panasonic
R4, R10	0	60.4	RES, 60.4, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	CRCW080560R4FKEA	Vishay-Dale

2 EVM Setup and Operation

This section describes the setup and operation of the EVM for parameter performance evaluation.

2.1 Overview and Basic Operation Settings

2.1.1 V_{CC} Power Supply (J2, J3, J9, and TP10)

The basic setup of the CAN EVM uses a single power supply required to evaluate standard 5-V or 3.3-V single-supply transceiver device performance. For single-supply transceivers, connect the 5- or 3.3-V V_{CC} supply to the J9 jumper header, or the V_{CC} and GND test-point loops. The power supplied should meet the required specification of V_{CC} for the transceiver being tested.

2.1.2 I/O Power Supply V_{IO} (J2, J10, and TP8)

For devices with I/O level shifting, a second supply pin for the I/O or RXD pin is on pin 5 of the transceiver device. Power can be supplied to this pin by either shunting V_{CC} and V_{IO} together via J10, or connect a separate power supply via J2, J10, or TP8.

2.1.3 Main Supply and I/O Header (J2)

All key I/O and supply GND functions are brought to this header. It may be used on either interface to test equipment or a short cable could be made to connect to an existing customer-application board with a CAN controller.

Table 2-1. J2 Pin Definitions

Pin	Connection	Description
2	STB	Pin 8 of transceiver, normally used to enable/disable standby mode
4	TXD	Pin 1 of transceiver, TXD (transmit data)
6	RXD	Pin 4 of transceiver, RXD (receive data)
8	V_{CC}	Pin 3 of transceiver, V_{CC}
10	VIO	Pin 5 of transceiver, supports level-shifiting functions of devices with VIO pins
1	GND	Pin 2 of transceiver, GND
3		
5		
7		
9		

This header is arranged to provide a separate ground for each signal pair (TXD/GND and RXD/GND). If the EVM is being used with lab equipment, connect separate cables to these main points via simple 2-pin header connectors. If connecting the board to a processor-based system, connect a single cable with all power and signals via a 10-pin header cable to this port.

2.1.4 TXD Input (J2 or TP6)

The TXD (pin 1) of the transceiver, transmit data, is routed to J2 and TP6. An optional pull resistor to V_{IO} can be installed on R3, and an optional filtering capacitor can be intalled on C3.

2.1.5 RXD Output (J2 or TP7)

The RXD (pin 4) of the transceiver, receive data, is routed to J2 and TP7. An optional pull resistor to V_{IO} can be installed on R7, and an optional filtering capacitor can be intalled on C5.

2.1.6 STB or Pin 8 (J1, J2, or TP1)

Pin 8 of the transceiver is normally a mode control pin of the device. Pin 8 of the device is routed to J1, J2, and TP1.

2.1.7 J1 Configuration

If using separate I/O inputs, J1 is used to configure pin 8 to pull up to V_{IO} or pull down to GND configuration. This pin can be pulled up to V_{IO} by connecting a shunt to the PU (pull up) and STB pins (1 & 2) on J1, or it can be pulled down to GND by connecting a shunt to the PD (pull down) and STB pins (2 & 3) on J1.

2.1.8 TP1 Configuration

This connects directly to device pin 8. Ensure J1 configuration is not conflicting if TP1 is used as the input connection.

2.1.9 VIO or Pin 5 (J2, J10, or TP8)

Pin 5 of the transceiver supports the level-shifting functionality of transcievers with VIO pins. Set the voltage of this pin to the desired digital logic level.

2.1.10 J10 Configurations

If using a device that supports I/O level shifiting with a V_{IO} pin on pin 5, this jumper can be used to provide power to pin 5. A shunt can be placed between pins 1 and 2 of J10 to short V_{CC} and V_{IO} together and allow V_{CC} to power V_{IO}.

2.1.11 J2 Configuration

Using header J2 assumes all the digital I/O signals, V_{CC}, and GND are routed to an external system. Ensure that pin 5 (J10) jumper settings are not conflicting with signals to J2.

2.1.12 SIC Network Configuration (J7 & J8)

The SIC network can be enabled connecting shunts to J7 and J8. This will connect the network of inductors, capacitors, and resistors to the CANH and CANL lines and create a much noisier CAN bus. Note that both J7 and J8 need to be shunted for this to work.

2.2 Using CAN Bus Load, Termination, and Protection Configurations

The CAN EVM is populated with two 120-Ω power resistors selectable via jumpers between CANH and CANL. When using one resistor, the EVM is used as a terminated end of a bus. For electrical measurements to represent the total loading of the bus, use both 120-Ω resistors in parallel to give the standard 60-Ω load for parametric measurement. The EVM also has footprints for split termination if needed for the application. Table 2-2 summarizes how to use these termination options. If using split termination, match the resistors. Calculate the common mode filter frequency using: $f_C = 1 / (2\pi RC)$. Normally, the split capacitance is in the range of 4.7 nF to 100 nF. Note the that a common-mode filter frequency, not a differential filter impacts the differential CAN signal directly.

Table 2-2. Bus Termination Configuration

Termination Configuration	120-Ω Resistors		Split Termination Footprints		Split Termination Footprints
	J5	J6	R4	R10	C4
Standard termination (120 Ω)	shorted	open	N/A	N/A	N/A
60-Ω load - electrical parametrics	shorted	shorted			
Split termination (common mode stabilization)	open	open	60 Ω	60 Ω	populated

The EVM also has footprints for various protection schemes to enhance robustness for extreme system-level EMC/ESD requirements. Table 2-3 summarizes these options.

Table 2-3. Protection and Filtering Configuration

Configuration	Footprint Reference	Use Case	Population and Description
Series resistors or common mode choke	R5/R9 or L1 (common footprint)	Direct CAN transceiver to bus connection	R5 and R9 populated with 0 Ω (default population)
		Series resistance protection, CAN transceiver to bus connection	R5 and R9 populated with MELF resistor as necessary for harsh EMC environment
		CM choke (bus filter)	L1 populated with CM choke to filter noise as necessary for harsh EMC environment
Bus filtering caps and transient protection	C2/C6	Bus filter	Filter noise as necessary for harsh EMC environment. Use filter caps in combination with L1 CM choke.
	D1	Transient and ESD protection	To add extra protection for system level transients and ±30 kV ESD events, ESD2CAN24-Q1is populated in the D1 socket.

2.3 Using Customer Installable I/O Options for Current Limiting, Pullup and Pulldown, Noise Filtering

The CAN EVM has footprints on the PCB for the installation of various filtering and protection options to adapt the EVM to match CAN network topology requirements if the EVM is being used as a CAN node.

Each digital input or output pin has footprints allowing for pullup or down resistors (depending on pin use) and a capacitor to GND which allows for EMI/EMC filtering. Table 2-4 lists these features for each of the digital input and output pins of the EVM. Replace or populate the RC components as necessary for the application.

Table 2-4. EMI/EMC Filter and Protection Lists

Device Pin			Jumperable		Pullup and Pulldown	C to GND	Description
No.	Description	Type	Pullup	Pulldown			
1	TXD	Input	N/A	N/A	R3 PU	C3	
4	RXD	Output	N/A	N/A	R7 PU	C5	
5	NC	No Connect	N/A	N/A	N/A	N/A	
	V_{IO}	Supply Input	N/A	N/A	N/A	C7/C14	Use TP8, JMP2, and JMP10 as necessary to provide supply input.
8	STB	Input	R1 (J1)	R2 (J1)	N/A	C1	
	NC	No Connect	N/A	N/A	N/A	N/A	

3 CAN EVM Configuration for TCAN1462-Q1 (Factory Installed)

The TCAN14xx family of devices interface CAN protocol controllers with the physical bus in accordance to the ISO 11898 standard. These devices are compatible with the ISO 11898 High Speed CAN (Controller Area Network) Physical Layer standards: 11898-2. TCAN1462-Q1 is designed to support CAN FD data rates of 5 Mbps. It includes many protection features providing device and CAN network robustness.

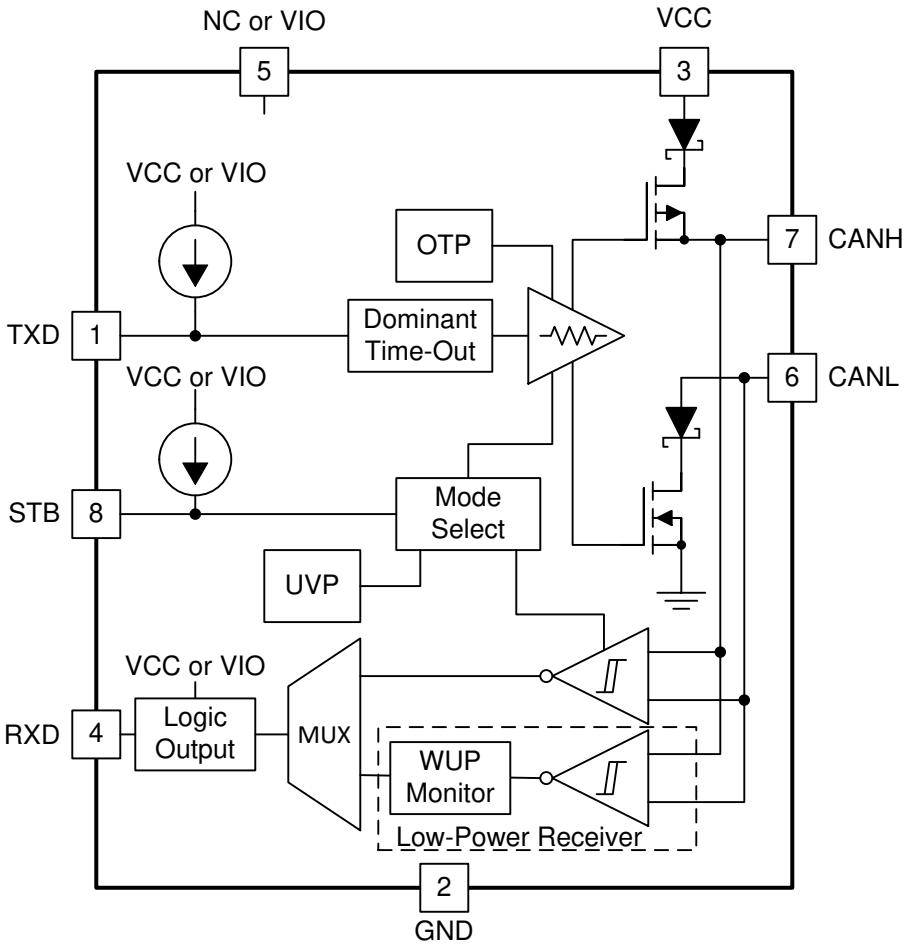

Figure 3-1. TCAN1462-Q1 Basic Block Diagram

Table 3-1. EVM Connection Settings for TCAN1462

Connection	Description
J1	Mode selection: Pull up to V_{CC} for standby mode, pull down to GND for normal mode
J2	Connection for access to all critical digital I/O, supply, and GND if being externally driven by test equipment or interfaced to a processor EVM. Note: ensure that J1, J9, J10 and T11 settings do not conflict with J2, if it is used.
J3/J4	CAN bus connection (CANH, CANL) and GND as necessary if interfacing EVM to a CAN network
J5	Connect if necessary for a single CAN network termination
J6	Connect, if necessary, in parallel with JMP5 to get a 60-Ω load to measure CAN parametrics
J7/J8	Connect if wanting to operate using the on-board SIC network.
J10	TCAN1462 V_{IO} - Level-shifting for applications that require 3.3-V operation. Connect to 5-V supply for 5-V applications and 3.3-V for 3.3-V applications.

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