TCAN EVM User Guide

This User Guide details the TCAN EVM (Controller Area Network Evaluation Module) transceiver operation. The TCAN EVM may be user-reconfigured for use with all TI CAN transceiver families: TCAN33x, TCAN10xx, SN65HVD23x, SN65HVD25x, SN65HVD10x0 and SN65HVDA54x 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, various load and termination settings.

Topic **Page**

1 Introduction

1.1 Overview

Texas Instruments offers a broad portfolio of High Speed (HS) CAN 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 Texas Instruments CAN EVM helps designers evaluate the operation and performance of various TI CAN transceivers. It also provides PCB footprints for different device packages, bus termination, bus filtering and protection concepts. It is easily configured by the customer for the TCAN33x, TCAN10xx, SN65HVD23x, SN65HVD25x, SN65HVD10x0 and SN65HVDA54x CAN transceiver families as needed by jumper settings, simple soldering tasks and replacement of standard components. 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 (various functions). The EVM supports many options for CAN bus configuration. It is pre-configured with two 120-Ω resistors that may be 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 “sees” in a properly terminated network (i.e. 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 component(s).

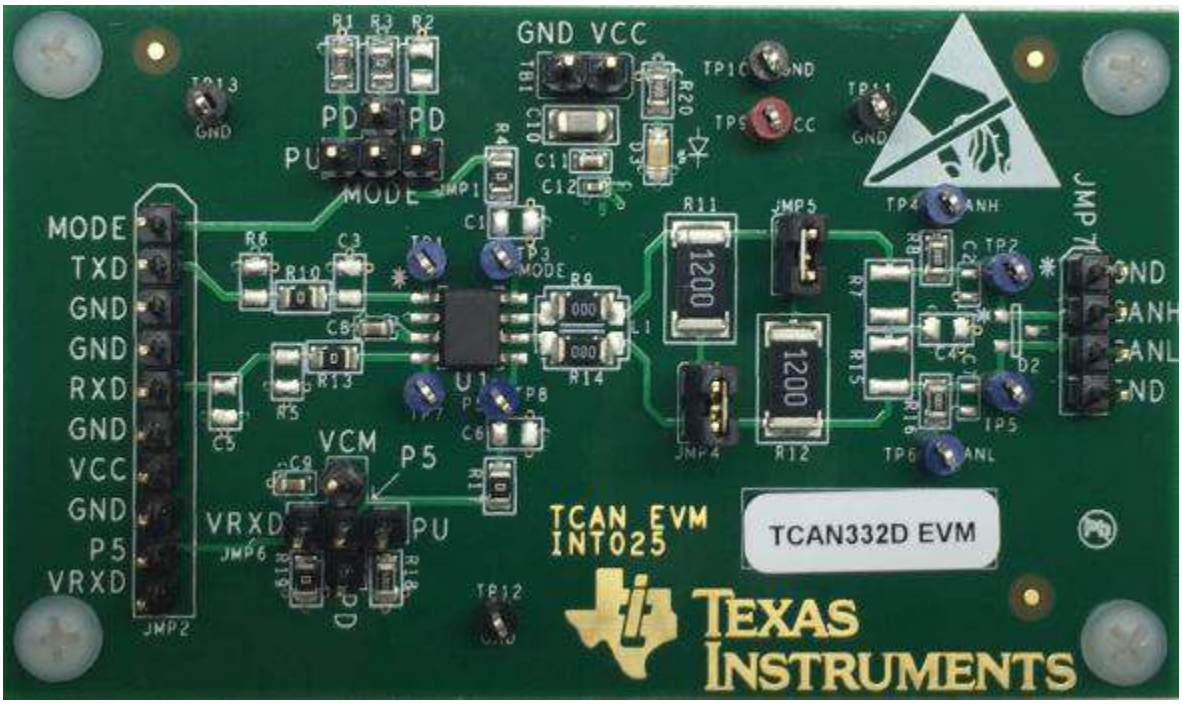

Figure 1. EVM PC Board

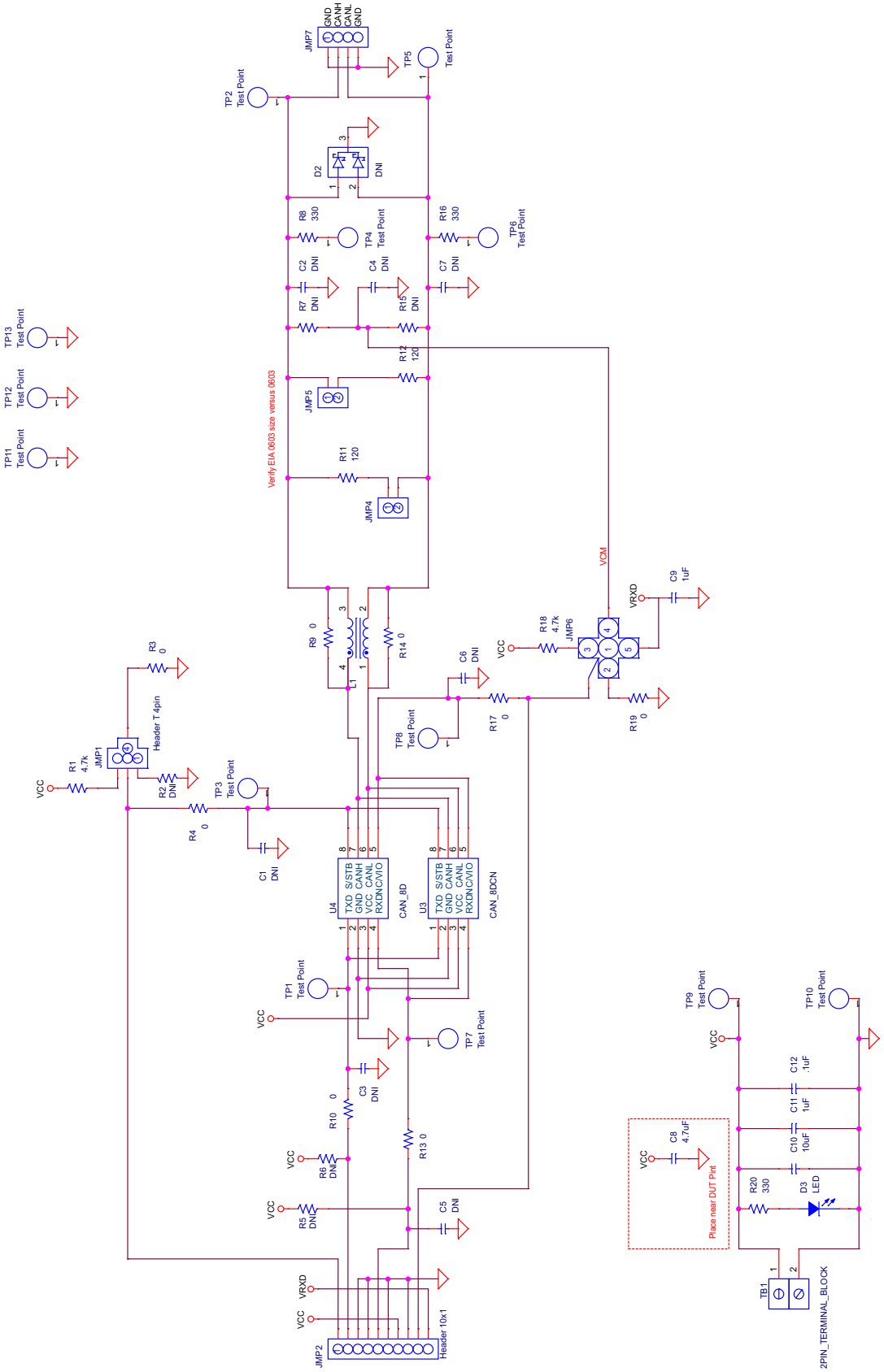

Figure 2. EVM Schematic

Table 1. Jumper Connections

Connection	Type	Description
JMP1	4 pin jumper	Used for mode selection on pin 8 (4.7 kΩ pull up to V_{CC}, 0 Ω pull down to GND, customer installable pull down for devices with slew rate control R_S pin).
JMP2	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
JMP3	4 pin header	CAN bus connection (CANH, CANL) and GND
JMP4	2 pin jumper	Connect 120Ω CAN termination to the bus. Used separately for a single termination if EVM is at end of the CAN bus and termination isn't in the cable. Used in combination with JMP5 to get to second CAN termination to represent the combined 60Ω load for CAN transceiver parametric measurement.
JMP5	2 pin jumper	Connect 120Ω CAN termination to the bus. Used in combination with JMP4 to get to second CAN termination to represent the combined 60Ω load for CAN transceiver parametric measurement.
JMP6	5 pin jumper	Functional use of pin 5. Options for use are:A) 4.7 kΩ pull up to V_{CC} for transceiver with digital input on pin 5B) 0 Ω pull down to GND for transceiver with digital input on pin 5C) Active split termination: for CAN transceiver with V_{REF} or SPLIT pin where active split termination is desired. Connect to V_{CM} and populate the components R7/R15 and C4 as required for the system.D) V_{RXD} (V_{IO}) for CAN transceivers with a separate V_{RXD} (V_{IO}) for I/O level shifting.
TB1	2 pin jumper	V_{CC} supply and GND connection for the EVM
TP1	Test Point	TXD, Device Pin 1 test point
TP2		CANH (bus) test point
TP3		Device Pin 8 test point
TP4		CANH via 330Ω serial resistor test point
TP5		CANL (bus) test point
TP6		CANL via 330Ω serial resistor test point
TP7		RXD, Device Pin 4 test point
TP8		Device Pin 5 test point
TP9		V_{CC} test point
TP10		GND test point
TP11		
TP12		
TP13		

2 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 (TB1 or TP9 or JMP2)

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 devices performance. For single-supply transceivers, connect the 5 V or 3.3 V V_{CC} supply to the TB1 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. LED D3 is used to indicate V_{CC} presence.

2.1.2 I/O Power Supply V_{RXD} or V_{IO} (JMP2, JMP6 or 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. A second power supply is needed to test one of these devices and should be connected via JMP2, JMP6 or TP8. A local buffering and decoupling capacitor should be installed at C6 if the EVM is used for one of these devices.

2.1.3 Main Supply and I/O Header (JMP2)

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 either an existing customer application board or MCU/DSP EVM board for a processor with a CAN controller

Table 2. JMP2 Pin Definitions

Pin	Connection	Description
1	MODE	Pin 8 of Transceiver, normally used for Mode control. Examples: SHDN, FAULT, R_S, S, STB.
2	TXD	Pin 1 of Transceiver. TXD (Transmit Data)
3	GND	Pin 2 of Transceiver. GND.
4	GND	Pin 2 of Transceiver. GND.
5	RXD	Pin 4 of Transceiver. RXD (Receive Data)
6	GND	Pin 2 of Transceiver. GND.
7	V_{CC}	Pin 3 of Transceiver. V_{CC}
8	GND	Pin 2 of Transceiver. GND.
9	P5	Pin 5 of Transceiver, various functions depending on transceiver. Examples: V_{REF}, SPLIT, V_{RXD}, V_{IO}, LBK, EN, AB and No Connect (NC).
10	V_{RXD}	Connects to Jumper JMP6 V_{RXD} header to allow flexibility in using device with power supply for I/O on Pin 5 of transceiver.

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

2.1.4 TXD Input (JMP2 or TP1)

The TXD (pin 1) of the transceiver, transmit data is routed to JMP2 and TP1. The signal path to the JMP2 header is pre-installed with a 0-Ω series resistor, R10.

2.1.5 RXD Output (JMP2 or TP7)

The RXD (pin 4) of the transceiver, receive data is routed to JMP2 and TP7. The signal path to the JMP2 header is pre-installed with a 0Ω series resistor, R13.

2.1.6 MODE Select/ Pin 8 (JMP1, JMP2 or TP3)

Pin 8 of the transceiver is normally a mode control pin of the device. Pin 8 of the device is routed to JMP1, JMP2 and TP7.

2.1.7 MODE - JMP1 configurations (3 way jumper)

If using separate I/O inputs JMP1 will be used to configure pin 8 to a pull up to V_{CC} or pull down to GND configuration. For most devices, when Pin 8 is pulled to GND the device will be in “normal” or high speed mode. R3 is pre-installed with 0-Ω resistor to GND for this purpose. For most devices, when Pin 8 is pulled to V_{CC} the device will be in a silent or low power standby mode. Devices with slope control mode use the resistance to ground value to determine the slope of the driver output. R2 is left open for customers who want to install a resistance to ground and use slope mode.

2.1.8 JMP2 configuration

Using header JMP2 which assumes all the digital I/O signals, V_{CC}, GND are routed to an external system. Ensure that the MODE (JMP1) jumper settings are not conflicting with signals to JMP2.

2.1.9 TP3 configuration

This connects directly to device pin 8. Ensure JMP1 configuration isn’t conflicting if TP3 is used as the input connection.

2.1.10 Pin 5 (JMP6, JMP2 or TP8)

Pin 5 of the transceiver have various uses depending on the transceiver. Examples are V_{REF}, SPLIT, V_{RXD}, V_{IO}, LBK, EN, AB and No Connect (NC). Pin 5 of the device is routed to JMP6, JMP2 and TP8.

2.1.11 Pin 5 – JMP6 configurations (4 way jumper)

If using separate I/O inputs JMP6 will be used to configure pin 5 to: pull up to V_{CC}, pull down to GND, V_{RXD} / V_{IO} supply input or V_{REF}/SPLIT termination output.

- **V_{REF}/SPLIT termination:** If the device and application support split termination then JMP6 should be set to V_{CM} (V Common Mode) to drive the V_{REF}/SPLIT pin common mode stabilizing voltage output to the center tap of the split termination capacitor. These components will need to be installed on the EVM as outlined in the CAN bus termination section.
- **No Connection:** If the device and application require no use of pin 5 then it may be left open. If the device has V_{REF} or SPLIT pin but the application isn’t using the pin for split termination then a capacitor may be added on C6 to improve EMC performance.
- **2nd Mode** / **Control Input:** if the device and application use pin 5 as a second mode or control pin then JMP6 should be set to as either a pull up to V_{CC} or pull down to GND as necessary.
- **I/O and RXD level shifting supply:** if the device and application use with V_{IO} or V_{RXD} to level shift I/O pins on the transceiver then JMP6 may be set to V_{RXD} which connects pin 5 of the device to V_{RXD} pin on JMP2. Local buffering and bypass capacitor C6 should be installed.

2.1.12 JMP2 configuration

Using header JMP2 assumes all the digital I/O signals, V_{CC}, GND are routed to an external system. Ensure that Pin 5 (JMP6) jumper settings are not conflicting with signals to JMP2. For power supply V_{RXD} the jumper needs to be set to route JMP2 supply input to the transceiver pin.

2.1.13 TP8 configuration

This connects directly to device pin 5. Ensure JMP6 configuration isn’t conflicting if TP8 is used as an input connection.

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. By using one, the EVM may be 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. The table below summarizes how to use these termination options. If split termination is used, care must be taken to match the resistors. The common mode filter frequency may be calculated by: $f_C = 1/(2\pi RC)$. Normally, the split capacitance is in the range of 4.7 nF to 100 nF. Keep in mind this is the common mode filter frequency, not a differential filter that will impact the differential CAN signal directly.

Table 3. Bus Termination Configuration

Termination Configuration	120Ω Resistors		Split Termination Footprints		Split Termination Footprints
	JMP4	JMP5	R7	R15	C4
Standard Termination (120Ω)	shorted	open	N/A	N/A	N/A
60Ω load - Electrical Parameterics	shorted	shorted			
Split Termination (Common Mode Stabilization)	open	open	60Ω	60 Ω	populated

The EVM also has footprints for various protection schemes to enhance robustness for extreme system level EMC requirements. The table below summarizes these options.

Table 4. Protection and Filtering Configuration

Configuration	Footprint Reference	Use Case	Population and Description
Series Resistors or Common Mode Choke	R9 / R14 or L1 (common footprint)	Direct CAN transceiver to bus connection	R9 and R14 populated with 0Ω (default population)
		Series resistance protection CAN transceiver to bus connection	R9 and R14 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 Transient Protection	C2 / C7	Bus filter	Filter noise as necessary for harsh EMC environment. Filter caps may be used in combination with L1 CM choke.
	C2 / C7 or D1 / D2	Transient & ESD Protection	To add extra protection for system level transients and ESD protection TVS diode population option via D1/D2 footprint or varistor population via C2 / C7 footprint.

2.3 Using Customer Installable I/O options for Current Limiting, Pullup/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 to allow for series current limiting resistors (default populated with 0 Ω), pull up or down resistors depending on pin use and a capacitor to GND which allows for RC filters when configured with a series resistor. The table below 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 5. RC Filter / Protection Lists

Device Pin			Jumperable		Series R	Pull Up/Down	C to GND	Description
No.	Description	Type	Pull Up	Pull Down				
1	TXD	Input	N/A	N/A	R10	R6 PU	C3	
2	RXD	Output	N/A	N/A	R13	R5 PU	C5	
5	NC	No Connect	N/A	N/A	N/A	N/A	N/A	
	SHDN	Input	R18 (JMP6)	R19 (JMP6)	R17	N/A	C6	
	FAULT	Output	N/A	N/A	R17	N/A	C4/C6	
	V_{REF}/SPLIT	Output	N/A	N/A	R17	N/A	C4 / C6	Split termination: JMP6 to route output to split termination center point capacitor C4. EMC for systems not using split termination: C6 to GND.
	V_{RXD}/V_{IO}	Supply Input	N/A	N/A	R17	N/A	C9 / C6	Use TM6, JMP6 & JMP2 as necessary to provide supply input.
	AB / EN / LBK	Input	R18 (JMP6)	R19 (JMP6)	R17	N/A	C6	
8	S, R_S, STB	Input	R1 (JMP1)	R2 / R3 (JMP1)	R4	N/A	C1	R2 pull down to GND (JMP1) user installable for use with slope mode on devices with R_S pin.
	NC	No Connect	N/A	N/A	N/A	N/A	N/A	

3 CAN EVM Configuration for TCAN332 (Factory Installed)

The TCAN33x 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. Standard versions are designed for data rates of 1 megabit per second (Mbps) in CAN networks and additional devices are designed to meet at least 2 Mbps in CAN FD networks. The devices include many protection features providing device and CAN network robustness.

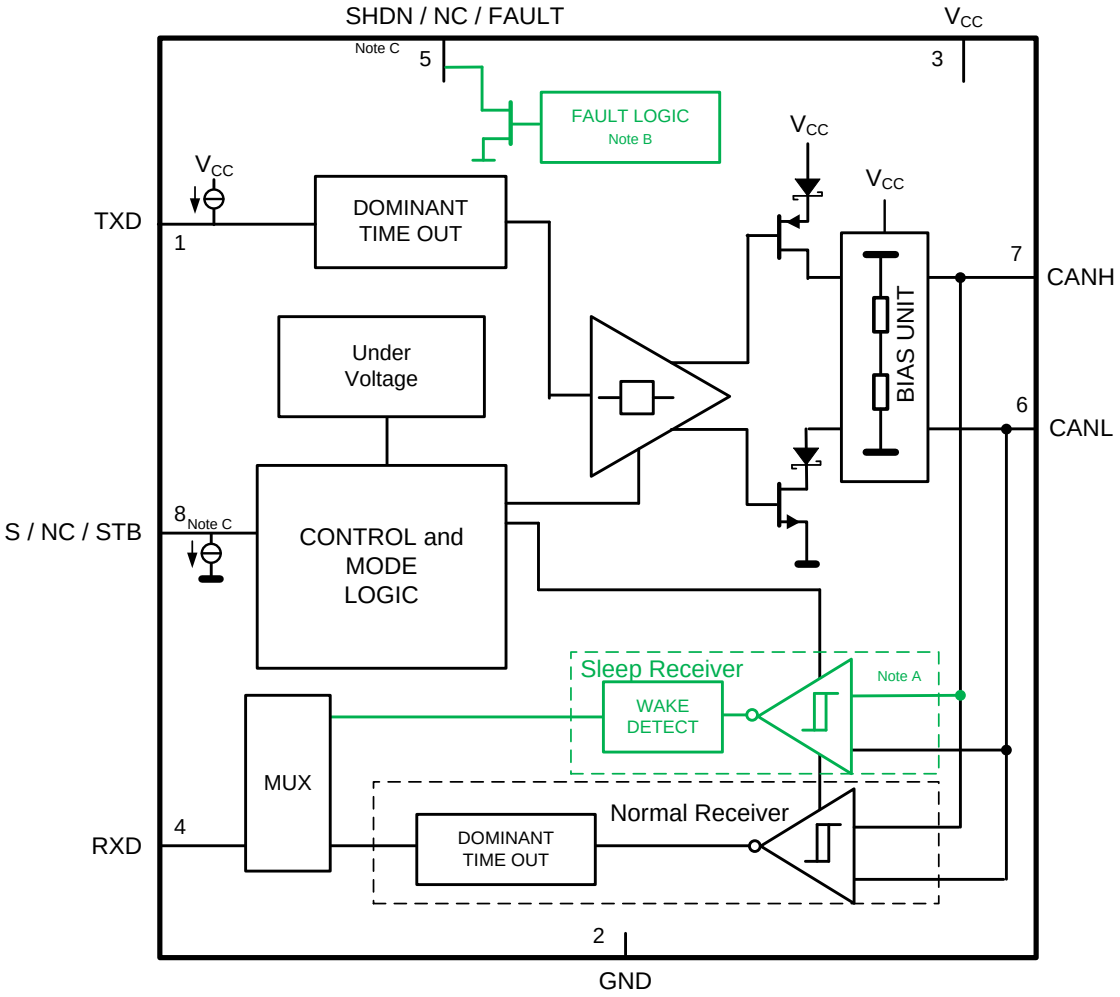

Figure 3. TCAN33x Basic Block Diagram

Table 6. EVM Connection Settings for TCAN33x

Connection	Description
JMP1	Mode selection: Pull up to V_{CC} for Silent Mode, Pull down to GND for normal mode
JMP2	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 JMP1, JMP6 & TB1 settings don't conflict with JMP2 if it is used.
JMP3	CAN bus connection (CANH, CANL) and GND as necessary if interfacing EVM to a CAN network
JMP4	Connect if necessary for a single CAN network termination
JMP5	Connect if necessary for in parallel with JMP4 to get a 60Ω load to measure CAN parametrics
JMP6	TCAN330/4 Pull High For Shutdown Mode; TCAN337 Open Drain Fault Output Pin

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