TCAN1046V Evaluation Module

This user guide details the TCAN1046V CAN (Controller Area Network) EVM transceiver operation. The TCAN1046V CAN EVM is configurable for the SOIC package version of both TCAN1046 and TCAN1046V. This user guide explains the EVM configurations for basic CAN evaluation, and various load and termination settings.

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1 Introduction

1.1 Overview

TI 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 TCAN1046V EVM helps designers evaluate the operation and performance of TCAN1046V transceiver in the SOIC package. It also provides bus termination, bus filtering, and protection concepts. It is easily configured by the customer to test different configurations with jumper settings, simple soldering tasks, and replacement of standard components, as well as both CAN interfaces on the device separately.

1.2 CAN EVM

The TCAN1046V 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, STBY, and VIO. 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 “sees” in a properly terminated network (that is, 120-Ω termination resistors at both ends of the cable). The bus also has termination of two 60-Ω resistors in series with a 4.7nF capacitor to GND at the midpoint, all soldered down. This gives the option to test the other typical termination network on CAN buses.

Figure 1 shows the EVM board image.

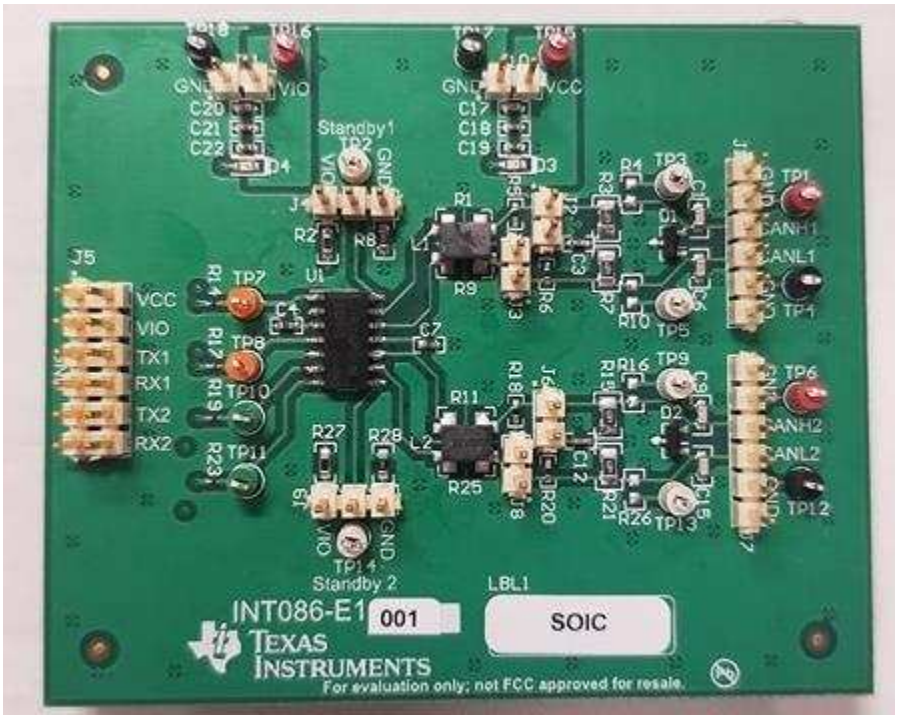

Figure 1. EVM PC Board

Figure 2 shows the EVM schematic.

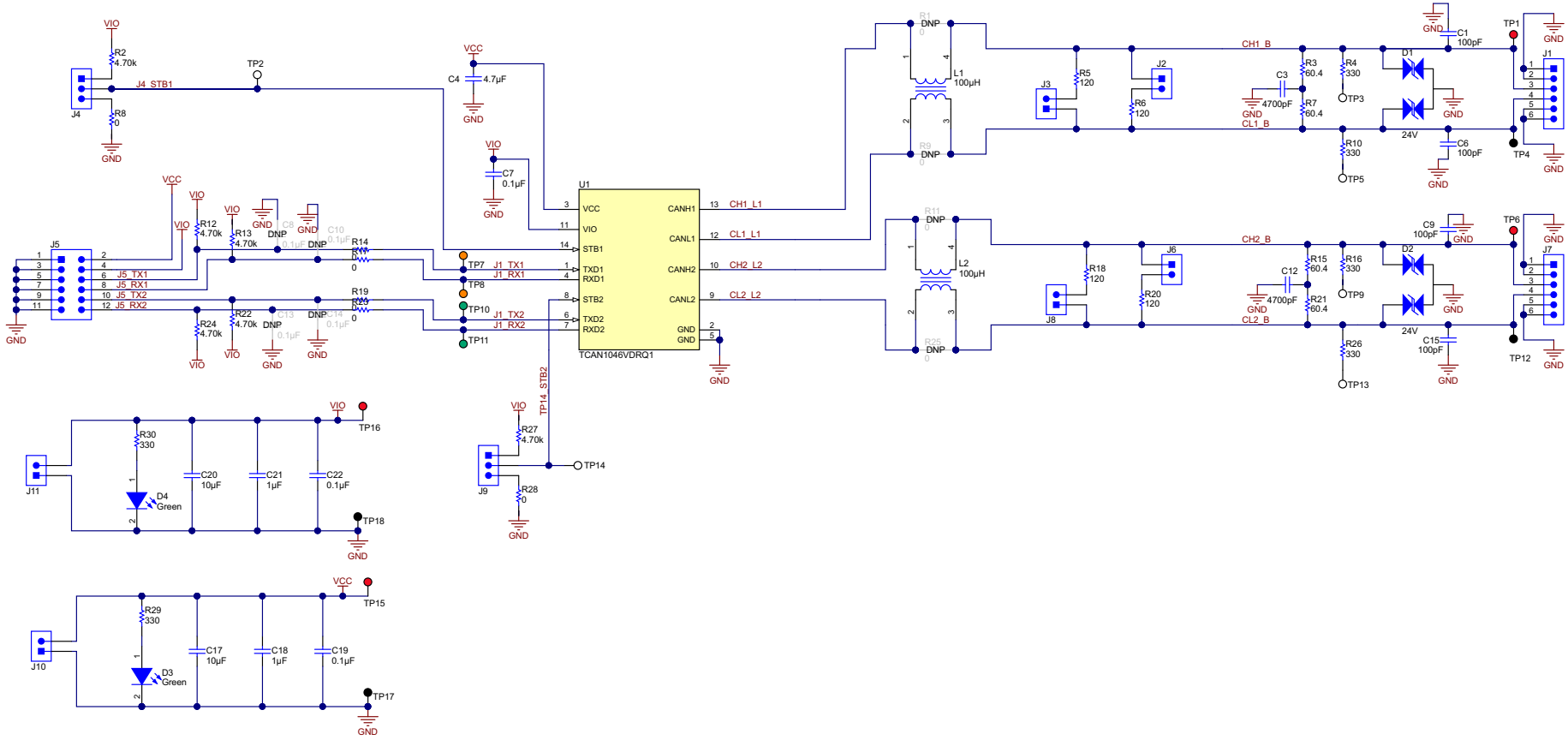

Figure 2. EVM Schematic

Table 1 lists the jumper connections for the EVM.

Table 1. Jumper Connections

Connection	Type	Description
J1	6-pin header	Used to monitor CANH and CANL on CAN1, GND connections available as well.
J2	2-pin jumper	Used to place R6 (120-Ω) on the CAN1 bus. Use in combination with J3 to represent the combined 60-Ω CAN termination.
J3	2-pin jumper	Used to place R5 (120-Ω) on the CAN1 bus. Use in combination with J2 to represent the combined 60-Ω CAN termination.
J4	3-pin jumper	Used to apply either VCC or GND to STBY1 (pin 14)
J5	12-pin header	Connections for VIO, VCC, TXD, and RXD for both CAN interfaces available, as well as GND connections.
J6	2-pin jumper	Used to place R20 (120-Ω) on the CAN2 bus. Use in combination with J3 to represent the combined 60-Ω CAN termination.
J7	6-pin header	Used to monitor CANH and CANL on CAN2, GND connections available as well.
J8	2-pin jumper	Used to place R20 (120-Ω) on the CAN2 bus. Use in combination with J3 to represent the combined 60-Ω CAN terminat
J9	3-pin jumper	Used to apply either VCC or GND to STBY2 (pin 8)
J10	2-pin header	VCC connection for external power supply
J11	2-pin header	VIO connection for external power supply
TP1	Test Point	CANH (CAN1) test point
TP2		STBY (CAN1) test point
TP3		CANH (CAN1) via 330-Ω series resistor test point
TP4		CANL (CAN1) test point
TP5		CANL (CAN1) via 330-Ω series resistor test point
TP6		CANH (CAN2) test point
TP7		TXD (CAN1) test point
TP8		RXD (CAN1) test point
TP9		CANH (CAN2) via 330-Ω series resistor test point
TP10		TXD (CAN2) test point
TP11		RXD (CAN2) test point
TP12		CANL (CAN2) test point
TP13		CANL (CAN2) via 330-Ω series resistor test point
TP14		STBY (CAN2) test point
TP15		VCC test point
TP16		VIO test point
TP17		GND test point
TP18		GND test point

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 (J10)

The basic setup of the TCAN1046V EVM uses at the most two power supply outputs required to evaluate standard 5-V supply transceiver with possibility of 3.3-V IO level device performance. When using 5-V for supply and IO levels, connect the 5-V supply to the J10 and J11 headers. The power supplied should meet 5-V and at least 100-mA. If using a separate supply for IO levels, leave J11 disconnected for now.

2.1.2 I/O Power Supply V_{IO} (J11)

For use cases where the IO level is going to be separate from the VCC voltage, a second power supply is needed to test the device. Connect this power supply via J11; the power supply will need to be capable of 3.3-V at 50-mA.

2.1.3 Transmit and Receive Connections(J5)

All transmit and receive (TXD and RXD) for both CAN interfaces, VIO, VCC, and GND connections are available on the J5 header. This allows the user the ability to evaluate the communication parameters of the transceiver in a straightforward manner.

Table 2. J5 Pin Definitions

Pin	Connection	Description
1	GND	Pin 2 and 5 of the transceiver, GND
2	VCC	Pin 3 of the transceiver, VCC
3	GND	Pin 2 and 5 of the transceiver, GND
4	VIO	Pin 11 of the transceiver, VIO
5	GND	Pin 2 and 5 of the transceiver, GND
6	TXD1	Pin 1 of the transceiver, TXD1
7	GND	Pin 2 and 5 of the transceiver, GND
8	RXD1	Pin 4 of transceiver, RXD1
9	GND	Pin 2 and 5 of the transceiver, GND
10	TXD2	Pin 6 of the transceiver, TXD2
11	GND	Pin 2 and 5 of the transceiver, GND
12	RXD2	Pin 7 of the transceiver, RXD2

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 Inputs (J5 or TP7 or TP10)

The TXD inputs (pin 1 and 6) of the transceiver; TXD1 is routed to pin 6 of J5, or TP7. The signal path to the J5 header is pre-installed with a 0-Ω series resistor, R14. TXD2 is routed to pin 10 of J5, or TP10, and the signal path to the J5 header is pre-installed with a 0-Ω resistor, R19.

2.1.5 RXD Outputs (J5 or TP8 or TP11)

The RXD outputs (pin 4 and 7) of the transceiver; RXD1 is routed to pin 8 of J5, or TP8. The signal path to the J5 header is pre-installed with a 0-Ω series resistor, R17. RXD2 is routed to pin 12 of J5, or TP11, and the signal path to the J5 header is pre-installed with a 0-Ω resistor, R23.

2.1.6 STBY inputs (J9/J4, TP2/TP14)

Pins 8 and 14 of the device are the STBY inputs. These pins are one way of controlling the state of the receiver. STBY1 is routed to J4 or TP2. J4 allows the selection of VCC or GND to connect to the STBY1 pin, while TP2 is just for observation. STBY2 is routed to J9 or TP14. J9 allows the selection of VCC or GND to connect to the STBY2 pin, while TP14 is just for observation.

2.1.7 Bus Observation (J1 or J7)

The CANH and CANL lines are available to be observed on an oscilloscope via the J1 or J7 headers. The CAN1 bus is routed to the J1 header, with CANH on pin 3, CANL on pin 4, and pins 1, 2, 5, and 6 connected to GND. The CAN2 bus is routed to the J7 header, with CANH on pin 3, CANL on pin 4, and pins 1, 2, 5, and 6 connected to GND.

2.1.8 Bus protection

Footprints for ESD protection diodes are available on both CAN buses. D1 and D2 are both in the SOT-23 package, which is a common package for ESD protection diodes for CAN interfaces.

2.1.9 TP3 Configuration

This connects directly to device pin 8. Ensure JMP1 configuration is not 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 is used to configure pin 5 to: pullup to V_{CC}, pulldown to GND, V_{RXD} or V_{IO} supply input, or V_{REF} or SPLIT termination output.

- **V_{REF} or SPLIT termination:** If the device and application support split termination, set JMP6 to V_{CM} (V common mode) to drive the V_{REF} or SPLIT pin common mode stabilizing voltage output to the center tap of the split termination capacitor. Install these components on the EVM as outlined in the CAN bus termination section.
- **No Connection:** If the device and application require no use of pin 5, leave it open. If the device has the V_{REF} or SPLIT pin but the application is not using the pin for split termination then add a capacitor on C6 to improve EMC performance.
- **2nd Mode or Control Input:** if the device and application use pin 5 as a second mode or control pin, then set JMP6 as either a pullup to V_{CC} or pulldown to GND, as necessary.
- **I/O and RXD level-shifting supply:** if the device and application used with V_{IO} or V_{RXD} to level shift I/O pins on the transceiver then set JMP6 to V_{RXD} connecting pin 5 of the device to the V_{RXD} pin on JMP2. Install local buffering and bypass capacitor C6.

2.1.12 JMP2 Configuration

Using header JMP2 assumes all the digital I/O signals, V_{CC}, and 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}, set the jumper to route JMP2 supply input to the transceiver pin.

2.1.13 TP8 Configuration

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

2.2 Using CAN Bus Load, Termination, and Protection Configurations

The TCAN1046V EVM has several bus termination options for both available buses. The termination on the CAN bus (CANH and CANL) can be configured with the J2 and J3 (CAN1) or J6 and J8 (CAN2) jumpers. Each jumper adds 120-Ω termination to the respective bus. 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. Split termination is also available and populated on both buses, and can be removed with some simple solder work.Table 3 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. Keep in mind this is the common-mode filter frequency, not a differential filter that impacts the differential CAN signal directly.

Table 3. Bus Termination Configuration

Termination Configuration	120-Ω Resistors (CAN1)		120-Ω Resistors (CAN2)		Split Termination Footprints (CAN1)		Split Termination Footprints (CAN2)		Split Termination Footprints (CAN1)	Split Termination Footprints (CAN2)
	J2	J3	J6	J8	R3	R7	R15	R21	C3	C12
Standard termination (120 Ω)	shorted		open		N/A		N/A		N/A	
60-Ω load - electrical parameterics	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 requirements. Table 4 summarizes these options.

Table 4. Protection and Filtering Configuration

Configuration	Footprint Reference	Use Case	Population and Description
Series resistors or common mode choke	R1/R9 or L1 (common footprint)	Direct CAN1 transceiver to bus connection	R1 and R9 populated with 0 Ω
		Series resistance protection, CAN1 transceiver to bus connection	R1and R9 populated with MELF resistor as necessary for harsh EMC environment
		CM choke (CAN1 bus filter)	L1 populated with CM choke to filter noise as necessary for harsh EMC environment (default population)
	R11/R25 or L2 (common footprint)	Direct CAN2 transceiver to bus connection	R11 and R25 populated with 0 Ω
		Series resistance protection, CAN2 transceiver to bus connection	R11 and R25 populated with MELF resistor as necessary for harsh EMC environment
		CM choke (CAN2 bus filter)	L1 populated with CM choke to filter noise as necessary for harsh EMC environment (default population)
Bus filtering caps transient protection	C1/C6	Bus filter	Filter noise as necessary for harsh EMC environment. Use filter caps in combination with L1 CM choke.
	C9/C15		Filter noise as necessary for harsh EMC environment. Use filter caps in combination with L2 CM choke.

Table 4. Protection and Filtering Configuration (continued)

Configuration	Footprint Reference	Use Case	Population and Description
	C1/C6 or D1	Transient and ESD protection	To add extra protection for system level transients and ESD protection, TVS diode population option via D1 footprint or varistor population via C1/C6 footprint.
	C9/C15 or D2		To add extra protection for system level transients and ESD protection, TVS diode population option via D2 footprint or varistor population via C9/C15 footprint.

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 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. Table 5 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 and Protection Lists

Device Pin			Jumperable		Series R	Pullup and Pulldown	C to GND
No.	Description	Type	Pullup	Pulldown			
1/6	TXD1/TXD2	Input	N/A	N/A	R14/R19	R12/R24 PU	C8/C14
4/7	RXD1/RXD2	Output	N/A	N/A	R17/R23	R13/R24 PU	C10/C13

3 CAN EVM Configuration for TCAN1046V (Factory Installed)

The TCAN1046V device interfaces CAN protocol controllers with the physical bus in accordance to the ISO 11898 standard. This device is compatible with the ISO 11898 High Speed CAN (Controller Area Network) Physical Layer standards: 11898-2. This device is designed for use of up to 5 Mbit CAN systems, and it includes many protection features providing device and CAN network robustness.

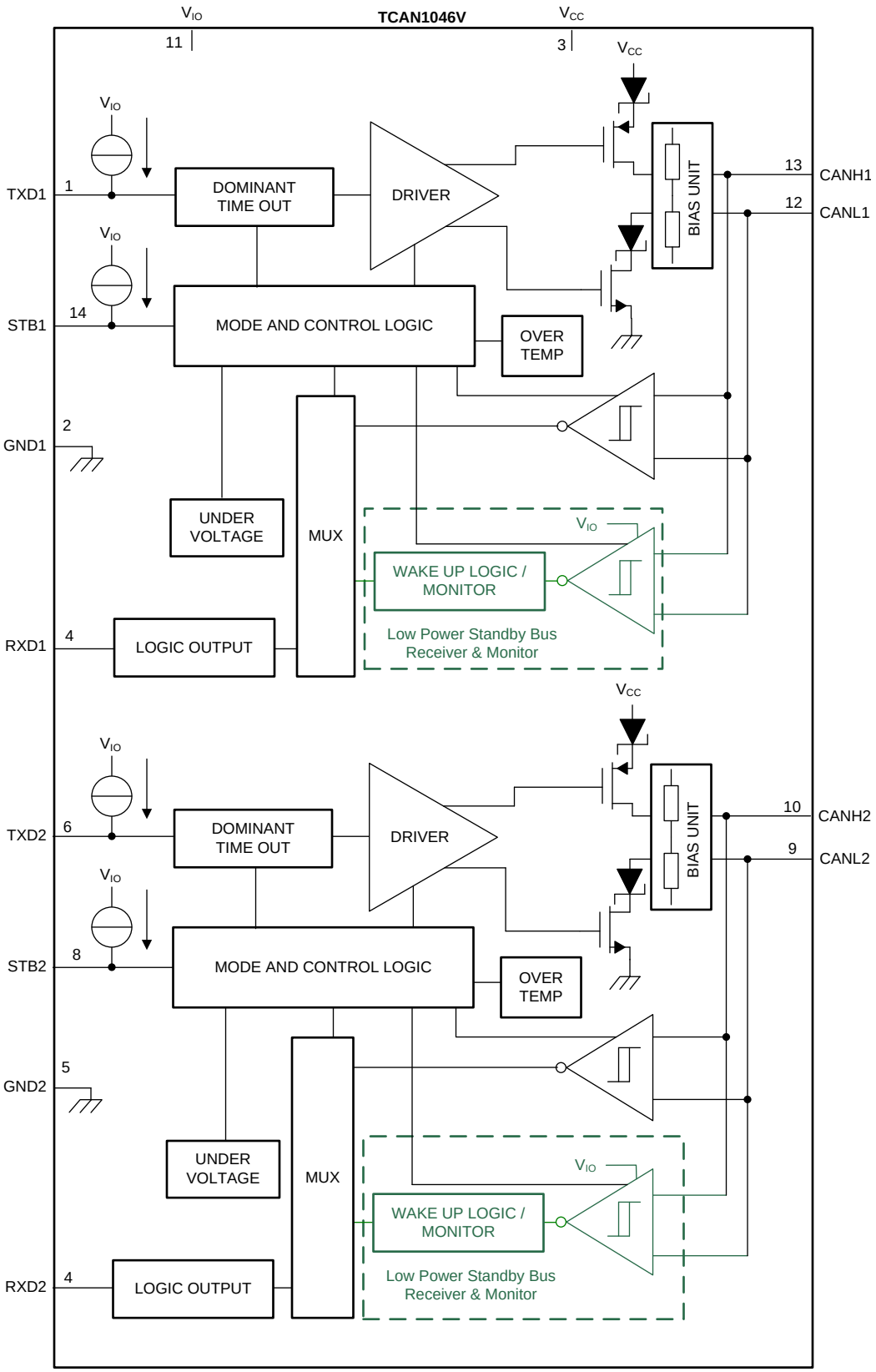

Figure 3. TCAN1046V Basic Block Diagram

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      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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