CAN Reference Guide

Texas Instruments

ISO1050, SN65HVD230, SN65HVD231, SN65HVD232, SN65HVD233
SN65HVD234, SN65HVD235, SN65HVD251, SN65HVD252, SN65HVD253

SN65HVD1040, SN65HVD1050, SN65HVDA540, SN65HVDA541
SN65HVDA542, SN65HVDA1040A, SN65HVDA1050A
SN65HVD255, SN65HVD256, SN65HVD257

- Industrial and Factory Automation
- Motion Control
- Transportation
- Sensors
- Backplanes

CAN Reference Guide

Introduction to CAN (Controller Area Network)

Whether you are looking for 5V CAN, 3.3V CAN, isolated CAN, automotive CAN or industrial CAN, Texas Instruments provides what you need. TI is committed to solving specialized networking requirements while optimizing CAN physical layers (transceivers) for various applications, microprocessors and power supply systems. Come explore the world of CAN in a wide range of packages and temperatures. These devices are compatible to the ISO11898 CAN standard including the original ISO11898:1993 and the updated transceiver part 2 (ISO11898-2, CAN high-speed medium access unit) and part 5 (ISO11898-5, CAN high-speed medium access unit with low-power mode), depending on the application.

5V CAN transceivers

- "Turbo" CAN
- Programmable slew rate
- EMC and speed optimized
- Low-power modes
- Wake-up via CAN network traffic
- Protection features
- Level shifting and 3.3V compatible
- Small VSON package
- Loopback for autobaud

3.3V CAN transceivers

- Voltage rail and regulator simplification (no 5V required)
- Power savings vs. 5V
- Programmable slew rate
- Low-power modes
- Protection features
- Loopback for autobaud & diagnostic purposes

Isolated CAN transceivers

- Isolation up to 5000V_{RMS}
- Failsafe outputs
- 3.3V/5V I/O
- 25-year life at rated working voltage

CAN Applications

Standardized CAN Data Bus/Protocol: ARINC 825, CANaerospace, CAN Kingdom, CANopen, DeviceNet, ISO11783, NMEA2000, SAEJ1939, SAEJ2284, SafetyBUS p

- Automotive (-Q1 versions)
- Industrial automation
- Building automation
- Process control equipment
- Elevators & lifts
- Backplane communication
- Construction equipment
- Farm equipment
- Transportation
- Factory automation
- Networked sensors & actuators
- Motor & motion control
- Medical
- Telecom
- Robotics
- Low power & battery applications

CAN-Based Buses and Protocols

Various higher level buses and higher level communication protocols have been implemented using or deriving from CAN protocol and physical layer standards. These standards include:

ARNIC825: CAN-based communication standard for airborne systems used by current and future aircraft. Driven by Airbus, Boeing and partners. **www.arinc825.com**

CANaerospace: Communication protocol on top of CAN designed for aerospace. **canaerospace.net**

CAN Kingdom: Communication protocol on top of CAN designed as fieldbus.

CANopen (EN 50325-4): CAN-based, higher-layer protocol for embedded control system. **www.can-cia.org**

DeviceNet: Industrial network system based on CAN. **www.odva.org**

ISO11898-x: Road vehicles. **www.iso.org**

ISO11783: Tractors and machinery for agriculture and forestry - serial control and communications data network. **www.iso.org**

NMEA 2000: National Marine Electronics Association – serial network utilizing CAN. **www.nmea.org**

SAEJ1939: Recommended practice for a serial control & communications vehicle network. **www.sae.org**

SAEJ2284: High-speed CAN (HSC) for vehicle applications. **www.sae.org**

SafetyBUS p: Protocol on top of CAN designed for fieldbus to SIL 3. **www.safety-network.de**

CAN PHY Basics (ISO11898-2 & -5)

High-Speed Medium Access Unit = HS CAN Transceiver with Transmission Rates of up to 1 Mbit/s

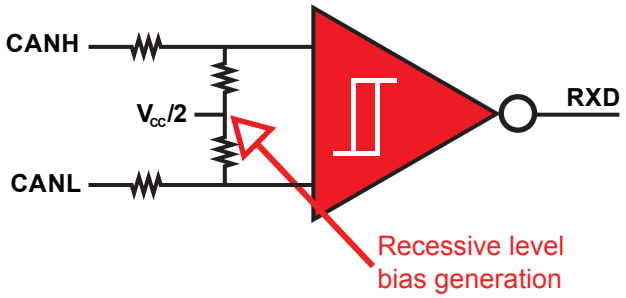
HS CAN is a Differential Bus (CANH & CANL Lines) with Two States:

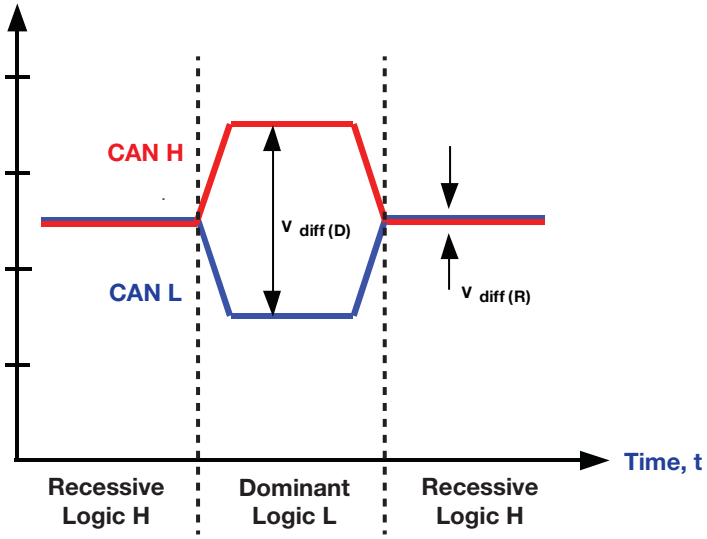
Recessive:
- Logic H
- Vdiff < = 0.5V
- CANH and CANL weakly biased to $V_{CC}/2$

Dominant:
- Logic L
- Vdiff = >0.9V
- CANH and CANL driven differentially by PHY driver
- Dominant overwrites recessive (enables CAN arbitration to work)

Recessive

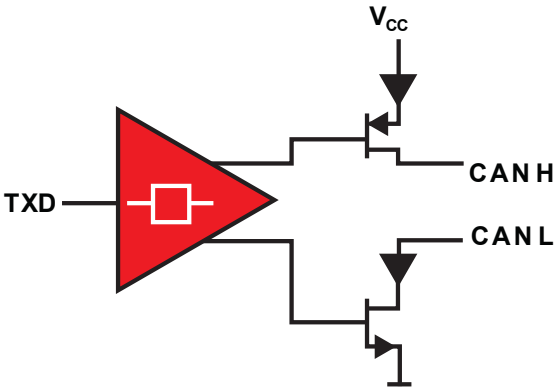
Simplified Receiver & Recessive Biasing Diagram





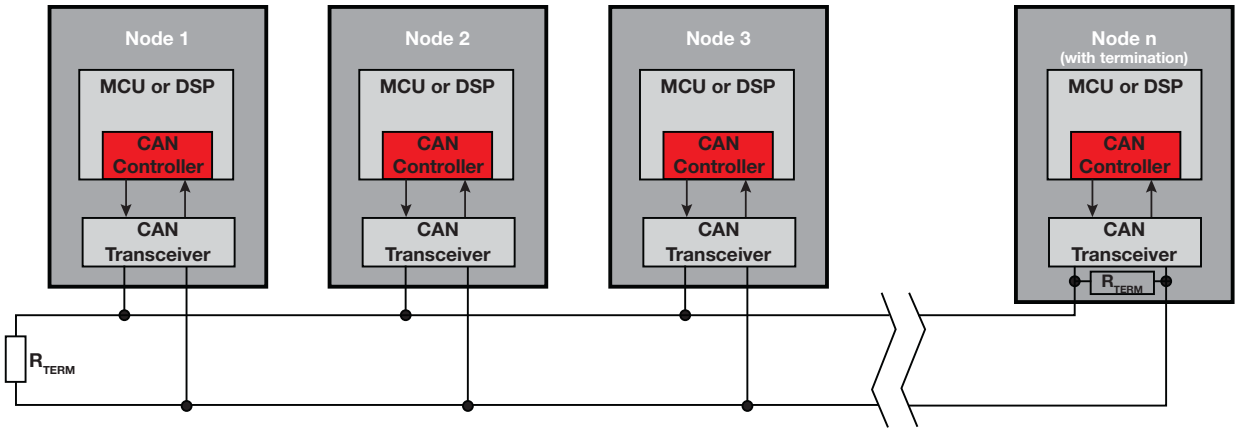
Dominant

Simplified Driver Diagram



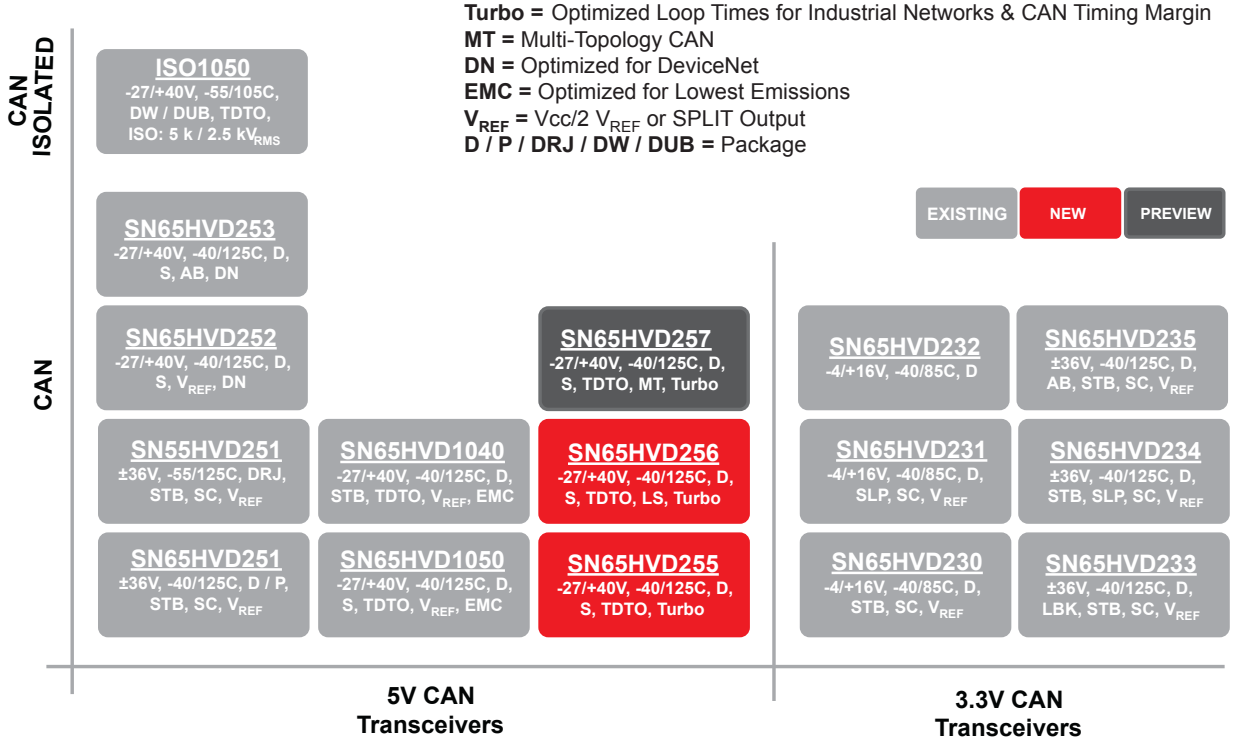
HS CAN Bus Topology

ISO11898 defined CAN as a linear bus topology. The original standard defined the electrical characteristics of a 30node, 40m bus capable of 1mbps. This basic topology is easily modified to support various configurations through the use of tradeoffs in data rate, number of nodes and bus length.



TI CAN Transceiver Portfolio

S / STB / SLP = Operating Modes: S=Silent, STB = Low Power Standby Mode w/Bus Wake (RXD active), SLP = Low Power Sleep Mode
SC = Driver Slope Control
LBK / AB = Loopback Modes: LBK = Diagnostic, AB = Autobaud
TDTO = TXD Dominant Time Out
LS = Level Shifting RXD pin for 2.8 – 5.5V P I/O
Turbo = Optimized Loop Times for Industrial Networks & CAN Timing Margin
MT = Multi-Topology CAN
DN = Optimized for DeviceNet
EMC = Optimized for Lowest Emissions
V_{REF} = Vcc/2 V_{REF} or SPLIT Output
D / P / DRJ / DW / DUB = Package



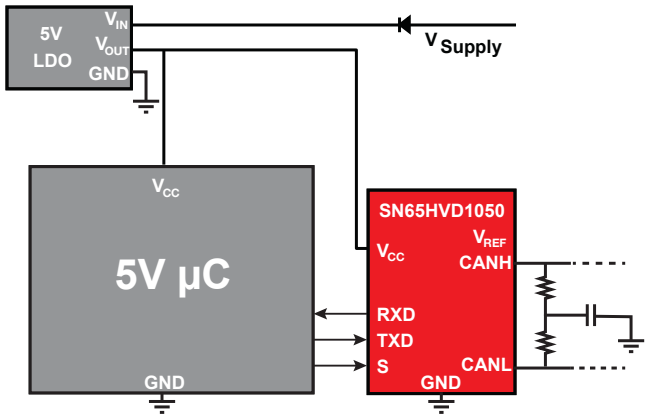
Selection Table

Device	I/O and V_{CC} Levels (V)	Short-Circuit Protection (V)	HBM ESD Protection (kV)	Suppy Current, Typical (mA)	Standby/Sleep Current, Typical (µA)	Features	Pin/Package
SN65HVD230	3.3	–4 to +16	16	10	370	Standby (Low Power)	SOIC-8
SN65HVD231	3.3	–4 to +16	16	10	0.04	Sleep (Ultra Low Power)	SOIC-8
SN65HVD232	3.3	–4 to +16	16	10	N/A	Economical	SOIC-8
SN65HVD233	3.3	–36 to +36	16	6	200	Standby (Low Power), Diagnostic Loop-Back	SOIC-8
SN65HVD234	3.3	–36 to +36	16	6	200/0.05	Standby (Low Power), Sleep (Ultra Low Power)	SOIC-8
SN65HVD235	3.3	–36 to +36	16	6	200	Standby (Low Power), Autobaud Loop-Back	SOIC-8
SN65HVD251	5	–36 to +36	14	14	<275	Standby (Low Power)	SOIC-8, PDIP-8
SN55HVD251	5	–36 to +36	14	14	<275	Small Package, High Tempertaure Range (–55ºC to 125ºC)	SON-8
SN65HVD1040	5	–27 to +40	12	6	5	Standby (Ultra Low Power with Bus Wake-Up), TXD Dominant Time Out	SOIC-8
SN65HVD1050	5	–27 to +40	8	6	NA	Listen Only Mode, TXD Dominant Time Out	SOIC-8
SN65HVD252	5	–27 to +40	12	13	NA	DeviceNet CAN, with V_{REF}	SOIC-8
SN65HVD253	5	–27 to +40	12	13	NA	DeviceNet CAN, Loopback	SOIC-8
SN65HVD255	5	–27 to +40	12	10	NA	"Turbo" CAN, "Ideal Passive", TXD Dominant Time Out (<10kbps)	SOIC-8
SN65HVD256	3.3/5	–27 to +40	12	10	NA	"Turbo" CAN, "Ideal Passive", TXD Dominant Time Out (<10kbps), V_{RXD} Level Shift	SOIC-8
SN65HVD257	5	–27 to +40	12	10	NA	"Turbo" CAN, "Ideal Passive", TXD Dominant Time Out (<10kbps), RXD Dominant Time Out, Fault output	SOIC-8
ISO1050	5	–27 to +40	4	10.3	NA	Isolated CAN (2.5kV_{RMS} and 5KV_{RMS})	SOP-8, SOIC-16

*New products are listed in **bold red.*** *Preview products are listed in **bold blue.***

5V Typical Applications

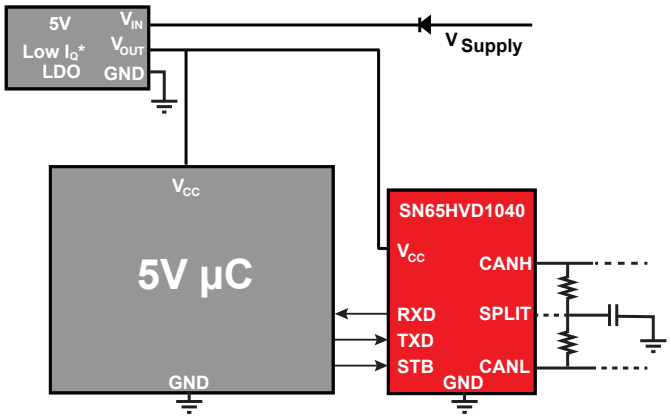
5V System with 1050 Type Transceiver
Normal and Silent Modes



Optimized 5V System with no CAN Wake

- No extra components.
- Lower cost V_{REG} (systems normally powered so no low power mode or low I_Q requirements).
- Silent (receive only) mode for software diagnostics on CAN bus.
- V_{REF} may be left open or connected with bypass cap to GND if unused for driving split termination.

5V System with 1040 Type Transceiver
Normal and Low Power Standby (with CAN Wake) Modes

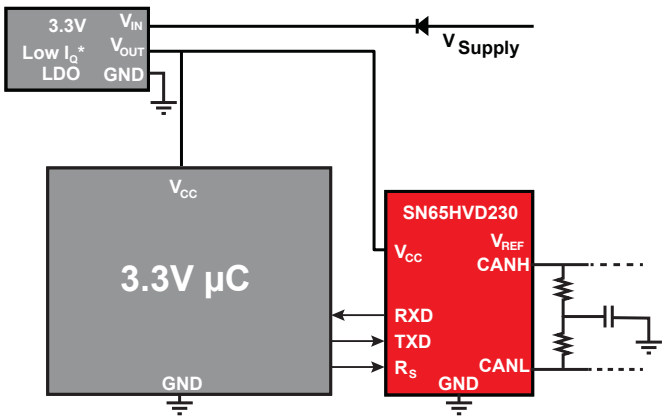


Optimized 5V System with Low Power CAN Wake

- No extra components.
- Low power Standby Mode (5µA typical) with CAN bus initiated wake up request to µP via RXD.
- Low quiescent current (I_Q) V_{REG} needed to keep system current (power) low if wake up from CAN in low power standby mode is used.
- SPLIT may be left open or connected with bypass cap to GND if unused for driving split termination.

3.3V Typical Applications

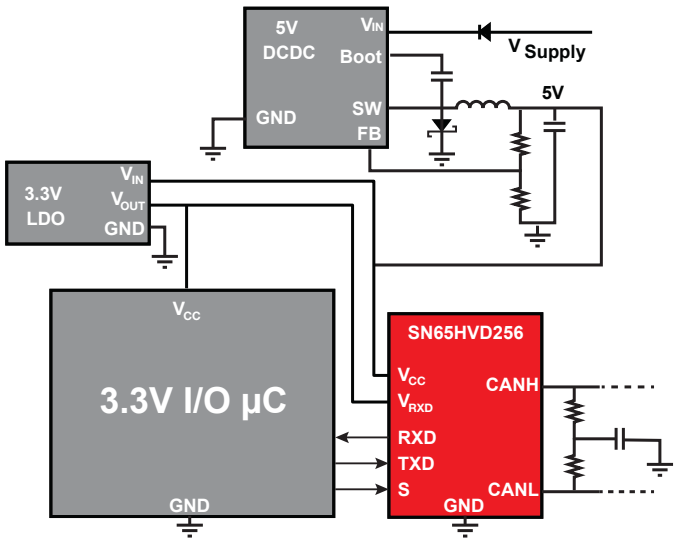
3.3V System with HVD230 3.3V Transceiver
Normal and Standby Modes



Optimized 3.3V System Including Low Power CAN Wake

- No extra components.
- Low power Standby Mode (370µA typical) with wake from CAN bus.
- Lower cost V_{REG} used for systems not requiring low power wake up; if low power wake up needed then a low quiescent current (I_Q) V_{REG} is needed to keep system current (power) low.
- V_{REF} may be left open or connected with bypass cap to GND if unused for driving split termination.

3.3V I/O MCU with 5V HVD256 Transceiver
Normal and Silent Modes

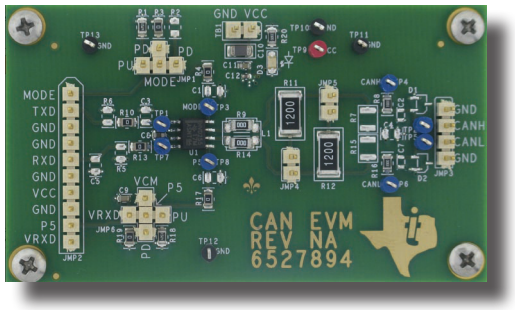


3.3V I/O MCU with 5V CAN PHY

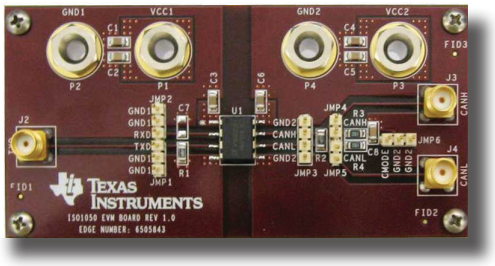
- I/O level shifter allows 5V CAN bus with direct interfacing to 3.3V µP.
- Can be used with various power supply rail and I/O voltage level schemes.
- Silent (receive only) mode for software diagnostics on CAN bus.

Support: Evaluation Boards

CAN EVM:
SN65HVD255D Evaluation Module



Isolated CAN EVM:
ISO1050 Evaluation Module



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China	800-820-8682
Hong Kong	800-96-5941
India	1-800-425-7888
Indonesia	001-803-8861-1006
Korea	080-551-2804
Malaysia	1-800-80-3973
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