

LIN Transceiver

BD41020FJ-C

•General Description

BD41020FJ-C is the best transceiver that can be used for BMS (Battery Management System). It has a Master/Slave protocol communication of LIN (Local Interconnect Network). BD41020FJ-C is available in small SOP Package. It has a normal slope mode, very low Electro Magnetic Emission (EME) and low standby electricity consumption that is realized by sleep mode.

•Key Specifications

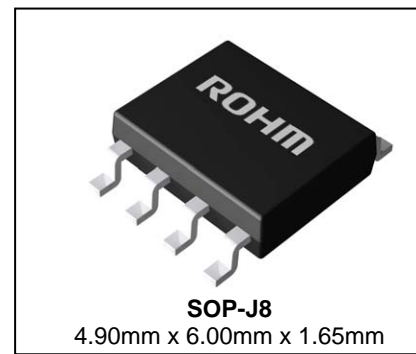
- Supply Voltage 5 to 27(V)
- Supply Current 1 on pin BAT 1 to 8(μA) (sleep mode)
- Supply Current 2 on pin BAT 100 to 1000(μA) (standby mode; recessive)
- Supply Current 3 on pin BAT 100 to 1000(μA) (normal slope mode; recessive)
- Supply Current 4 on pin BAT 1.0 to 8.0(mA) (normal slope mode; dominant)

•Features

- LIN pin absolute maximum rating: -27 to +40V
- Max transmission rate: 20kbps
- Low Electro Magnetic Emission (EME)
- High Electro Magnetic Immunity (EMI)
- Low slope mode for an even further reduction of EME
- High impedance at power off BMS
- Interface (RXD/TXD) with protocol layer corresponds to 3.3V/5.0V logic.
- Built in terminator for LIN slave
- Local/remote wake-up identification function
- Standby power consumption in sleep mode
- Transmit data (TXD) dominant time-out function
- Resistant to LIN-BAT/GND short
- Built in Thermal Shut Down (TSD)

•Package

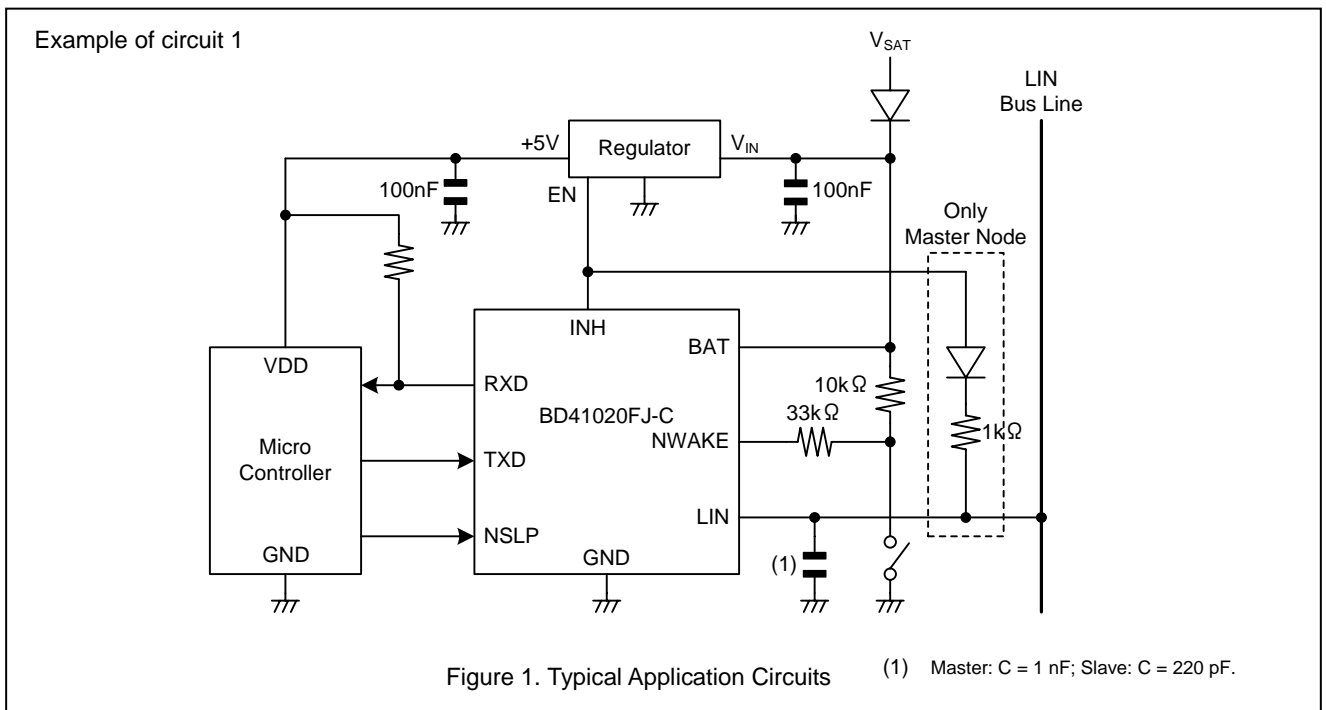
W (Typ.) x D (Typ.) x H (Max.)



•Applications

LIN communication for Automotive networks

•Typical Application Circuits



○Product structure : Silicon monolithic integrated circuit ○This product is not designed for protection against radioactive rays

●Pin Configuration

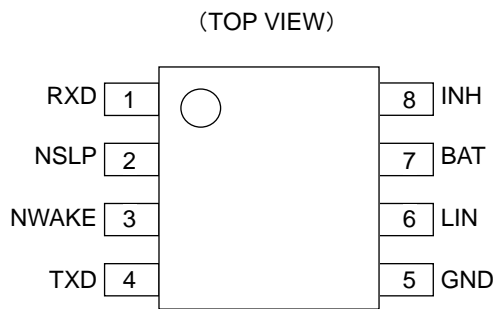


Figure 2. Pin Configuration

●Pin Description

Pin No.	Symbol	Function
1	RXD	Receive data output pin(Open Drain) "L" is output at standby mode.
2	NSLP	Sleep control input pin ("L" Active mode) Prohibits Output, request from local/remote wake-up flag at TXD pin, and resets wake-up from RXD pin.
3	NWAKE	Local wake-up input pin ("L" Active mode) Active at rising edge
4	TXD	Transmission data input pin ("L" Active mode) Shift sleep mode to standby mode by NWAKE, output is "L".
5	GND	Ground
6	LIN	LIN BMS input and output pin
7	BAT	Power supply pin
8	INH	"Hi-Z" at sleep mode and "H" in other mode.

●Block Diagram

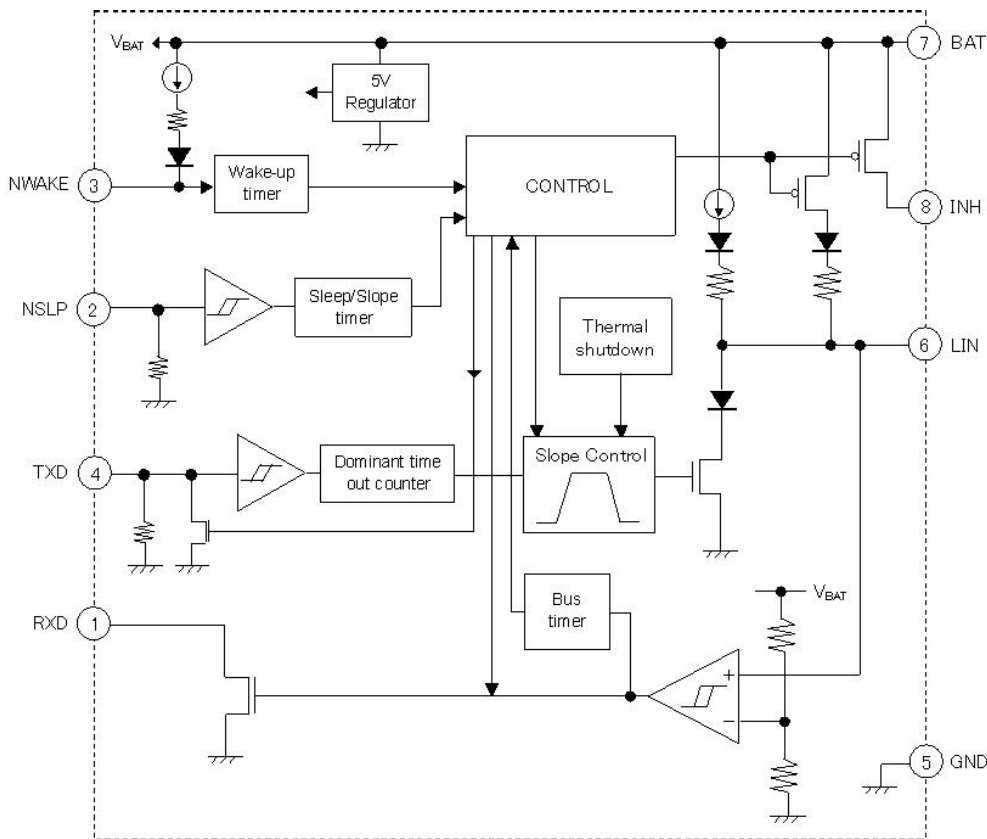


Figure 3. Block Diagram

•State transition

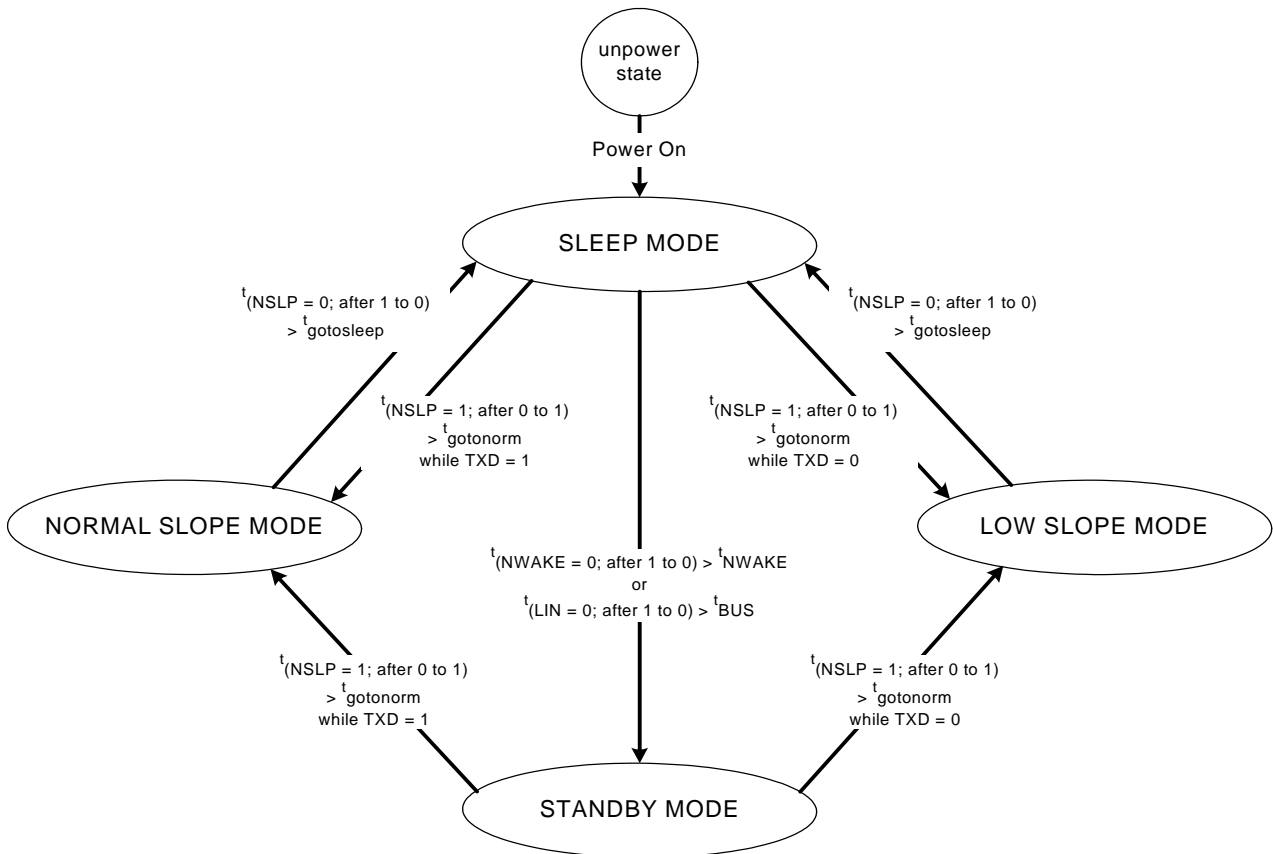


Figure 4. State transition chart

Terminal operation table according to state

STATE	NSLP	TXD	RXD	INH	TRANSMIT and RECEIVE FUNCTION
SLEEP	0	Weak pull-down	Floating	Floating	OFF
STANDBY	0	Remote wake up: Weak pull-down Local wake up: Strong pull-down	Low	HIGH	OFF
NORMAL SLOPE	1	Weak pull-down	HIGH: recessive state LOW: dominant state	HIGH	ON
LOW SLOPE	1	Weak pull-down	HIGH: recessive state LOW: dominant state	HIGH	ON

●Absolute Maximum Rating (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply voltage on pin BAT *1	V _{BAT}	-0.3 to +40.0	V
DC voltage on pins TXD, RXD, NSLP	V _{TXD} , V _{RXD} , V _{NSLP}	-0.3 to +7.0	V
DC voltage on pin LIN	V _{LIN}	-27 to +40	V
DC voltage on pin NWAKE	V _{NWAKE}	-1 to +40	V
Current on pin NWAKE	I _{NWAKE}	-15	mA
DC voltage on pin INH	V _{INH}	-0.3 to V _{BAT} + 0.3	V
Output current at pin INH	I _{INH}	-50 to +15	mA
Power dissipation *2	Pd	674	mW
Storage temperature range	T _{stg}	-55 to +150	°C
Junction temperature	T _{jmax}	+150	°C

*1 Pd, ASO should not be exceeded.

*2 Pd decreased at 5.39mW/°C for temperatures above Ta=25°C, mounted on 70x70x1.6mm Glass-epoxy PCB.

NOTE: This product is not designed for protection against radioactive rays.

●Recommended Operating Rating(s) (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V _{BAT}	5.0 to 27.0	V
Operating temperature range	T _{opr}	-40 to +125	°C

●Electrical Characteristics

(Ta= -40 to 125°C; V_{BAT}=5 to 27V; R_{L(LIN-BAT)}=500Ω; typical values are given at Ta=25°C; V_{BAT}=12V; unless otherwise specified)

Parameter	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
○ BAT						
Supply current 1 on pin BAT (Sleep mode)	I _{BAT1}	1	3	8	μA	Sleep mode. V _{LIN} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 0V V _{NSLP} = 0V
Supply current 2 on pin BAT (Standby mode,Recessive)	I _{BAT2}	100	400	1000	μA	Standby mode. (bus recessive) V _{LIN} = V _{BAT} V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 0V V _{NSLP} = 0V
Supply current 3 on pin BAT (Standby mode,Dominant)	I _{BAT3}	300	900	2000	μA	Standby mode. (bus dominant) V _{BAT} = 12V V _{LIN} = 0V V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 0V V _{NSLP} = 0V
Supply current 4 on pin BAT (Low slope mode, Recessive)	I _{BAT4}	100	400	1000	μA	Low slope mode. (bus recessive) V _{LIN} = V _{BAT} V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 5V V _{NSLP} = 5V
Supply current 5 on pin BAT (Normal slope mode, Recessive)	I _{BAT5}	100	400	1000	μA	Normal slope mode. (bus recessive) V _{LIN} = V _{BAT} V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 5V V _{NSLP} = 5V
Supply current 6 on pin BAT (Low slope mode, Dominant)	I _{BAT6}	1.0	3.5	8.0	mA	Low slope mode. (bus dominant) V _{BAT} = 12V V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 0V V _{NSLP} = 5V
Supply current 7 on pin BAT (Normal slope mode, Dominant)	I _{BAT7}	1.0	3.5	8.0	mA	Normal slope mode. (bus dominant) V _{BAT} = 12V V _{INH} = V _{BAT} V _{NWAKE} = V _{BAT} V _{TXD} = 0V V _{NSLP} = 5V
○ TXD						
HIGH-level input voltage	V _{IH}	2.0	-	7.0	V	
LOW-level input voltage	V _{IL}	-0.3	-	+0.8	V	
Hysteresis voltage	V _{hys}	0.03	-	0.50	V	
Pull-down resistor	R _{TXD}	125	350	800	kΩ	V _{TXD} = 5V
LOW-level input current	I _{IL}	-5.0	0.0	+5.0	μA	V _{TXD} = 0V
LOW-level output current	I _{OL}	1.5	3.0	-	mA	Standby mode. Local wake-up. V _{NWAKE} = 0V V _{LIN} = V _{BAT} V _{TXD} = 0.4V

●Electrical Characteristics

(Ta= -40 to 125°C; V_{BAT}=5 to 27V; R_{L(LIN-BAT)}=500Ω; typical values are given at Ta=25°C; V_{BAT}=12V; unless otherwise specified)

Parameter	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
○ NSLP						
HIGH-level input voltage	V _{IH}	2.0	-	7.0	V	
LOW-level input voltage	V _{IL}	-0.3	-	+0.8	V	
Hysteresis voltage	V _{hys}	0.03	-	0.50	V	
Pull-down resistor	R _{NSLP}	125	350	800	kΩ	V _{NSLP} = 5V
LOW-level input current	I _{IL}	-5.0	0.0	+5.0	μA	V _{NSLP} = 0V
○ RXD (open-drain)						
LOW-level output current	I _{OL}	1.3	3.5	-	mA	Normal slope mode. V _{LIN} = 0V V _{RXD} = 0.4V
HIGH-level leakage current	I _{OZH}	-5.0	0.0	+5.0	μA	Normal slope mode. V _{LIN} = V _{BAT} V _{RXD} = 5V
○ NWAKE						
HIGH-level input voltage	V _{IH}	V _{BAT} - 1.0	-	V _{BAT} + 0.3	V	
LOW-level input voltage	V _{IL}	-0.3	-	V _{BAT} - 3.3	V	
HIGH-level leakage current	I _{IH}	-5.0	0.0	+5.0	μA	V _{NWAKE} = 27V V _{BAT} = 27V
Pull-up current	I _{IL}	-30	-10	-3	μA	V _{NWAKE} = 0V
○ INH						
Switch-on resistance between pins BAT and INH	R _{INH}	-	30	50	Ω	Standby mode, low slope or normal slope mode. I _{INH} = -15mA, V _{BAT} = 12V
HIGH-level leakage current	I _{OZH}	-5.0	0.0	+5.0	μA	Sleep mode. V _{INH} = V _{BAT} = 27V
○ LIN						
LIN recessive output voltage	V _{O_rec}	V _{BAT} × 0.9	-	V _{BAT}	V	V _{TXD} = 5V, I _{LIN} = 0mA
LIN dominant output voltage	V _{O_dom1}	-	-	1.2	V	V _{TXD} = 0V, V _{BAT} = 7.3V
	V _{O_dom2}	0.6	-	-	V	V _{TXD} = 0V, V _{BAT} = 7.3V R _{L(LIN-BAT)} = 1kΩ
	V _{O_dom3}	-	-	2.0	V	V _{TXD} = 0V, V _{BAT} = 18V
	V _{O_dom4}	0.8	-	-	V	V _{TXD} = 0V, V _{BAT} = 18V R _{L(LIN-BAT)} = 1kΩ
HIGH-level leakage current	I _{IH}	-1.0	0.0	+1.0	μA	V _{LIN} = V _{BAT}
LIN pull-up current	I _{IL}	-10.0	-5.0	-2.0	μA	Sleep mode. V _{LIN} = V _{NSLP} = 0V
Slave termination resistance to pin BAT	R _{SLAVE}	20	30	47	kΩ	Standby mode, low slope or normal slope mode. V _{LIN} = 0V, V _{BAT} = 12V
Capacitance on pin LIN	C _{LIN}	-	-	250	pF	
Short-circuit output current	I _{O_SC0}	40	-	100	mA	V _{LIN} = V _{BAT} = 18V, V _{TXD} = 0V t < t _{dom}
	I _{O_SC1}	27	40	60	mA	V _{LIN} = V _{BAT} = 12V, V _{TXD} = 0V t < t _{dom}
	I _{O_SC2}	60	90	125	mA	V _{LIN} = V _{BAT} = 27V, V _{TXD} = 0V t < t _{dom}

●Electrical Characteristics

(Ta= -40 to 125°C; V_{BAT}=5 to 27V; R_{L(LIN-BAT)}=500Ω; typical values are given at Ta=25°C; V_{BAT}=12V; unless otherwise specified)

Parameter	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
Input leakage current at the Receiver include pull-up resistor	I _{BMS_PAS_dom}	-1	-	-	mA	V _{LIN} = 0V V _{BAT} = 12V V _{TXD} = 5V
Receiver recessive Input leakage current	I _{BMS_PAS_rec}	-	-	20	μA	V _{LIN} = 18V V _{BAT} = 8V V _{TXD} = 5V
Loss of ground leakage current	I _{BMS_NO_GND}	-1	-	1	mA	V _{BAT} = V _{GND} = 12V V _{LIN} = 0V to 18V
Loss of battery leakage current	I _{BMS_NO_BAT}	-	-	100	μA	V _{BAT} = 0V V _{LIN} = 18V
Receiver threshold voltage	V _{th_rx}	V _{BAT} × 0.4	-	V _{BAT} × 0.6	V	V _{BAT} = 7.3 to 27.0V
Receiver center voltage	V _{cn_rx}	V _{BAT} × 0.475	V _{BAT} × 0.500	V _{BAT} × 0.525	V	V _{BAT} = 7.3 to 27.0V
Receiver threshold hysteresis voltage	V _{th_hys}	V _{BAT} × 0.145	V _{BAT} × 0.160	V _{BAT} × 0.175	V	V _{BAT} = 7.3 to 27.0V
OAC characteristics						
TXD propagation delay failure	Δt _{d(TXD-BMS)1}	-2.0	0.0	+2.0	μs	Normal slope mode. C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω t _{PropTxDom} - t _{PropTxRec} Figure 6
	Δt _{d(TXD-BMS)2}	-5.0	0.0	+5.0	μs	Low slope mode. C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω t _{PropTxDom} - t _{PropTxRec} Figure 6
RXD propagation delay	t _{d_(BMS-RXD)}	-	-	5.5	μs	C _{RXD} = 20pF R _{RXD} = 2.4kΩ
RXD propagation delay failure	Δt _{d_(BMS-RXD)}	-2.0	0.0	+2.0	μs	Normal slope mode and low slope mode C _{L(LIN-BAT)} = 0nF R _{L(LIN-BAT)} = ∞ Voltage on LIN externally forced. LIN t _f , t _r < 500ns C _{RXD} = 20pF R _{RXD} = 2.4kΩ t _{PropRxDom} - t _{PropRxRec} Figure 6
Fall time LIN	t _{f_dom}	-	16	27	μs	Normal slope mode C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω V _{BAT} = 12V Transition from recessive to dominant. V _{LIN} : 100 to 0% *2 Figure 7
Rise time LIN	t _{r_rec}	-	16	27	μs	Normal slope mode C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω V _{BAT} = 12V Transition from dominant to recessive. V _{LIN} : 0 to 100% *3 Figure 7
Normal slope symmetry	Δt _{slope_norm1}	-5.0	0.0	+5.0	μs	Normal slope mode C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω V _{BAT} = 12V t _{f_dom} - t _{r_rec}

●Electrical Characteristics

(Ta= -40 to 125°C; V_{BAT}=5 to 27V; R_{L(LIN-BAT)}=500Ω; typical values are given at Ta=25°C; V_{BAT}=12V; unless otherwise specified)

Parameter	Symbol	Limit			Unit	Condition
		Min	Typ	Max		
Normal slope fall time LIN	t _{f_norm_dom}	-	12.0	22.5	μs	Normal slope mode C _{L(LIN-BAT)} = 6.8nF R _{L(LIN-BAT)} = 660Ω V _{BAT} = 12V Transition from recessive to dominant. V _{LIN} : 100 to 0% *2 Figure 7
Normal slope rise time LIN	t _{r_norm_rec}	-	12.0	22.5	μs	Normal slope mode C _{L(LIN-BAT)} = 6.8nF R _{L(LIN-BAT)} = 660Ω V _{BAT} = 12V Transition from dominant to recessive. V _{LIN} : 0 to 100% *3 Figure 7
Normal slope symmetry	Δt _{slope_norm2}	-4.0	0.0	+4.0	μs	Normal slope mode C _{L(LIN-BAT)} = 6.8nF R _{L(LIN-BAT)} = 660Ω V _{BAT} = 12V t _{f_norm_dom} - t _{r_norm_rec}
Low slope fall time LIN	t _{f_low_dom}	-	30	62	μs	Low slope mode C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω V _{BAT} = 12V Transition from recessive to dominant. V _{LIN} : 100 to 0% *2 Figure 7
Low slope rise time LIN	t _{r_low_rec}	-	30	62	μs	Low slope mode C _{L(LIN-BAT)} = 10nF R _{L(LIN-BAT)} = 500Ω V _{BAT} = 12V Transition from dominant to recessive. V _{LIN} : 0 to 100% *3 Figure 7
Duty cycle 1	D1	0.396	-	-		Normal slope mode TH _{Rec(max)} = 0.744 x V _{BAT} TH _{Dom(max)} = 0.581 x V _{BAT} V _{BAT} =7.0 to 18.0V t _{Bit} =50μs *4 *5 Figure 8
Duty cycle 2	D2	-	-	0.581		Normal slope mode TH _{Rec(min)} = 0.422 x V _{BAT} TH _{Dom(min)} = 0.284 x V _{BAT} V _{BAT} =7.6 to 18.0V t _{Bit} =50μs *4 *6 Figure 8
Duty cycle 3	D3	0.417	-	-		TH _{Rec(max)} = 0.778 x V _{BAT} TH _{Dom(max)} = 0.616 x V _{BAT} V _{BAT} =7.0 to 18.0V t _{Bit} =96μs *4 *5 Figure 8
Duty cycle 4	D4	-	-	0.590		TH _{Rec(min)} = 0.389 x V _{BAT} TH _{Dom(min)} = 0.251 x V _{BAT} V _{BAT} =7.6 to 18.0V t _{Bit} =96μs *4 *6 Figure 8
Dominant time for wake-up via bus	t _{BMS}	30	70	150	μs	Sleep mode (Remote wake-up) Figure 8
Dominant time for wake-up via pin NWAKE	t _{NWAKE}	7	20	50	μs	Sleep mode (Local wake-up) Figure 4
Time period for mode change from sleep or standby mode into normal/low slope mode.	t _{gotonorm}	2	5	10	μs	Shift from sleep/standby mode to normal/low slope mode Figure 5
Time period for mode change from normal/low slope mode into sleep mode.	t _{gotosleep}	2	5	10	μs	Shift from normal/low slope mode to sleep mode Figure 6
TXD dominant time out	t _{dom}	6	12	20	ms	V _{TXD} = 0V

*1 When V_{BAT} is more than 12V, add to the circuit current the value calculated by this expression because I_{BAT} depends on pull-up resistor inside LIN Terminal.

$$I_{\text{BAT (increase)}} = \frac{V_{\text{BAT}} - 12\text{V}}{20\text{k}\Omega} \quad (20\text{k}\Omega \text{ is the minimum value of pull-up resistor inside LIN terminal})$$

$$*2 \quad t_{\text{t_dom}} = \frac{(t_{\text{VLIN}=40\%}) - (t_{\text{VLIN}=95\%})}{0.55}$$

$$*3 \quad t_{\text{t_rec}} = \frac{(t_{\text{VLIN}=60\%}) - (t_{\text{VLIN}=5\%})}{0.55}$$

*4 Load condition at BMS (CBMS; RBMS): 1nF; 1kΩ / 6.8nF; 660Ω / 10nF; 500Ω

$$*5 \quad D1, D3 = \frac{t_{\text{B}\mu\text{s_rec (min)}}}{2 \times t_{\text{Bit}}}$$

$$*6 \quad D2, D4 = \frac{t_{\text{B}\mu\text{s_rec (max)}}}{2 \times t_{\text{Bit}}}$$

•Timing Chart

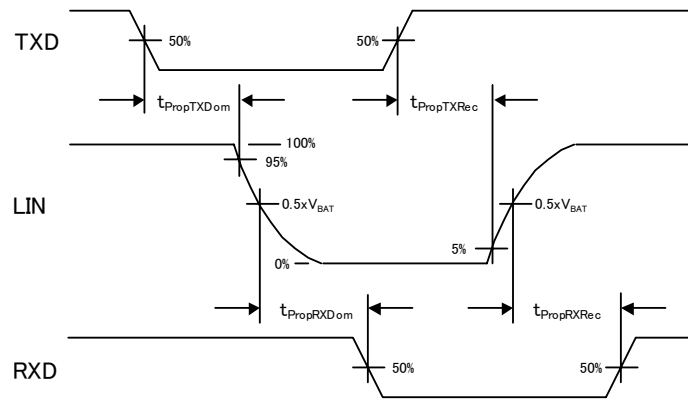


Figure 5. AC characteristics Timing Chart

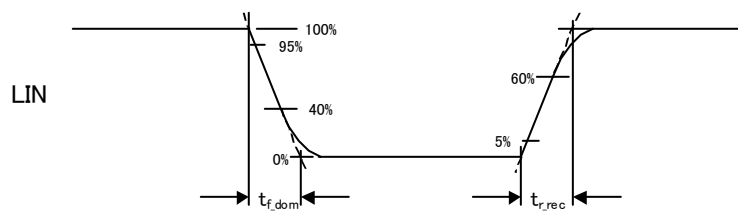


Figure 6. Slope Timing Chart

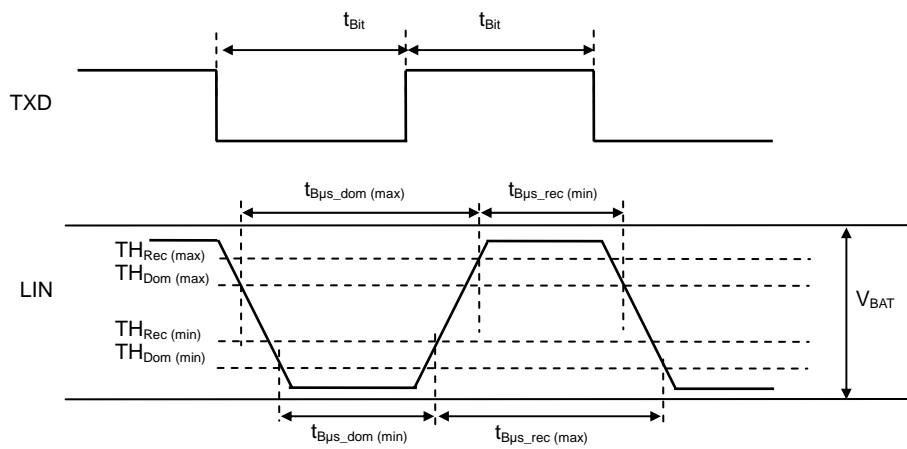


Figure 7. BMS Timing Chart

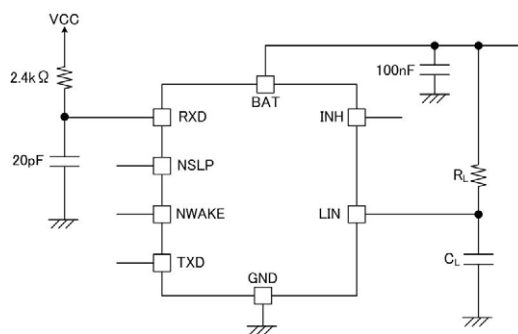


Figure 8. Rating Circuit of AC Characteristics

Sleep mode

This mode is the most power saving mode that stops the transmit/receive function.

The following conditions will enter the sleep mode:

- After start-up of power supply (V_{BAT})
- Normal/Low slope mode switches when pin NSLP= "L".

In this mode, one of the next wake-up event switches a state.

- Pin NWAKE "H"→"L" (Shift to Standby mode)
- Pin LIN "H"→"L"→"H" (Shift to Standby mode)
- Pin NSLP "L"→"H" (Shift to Normal slope mode at TXD="H", Shift to Low slope mode at TXD="L")

All wake-up events must be maintained for a certain time period (t_{NWAKE} , t_{BUS} , $t_{gotonorm}$)

Standby mode

Sleep mode will shift to standby mode if wake-up events occur at NWAKE terminal or LIN terminal.

While the device is in standby mode, each PIN has the following conditions:

- INH PIN is "H" ($\cong V_{BAT}$ voltage)
- RXD PIN is at "L" level (It indicates to microcontroller that the state is in standby mode.)
- TXD PIN is weak/strong pull-down (It indicates to microcontroller the remote wake-up or local wake-up)
- Pin LIN Slave Resistance is ON

If the state is in Standby mode, a shift to slope mode will happen when NSLP INPUT is changed to "H". At the time that TXD="H", the mode will shift to Normal slope mode, but If TXD="L", it will shift to Low slope mode.

Normal slope mode

The IC goes to Normal slope mode when NSLP changes to "H" at Sleep/Standby mode and TXD="H". In this mode, the transceiver is able to transmit and receive data via the LIN bus line. The receiver detects the data stream at the LIN bus input pin and transfers it via pin RXD to the microcontroller. The transmit data stream of the protocol controller at the TXD input is converted by the transmitter into a bus signal with optimized slew rate.

The maximum operating frequency at normal slope mode is 10(kHz). BD41020FJ-C switches to sleep mode in case a LOW logiclevel on pin NSLP is maintained within a fixed time ($t_{gotosleep}$).

Low slope mode

The IC goes to Low slope mode when NSLP changes to "H" at Sleep/Standby mode and TXD="L". The difference between Low slope mode and Normal slope mode is in the rate of transmission at LIN output. This mode conducts LIN bus signal converted from TXD input signal to bus line when start and stop later than Normal slope mode.

The maximum operating frequency at low slope mode is 5.2(kHz). BD41020FJ-C shifts to sleep mode when input on pin NSLP is changed to "L" and maintained within a fixed time ($t_{gotosleep}$).

TXD dominant time-out counter function

A TXD dominant time-out counter prevents the bus line from being driven to a permanent dominant state (blocking all network communication) if pin TXD is forced permanently LOW by a hardware and/or software application failure. The timer is triggered by a negative edge on pin TXD. If the duration of the LOW-level on pin TXD exceeds the internal timer value (t_{dom}), the transmitter is disabled, driving the bus line into a recessive state. The timer is reset by a positive edge on pin TXD.

Fail-safe function

- Pin TXD provides a pull-down to GND in order to force a predefined level on input pin TXD in case the pin TXD is unsupplied.
- Pin NSLP provides a pull-down to GND in order to force the transceiver into sleep mode in case the pin NSLP is unsupplied.
- Pin RXD is set floating in case of lost power supply on pin V_{BAT}.
- The output driver at pin LIN will be off when junction temperature exceeds T_J activating the TSD circuit without relation to input signal at pin TXD. However, when junction temperature drops below T_J, the output driver at pin LIN will depend again on the input signal at pin TXD.

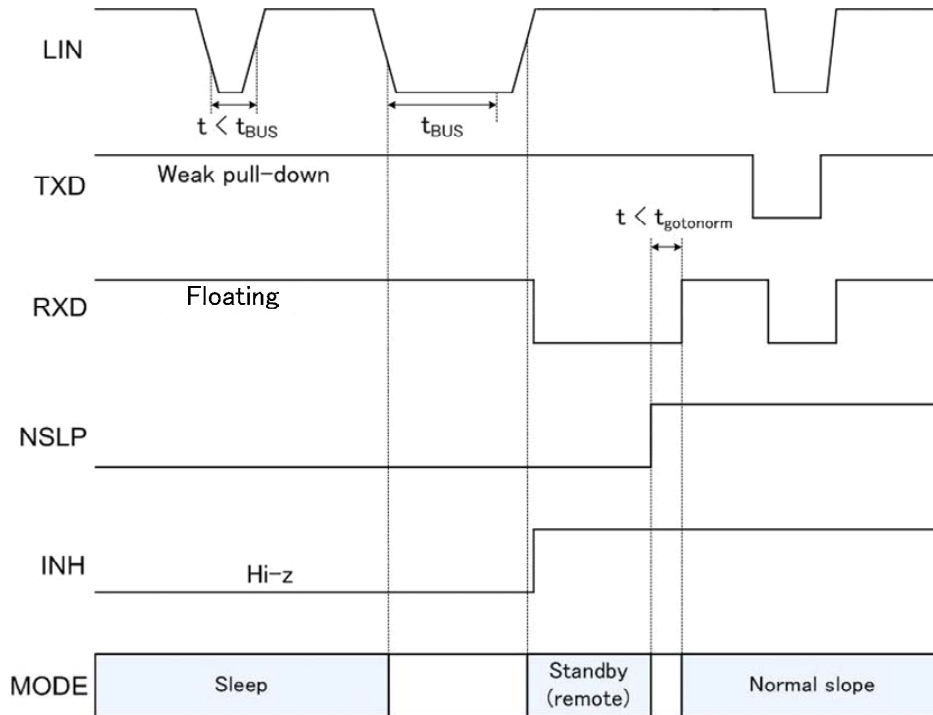


Figure 9. Timing Chart (at remote wake-up)

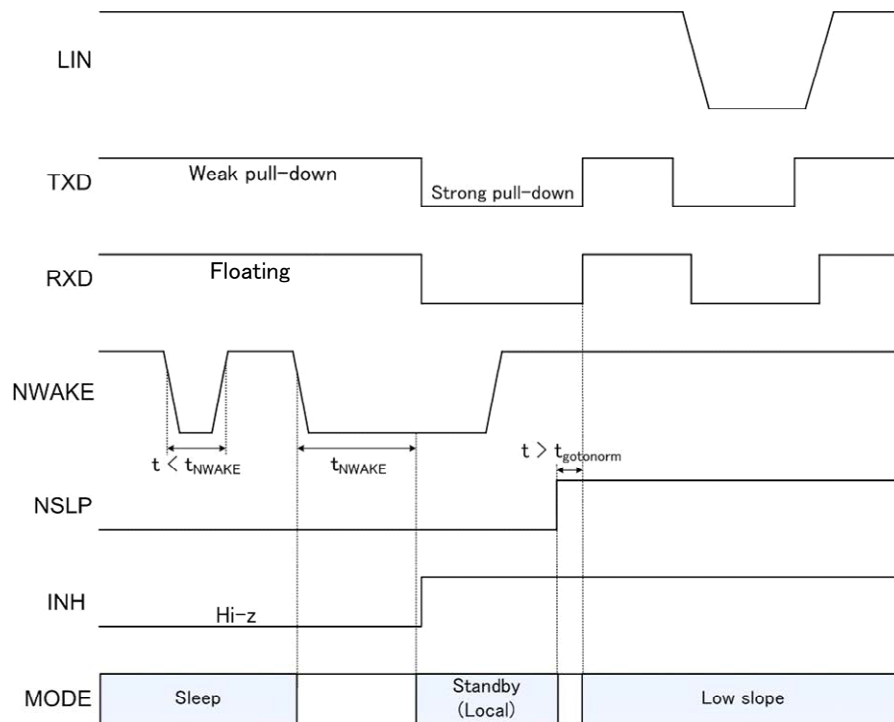


Figure 10. Timing Chart (At local wake-up)

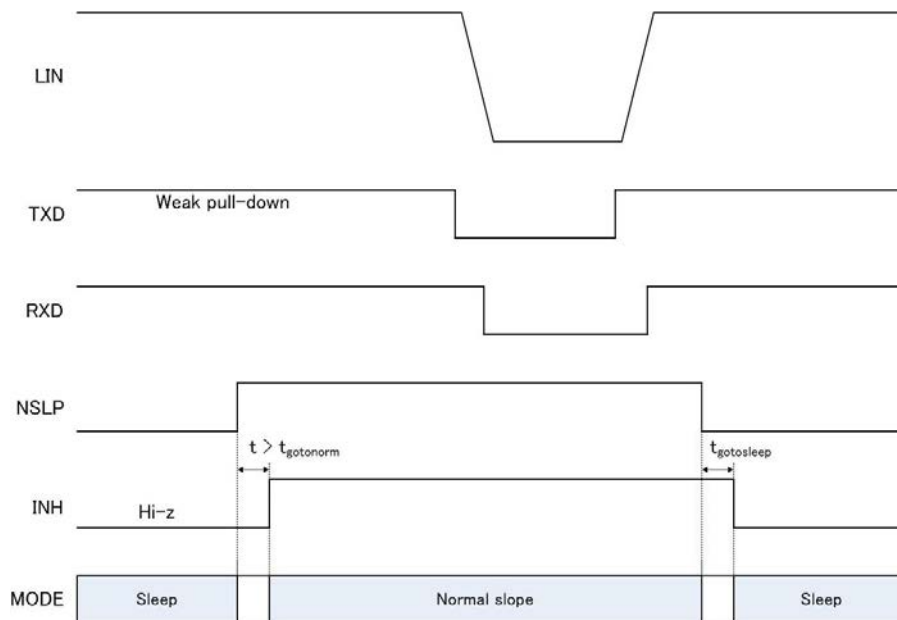
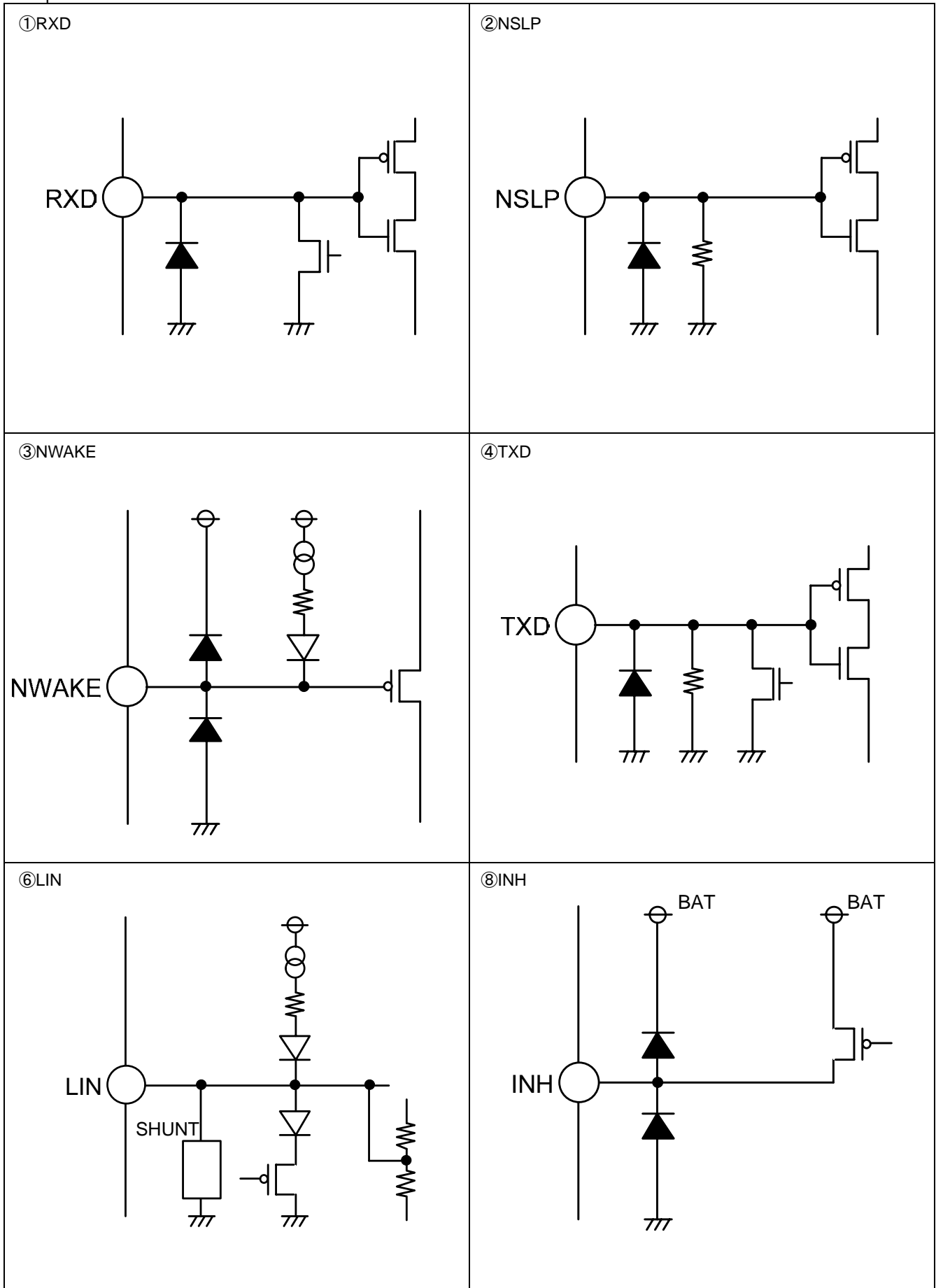


Figure 11. Timing Chart (At shift to Normal slope mode)

•I/O equivalent circuit



•Operational Notes

1) Absolute maximum ratings

Operating the IC over the absolute maximum ratings may damage the IC. In addition, it is impossible to predict all destructive situations such as short-circuit modes or open circuit modes. Therefore, it is important to consider circuit protection measures, like adding a fuse, in case the IC is expected to be operated in a special mode exceeding the absolute maximum ratings

2) Thermal consideration

Use a thermal design that allows for a sufficient margin by taking into account the permissible power dissipation (Pd) in actual operating conditions. Consider Pc that does not exceed Pd in actual operating conditions (Pc≥Pd).

Package Power dissipation : Pd (W)=(Tjmax – Ta)/ θ ja

Power dissipation : Pc (W)=(Vcc – Vo) × Io + Vcc × Ib

Tjmax : Maximum junction temperature=150°C, Ta : Peripheral temperature(°C) ,

θ ja : Thermal resistance of package-ambience(°C/W), Pd : Package Power dissipation (W),

Pc : Power dissipation (W), Vcc : Input Voltage, Vo : Output Voltage, Io : Load, Ib : Bias Current

3) Operation under strong electromagnetic field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

4) Thermal shutdown circuit(TSD)

The IC incorporates a built-in thermal shutdown circuit, which is designed to turn off the IC when the internal temperature of the IC reaches a specified value. It is not designed to protect the IC from damage or guarantee its operation. Do not continue to operate the IC after this function is activated. Do not use the IC in conditions where this function will always be activated.

5) GND voltage

The voltage of the ground pin must be the lowest voltage of all pins of the IC at all operating conditions. Ensure that no pins are at a voltage below the ground pin at any time, even during transient condition.

6) Short between pins and mounting errors

Be careful when mounting the IC on printed circuit boards. The IC may be damaged if it is mounted in a wrong orientation or if pins are shorted together. Short circuit may be caused by conductive particles caught between the pins.

7) GND wiring pattern

When using both small-signal and large-current GND traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the GND traces of external components do not cause variations on the GND voltage. The power supply and ground lines must be as short and thick as possible to reduce line impedance.

8) Regarding input pins of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.

When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

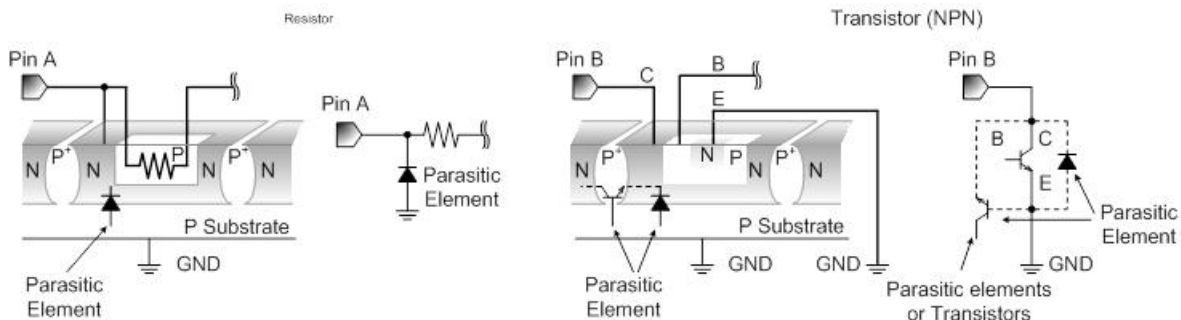
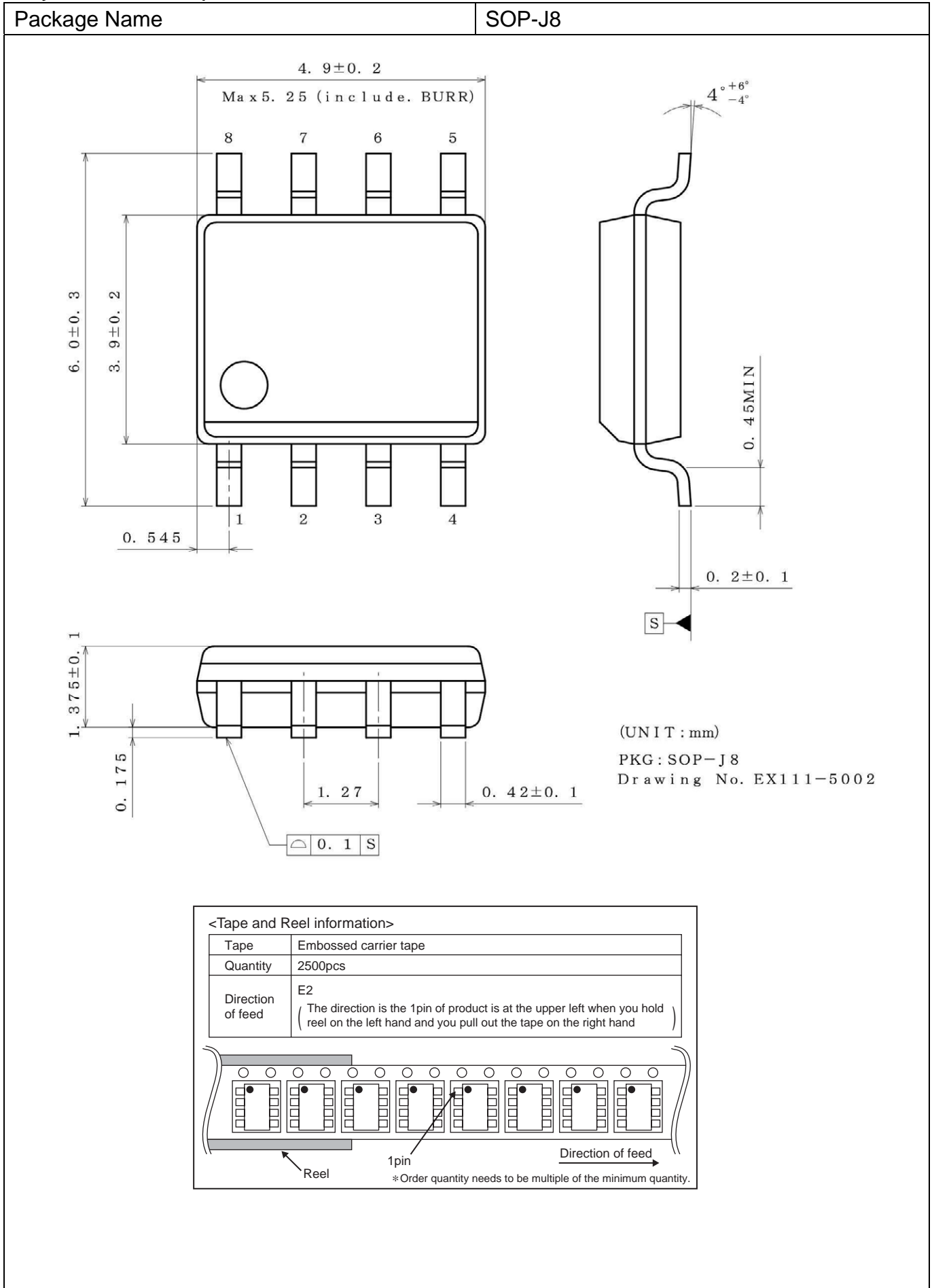
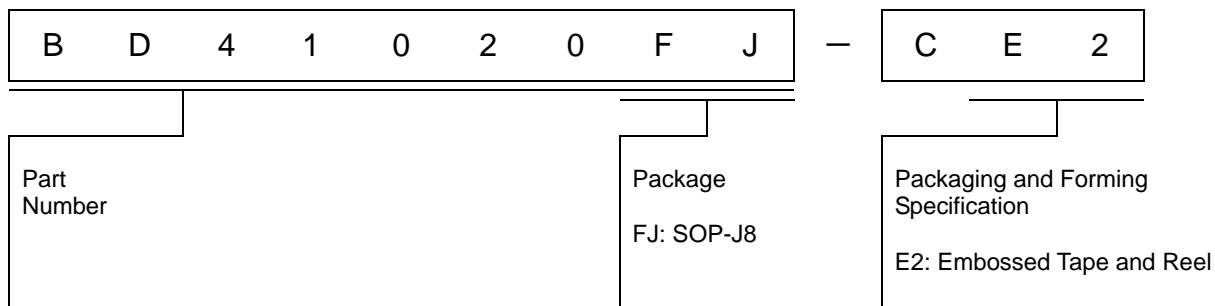


Figure 12 . Example of IC's basic structure

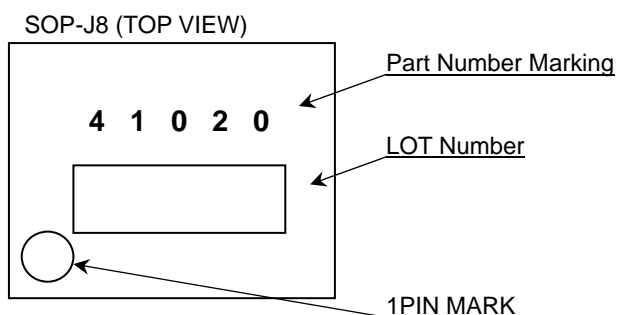
●Physical Dimension, Tape and Reel Information – continued



•Ordering Information



•Marking Diagram



•Revision History

Date	Revision	Changes
2013.02.12	002	New Release
2013.03.25	003	P.4 Item Name change "Operating Condition"→"Recommended Operating Rating(s)" P.16 Physical Dimension, Tape and Reel Information Format change

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1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment ^(Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property (“Specific Applications”), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM’s Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

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 - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
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 - [h] Use of the Products in places subject to dew condensation
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7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
8. Confirm that operation temperature is within the specified range described in the product specification.
9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

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2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

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 - [b] the temperature or humidity exceeds those recommended by ROHM
 - [c] the Products are exposed to direct sunshine or condensation
 - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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