钍地半导体
Tudi Semiconductor

Product Specification

TUDI-TJA1020

LIN transceiver

网址 www.sztdbdt.com

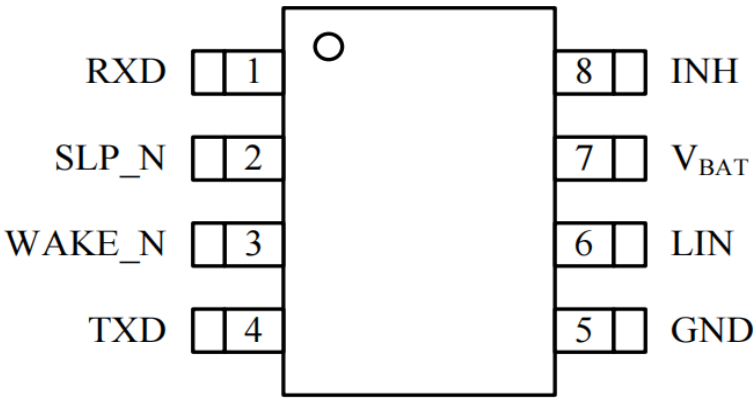
用芯智造·卓越品质

semiconductor device manufacturer

- Design
- research and development
- production
- and sales

Features

- Baud rate up to 20 Kbaud
- Very low ElectroMagnetic Emission (EME)
- High ElectroMagnetic Immunity (EMI)
- Low slope mode for an even further reduction of EME
- Passive behaviour in unpowered state
- Input levels compatible with 3.3 and 5 V devices
- Integrated termination resistor for Local Interconnect Network (LIN) slave applications
- Wake-up source recognition (local or remote)
- Supports K-line like functions.
- Very low current consumption in sleep mode with local and remote wake-up.
- Transmit data (TXD) dominant time-out function
- Bus terminal and battery pin protected against transients in the automotive environment (ISO7637)
- Bus terminal short-circuit proof to battery and ground
- Thermally protected.



Pin Diagram

Description

The TJA1020 is the interface between the LIN master/slave protocol controller and the physical bus in a Local Interconnect Network (LIN). It is primarily intended for in-vehicle sub-networks using baud rates from 2.4 up to 20 Kbaud.
The transmit data stream of the protocol controller at the TXD input is converted by the LIN transceiver into a bus signal with controlled slew rate and wave shaping to minimize EME. The LIN bus output pin is pulled HIGH via an internal termination resistor. For a master application an external resistor in series with a diode should be connected between pin INH or pin BAT and pin LIN. The receiver detects the data stream at the LIN bus input pin and transfers it via pin RXD to the microcontroller.
In normal transceiver operation the TJA1020 can be switched in the normal slope mode or the low slope mode. In the low slope mode the TJA1020 lengthens the rise and fall slopes of the LIN bus signal, thus further reducing the already very low emission in normal slope mode.
In sleep mode the power consumption of the TJA1020 is very low, whereas in failure modes the power consumption is reduced to a minimum.

Pin Definition

Pin No.	Pin Name	Pin Function Description
1	RXD	Receiver data output (open-drain). Pulls low when a wake-up event occurs.
2	SLP_N	Enable input. High level enables normal operation; low level activates sleep mode. Resets wake-up flag on TXD and wake-up request on RXD.
3	WAKE_N	Local wake-up input (active low), falling edge triggered.
4	TXD	Transmitter data input. Outputs low after a local wake-up event.
5	GND	Ground.
6	LIN	LIN bus input/output.
7	VBAT	Battery supply voltage.
8	INH	Controls the operating state of the external regulator. Pulls high when a wake-up event occurs.

Table 1 TJA1020 Pin Definitions

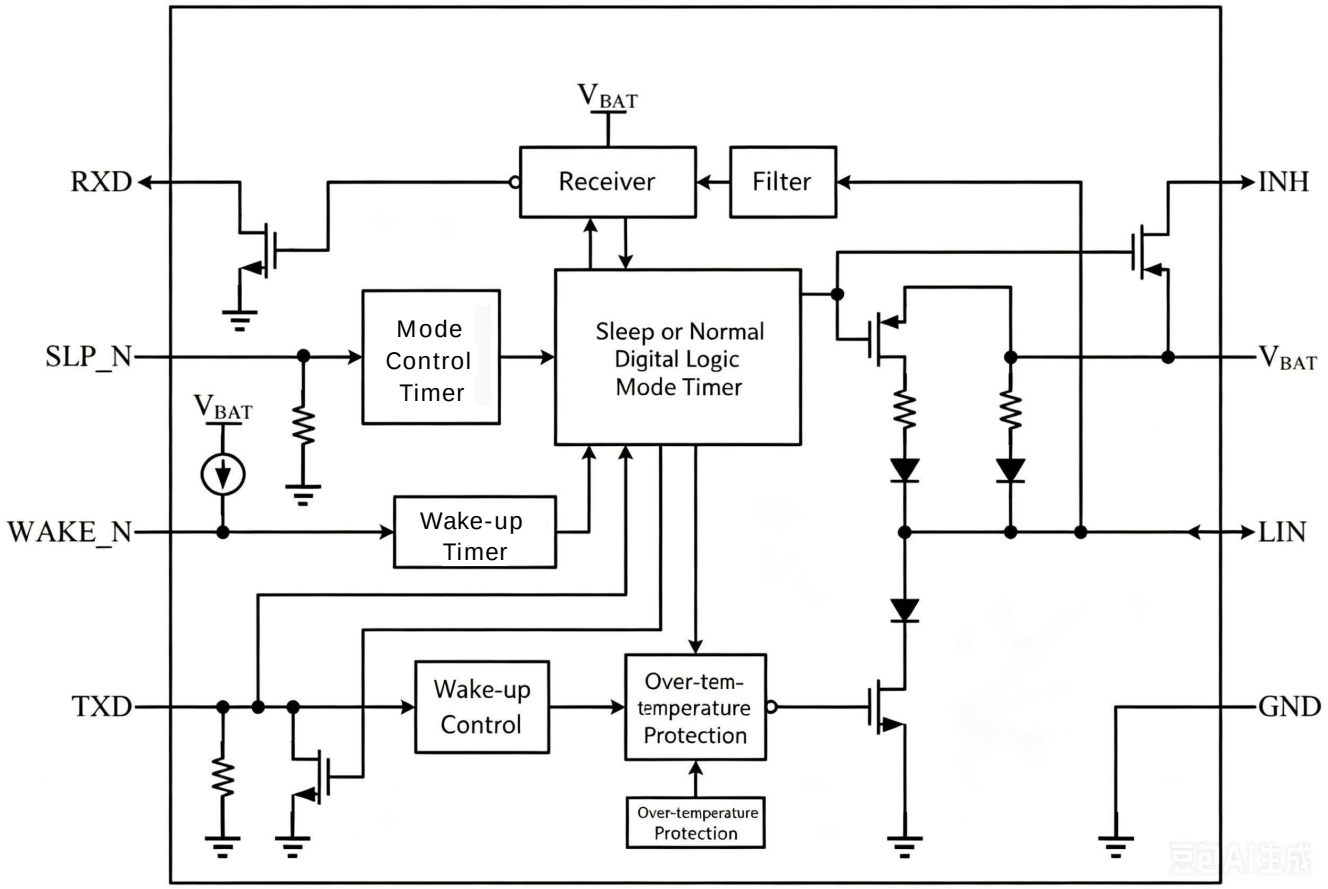


Figure 1 Internal Block Diagram

General Description

The TJA1020 is an interface chip designed between the LIN protocol controller and the physical bus, suitable for applications such as trucks, buses, passenger cars, and industrial control systems, with a data rate of up to 20 kbps.
At its transmit data input (TXD), the TJA1020 receives the transmit data stream from the protocol controller and converts it into a bus signal with optimized slew rate and waveform shaping. Input data on the LIN bus is output to the external microcontroller via the receiver ' s RXD pin. The device is compliant with LIN 2.x / ISO 17987-4:2016 (12V) / SAE J2602 standards.

Short-circuit Protection

The TXD pin provides an internal pull-down to GND, applying a predefined level to TXD when the pin is undriven. The SLP_N pin also includes an internal pull-down to GND, forcing the transceiver into sleep mode when the pin is undriven.
If the supply at the VBAT pin is turned off, the RXD pin will float, and the transmitter output stage current is limited to protect against short circuits of the transmitter to VBAT or GND. A power-off condition (VBAT and GND pins) has no effect on the bus or the microcontroller. There is no reverse current on the bus, so the LIN transceiver can be disconnected from the power supply without affecting the LIN bus.

Overtemperature Protection

The TJA1020 features an overtemperature protection function. In normal mode, when the junction temperature exceeds the shutdown junction temperature $T_{j(sd)}$, the overtemperature protection circuit disables the output driver; when the junction temperature drops below the hysteresis temperature, the driver is re-enabled. If VBAT falls below $V_{th}(V_{BATL})$, the protection circuit will disable the output driver; when $V_{BAT} > V_{th}(V_{BATL})$, the driver is re-enabled.

Explicit Timeout Function

If the TXD pin is forcibly set to a permanent low level due to hardware and/or software failures , the built-in TXD explicit timeout timer circuit prevents the bus from entering a permanent explicit state (which blocks all network communications). The timer is triggered by the falling edge on the TXD pin. If the low-level duration on the TXD pin exceeds the internal timer duration ($t_{to(dom)TXD}$), the transmitter is disabled and the bus transitions to an implicit state. The timer is reset by the rising edge on the TXD pin.

Work Pattern

As shown in Figure 4, the TJA1020 operates primarily in four modes: sleep mode, standby mode, normal mode, and power-on mode, with their respective operational characteristics detailed in Table 2.

Sleep Mode: This is the power-efficientest mode for the TJA1020. It can be remotely awakened via the LIN pin, locally awakened via the WAKE_N pin, or directly awakened via the SLP_N pin. To prevent unintended awakenings caused by automotive transients or EMI, filters are implemented at the receiver's input (LIN pin), WAKE_N pin, and SLP_N pin respectively. The necessary conditions for awakening the TJA1020 from sleep mode are: the duration of remote awakening via the LIN pin must exceed $t_{wake(dom)}$LIN(LIN's wake-up time); the duration of local awakening via the WAKE_N pin must exceed $t_{wake(dom)}$WAKE_N; and the duration of direct awakening via the SLP_N pin must exceed $t_{gotonorm}$.

In normal mode, when a falling edge occurs on pin SLP_N and the low-level duration exceeds $t_{gotosleep}$, the TJA1020 enters sleep mode. During sleep mode, pin INH remains at low level; in all other modes, pin INH remains high level.

Standby Mode: When the TJA1020 is in sleep mode, it automatically enters standby mode upon detecting a local or remote wake-up event; a low voltage on the RXD pin indicates this wake-up process. Upon transitioning from sleep to standby mode, the INH pin becomes high, activating the external voltage regulator and microcontroller.

If you set the SLP_N pin to high level in standby mode, the following issues may occur:

（1）Reset the wake-up source flag immediately; this prevents the release of any potential strong pull-down state on TXD before performing the actual mode switch ($t_{gotonorm}$).

（2）When the high-level duration on pin SLP_N exceeds $t_{gotonorm}$, the device enters normal mode.

（3）The wake-up request signal on the RXD pin is immediately reset.

Normal Mode: In normal mode, the TJA1020 transmits and receives data via the LIN bus, where a high bus level indicates implicit mode and a low level indicates explicit mode. Upon detecting data flow on the LIN bus input pin, the receiver outputs it to the microcontroller through the RXD pin. During sleep, standby, or power-on modes, the device enters normal mode if the high-level duration of the SLP_N pin exceeds $t_{gotonorm}$; if the low-level duration exceeds $t_{gotosleep}$, the device switches to sleep mode.

Power-on mode: When the TJA1020 is in power-on mode, the RXD pin remains floating and the TXD pin is weakly pulled down, but neither the transmitter nor the receiver is activated. If the high-level duration of the SLP_N pin exceeds $t_{gotonorm}$, the device enters normal mode.

Wake-up Source Identification

In sleep mode, the TJA1020 can be remotely awakened via the LIN bus pins or locally awakened using the WAKE_N pin. In standby mode, the device detects the wake-up source by monitoring the TXD pin status: a weak pull-down indicates remote awakening, while a strong pull-down indicates local awakening. When the controller sets SLP_N to high level, both the wake-up request flag (on the RXD pin) and the wake-up source flag (on the TXD pin) are immediately reset.

Awakening Mechanism

When the device is in sleep mode, it can be awakened in one of three ways:

（1）Remote wake up via the LIN pin;
（2）Local wake-up via the WAKE_N pin;
（3）Wake up by switching modes directly via the SLP_N pin.

Remote Wakeup and Local Wakeup

Remote wake-up on a LIN pin: When the LIN pin is pulled low to a low level by a falling edge, and a rising edge follows immediately thereafter with the duration of the low-level period between this rising edge and the preceding falling edge exceeding $t_{wake(dom)LIN}$, the process is considered a valid remote wake-up (as shown in Figure 3).
Local wake-up on the WAKE_N pin: When a falling edge occurs on the WAKE_N pin and the subsequent low-level duration exceeds $t_{wake(dom)WAKE\_N}$, this event is considered a valid local wake-up. The WAKE_N pin provides an internal pull-up path to V_{BAT}. To prevent EMI issues, it is recommended to connect unused WAKE_N pins to V_{BAT}.
Upon local or remote wake-up, the INH pin is activated (set to high level), and the internal slave terminal resistor is turned on. The wake-up request event uses the low-level signal on the RXD pin as an indicator to interrupt the microcontroller.

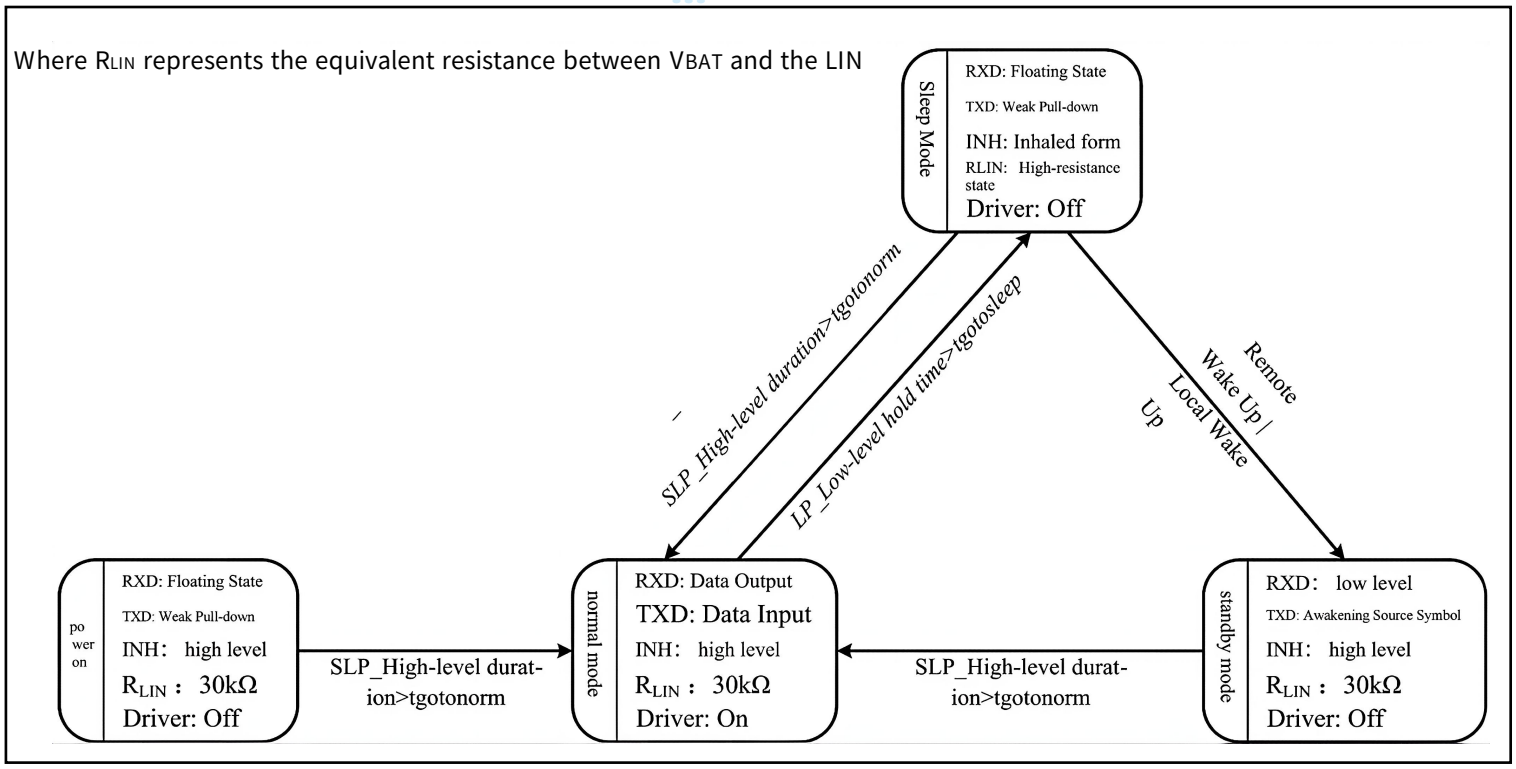


Figure 2 State Transition Diagram

Pattern	SLP_N	TXD	RXD	INH	Actuator	Sign
Dormancy	Low level	Weak Pull Down	floating	floating	Close	No wake request detected
Await the opportunemoment	Low level	Remote Wake:Weak Pull-downLocal Wake Up:Strong Pull-down	Low level	High level	Close	Wake request detection;In this mode,the externalmicrocontroller can readthe wake-up source signal:either remotely or locally.
Normal	High level	Implicit:High LevelDominant:Low level	Implicit:High LevelDominant: Low level	High level	Open	
Power on	Low level	Weak Pull Down	floating	High level	Close	

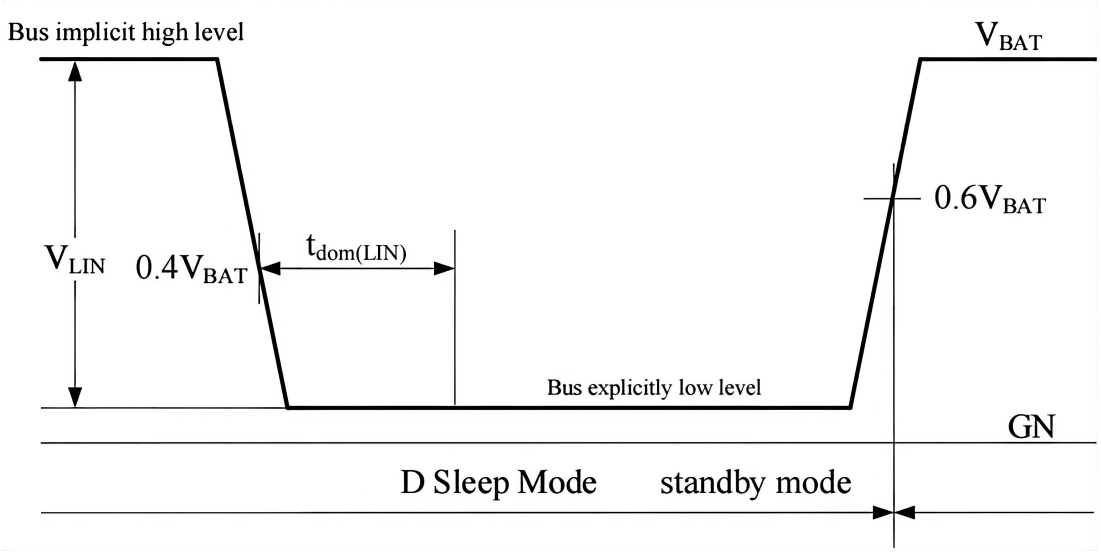


Figure 3: Remote Wakeup Sequence Diagram

Limit Parameter

Parameter	Symbol	Test condition	Big or small	Unit
Supply voltage	V^{BAT}	Earth potential	-0.3～+42	V
TXD Pin Voltage	V^{TXD}	Unlimited IsLP_N	-0.3～+6	V
		IsLPN<500μA	-0.3～+7	
RXD Pin Voltage	V^{RXD}	Unlimited IsLP_N	-0.3～+6	V
		IsLPN<500μA	-0.3～+7	
SLP_N Pin Voltage	V^{SLPN}	Unlimited IsLP_N	-0.3～+6	V
		IsLP_N<500μA	-0.3～+7	
LIN Pin Voltage	V^{LIN}	Earth potential	-42～+42	V
WAKE_N Pin Voltage	V^{WAKEN}		-0.3～+42	V
INH Pin Voltage	V^{INH}		-0.3～VBAT+0.3	V
Junction temperature	T^{VJ}		-40～150	℃
Storage temperature	T^{stg}		-55～150	℃

Note: The maximum limit parameter value indicates the threshold beyond which the device may suffer irreversible damage. Operating under these conditions is detrimental to the device.
When operating normally, continuous operation of the device at its maximum allowable rated value may affect its reliability.
The reference point for all voltages is ground

Direct-Current Char-acteristic

Parameter	Symbol	Test condition	Minimum	Typical case	Maximum	Unit
Power dissipation						
Current consumedat the V_{BAT} pin	I_{BAT}	Hibernationmode: (V_{LIN}=V_{BAT};V_{WAKE_N}=V_{BAT};V_{TXD}=0V; V_{SLP_N}=0V)	1	3	15	μA
		Standby mode (implicit):(V_{INH}=V_{BAT};V_{LIN}=V_{BAT}); V_{WAKEN}=V_{BAT},V_{TXD}=0V;V_{SLPN}=0V)	150	350	800	μA
		Standby mode (act-ive):(V_{BAT}=12V;V_{INH}=12V;V_{LIN}=0V;V_{WAKEN}=12V; V_{TXD}=0V;V_{SLP_N}=0V)	500	750	1000	μA
		Normal mode(re-cessive):(VINH=V_{BAT};V_{LIN}=V_{BAT}); V_{WAKEN}=V_{BAT};V_{TXD}=5V;V_{SLPN}=5V)	200	380	600	μA
		Normal mode (domi-nant):(V_{BAT}=12V;V_{INH}=12V; V_{WAKEN}=12V;V_{TXD}=0V;V_{SLP_N}=5V)	0.5	1.4	3	mA

Power-on reset						
V^{BAT}Power-of threshold voltage	$V^{th(BAT)}L$		3.9	4.4	4.8	V
V^{BAT} On-off threshold voltage	$V^{th(BAT)}H$		4.2	4.7	5.1	V
V^{BAT} Delay Voltage	$V^{hys(BAT)}$		0.05	0.3	1	V
TXD pin						
High level input voltage	V^{IH}		2		7	V
Low level input voltage	V^{IL}		-0.3		+0.8	V
Hysteresis voltage	V^{hys}		50	200	400	mV
TXD Pull-down Resistance	$R^{PD(TXD)}$	V^{TXD}=5V	140	500	1200	kΩ
Low-level input current	I^{IL}	V^{TXD}=0V	-5		+5	μA
Low-level output current	I^{OL}	Local wake-uprequest;Normal mode;V_{WAKE_N}=0 V;V_{LIN}=VBAT, V_{TXD}=0.4 V	1.5			mA
SLP_N pin						
High level input voltage	V^{IH}		2		7	V
Low level input voltage	V^{IL}		-0.3		0.8	V
Hysteresis voltage	V^{hys}		50	200	400	mV
SLP_N's pull-down resistor	$R^{PD(SLPN)}$	V^{SLP_N}=5V	140	500	1200	kΩ
Low-level input current	I^{IL}	V^{SLPN}=0V	-5		5	μA
RXD pin						
Low-level output current	I^{OL}	Normal mode; V_{RXD}=0.4V;V_{LIN}=0V	1.5			mA
High-level leakage current	I^{LH}	Normal mode; V_{RXD}=5V;V_{LIN}=V_{BAT}	-5		5	μA

WAKE_N Pin						
High level input voltage	V^{IH}		VBAT-1		V^{BAT}+0.3	V
Low level input voltage	V^{IL}		-0.3		V^{BAT}-3.3	V
Low-level pull-down current	$I^{pu(L)}$	V^{WAKEN}=0V;	-30	-12	-1	μA
High-level leakage current	I^{LH}	V^{WAKEN}=27V;V^{BAT}=27V	-5		5	μA
INH pin						
The on-resistancebetween VBAT and INH	R^{SW}	In standby, normal,and power-on modes: I_{INH}=-15mA;V_{BAT}=12V		20	50	Ω
High-level leakage current	I^{LH}	Hibernation mode;V_{INH}=27V; V_{BAT}=27V	-5		5	μA
LIN pin						
Limiting current for thedriver's active state	I^{BUS_LIM}	V^{TXD}=0V;V^{LIN}= V_{BAT}=18V	40		100	mA
Pull-up resistor	R^{PU}	Hibernationmode ;V_{SLP_N}=0V	50	160	250	kS
Receiver's implicitinput leakage current	$I^{BUS\_PAS\_rec}$	V^{TXD}=5V;V^{LIN}=27V ;V_{BAT}=5.5V			10	μA
Receptor's dominantinput leakage current	$I^{BUS\_PAS\_dom}$	Normal mode; V_{TXD}=5V;V_{LIN}=0V; V_{BAT}=12V	-1000			μA
Bus-to-ground leakage current	$I^{BUS\_NO\_GND}$	V^{BAT}=27V;V^{LIN}=0V	-1000		10	μA
Bus-to-power leakage current	$I^{BUS\_NO\_BAT}$	V^{BAT}=0V;V^{LIN}=27V			10	μA
Receiver explicit inver-sion threshold voltage	$V^{th(dom)RX}$				0.4V^{BAT}	V
Receiver implicit inve-rsion threshold voltage	$V^{th(rec)RX}$		0.6V^{BAT}			V

LIN pin						
Receiver Center FlipThreshold Voltage	$V_{th(RX)cntr}$	$V_{th(RX)cntr}=(V_{th(rec)RX}+V_{th(dom)RX})/2$	$0.475V_{BAT}$	$0.5V_{BAT}$	$0.525V_{BAT}$	V
Receiver hysteresisthreshold voltage	$V_{th(hys)RX}$	$V_{th(hys)RX}=V_{th(rec)RX}-V_{th(dom)RX}$			$0.175V_{BAT}$	V
From electromechanical resistance	R_{slave}	The equivalent resi-stance between LINand V_{BAT};V_{LIN}=0V ;V_{BAT}=12V;V_{TXD}= V_{SLPN}=5V	20	30	60	kS
LIN Pin Equivalent Capacitance	C_{LIN}				30	pF
Dominant output voltage	$V_{o(dom)}$	Normal mode;V_{TXD}= 0V;V_{BAT}=7V			1.4	V
		Normal mode;V_{TXD}= 0V;V_{BAT}=18V			2.0	V
Thermal shutdown						
Turn-off junction temperature	$T_{j(sd)}$		150	175	200	℃

(Unless otherwise specified, 5.5V ≤ VBAT ≤ 27V, -40°C ≤ Tvj ≤ 150°C, with typical values at VBAT= 12V and Tvj= 25°C.)

Switching Characteristic

Parameter	Symbol	Test condition	Minimum	Typical case	Maximum	Unit
Occupancy Ratio						
Occupancy Ratio 1	δ 1[1I²]	Vth（ree)(max)=0.744×VBAT,Vtf（dom)(max)=0.581×VBAT,tbit=50 μs;VBAT=7V～18V Figure 4	0.396			
		Vth（ree)(max)=0.76×VBAT,Vth（dom)(max)=0.593×VBAT,tbit=50μs;VBAT=5.5V~7VFigure 4	0.396			
Occupancy Ratio 2	δ212]13]	Vth（ree）(min)=0.422×VBAT,Vth(dom）(min)=0.284×VBAT;tbit=50μs;VBAT=7.6V～18V Figure 4			0.581	
		Vth(ree)(min)=0.41×VBAT;Vth(dom)(min)=0.275×VBAT;tbit=50μs;VBAT=6.1V～7.6V Figure 4			0.581	
Occupancy Ratio 3	83 [1JI2]	Vth(ree)(max)=0.778×VBAT,Vth(dom)(max)=0.616×VBAT;tbit=96 μs;VBAT=7V～18V Figure 4	0.417			
		Vth(ree)(max)=0.797×VBAT;Vth(dom)(max)=0.630×VBAT,tbit=96μs;VBAT=5.5V~7VFigure 4	0.417			

Parameter	Symbol	Test condition	Minimum	Typical case	Maximum	Unit
Occupancy Ratio						
Occupancy Ratio 4	δ4 [2I3]	Vth(rec)(min)=0.389×VBAT;Vth(dom)(min)=0.251×VBAT;tbit=96μs; VBAT=7.6V～18V Figure 4			0.590	
		Vth(ree)(min)=0.378×VBAT;Vth(dom(min)=0.242×VBAT,tbit=96μs; VBAT=6.1V～7.6V Figure 4			0.590	
Temporal Characteristics						
Receiver propagation delay	tPD(RX)[4]				6	μs
Symmetry of the propag-ation delay in the receiver	$t^{PD(RX)sym}$[4]		-2		2	μs
LIN's explicit arousaltime (remote arousal)	$t^{wake(dom)LIN}$	Hibernation Mode	30	65	150	μs
WAKE_N's explicit awa-kening time (local awake-ning)	$t^{wake(dom)WAKE\_N}$	Hibernation Mode	7	22	50	μs
Time to enter normal mode	$t^{gotonorm}$		2	5	10	μs
Time to enter sleep mode	$t^{gotosleep}$		2	5	10	μs
TXD Dominant Timeout Time	$t^{to(dom)TXD}$	V^{TXD}=0V	27	52	90	ms

(Unless otherwise specified, 5.5V ≤ V_{BAT} ≤ 27V, -40 ° C ≤ T_{vj} ≤ 150 ° C, with typical values at V_{BAT}= 12V and T_{vj}= 25 ° C.)

▲ $\delta 1, \delta 3 = \frac{t_{bus(rec)(\min)}}{2 \times t_{bit}}$

▲ Bus load conditions: (1)CL= 1 nF,RL= 1 kΩ; (2)CL= 6.8 nF,RL= 660 Ω; (3)CL= 10 nF,RL= 500 Ω

▲ $\delta 2, \delta 4 = \frac{t_{bus(rec)(\max)}}{2 \times t_{bit}}$

▲ Load conditions of receiver output pin RXD:CTXD= 20 pF,RRXD= 2.4 kΩ

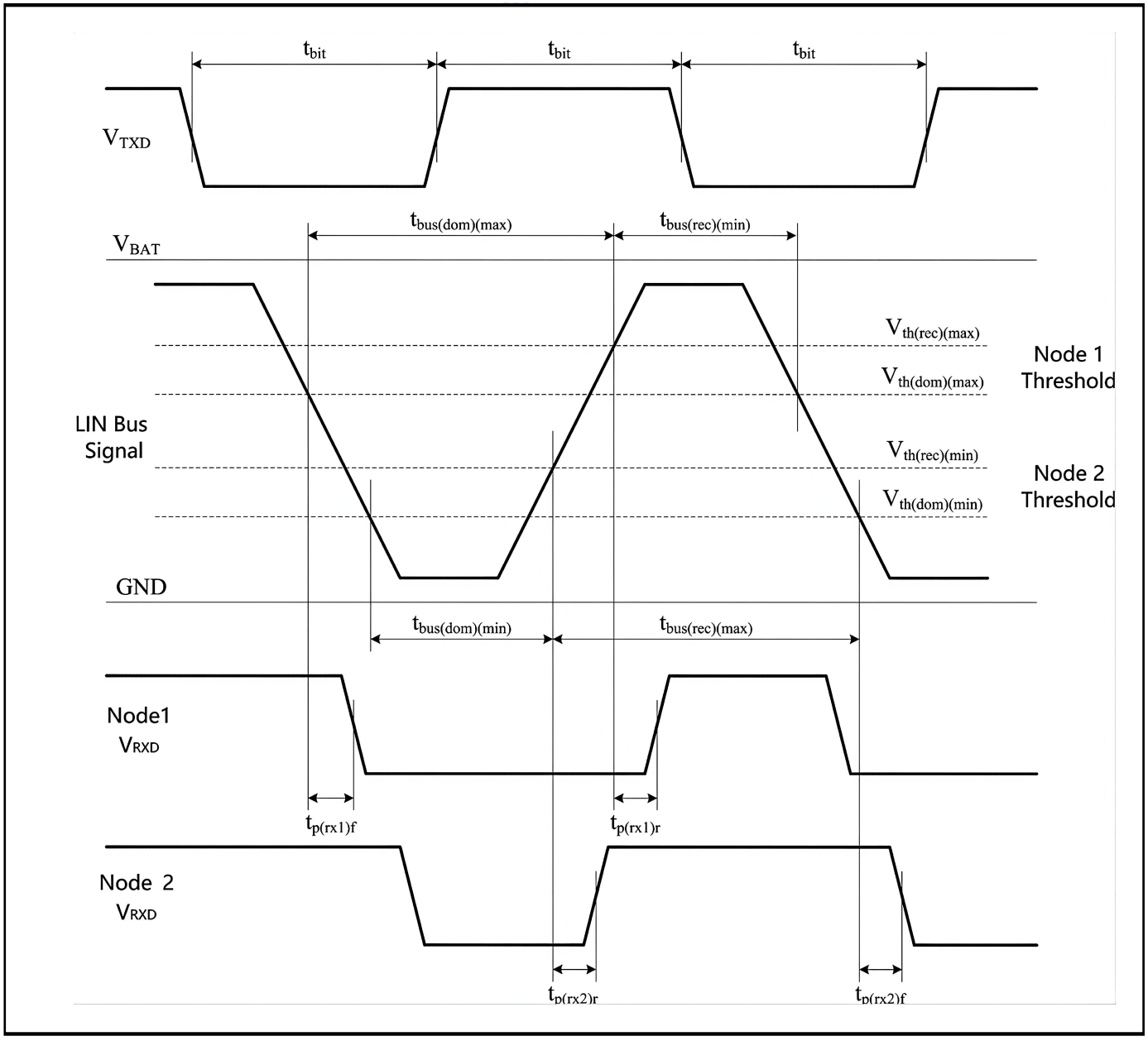


Figure 4: Bus Signal Transmission Timing Diagram

Typical Application Example

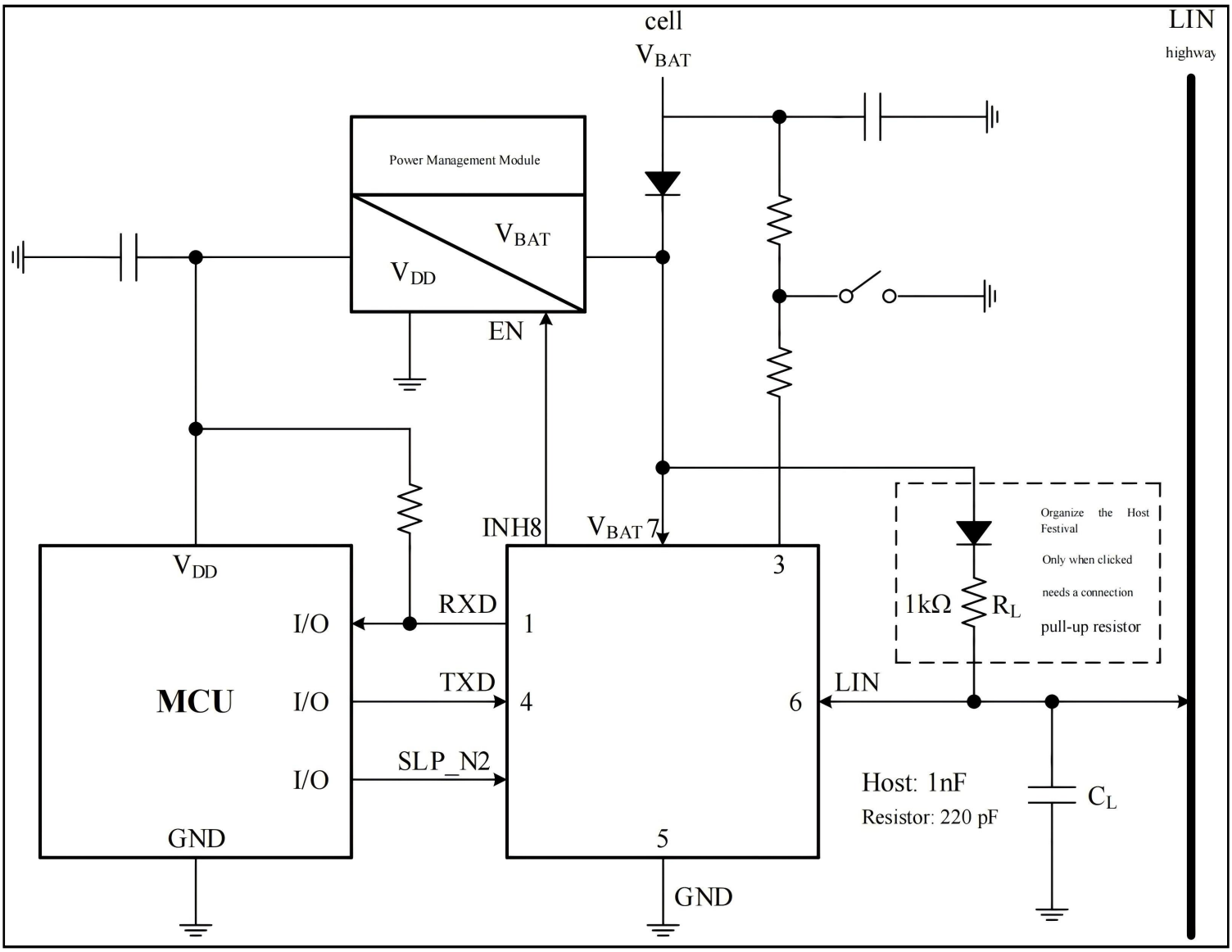


Figure 5 Schematic Diagram of Typical Applications for the TJA1020

Note: To achieve a gentler bus waveform slope, it is recommended to use the R_L/C_L combination of 660 Ω/6.8 nF.

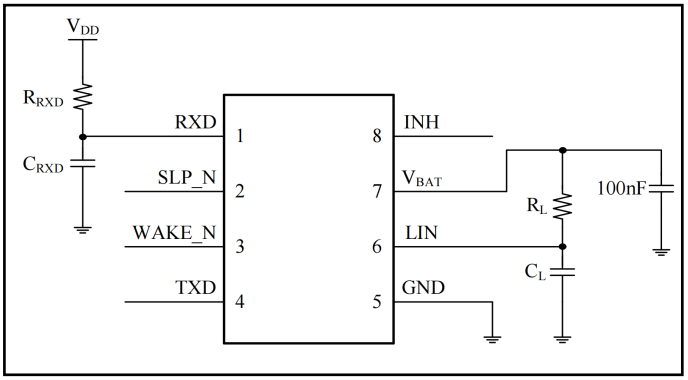
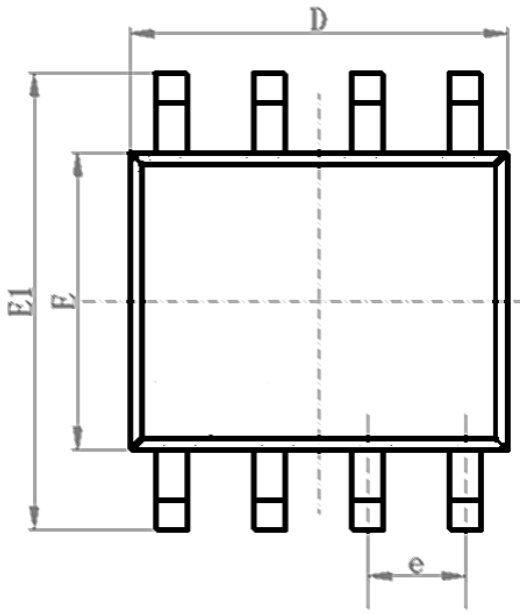
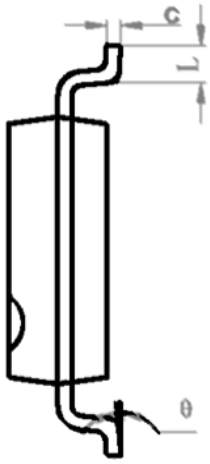


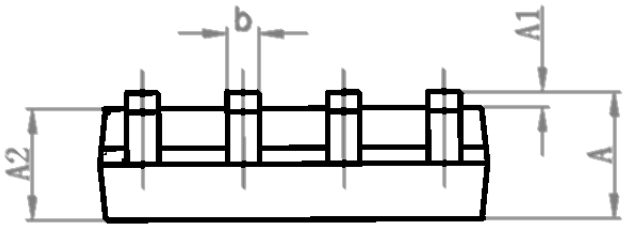
Figure 6: Switch Characteristic Testing Circuit

External Dimensions

SOP8







Symbol	Least value / mm	Representative value/ mm	Crest value / mm
A	1.50	1.60	1.70
A1	0.1	0.15	0.2
A2	1.35	1.45	1.55
b	0.355	0.400	0.455
D	4.800	4.900	5.00
E	3.780	3.880	3.980
E1	5.800	6.000	6.200
e		1.270BSC	
L	0.40	0.60	0.80
C	0.153	0.203	0.253
θ	-2°	-4°	-6

ORDERING INFORMATION

Order Number	Package	Package Quantity	Marking On The park	Temperature
TJA1020T/CM,118-TUDI	SOP8	Tape,Reel,4000	A1020/C	-40℃ to +125℃

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