

## CA-IF1042Lx $\pm 40V$ Fault Protected CAN Transceiver with CAN FD

### 1. Features

- **Meets the ISO 11898-2:2016 and ISO 11898-5:2007 physical layer standards**
- **'Turbo' CAN:**
  - Support classic CAN and 5 Mbps CAN FD (flexible data rate)
  - Short and symmetrical propagation delay time and fast loop time for enhanced timing margin
  - Higher data rate in loaded CAN networks
- **Ideal passive behavior when unpowered**
  - Bus and logic terminals are high impedance (no load)
  - Power up/down with glitch free operation on bus and RXD output
- **Integrated protection increases robustness**
  - $\pm 30V$  extended common-mode input range (CMR)
  - Undervoltage protection on  $V_{CC}$  and  $V_{IO}$  supply terminals
  - Transmitter dominant timeout prevents lockup, data rates down to 4 kbps
  - Thermal shutdown
- **Typical loop delay: 155ns**
- **3.0V to 5.5V Logic-Supply ( $V_{IO}$ ) Range (CA-IF1042LVS-Q1 only)**
- **$-55^{\circ}C$  to  $150^{\circ}C$  Junction Temperatures Range**
- **Available in SOIC8**
- **AEC Q-100 qualified for automotive applications**

### 2. Applications

- Body electronics and lighting
- Automotive gateway
- Advanced driver assistance systems (ADAS)
- Infotainment and cluster

- Hybrid, electric & powertrain systems
- Personal transport vehicles - Electric bike
- Industrial control

### 3. General Description

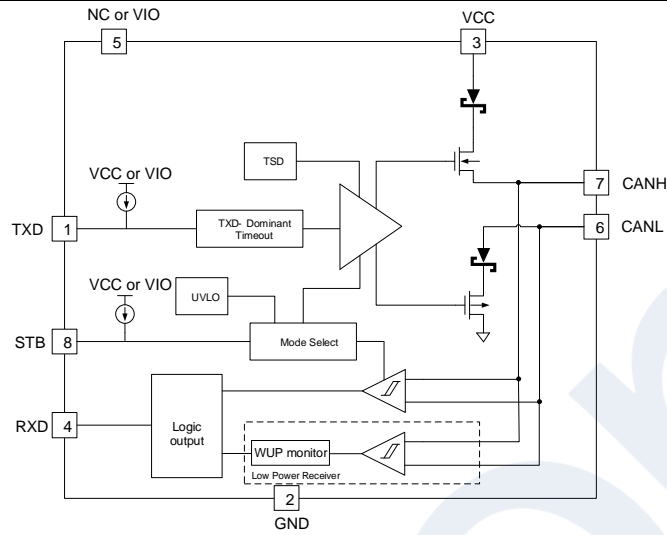
The CA-IF1042Lx devices are control area network (CAN) transceivers with integrated protection for industrial and automotive applications. These devices are designed for using in CAN FD networks up to 5 Mbps and feature  $\pm 40V$  extended fault protection on the CAN bus for equipment where overvoltage protection is required. This family of CAN transceivers also incorporate an input common-mode range (CMR) of  $\pm 30V$ , exceeding the ISO 11898 specification of  $-2V$  to  $+7V$ , well suited for applications where ground planes from different systems are shifting relative to each other.

The CA-IF1042Lx series devices include a dominant timeout to prevent bus lockup caused by controller error or by a fault on the TXD input. When the TXD remains in the dominant state (low) for longer than  $t_{DOM}$ , the driver is switched to the recessive state, releasing the bus and allowing other nodes to communicate. The transceivers feature a STB pin for two modes of operation: normal high-speed mode and standby mode for low current consumption.

The CA-IF1042Lx family of devices is available in a standard 8-pin narrow-body SOIC package, operates over the  $-55^{\circ}C$  to  $+150^{\circ}C$  junction temperature range.

#### Device Information

Part number	Package	Package size(NOM)
CA-IF1042LS-Q1	SOIC8	4.9mm x 3.9mm
CA-IF1042LVS-Q1		



**Simplified Block Diagram**

#### 4. Ordering Information

**Table 4-1 Ordering Information**

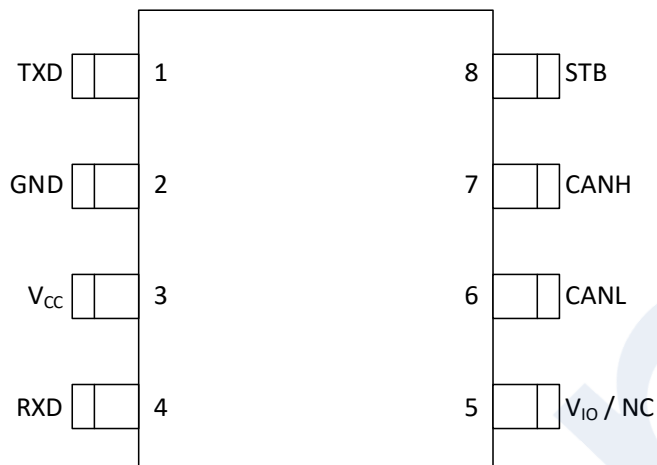
Part Number	Features	Package
CA-IF1042LS-Q1	Automotive qualified part, Pin 5 = NC	SOIC8
CA-IF1042LVS-Q1	Automotive qualified part; with low level translation, Pin 5 = V <sub>IO</sub>	SOIC8

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### 5. Revision History

Revision Number	Description	Page Changed
Preliminary	N/A	N/A

**6. Pin Configuration and Functions**

**Figure 6-1 CA-IF1042Lx Pin Configuration**
**Table 6-1 CA-IF1042Lx Pin Configuration and Description**

Pin #		Pin Name	Type	Description
CA-IF1042LS-Q1	CA-IF1042LVS-Q1			
1	1	TXD	Digital I/O	Transmit Data Input, Drive TXD high to set the driver in the recessive state. Drive TXD low to set the driver in the dominant state. TXD is a CMOS/TTL compatible input from a CAN controller with an internal pull-up to $V_{CC}$ or $V_{IO}$ .
2	2	GND	GND	Ground.
3	3	$V_{CC}$	Power	+5V Supply Voltage. Bypass $V_{CC}$ to GND with an at least 0.1 $\mu$ F capacitor.
4	4	RXD	Digital I/O	Receive Data Output, RXD is LOW for dominant bus state and HIGH for recessive bus state. RXD is a CMOS/TTL compatible output from the physical bus lines CANH and CANL.
5	-	NC	NC	No connect.
-	5	$V_{IO}$	Power	Logic Supply Input. $V_{IO}$ is the logic supply voltage for the input/output between the CAN transceiver and controller. $V_{IO}$ allows full compatibility from +3.0V to +5.5V logic on all digital lines. Bypass to GND with a 0.1 $\mu$ F capacitor. Connect $V_{IO}$ to $V_{CC}$ for 5V logic compatibility.
6	6	CANL	Bus I/O	CAN bus line low.
7	7	CANH	Bus I/O	CAN bus line high.
8	8	STB	Digital I/O	Standby Mode. A logic-high on STB pin or leave it open to select the standby mode. In standby mode, the transceiver is not able to transmit data and the receiver is in low-power mode. A logic-low on STB pin puts the transceiver in normal operating mode.

## 7. Specifications

### 7.1. Absolute Maximum Ratings

PARAMETER		MIN	MAX	UNIT
V <sub>CC</sub>	5V Bus Supply Voltage Range	-0.3	7	V
V <sub>IO</sub>	Logic Supply Voltage Range	-0.3	7	V
V <sub>BUS</sub>	CAN Bus I/O voltage range (CANH,CANL)	-40	40	V
V <sub>(DIFF)</sub>	Max differential voltage between CANH and CANL	-40	40	V
V <sub>(Logic_Input)</sub>	Logic input terminal voltage range (TXD, S)	-0.3	V <sub>IO</sub> +0.3 and <+7	V
V <sub>(Logic_Output)</sub>	Logic output terminal voltage range (RXD)	-0.3	V <sub>IO</sub> +0.3 and <+7	V
I <sub>O(RXD)</sub>	RXD (receiver) terminal output current	-8	8	mA
T <sub>J</sub>	Virtual junction temperature range	-55	150	°C
T <sub>STG</sub>	Storage temperature range	-65	150	°C

**Note:**

- The stresses listed under “Absolute Maximum Ratings” are stress ratings only, not for functional operation condition. Exposure to absolute maximum rating conditions for extended periods may cause permanent damage to the device.

### 7.2. ESD Ratings

Parameters	TEST CONDITIONS		VALUE	UNIT
<b>CA-IF1042Lx</b>				
HBM <sup>1</sup> ESD	CAN bus terminals (CANH, CANL) to GND		±6000	V
	Other pins		±6000	
CDM ESD	All pins		±2000	V
System Level ESD	CAN bus terminals (CANH, CANL) to GND	IEC 61000-4-2: unpowered contact discharge.	±6000 <sup>2</sup>	V

**Note:**

- Per JEDEC document JEP155, 500V HBM allows safe manufacturing of standard ESD control process.
- Testing on System Board Level.

### 7.3. Recommended Operating Conditions

PARAMETER		MIN	TYP	MAX	UNIT
V <sub>CC</sub>	Supply Voltage Range	4.5		5.5	V
V <sub>IO</sub>	Logic Supply Voltage Range	3.0		5.5	V
I <sub>OH(RXD)</sub>	RXD terminal high level output current	-2			mA
I <sub>OL(RXD)</sub>	RXD terminal low level output current			2	mA

### 7.4. Thermal Information

Thermal Metric		SOIC8	UNIT
R <sub>θJA</sub>	Junction to Ambient	170	°C/W
R <sub>θJC(top)</sub>	Junction to Case (top)	40	°C/W

**7.5. Electrical Characteristics**

 Over recommended operating conditions,  $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>POWER</b>							
$I_{CC}$	5V Supply Current	TXD=0V, $R_L = 60\ \Omega$ (dominant), $C_L$ =open, $R_{CM}$ =open, STB=0V, see Figure 8-1		45	70	mA	
		TXD=0V, $R_L = 50\ \Omega$ (dominant), $C_L$ =open, $R_{CM}$ =open, STB=0V, see Figure 8-1		50	80	mA	
		TXD=0V, STB=0V, CANH=-12V, $R_L$ =open, $C_L$ =open, $R_{CM}$ =open, see Figure 8-1				110	mA
		TXD= $V_{CC}$ or $V_{IO}$ , $R_L$ =50 Ohm, $R_{CM}$ =open, $C_L$ =open, STB=0V, see Figure 8-1		1.3	2.5	mA	
		TXD = STB = $V_{IO}$ (standby, CA-IF1042LVx), $R_L = 50\ \text{Ohm}$ , $C_L$ =open, $R_{CM}$ =open, see Figure 8-1		0.5	5	$\mu\text{A}$	
		TXD = STB = $V_{CC}$ (standby, CA-IF1042LS-Q1), $R_L = 50\ \text{Ohm}$ , see Figure 8-1		14	22	$\mu\text{A}$	
$I_{IO}$	I/O Supply Current	TXD = 0V, STB = 0V, RXD open		70	300	$\mu\text{A}$	
		TXD= $V_{IO}$ , STB= $V_{IO}$ , RXD open		11	17	$\mu\text{A}$	
$V_{UV\_VCC}$	$V_{CC}$ UVLO Threshold	Rising		4.1	4.45	V	
$V_{UV\_VCC}$	$V_{CC}$ UVLO Threshold	Falling	3.7	3.9	4.25	V	
$V_{UV\_VCC\_HY\_S}$	$V_{CC}$ UVLO Threshold	Hysteresis		200		mV	
$V_{UV\_IO}/V_{UV\_VCC\_SD}$	$V_{IO}$ UVLO threshold (CA-IF1042LVS-Q1) / $V_{CC\_SD}$ UVLO threshold (CA-IF1042LS-Q1)	Rising		2.35	2.75	V	
$V_{UV\_IO}/V_{UV\_VCC\_SD}$	$V_{IO}$ UVLO threshold(CA-IF1042LVS-Q1) / $V_{CC\_SD}$ UVLO threshold (CA-IF1042LS-Q1)	Falling	1.3	2.2	2.6	V	
$V_{UV\_IO\_HY\_S}$	$V_{IO}$ UVLO threshold(CA-IF1042LVS-Q1) / $V_{CC\_SD}$ UVLO threshold (CA-IF1042LS-Q1)	Hysteresis		150		mV	
<b>LOGIC INTERFACE (Mode select input, STB)</b>							
$V_{IH}$	High-level input voltage		$0.7 \times V_{CC}^1$			V	
$V_{IL}$	Low-level input voltage			$0.3 \times V_{CC}^1$		V	
$I_{IH}$	High-level input leakage current	STB = $V_{CC} = V_{IO} = 5.5\text{V}$	-2	2		$\mu\text{A}$	
$I_{IL}$	Low-level input leakage current	STB = 0V, $V_{CC} = V_{IO} = 5.5\text{V}$	-20	-2		$\mu\text{A}$	
$I_{lek(off)}$	Unpowered leakage current	STB=5.5V, $V_{CC} = V_{IO} = 0\text{V}$	-1	1		$\mu\text{A}$	
<b>LOGIC INTERFACE (CAN transmit data input, TXD)</b>							
$V_{IH}$	High-level input voltage		$0.7 \times V_{CC}^1$			V	
$V_{IL}$	Low-level input voltage			$0.3 \times V_{CC}^1$		V	
$I_{IH}$	High-level input leakage current	TXD = $V_{CC} = V_{IO} = 5.5\text{V}$	-2.5	0	1	$\mu\text{A}$	
$I_{IL}$	Low-level input leakage current	TXD = 0V, $V_{CC} = V_{IO} = 5.5\text{V}$	-100	-50	-7	$\mu\text{A}$	
$I_{lek(off)}$	Unpowered leakage current	TXD = 5.5V, $V_{CC} = V_{IO} = 0\text{V}$	-1	0	1	$\mu\text{A}$	
$C_i$	Input capacitance			5		pF	
<b>LOGIC INTERFACE (CAN receive data output, RXD)</b>							
$V_{OH}$	High-level output voltage	$I_o = -2\text{mA}$ , see Figure 8-2	$0.8 \times V_{CC}^1$			V	
$V_{OL}$	Low-level output voltage	$I_o = +2\text{mA}$ , see Figure 8-2		$0.2 \times V_{CC}^1$		V	
$I_{lek(off)}$	Unpowered leakage current	STB = 5.5V, $V_{CC} = 0\text{V}$ , $V_{IO} = 0\text{V}$	-1	0	1	$\mu\text{A}$	
<b>Note:</b>							
1. The reference voltage of CA-IF1024LS-Q1 is $V_{CC}$ .The reference voltage of CA-IF1024LVS-Q1 is $V_{IO}$ .							

<b>OTP</b>						
$T_{TSD}$	Thermal shutdown temperature		185		°C	
$T_{TSD\_HYS}$	Thermal shutdown temperature threshold hysteresis		15		°C	
<b>CAN BUS DRIVER</b>						
$V_{O(DOM)}$	Bus output voltage (dominant)	TXD = low, STB = 0V, $R_L=50-65\ \Omega$ , $C_L=open$ , $R_{CM}=open$ , CANH, see Figure 8-1	2.75	4.5	V	
		TXD = low, STB = 0V, $R_L=50-65\ \Omega$ , $C_L=open$ , $R_{CM}=open$ , CANL, see Figure 8-1	0.5	2.25	V	
$V_{O(REC)}$	Bus output voltage (recessive)	TXD= $V_{CC}$ or $V_{IO}$ , $V_{CC}=V_{IO}$ , STB=0V, $R_L=open$ , $R_{CM}=open$ , CANH,CANL, see Figure 8-1	2	$0.5 \times V_{CC}$	3	V
$V_{O(STB)}$	Bus output at standby mode	STB= $V_{IO}$ , $R_L$ open, $R_{CM}$ open, CANH	-0.1	0.1	V	
		STB= $V_{IO}$ , $R_L$ open, $R_{CM}$ open, CANL	-0.1	0.1	V	
		STB= $V_{IO}$ , $R_L$ open, $R_{CM}$ open, CANH-CANL	-0.2	0.2	V	
$V_{OD(DOM)}$	Bus output differential voltage (dominant)	TXD = low, STB=0V, $R_L=45-50\ \Omega$ , $R_{CM}$ open, see Figure 8-1	1.4	3	V	
		TXD = low, STB=0V, $R_L=50-65\ \Omega$ , $R_{CM}$ open, see Figure 8-1	1.5	3.0	V	
		TXD = low, STB = 0V, $R_L=2240\ \Omega$ , $R_{CM}$ open, see Figure 8-1	1.5	5.0	V	
$V_{OD(REC)}$	Bus output differential voltage (recessive)	TXD = high, STB=0V, $R_L=60\ \Omega$ , $C_L=open$ , $R_{CM}=open$ , see Figure 8-1	-120	12	mV	
		TXD = high, STB=0V, no load, $C_L=open$ , $R_{CM}=open$ , see Figure 8-1	-50	50	mV	
$V_{SYM}$	Transient symmetry (dominant or recessive)	$R_L=60\ \Omega$ , STB=0V, $R_{CM}$ open, $C_{split}=4.7nF$ , $R_{CM}$ open, TXD = 250kHz, 1MHz, 2.5M Hz, see Figure 8-1	0.9	1.1	V/V	
$V_{SYM\_DC}$	DC Output symmetry (dominant or recessive)	$R_L=60\ \Omega$ , STB = 0, $R_{CM}$ open, see Figure 8-1	-0.4	0.4	V	
$I_{OS(SS\_DOM)}$	Short-circuit current (dominant)	TXD = low, STB=0V, CANL open, $V_{CANH} = -5V$ to 40V, see Figure 8-7	-100		mA	
		TXD = low, STB=0V, CANH open, $V_{CANL} = -5V$ to 40V, see Figure 8-7		100		
$I_{OS(SS\_rec)}$	Short-circuit current (recessive)	TXD = high, STB=0V, $V_{BSU} = CANH = CANL = -27V$ to 32V, see Figure 8-7	-5	5	mA	
$V_{CM}$	Common-mode input range	CANH or CANL to GND, RXD output valid, see Figure 8-2	-30	+30	V	
$V_{IT}$	Input differential threshold voltage at normal mode	STB = 0V, $V_{CM}$ from -20V to 20V, see Figure 8-2	0.5	0.9	V	
		STB=0V, $V_{CM}$ from -30V to 30V, see Figure 8-2	0.4	1.0	V	
$V_{IT(HYS)}$	Input differential threshold hysteresis	STB = 0		120	mV	
$V_{IT(STB)}$	Input differential threshold at standby mode for the CA-IF1042Lx series devices	STB = high, $V_{CM} = -20V$ to 20V, ( $3 \leq V_{IO} \leq 5.5V$ ), see Figure 8-2	0.4	1.15	V	
$V_{IT(STB)}$	Input differential threshold at standby mode for the CA-IF1042LS-Q1 devices	STB = high, $V_{CM} = -20V$ to 20V, see Figure 8-2	0.4	1.15	V	
$R_{IN}$	CANH/CANL input resistance	TXD = high, STB = 0, $V_{CM} = -30V$ to 30V	10	40	k $\Omega$	
$R_{DIFF}$	Differential input resistance	TXD = high, STB = 0, $V_{CM} = -30V$ to 30V	20	80	k $\Omega$	
$R_{DIFF(M)}$	Input resistance matching	$V_{CANH} = V_{CANL} = 5V$	-2	2	%	
$I_{LKG}$	Input Leakage Current	$V_{IO} = V_{CC} = 0V$ , $V_{CANH} = V_{CANL} = 5V$		5	$\mu A$	
$C_{IN}$	Input capacitance	CANH or CANL to GND, TXD= $V_{CC}$ , $V_{IO} = V_{CC}$ , STB = 0		24	pF	
$C_{IN\_DIFF}$	Differential input capacitance	CANH to CANL, TXD = High		12	pF	

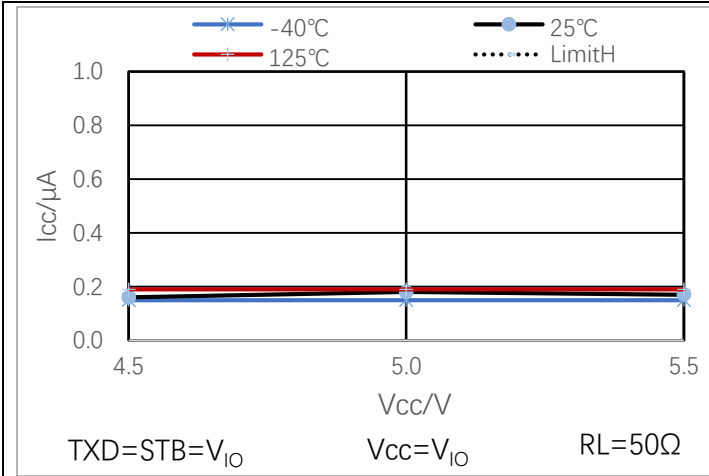
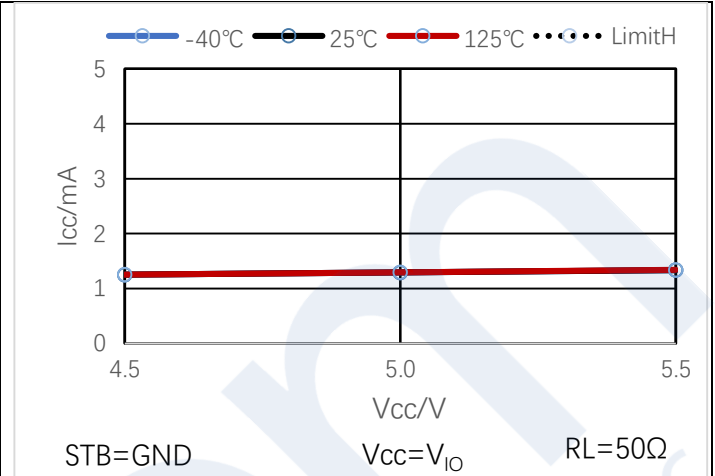
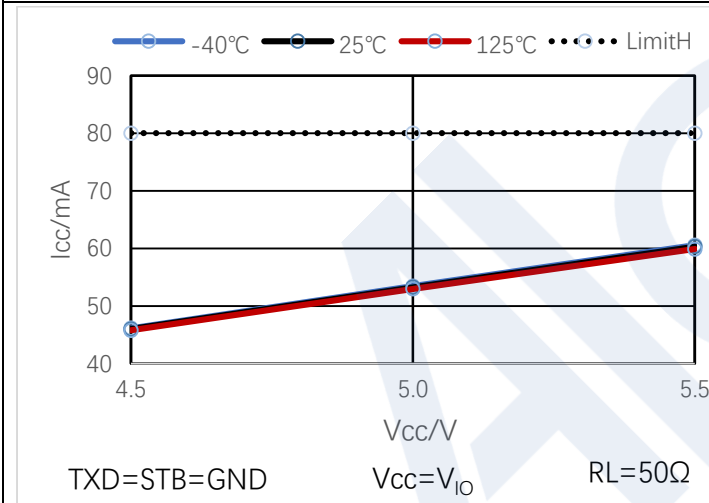
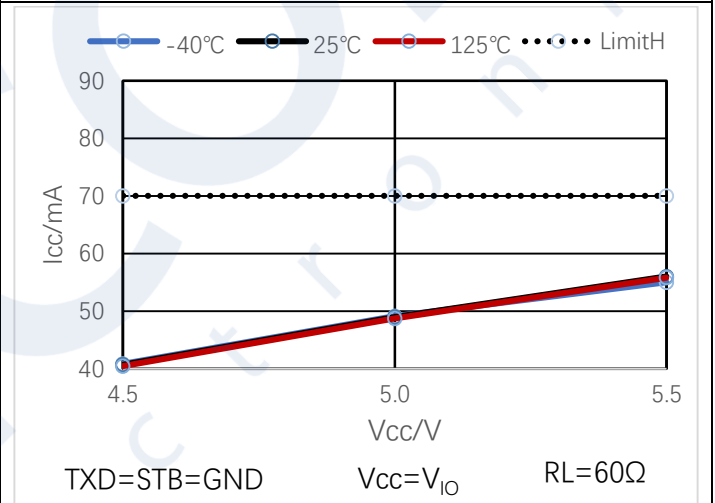
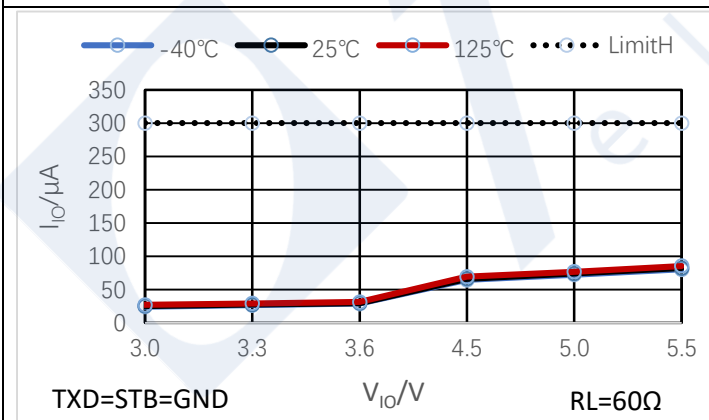
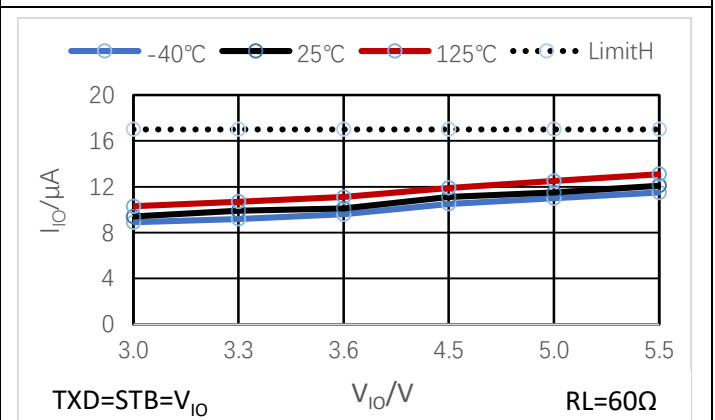
**7.6. Switching Characteristics**

 Over recommended operating conditions,  $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>DRIVER</b>						
$t_{\text{ONTXD}}$	TXD propagation delay (recessive to dominant)	STB = 0, $R_L=60\ \Omega$ , $C_L=100\text{pF}$ , see Figure 8-1		55		ns
$t_{\text{OFFTXD}}$	TXD propagation delay (dominant to recessive)	STB = 0, $R_L=60\ \Omega$ , $C_L=100\text{pF}$ , see Figure 8-1		75		ns
$t_{\text{DOM}}$	TXD-dominant Timeout	$R_L=60\ \Omega$ , $C_L$ open, see Figure 8-5	2.5	6.8	10	ms
<b>RECEIVER</b>						
$t_{\text{ONRXD}}$	RXD propagation delay (recessive to dominant)	STB = 0, $C_{\text{RXD}}=15\text{pF}$ , see Figure 8-2		90		ns
$t_{\text{OFFRXD}}$	RXD Propagation delay (dominant to recessive)	STB = 0, $C_{\text{RXD}}=15\text{pF}$ , see Figure 8-2		100		ns
<b>DEVICE</b>						
$t_{\text{loop1}}$	Total loop delay, driver input (TXD) to receiver output (RXD), recessive to dominant	$R_L=60\ \Omega$ , $C_{\text{RXD}}=15\text{pF}$ , $C_L=100\text{pF}$ , see Figure 8-3		125	255	ns
$t_{\text{loop2}}$	Total loop delay, driver input (TXD) to receiver output (RXD), dominant to recessive	$R_L=60\ \Omega$ , $C_{\text{RXD}}=15\text{pF}$ , $C_L=100\text{pF}$ , see Figure 8-3		155	255	ns
$t_{\text{MODE}}$	Mode change time, from normal to silent or from silent to normal	see Figure 8-4		12	45	$\mu\text{s}$
$T_{\text{wk\_FILTER}}$	Filter time for a valid wake-up pattern	See Figure 9-4.	0.5		1.8	$\mu\text{s}$
$T_{\text{WK\_FILTEROUT}}$	Bus wake-up timeout	See Figure 9-4.	0.8		10	ms
<b>FD TIMING</b>						
$t_{\text{bit}(\text{bus})}$	Bit time on CAN bus output pins with $t_{\text{BIT}(\text{TXD})} = 500\ \text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}}=15\text{pF}$ , see Figure 8-6	435		530	ns
$t_{\text{bit}(\text{bus})}$	Bit time on CAN bus output pins with $t_{\text{BIT}(\text{TXD})} = 200\ \text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}} = 15\text{pF}$ , see Figure 8-6	155		210	ns
$t_{\text{bit}(\text{rxd})}$	Bit time on RXD output pins with $t_{\text{BIT}(\text{TXD})} = 500\ \text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}} = 15\text{pF}$ , see Figure 8-6	400		550	ns
$t_{\text{bit}(\text{rxd})}$	Bit time on RXD output pins with $t_{\text{BIT}(\text{TXD})} = 200\ \text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}} = 15\text{pF}$ , see Figure 8-6	120		220	ns
$t_{\text{rec}}$	Receiver timing symmetry with $t_{\text{BIT}(\text{TXD})} = 500\text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}} = 15\text{pF}$ , see Figure 8-6	-65		40	ns
$t_{\text{rec}}$	Receiver timing symmetry with $t_{\text{BIT}(\text{TXD})} = 200\text{ns}$	STB = 0, $R_L = 60\ \Omega$ , $C_L=100\text{pF}$ , $C_{\text{RXD}} = 15\text{pF}$ , see Figure 8-6	-45		15	ns



**7.7. Typical Operating Characteristics and Waveforms**

 Over recommended operating conditions,  $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  (unless otherwise noted).

**Figure 7-1 Vcc Supply Current @ Standby ,CA-IF1042VS-Q1**

**Figure 7-2 Vcc Supply Current @ Recessive**

**Figure 7-3 Vcc Supply Current @ Dominant (R L = 50Ω)**

**Figure 7-4 Vcc Supply Current @ Dominant (R L = 60Ω)**

**Figure 7-5 VIO Supply Current @ Normal mode**

**Figure 7-6 VIO Supply Current @ Standby mode**

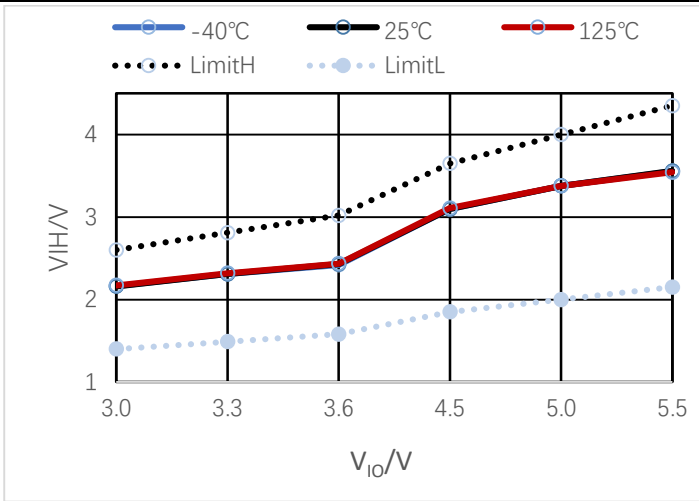


Figure 7-7 S Input High-Level

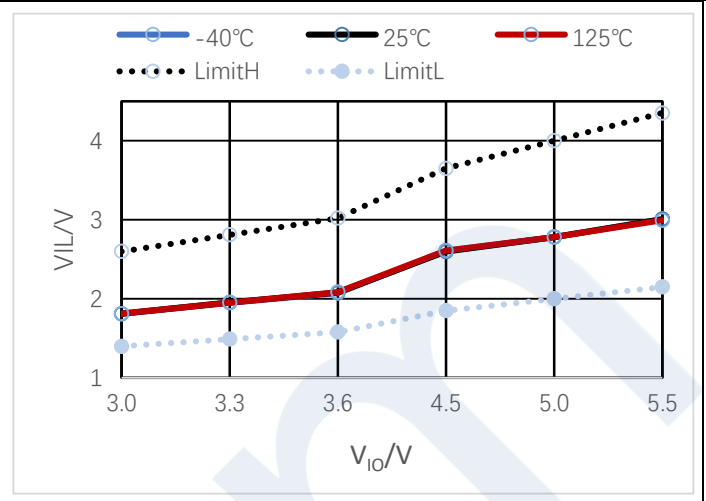


Figure 7-8 S TXD Input Low-Level

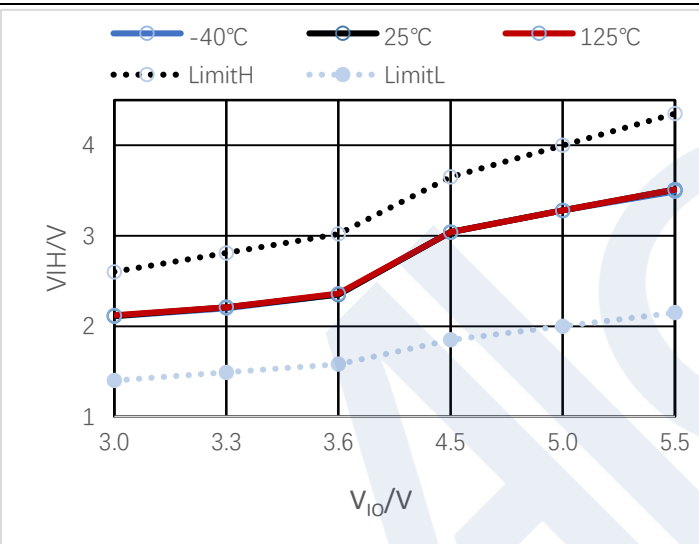


Figure 7-9 TXD Input High-Level

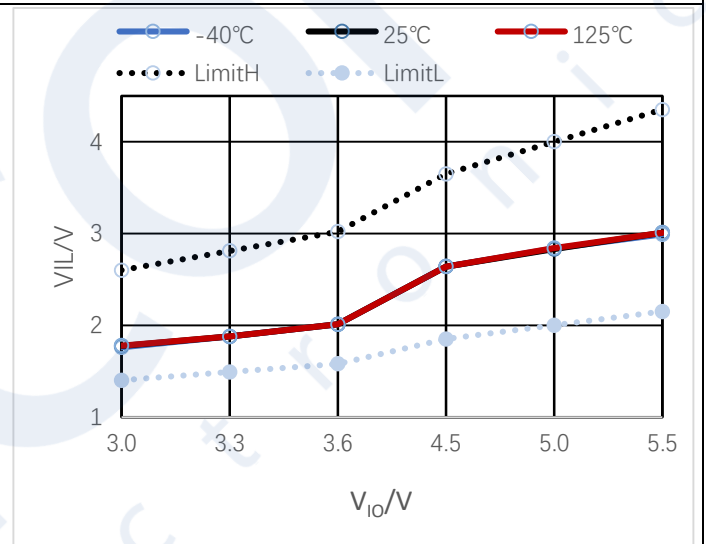


Figure 7-10 TXD TXD Input Low-Level

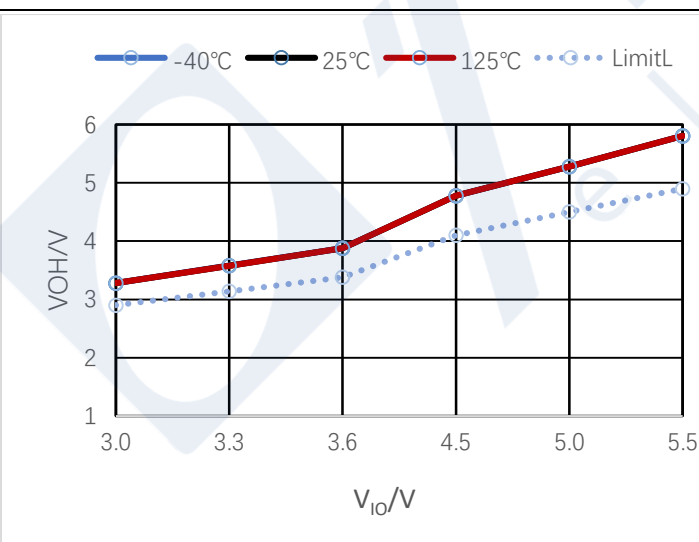


Figure 7-11 RXD High-Level Output

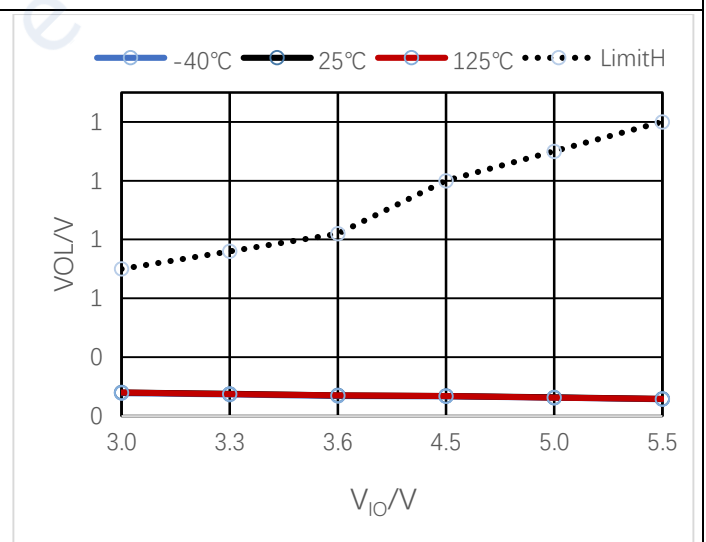


Figure 7-12 RXD Low-Level Output

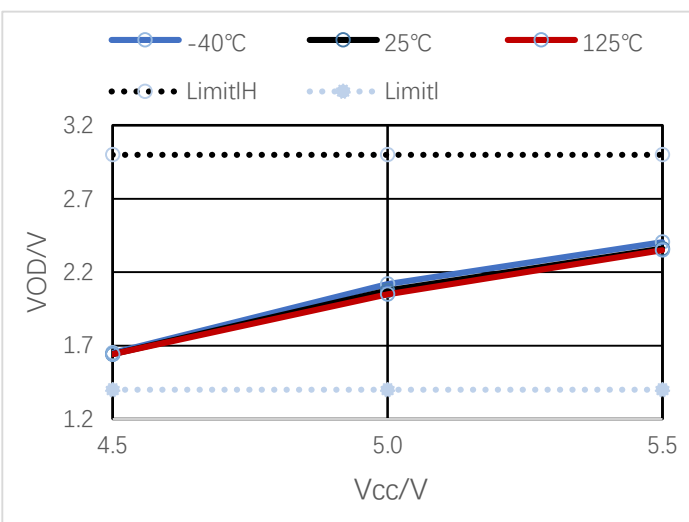


Figure 7-13 Differential Output Voltage (RL = 50Ω)

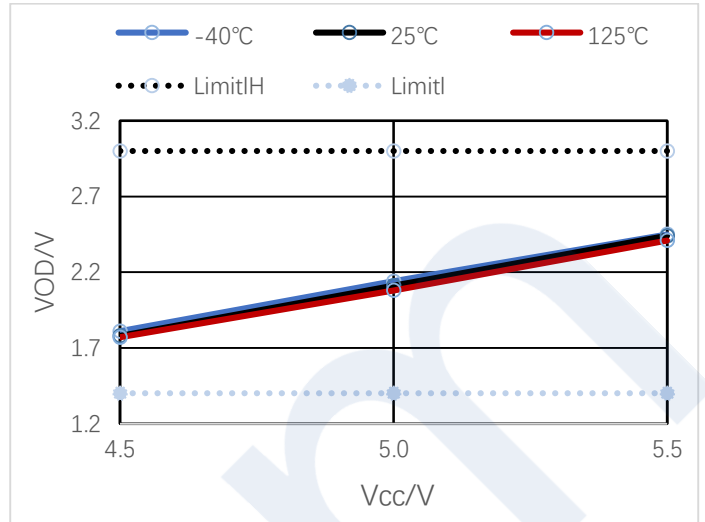


Figure 7-14 Differential Output Voltage (RL = 60Ω)

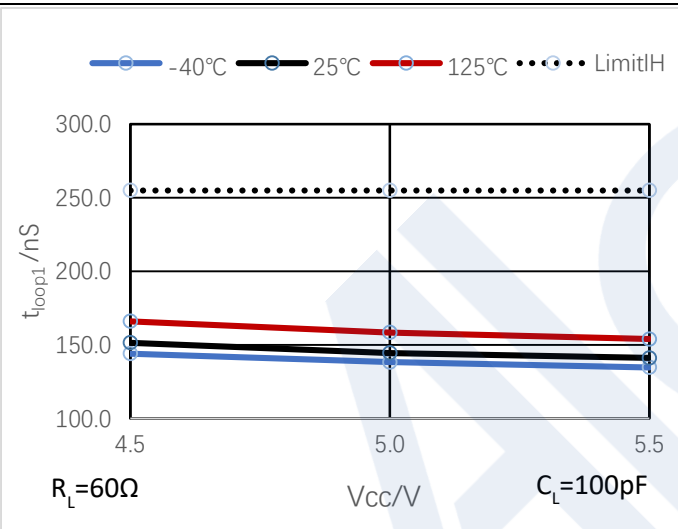


Figure 7-15 Loop1 Delay

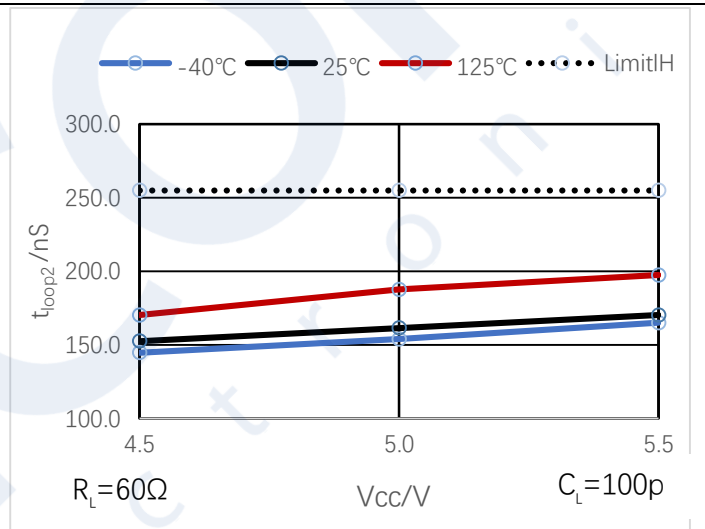


Figure 7-16 Loop2 Delay

8. Parameter Measurement Information

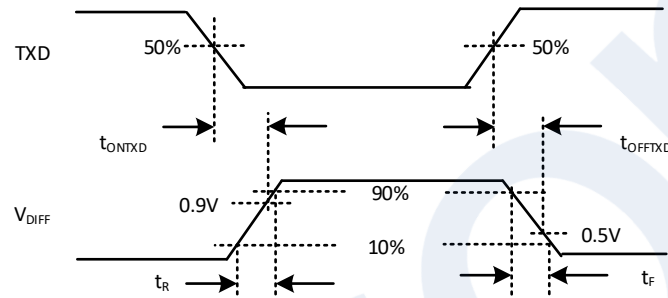
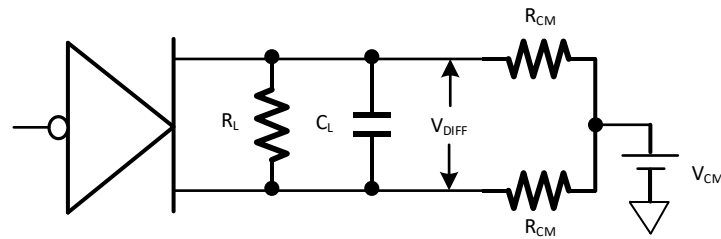


Figure 8-1 Transmitter Test Circuit and Timing Diagram

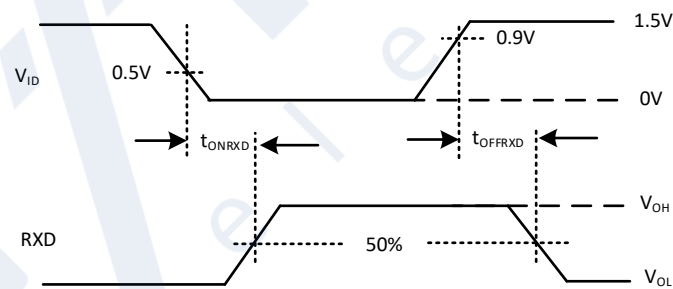
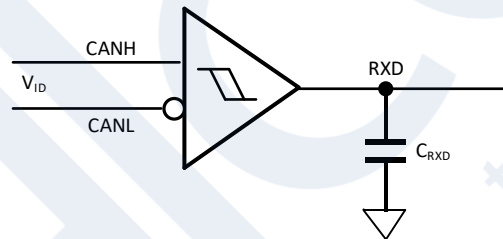
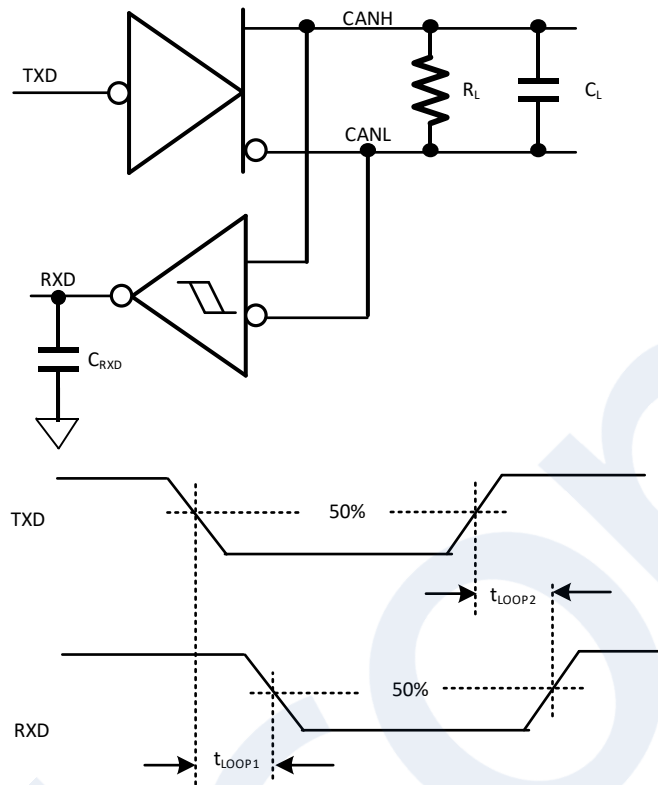
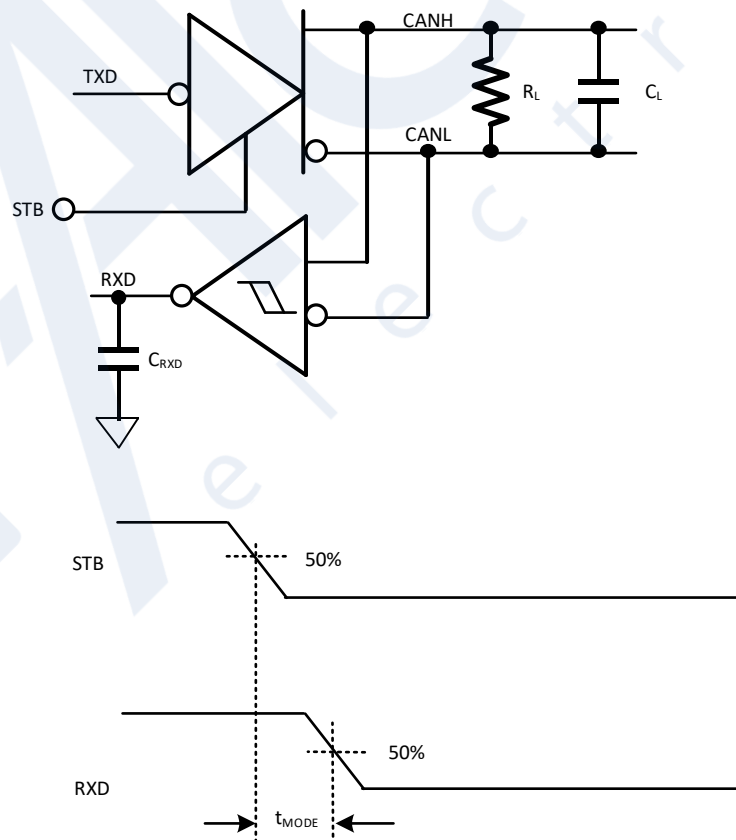


Figure 8-2 Receiver Test Circuit and Measurement



**Figure 8-3 TXD to RXD Loop Delay**



**Figure 8-4 Mode Change Test Circuit and Measurement**

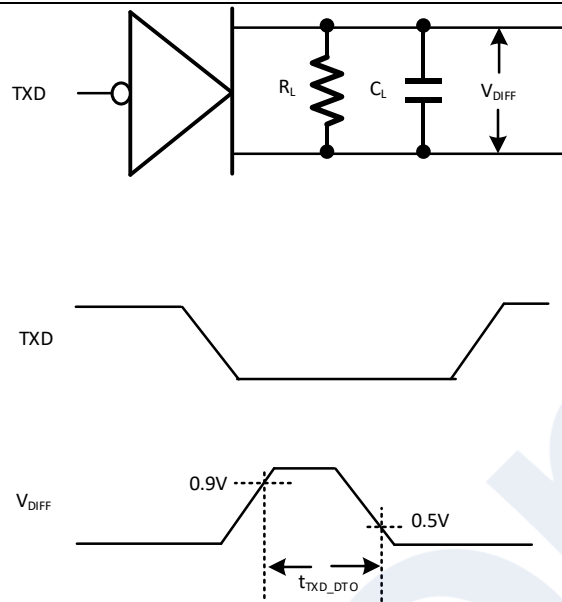


Figure 8-5 Transmitting Dominant Timeout Timing Diagram

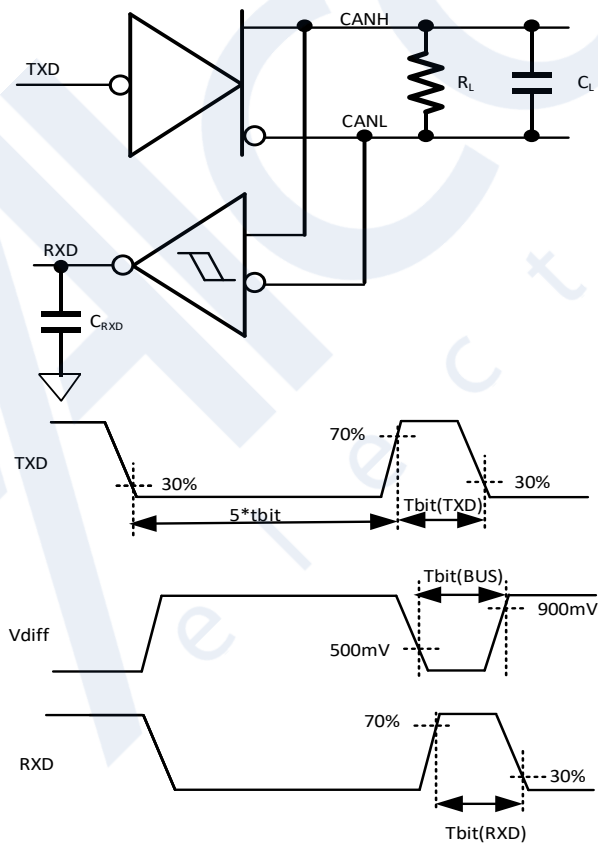
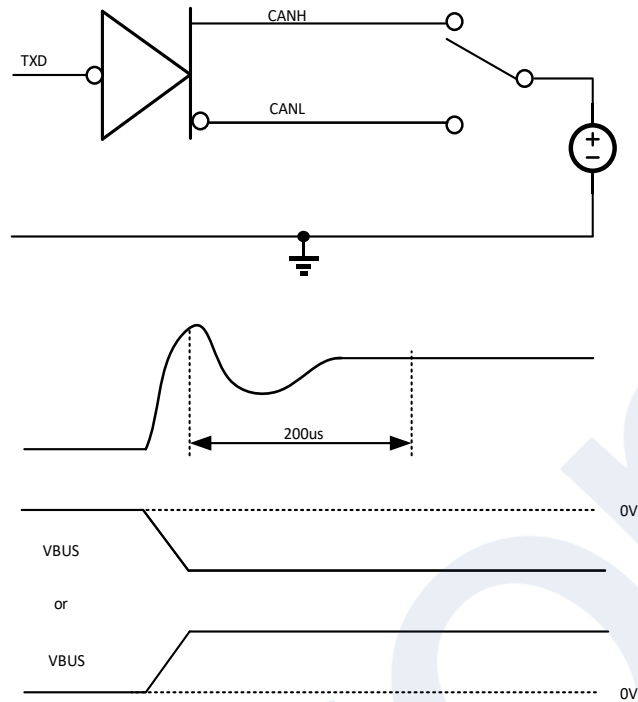


Figure 8-6 CAN FD Timing Parameter Measurement



**Figure 8-7 Driver Short Circuit Current Test Circuit and Measurement**

Chipanalog  
Microelectronics

## 9. Detailed Description

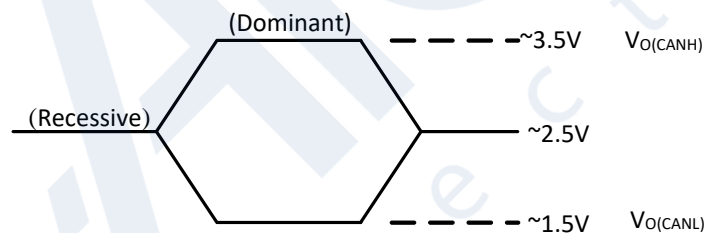
The CA-IF1042Lx family of devices is fault-protected Controller Area Network (CAN) transceiver, meets the ISO11898-2 (2016) high speed CAN physical layer standard. These devices are designed for harsh industrial and automotive applications with a number of integrated robust protection features set that improve the reliability of end equipment. All devices are fault protected up to  $\pm 40V$  for the bus pins, making them ideal for applications where overvoltage protection is required. A common-mode voltage range of  $\pm 30V$  enables communication in noisy environments where there are ground plane differences between different systems. Dominant timeout prevents the bus from being blocked by a hung-up microcontroller, and the outputs CANH and CANL are short-circuit current-limited and protected against excessive power dissipation by thermal shutdown circuitry that places the driver outputs in a high-impedance state.

A separate input  $V_{IO}$  allows the CA-IF1042LVx devices to communicate with logic systems down to 3.0V while operating up to a +5.5V bus supply. This provides a reduced input voltage threshold to the TXD and STB inputs, and provides a logic-high output at RXD compatible with the microcontroller's supply rail. The logic compatibility eliminates external logic level translator and longer propagation delay due to level shifting. Connect  $V_{IO}$  to  $V_{CC}$  to operate with +5V logic systems.

The CA-IF1042Lx devices can operate up to 5Mbps data rate and support CAN FD. However, the maximum data rate is limited by the bus loading, number of nodes, cable length etc. factors, for CAN network design, margin must be given for signal loss across the system and cabling, parasitic loadings, timing, network imbalances, ground offsets and signal integrity thus a practical maximum data rate, number of nodes often lower than the theoretical value.

### 9.1. CAN Bus Status

The CAN bus has two states: dominant and recessive. In the dominant state (a zero bit, used to determine message priority), CANH-CANL are defined to be logic '0' when the voltage across them is between +1.5V and +3V (higher than 0.9V). In the recessive state (a 1-bit and the state of the idle bus), the driver is defined to be logic '1' when differential voltage is between -120mV and +120mV, or when it is near zero (lower than 0.5V), see *Figure 9-1* for the bus logic state voltage definition.



**Figure. 9-1 Bus Logic State Voltage Definition**

### 9.2. Receiver

The receiver of CA-IF1042Lx family of devices includes a main receiver to support normal bi-directional communication and a low-power receive channel to monitor the bus line and detect the wakeup event on the bus line during standby mode. In normal operation (STB = low), the main receiver reads the differential input from the bus line (CANH and CANL) and transfers this data as a single-ended output RXD to the CAN controller. The internal comparator senses the difference voltage  $V_{DIFF} = (V_{CANH} - V_{CANL})$ , with respect to an internal threshold of 0.7V. If  $V_{DIFF} > 0.9V$ , a logic-low is present on RXD; If  $V_{DIFF} < 0.5V$ , a logic-high is present. The CANH and CANL common-mode range is  $\pm 30V$  in normal mode. See *Figure 9-2* for the receiver input bias circuit.

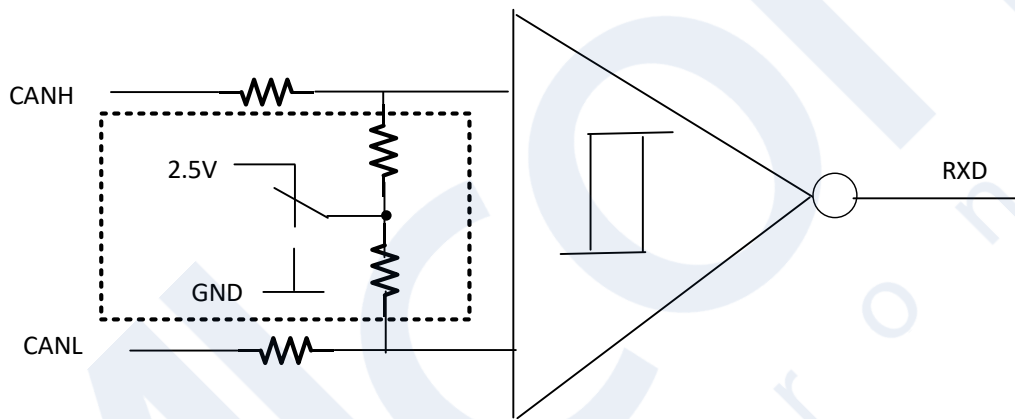
Drive the STB pin high or leave it open for standby mode, in this case, the main receiver is disabled and the low-power receive channel is enabled. This switches the receiver to a low current and low-speed state. The bus line is monitored by a low-power differential comparator to detect and recognize a wakeup event on the bus line. RXD is logic High until a valid wake-up is received. Once a valid remote wake-up event occurred, RXD transition to logic Low.



RXD is a logic-high when CANH and CANL are shorted or terminated and un-driven in both normal mode and standby mode, see *Table 9-1* for more details about the receiver truth table.

**Table 9-1 Receiver Truth Table**

DEVICE MODE	$V_{ID} = V_{CANH} - V_{CANL}$	BUS STATE	RXD
Normal STB = Low	$V_{ID} \geq 0.9V$	Dominant	Low
	$0.5V < V_{ID} < 0.9V$	Indeterminate	Indeterminate
	$V_{ID} \leq 0.5V$	Recessive	High
Standby STB = High or open	$V_{ID} > 1.15V$	Dominant	Low if a remote wake event occurred, otherwise output High.
	$0.4V < V_{ID} < 1.15V$	Indeterminate	Indeterminate
	$V_{ID} \leq 0.4V$	Recessive	High
Any	Open ( $V_{ID} \approx 0V$ )	Open	High


**Figure 9-2 Receiver Input/Transmitter Output Bias Circuit**

### 9.3. Transmitter

In normal operation (STB = Low), the transmitter converts a single-ended input signal (TXD) from the local CAN controller to differential outputs for the bus lines CANH and CANL. The truth table for the transmitter is provided in *Table 9-2*. The CA-IF1042Lx family of devices protects the transmitter output stage against a short-circuit to a positive or negative voltage by limiting the driver current. Thermal shutdown further protects the devices from excessive temperatures that may result from a short circuit. The transmitter returns to normal operation once the short is removed and the junction temperature drops at least the thermal shutdown hysteresis temperature below the thermal shutdown temperature of the device.

Drive the STB pin high for standby mode, the transmitter is disabled and put the bus in high-impedance with internal weak pull-down to ground, see *Figure 9-2*.

**Table 9-2 Transmitter Truth Table (When Not Connected to the Bus)**

INPUT		TXD LOW TIME	OUTPUT		BUS STATE
STB	TXD		CANH	CANL	
Low	Low	$< t_{DOM}$	High	Low	Dominant
	Low	$> t_{DOM}$	$V_{CC}/2$	$V_{CC}/2$	Recessive
	High or Open	X	$V_{CC}/2$	$V_{CC}/2$	Recessive
High or Open	X	X	High-Z	High-Z	Weak pull-down to GND

X = Don't care

## 9.4. Protection Functions

### 9.4.1. Undervoltage Lockout

The CA-IF1042LVx devices have undervoltage detection on  $V_{CC}$  supply terminal, the CA-IF1042LVS-Q1 devices also feature undervoltage detection on  $V_{IO}$  supply terminal, that place the device in protected mode during an undervoltage event on  $V_{CC}$  or/and  $V_{IO}$ , see *Table 9-3* and *Table 9-4*.

For the CA-IF1042LS-Q1, if the supply voltage  $V_{CC}$  is less than  $V_{UN\_VCC}$ , will put the device into protected state and leave the bus in high-impedance as shown in *Table 9-3*. Once an undervoltage condition is cleared on  $V_{CC}$  and the supply voltage has returned to a valid level, the devices transition to normal mode after the  $t_{ONTXD}$  time has expired. The host controller should not attempt to send or receive messages until the  $t_{ONTXD}$  time has expired.

**Table 9-3 CA-IF1042LS-Q1 Undervoltage Lockout**

$V_{CC}$	DEVICE STATE	BUS OUTPUT	RXD
$> V_{UV\_VCC}$	STB= $V_{CC}$ , Standby	Weak pull-down to GND	High until valid wake-up is received
	STB= $V_{CC}$ , Normal	Per TXD	Mirrors Bus
$< V_{UV\_VCC} \& \> V_{UV\_VCC\_SD}$	STB= $V_{CC}$ , Standby	Weak pull-down to GND	High until valid wake-up is received
	STB= $V_{CC}$ , Protected mode	Weak pull-down to GND	Recessive
$< V_{UV\_VCC\_SD}$	Protected mode	High Impedance	High Impedance

For the CA-IF1042LVS-Q1 devices, see *Table 9-4* for the undervoltage lockout status. Once the undervoltage condition is cleared and the supply voltage has returned to a valid level, the devices transition to normal mode after the  $t_{MODE}$  time has expired. The host controller should not attempt to send or receive messages until the  $t_{MODE}$  time has expired.

**Table 9-4 CA-IF1042LV-Q1 Undervoltage Lockout**

$V_{CC}$	$V_{IO}$	DEVICE STATE	BUS OUTPUT	RXD
$> V_{UV\_VCC}$	$> V_{UV\_IO}$	Standby (STB = high)	Weak pull-down to GND	High until valid wake-up is received
		Normal (STB = low)	Per TXD	Mirrors Bus
$< V_{UV\_VCC}$	$> V_{UV\_IO}$	Standby (STB = high)	Weak pull-down to GND	High until valid wake-up is received
		Protected mode (STB = low)	Weak pull-down to GND	Recessive
$X^1$	$< V_{UV\_IO}$	Protected mode	High Impedance	High Impedance

X = Don't care

### 9.4.2. Fault Protection

The CA-IF1042Lx devices has an internal  $\pm 40V$  overvoltage protection circuit on the driver output and receiver input to protect the devices from accidental shorts between a local power supply and the data lines of the transceivers. This level of protection is present whether the transceiver is powered or un-powered.

### 9.4.3. Thermal Shutdown

If the junction temperature of the devices exceeds the thermal shutdown threshold  $T_{TSD}$  ( $185^{\circ}C$ ), the device turns off the CAN driver circuits thus blocking the TXD-to-bus transmission path. The CAN bus terminals are biased to the recessive level during a thermal shutdown, and the receiver-to-RXD path remains operational. The shutdown condition is cleared when the junction temperature drops at least the thermal shutdown hysteresis temperature below the thermal shutdown threshold.

### 9.4.4. Current-Limit

The CA-IF1042Lx protect the transmitter output stage against a short-circuit to a positive or negative voltage by limiting the driver current. However, this will cause large supply current and dissipation. Thermal shutdown further protects the devices

from excessive temperatures that may result from a short circuit. The transmitter returns to normal operation once the short is removed.

#### 9.4.5. Transmitter-Dominant Timeout

The CA-IF1042Lx family of devices features a transmitter-dominant timeout ( $t_{DOM}$ ) that prevents erroneous CAN controllers from clamping the bus to a dominant level by maintaining a continuous low TXD signal. When TXD remains in the dominant state (low) for greater than  $t_{DOM}$ , the transmitter is disabled, releasing the bus to a recessive state (see *Figure 9-3*). After a dominant timeout fault, the transmitter is re-enabled when receiving a rising edge at TXD. The transmitter-dominant timeout limits the minimum possible data rate to 4kbps.

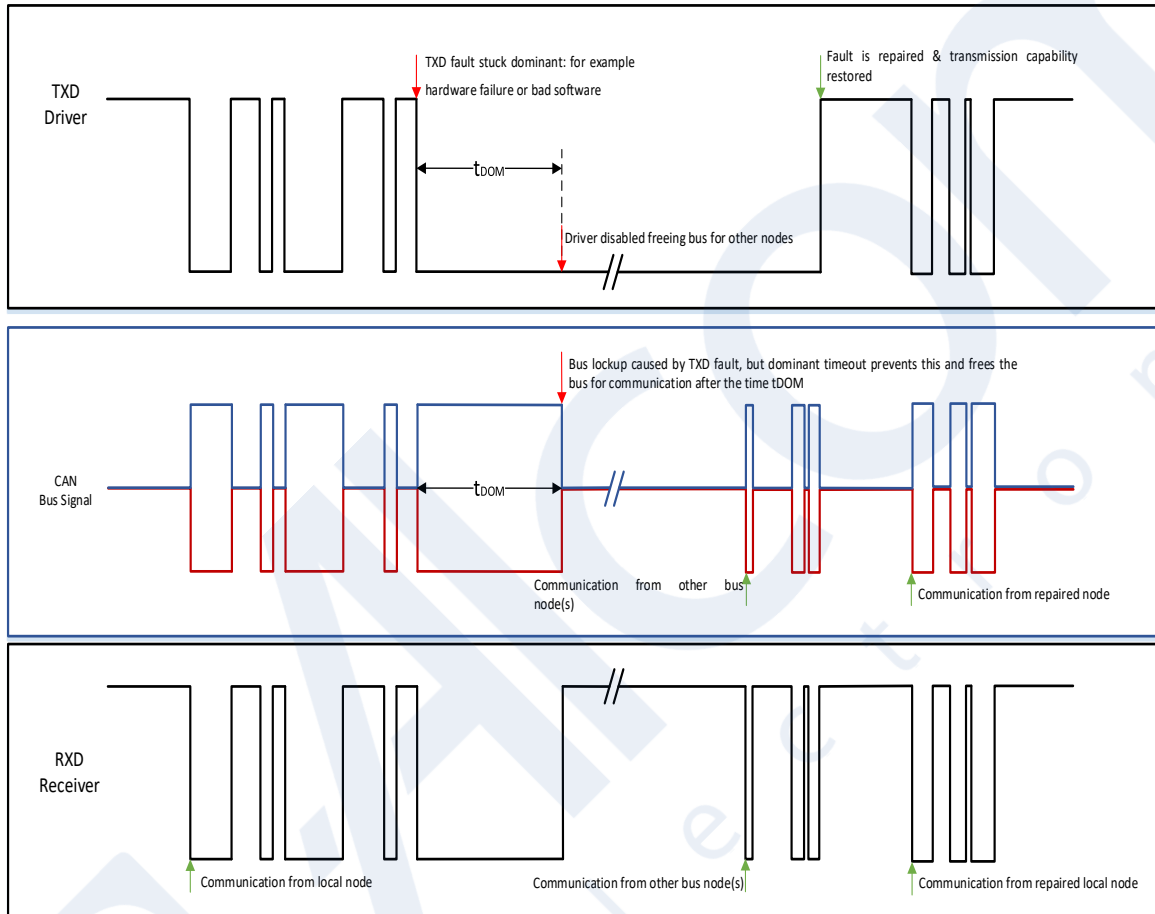


Figure 9-3 Transmitter-Dominant Timeout Protection

#### 9.5. Unpowered Device

The device is designed to be 'ideal passive' or 'no load' to the CAN bus if it is unpowered. The bus terminals (CANH, CANL) have extremely low leakage currents when the device is unpowered to avoid loading down the bus.

#### 9.6. Floating Terminals

These devices have internal pull-up on critical terminals to place the device into known states if the terminals float. The TXD terminal is pulled up to  $V_{CC}$  or  $V_{IO}$  to force a recessive input level if the terminal floats. The pin STB is also pulled up to force the device into standby mode if the terminal floats.

### 9.7. Operating Mode

All devices have two operating modes: normal mode and standby mode. Operating mode selection is made via the STB input.

#### 9.7.1. Normal Mode

Select the normal mode of devices operation by setting STB terminal to logic-low. The CAN driver and receiver are fully operational and CAN communication is bi-directional. The driver translates a digital input on TXD to a differential output on CANH and CANL. The receiver translates the differential signal from CANH and CANL to a single-ended output on RXD.

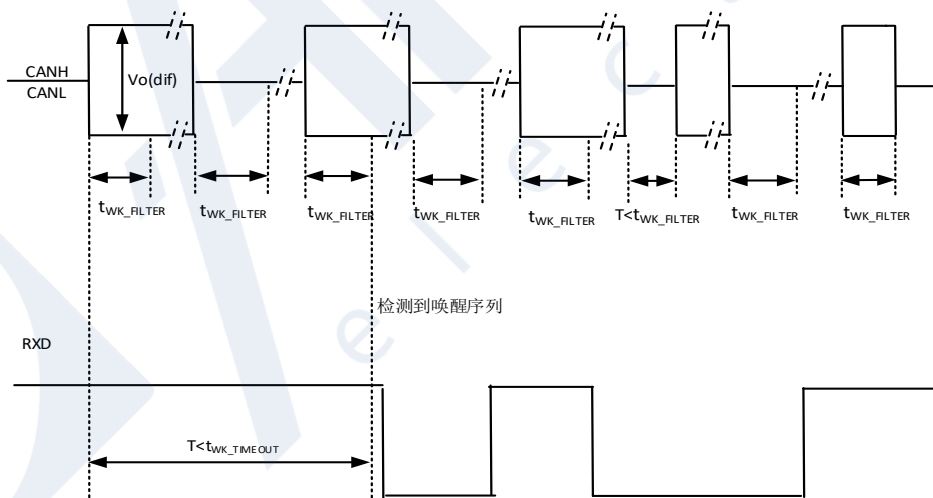
#### 9.7.2. Standby Mode

Drive STB pin high or leave it open for standby mode, which switches the transmitter off and disables the main receiver. The low-power receive channel is enabled and put the device to a low current and low-speed state. Thus the supply current is reduced during standby mode. The bus line is monitored by a low-power differential comparator to detect and recognize a wakeup event on the bus line, see *Table 9-5*.

**Table 9-5 Operating Mode**

STB	MODE	DRIVER	RECEIVER
Low	Normal	Enabled	Enabled
High or open	Standby	Disabled	Low-power receive channel is enabled and monitor the bus line.

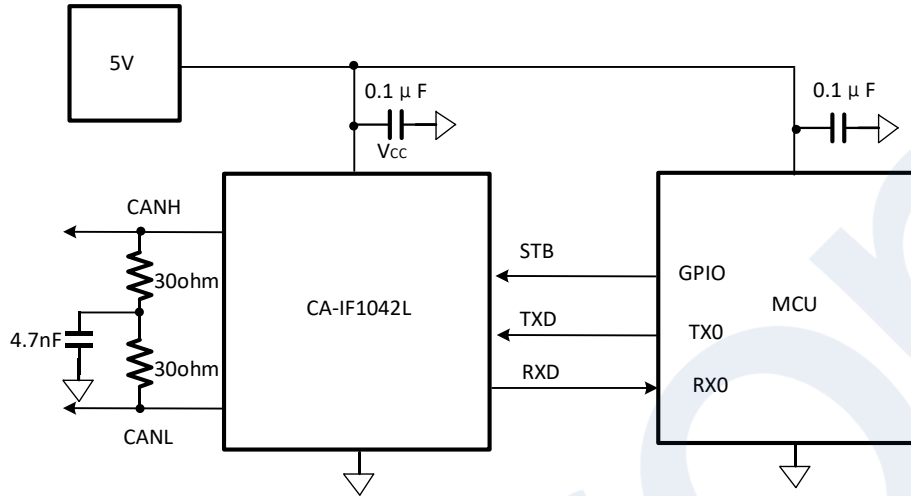
To improve the system operation reliability and to prevent false wake-up, the CA-IF1042Lx devices' receiver features wake-up timeout detection and filtered dominant wake-up detection according to the ISO 11898-2:2016 standard. This means, for a dominant or recessive to be considered, the bus must be kept in that state for more than the  $t_{WK\_FILTER}$  time. Also, for a remote wake-up event to successfully occur, a dominant bus level greater than  $t_{WK\_FILTER}$  must be detected and received by the low-power receive channel within the timeout value  $t \leq t_{WK\_TIMEOUT}$ . Once the low-power receive channel detects a successful wake-up event, RXD pulls low. CAN controller can drive the STB low based on this wake-up signal from RXD for normal operation. RXD is high until a valid wake-up is received during standby mode, see *Figure 9-4* for more details.



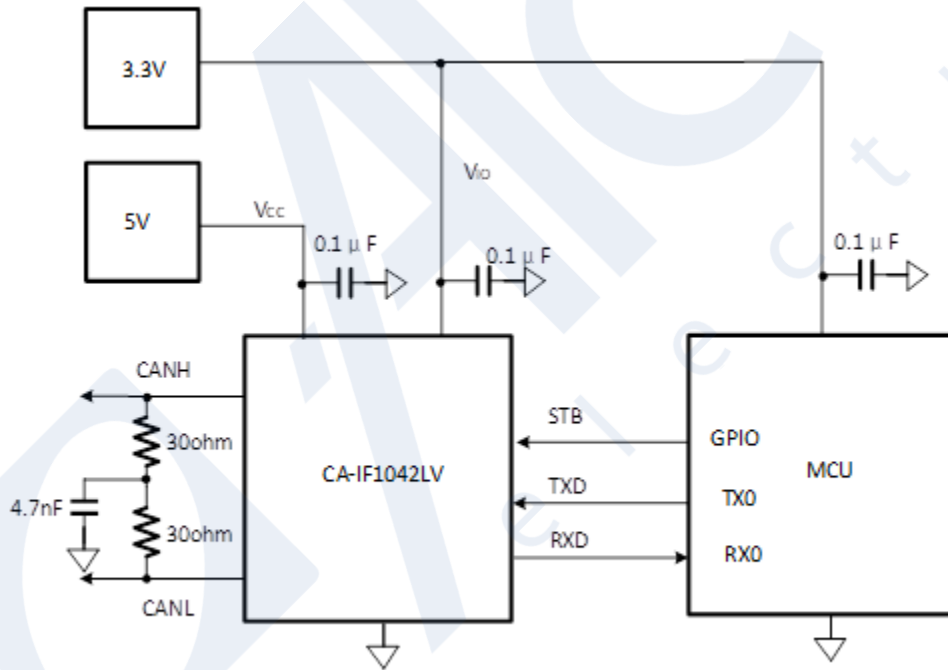
**Figure 9-4 Wake-up Detection**

**10. Application Information**

The CA-IF1042Lx CAN transceivers are typically used in applications with a host microprocessor or FPGA that includes the data link layer portion of the CAN protocol. Figure 10-1, Figure 10-2 show the typical application circuit for the CA-IF1042LS-Q1 and CA-IF1042LVS-Q1, in Figure 10-2, connect the  $V_{IO}$  to the MCU logic-supply.



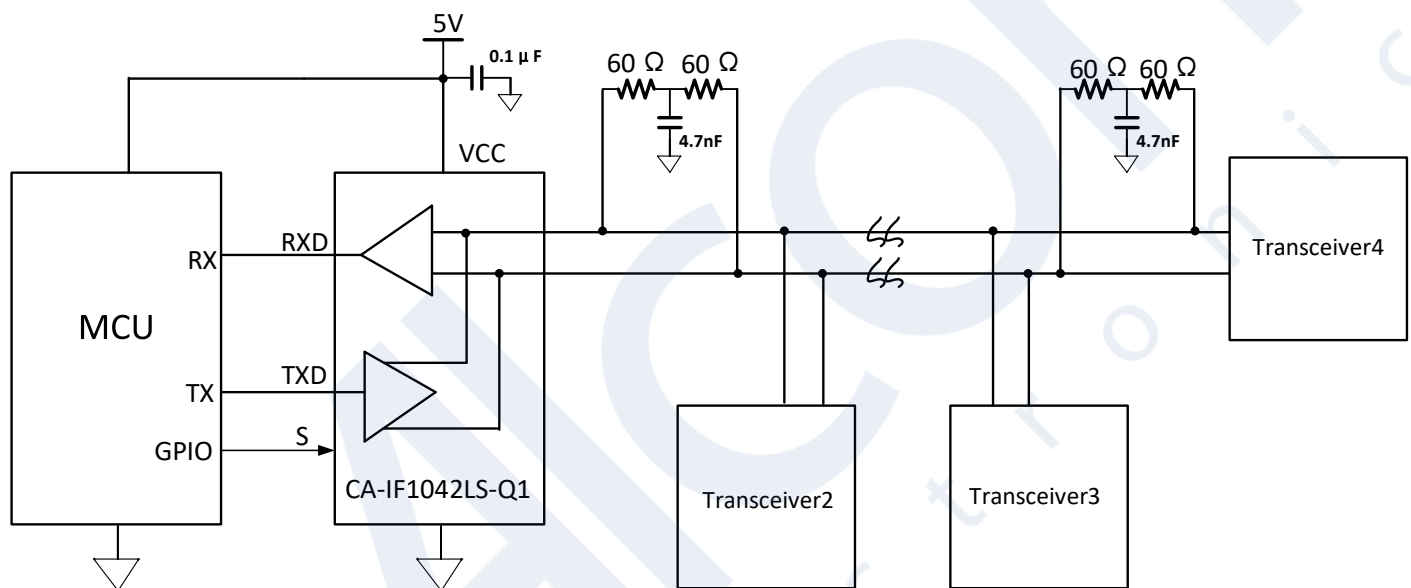
**Figure 10-1 Typical Application Circuit for the CA-IF1042LS-Q1**



**Figure 10-2 Typical Application Circuit for the CA-IF1042LVS-Q1**

All of the CA-IF1042Lx series devices can operate up to 5Mbps data rate. However, the maximum data rate is limited by the bus loading, number of nodes, cable length etc. For CAN network design, margin must be given for signal loss across the system and cabling, parasitic loadings, timing, network imbalances, ground offsets and signal integrity thus a practical maximum data rate, number of nodes often lower. The ISO11898 Standard specifies a maximum of 30 nodes. However, with careful design, and consider of high input impedance of the CA-IF1042Lx, designers can have many more nodes on the CAN bus.

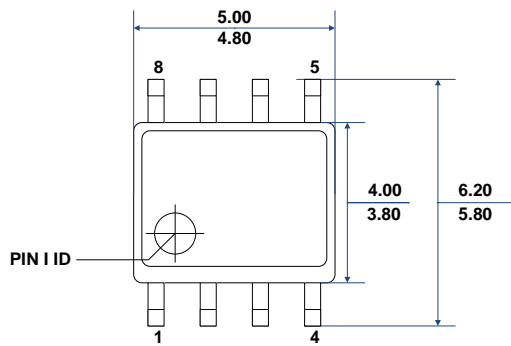
In multidrop CAN applications, it is important to maintain a single linear bus of uniform impedance that is properly terminated at each end. A star, ring, or tree configuration should never be used. Any deviation from the end-to-end wiring scheme creates a stub. High-speed data edges on a stub can create reflections back down to the bus. These reflections can cause data errors by eroding the noise margin of the system. Although stubs are unavoidable in a multidrop system, care should be taken to keep these stubs as short as possible, especially when operating with high data rates. See *Figure 10-3*, the typical CAN bus operating circuit, termination can be used to absorb reflections. Termination may be a single 120Ω resistor at the end of the bus, either on the cable or in a terminating node; or split termination, the two 60Ω termination resistors in parallel may be used if filtering and stabilization of the common mode voltage of the bus is desired.



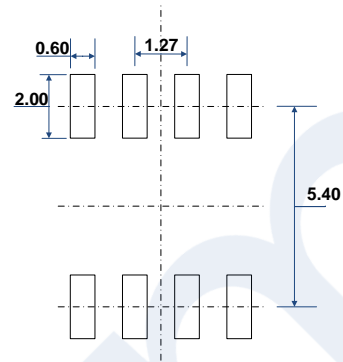
**Figure 10-3 Typical CAN bus Network**

**11. Package Information**

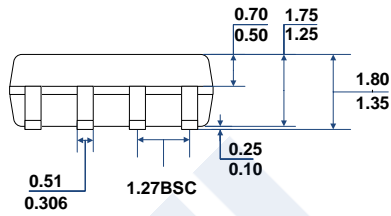
**SOIC8 Package Outline**



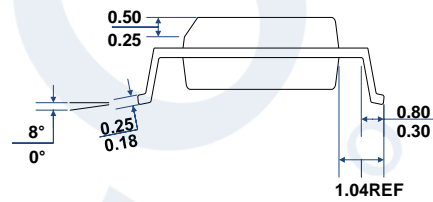
**TOP VIEW**



**RECOMMENDED LAND PATTERN**



**FRONT VIEW**



**LEFT-SIDE VIEW**

**Note:**

1. Controlling dimensions are in millimeters.

Figure 11-1 SOIC8 Package Outline

12. Soldering Temperature (reflow) Profile

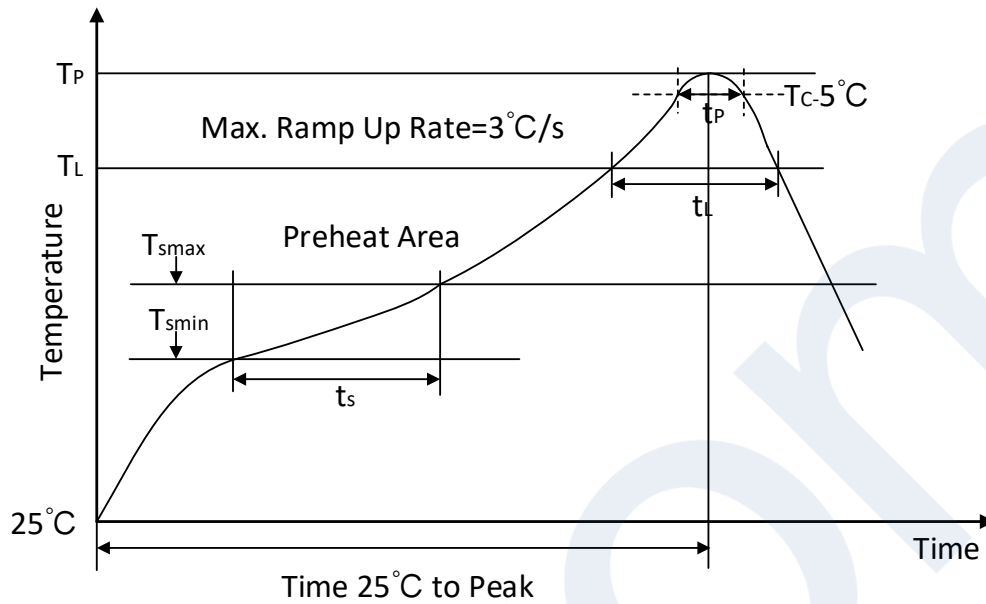
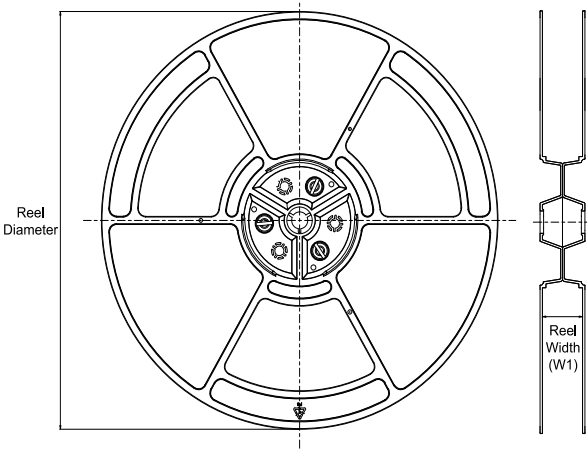
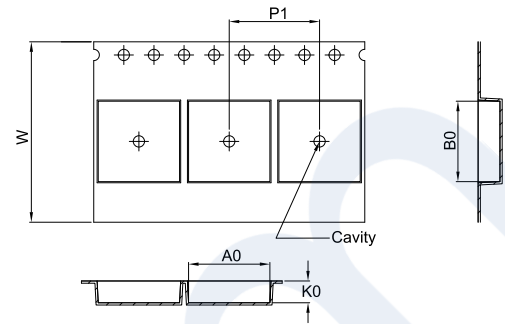


Figure 12- 1 Soldering Temperature (reflow) Profile

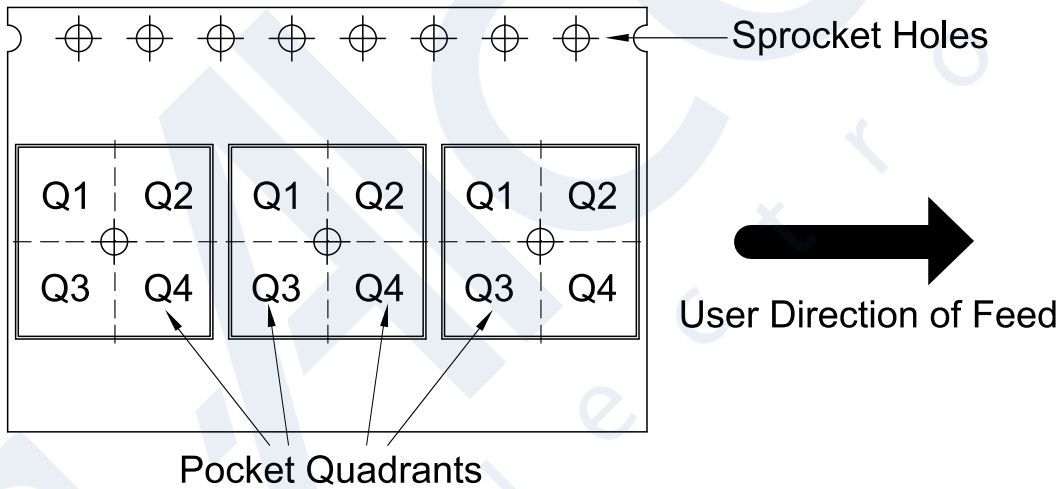
Table12- 1 Soldering Temperature Parameter

Profile Feature	Pb-Free Assembly
Average ramp-up rate(217 °C to Peak)	3°C/second max
Time of Preheat temp(from 150 °C to 200 °C)	60-120 second
Time to be maintained above 217 °C	60-150 second
Peak temperature	260 +5/-0 °C
Time within 5 °C of actual peak temp	30 second
Ramp-down rate	6 °C/second max.
Time from 25 °C to peak temp	8 minutes max



**13. Tape and Reel Information**
**REEL DIMENSIONS**

**TAPE DIMENSIONS**


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CA-IF1042LS-Q1	SOIC8	S	8	2500	330	12.4	6.40	5.40	2.10	8.00	12.00	Q1
CA-IF1042LVS-Q1	SOIC8	S	8	2500	330	12.4	6.40	5.40	2.10	8.00	12.00	Q1

**14. Appendix**
**Table. 14-1 Comparison Table of Parameter Symbols in ISO11898-2:2016 Standard and CA-IF1042-Q1 Datasheet**

ISO 11898-2:2016		CA-IF1042-Q1 Datasheet	
Parameter	Note	Symbol	Parameter
<b>HS-PMA dominant output characteristics</b>			
Single ended voltage on CAN_H	V <sub>CAN_H</sub>	V <sub>O(DOM)</sub>	dominant output voltage
Single ended voltage on CAN_L	V <sub>CAN_L</sub>		
Differential voltage on normal bus load	V <sub>Diff</sub>	V <sub>OD(DOM)</sub>	dominant differential output voltage
Differential voltage on effective resistance during arbitration			
Optional: Differential voltage on extended bus load range			
<b>HS-PMA driver symmetry</b>			
Driver symmetry	V <sub>sym</sub>	V <sub>sym</sub>	transmitter voltage symmetry
<b>Maximum HS-PMA driver output current</b>			
Absolute current on CAN_H	I <sub>CAN_H</sub>	I <sub>OS(SS_DOM)</sub>	dominant short-circuit output current
Absolute current on CAN_L	I <sub>CAN_L</sub>		
<b>HS-PMA recessive output characteristics, bus biasing active/inactive</b>			
Single ended output voltage on CAN_H	V <sub>CAN_H</sub>	V <sub>O(REC)</sub>	recessive output voltage
Single ended output voltage on CAN_L	V <sub>CAN_L</sub>		
Differential output voltage	V <sub>Diff</sub>	V <sub>OD(REC)</sub>	recessive differential output voltage
<b>Optional HS-PMA transmit dominant timeout</b>			
Transmit dominant timeout, long	t <sub>dom</sub>	t <sub>DOM</sub>	TXD dominant time-out time
Transmit dominant timeout, short			
<b>HS-PMA static receiver input characteristics, bus biasing active/inactive</b>			
Recessive state differential input voltage range Dominant state differential input voltage range	V <sub>Diff</sub>	V <sub>DIFF_D</sub> V <sub>DIFF_R</sub> V <sub>DIFF_D(STB)</sub> V <sub>DIFF_R(STB)</sub>	Receiver dominant/recessive state differential input voltage range in normal /standby mode
<b>HS-PMA receiver input resistance (matching)</b>			
Differential internal resistance	R <sub>Diff</sub>	R <sub>DIFF</sub>	differential input resistance
Single ended internal resistance	R <sub>CAN_H</sub> R <sub>CAN_L</sub>	R <sub>IN</sub>	input resistance
Matching of internal resistance	m <sub>R</sub>	R <sub>DIFF(M)</sub>	input resistance deviation
<b>HS-PMA implementation loop delay requirement</b>			
Loop delay	t <sub>Loop</sub>	t <sub>loop2</sub>	delay time from TXD HIGH to RXD HIGH
		t <sub>loop1</sub>	delay time from TXD LOW to RXD LOW
<b>Optional HS-PMA implementation data signal timing requirements for use with bit rates above 1 Mbit/s up to 2 Mbit/s and above 2 Mbit/s up to 5 Mbit/s</b>			
Transmitted recessive bit width @ 2 Mbit/s / @ 5 Mbit/s, intended	t <sub>Bit(Bus)</sub>	t <sub>bit(BUS)</sub>	transmitted recessive bit width
Received recessive bit width @ 2 Mbit/s / @ 5 Mbit/s	t <sub>Bit(RXD)</sub>	t <sub>bit(RXD)</sub>	bit time on pin RXD
Receiver timing symmetry @ 2 Mbit/s / @ 5 Mbit/s	Δt <sub>Rec</sub>	Δt <sub>Rec</sub>	receiver timing symmetry
<b>HS-PMA maximum ratings of V<sub>CAN_H</sub>, V<sub>CAN_L</sub> and V<sub>Diff</sub></b>			
Maximum rating V <sub>Diff</sub>	V <sub>Diff</sub>	V(DIFF)	voltage between pin CANH and pin CANL
General maximum rating V <sub>CAN_H</sub> and V <sub>CAN_L</sub>	V <sub>CAN_H</sub> V <sub>CAN_L</sub>	V(BUS)	voltage on CANH, CANL pin
Optional: Extended maximum rating V <sub>CAN_H</sub> and V <sub>CAN_L</sub>			

Table. 14-1 Comparison Table of Parameter Symbols in ISO11898-2:2016 Standard and CA-IF1042-Q1 Datasheet (continued)

ISO 11898-2:2016		CA-IF1042-Q1 Datasheet	
Parameter	Symbol	Symbol	Parameter
<b>HS-PMA maximum leakage currents on CAN_H and CAN_L, unpowered</b>			
Leakage current on CAN_H, CAN_L	$I_{CAN\_H}$ $I_{CAN\_L}$	ILKG	leakage current
<b>HS-PMA bus biasing control timings</b>			
CAN activity filter time, long	$t_{Filter}$	$t_{WK\_FILTER}$	bus dominant wake-up time bus recessive wake-up time
CAN activity filter time, short			
Wake-up timeout, short	$t_{Wake}$	$t_{WK\_TIMEOUT}$	bus wake-up time-out time
Wake-up timeout, long			
Timeout for bus inactivity	$t_{Silence}$	$t_{DTO}$	bus silence time-out time
Bus Bias reaction time	$t_{Bias}$	$t_{ONTXD}$	delay time from bus active to bias or from bias to active

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