

## FEATURES

- 3V~5.5V power supply, half-duplex
- ESD protection for bus terminals:  
contact discharge  $\pm 16\text{kV}$
- Bus fault tolerance and withstand voltage reach  $\pm 15\text{V}$
- 1/8-unit-load, allows up to 256 transceivers on the bus
- Driver short-circuit out protection
- Overtemperature protection function
- Low power shutdown function
- Receiver open-circuit failure protection
- Strong anti-noise ability
- Integrated transient voltage suppression function
- Data transmission up to 10Mbps in an electric noise environment

## PRODUCT APPEARANCE



Provide Green and Environmentally  
Friendly Lead-free package

## DESCRIPTION

KRN3088E is a 3.0V~5.5V power supply, the contact discharge voltage of A/B is  $\pm 16\text{kV}$ , the fault protected voltage is  $\pm 15\text{V}$ , half-duplex, low power, RS485 Transceiver. KRN3088E fully meets the TIA/EIA-485 standard.

KRN3088E includes a driver and a receiver, both of which can be enabled and disabled independently. When both are disabled, the driver and receiver outputs are high resistance state. KRN3088E has a 1/8-unit-load receiver input impedance, that allows up to 256 transceivers on the bus. The KRN3088E allowing error-free data transmission up to 10Mbps.

KRN3088E has a working voltage range of 3.0V to 5.5V and has the functions of fail-safe, overtemperature protection, current-limiting protection and overvoltage protection.

## PIN CONFIGURATION

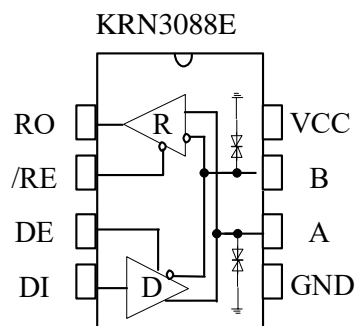


Fig 1 pin configuration

## PIN DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1	RO	Receiver output. When /RE is low, if $A-B \geq 200$ mV, then RO=high. If $A-B \leq -200$ mV, then RO=low.
2	/RE	Receiver output enable. Drive /RE low to enable RO; RO is high impedance when /RE is high. Drive /RE high and DE low to enter low-power shutdown mode.
3	DE	Driver output enable. Drive DE high to enable driver outputs. These outputs are high impedance when DE is low. Drive /RE high and DE low to enter low-power shutdown mode.
4	DI	Driver input. With DE high, a low on DI forces non-inverting output low and inverting output high. Similarly, a high on DI forces non-inverting output high and inverting output low.
5	GND	Ground.
6	A	Non-inverting receiver input and non-inverting driver output.
7	B	Inverting receiver input and inverting driver output.
8	VCC	Power supply.

## LIMITING VALUES

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	VCC	+7	V
CTR Port	/RE, DE, DI	-0.3~VCC+0.5	V
Driver Output Voltage	A, B	-15~15	V
Receiver Output Voltage	RO	-0.3~VCC+0.5	V
Operating Temperature Range	T <sub>A</sub>	-40~85	°C
Storage Temperature Range	T <sub>stg</sub>	-60~150	°C
Lead Temperature		300	°C
Continuous Power Dissipation	SOP8	470	mW
	MSOP8	830	mW
	DIP8	700	mW

The maximum limit parameters mean that exceeding these values may cause irreversible damage to the device. Under these conditions, it is not conducive to the normal operation of the device. The continuous operation of the device at the maximum allowable rating may affect the reliability of the device. The reference point for all voltages is ground.

## DRIVER DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Differential driver output (no load)	$V_{OD1}$		3.0		5.5	V
Differential driver output	$V_{OD2}$	<a href="#">Fig 2</a> , $R_L=54\Omega$ , $V_{CC}=3.3\text{V}$		2	$V_{CC}$	V
		<a href="#">Fig 2</a> , $R_L=54\Omega$ , $V_{CC}=5.0\text{V}$		3.5	$V_{CC}$	
Change in magnitude of differential output voltage (NOTE1)	$\Delta V_{OD}$	<a href="#">Fig 2</a> , $R_L=54\Omega$			0.2	V
Driver common-mode Output Voltage	$V_{OC}$	<a href="#">Fig 2</a> , $R_L=54\Omega$			3	V
Change in magnitude of common-mode voltage (NOTE1)	$\Delta V_{OC}$	<a href="#">Fig 2</a> , $R_L=54\Omega$			0.2	V
High-level input voltage	$V_{IH}$	DE, DI, /RE	2.0			V
Low-level input voltage	$V_{IL}$	DE, DI, /RE			0.8	V
Logic input current	$I_{IN1}$	DE, DI, /RE	-2		2	$\mu\text{A}$
Short-circuit output current, short to HIGH	$I_{OSD1}$	Short to $0\text{V}\sim 12\text{V}$			250	mA
Short-circuit output current, short to LOW	$I_{OSD2}$	Short to $-7\text{V}\sim 0\text{V}$	-250			mA
Thermal-shutdown threshold temperature				140		$^{\circ}\text{C}$
Thermal-shutdown hysteresis temperature				20		$^{\circ}\text{C}$

(Unless otherwise stated,  $\text{Temp}=T_{\text{MIN}}\sim T_{\text{MAX}}$ ,  $\text{Temp}=25^{\circ}\text{C}$ ,  $V_{CC}=5\text{V}$ ).

NOTE1:  $\Delta V_{OD}$  and  $\Delta V_{OC}$  are the changes in  $V_{OD}$  and  $V_{OC}$ , respectively, when the DI input changes state.

## RECEIVER DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Current(A, B)	$I_{IN2}$	DE=0V, VCC=0 or 3.3/5V, V <sub>IN</sub> =12V			125	$\mu\text{A}$
		DE=0V, VCC=0 or 3.3/5V, V <sub>IN</sub> =-7V	-100			$\mu\text{A}$
Positive-going input threshold voltage	V <sub>IT+</sub>	-7V $\leq$ V <sub>CM</sub> $\leq$ 12V			+200	mV
Negative-going input threshold voltage	V <sub>IT-</sub>	-7V $\leq$ V <sub>CM</sub> $\leq$ 12V	-200			mV
Receiver input hysteresis voltage	V <sub>hys</sub>	-7V $\leq$ V <sub>CM</sub> $\leq$ 12V	10	30		mV
HIGH-level output voltage	V <sub>OH</sub>	I <sub>OUT</sub> =-4mA, V <sub>ID</sub> =+200mV	VCC-1.5			V
LOW-level output voltage	V <sub>OL</sub>	I <sub>OUT</sub> =+4mA, V <sub>ID</sub> =-200mV			0.4	V
Three-state input leakage current	I <sub>OZR</sub>	0.4V<V <sub>O</sub> <2.4V			$\pm 1$	$\mu\text{A}$
Receiver input resistance	R <sub>IN</sub>	-7V $\leq$ V <sub>CM</sub> $\leq$ 12V	96			k $\Omega$
Receiver output short-circuit current	I <sub>OSR</sub>	0 V $\leq$ V <sub>O</sub> $\leq$ VCC	$\pm 8$		$\pm 60$	mA

(Unless otherwise stated, Temp=T<sub>MIN</sub>~T<sub>MAX</sub>, Temp=25°C).

## SUPPLY CURRENT

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Supply Current	I <sub>CC1</sub>	/RE=DE=0V, VCC=3.3V		430	650	$\mu\text{A}$	
		/RE=DE=0V, VCC=5V		470	750	$\mu\text{A}$	
	I <sub>CC2</sub>	/RE=DE=VCC, VCC=3.3V			450	650	$\mu\text{A}$
		/RE=DE=VCC, VCC=5V			510	750	$\mu\text{A}$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Shutdown current	$I_{SHDN}$	/RE=VCC, DE=0V, VCC=3.3V		0.4	10	$\mu A$
		/RE=VCC, DE=0V, VCC=5V		0.1	10	$\mu A$

## DRIVER SWITCHING CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Differential Output Delay	$t_{DD}$	$R_L=60\Omega$ , $C_L=100pF$ , <a href="#">Fig 3</a> & <a href="#">Fig 4</a>		12	32	ns
Driver Differential Output Transition Time	$t_{TD}$				15	28
Driver Propagation Delay, Low-to-High Level	$t_{DZH}$	$R_L=27\Omega$ <a href="#">Fig 3</a> & <a href="#">Fig 4</a>	18		40	ns
Driver Propagation Delay, High-to-Low Level	$t_{DZL}$		18		40	ns
$ t_{PLH} - t_{PHL} $ Driver Propagation-Delay Skew (Note 2)	$t_{PDS}$				2	2.5
Driver-Output Enable Time to High Level	$t_{PZH}$	$R_L=110\Omega$ , <a href="#">Fig 5</a> & <a href="#">Fig 6</a>			55	ns
Driver-Output Enable Time to Low Level	$t_{PZL}$				55	ns
Driver-Output Disable Time from Low Level	$t_{PLZ}$	$R_L=110\Omega$ , <a href="#">Fig 5</a> & <a href="#">Fig 6</a>			85	ns
Driver-Output Disable Time from High Level	$t_{PHZ}$				85	ns
Driver-Output Enable Time from Shutdown to Low Level	$t_{DSH}$	$R_L=110\Omega$ , <a href="#">Fig 5</a> & <a href="#">Fig 6</a>		400	1000	ns

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver-Output Enable Time from Shutdown to High Level	$t_{DSL}$	$R_L=110\Omega$ , <a href="#">Fig 5</a> & <a href="#">Fig 6</a>		400	1000	ns

## RECEIVER SWITCHING CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay (low to high)	$t_{RPLH}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		70		ns
Receiver Propagation Delay (high to low)	$t_{RPHL}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		70		ns
$ t_{RPLH} - t_{RPHL} $	$t_{RPDS}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		5		ns
Receiver Enable to Output Low	$t_{RPZL}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		15		ns
Receiver Enable to Output High	$t_{RPZH}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		15		ns
Receiver Disable Time from Low	$t_{RPLZ}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		25	55	ns
Receiver Disable Time from High	$t_{RPHZ}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		25	55	ns
Receiver Enable from shutdown to Output High	$t_{RPSH}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		250	1500	ns
Receiver Enable from Shutdown to Output Low	$t_{RPSL}$	$C_L=15pF$ <a href="#">Fig 7</a> & <a href="#">Fig 8</a>		250	1500	ns
Time to Shutdown	$t_{SHDN}$	NOTE2	80		300	ns

NOTE2: The device is put into shutdown by bringing RE high and DE low. If the enable inputs are in this state for less than 50ns, the device is guaranteed not to enter shutdown. If the enable inputs are in this state for at least 600ns, the device is guaranteed to have entered shutdown.

**FUNCTION TABLES**

**TRANSMITTING**

CTR		INPUTS	OUTPUTS	
/RE	DE	DI	A	B
X	1	1	H	L
X	1	0	L	H
0	0	X	Z	Z
1	0	X	Z(shutdown)	

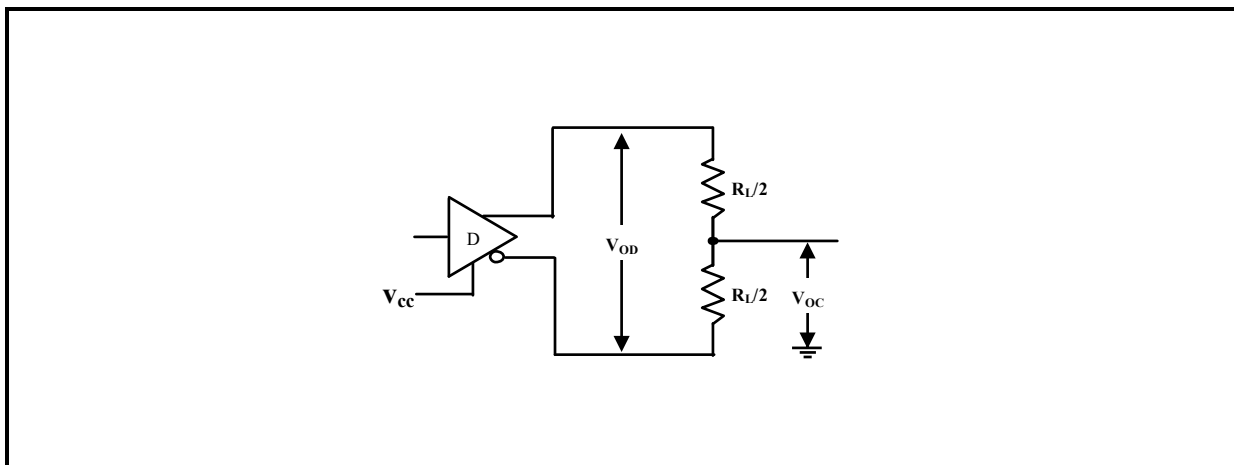
X: Don't care; Z: high impedance.

**RECEIVING**

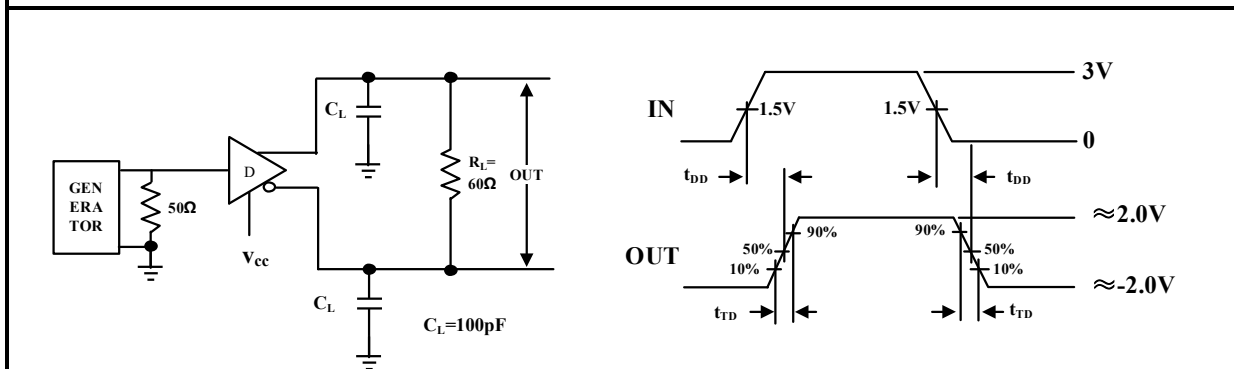
CTR		INPUTS	OUTPUTS
/RE	DE	A-B	RO
0	X	≥200mV	H
0	X	≤-200mV	L
0	X	Open/shorted	H
1	X	X	Z

X: Don't care; Z: high impedance.

**TEST CIRCUIT**



**Fig 2 Driver DC Test Load**



CL includes probe and stray capacitance, Same as below.

**Fig 3 Driver Differential Output Delay and Transition Times**

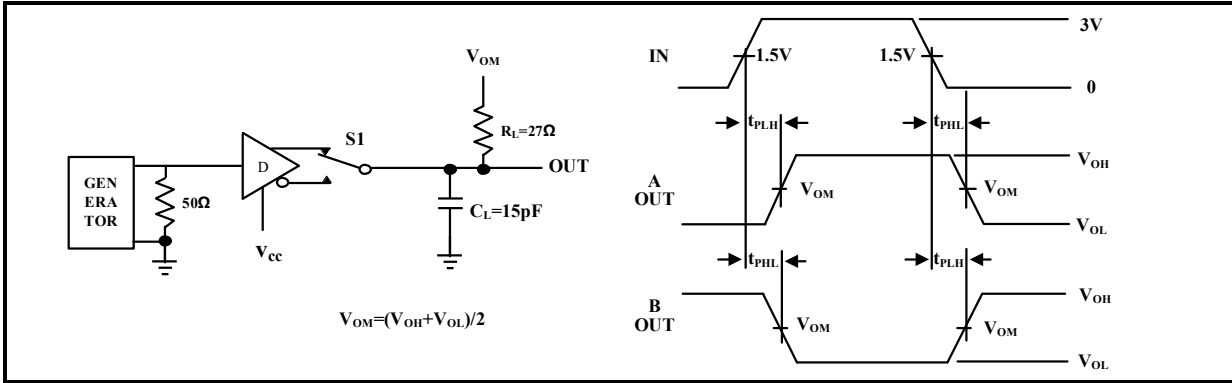


Fig 4 Driver Propagation Times

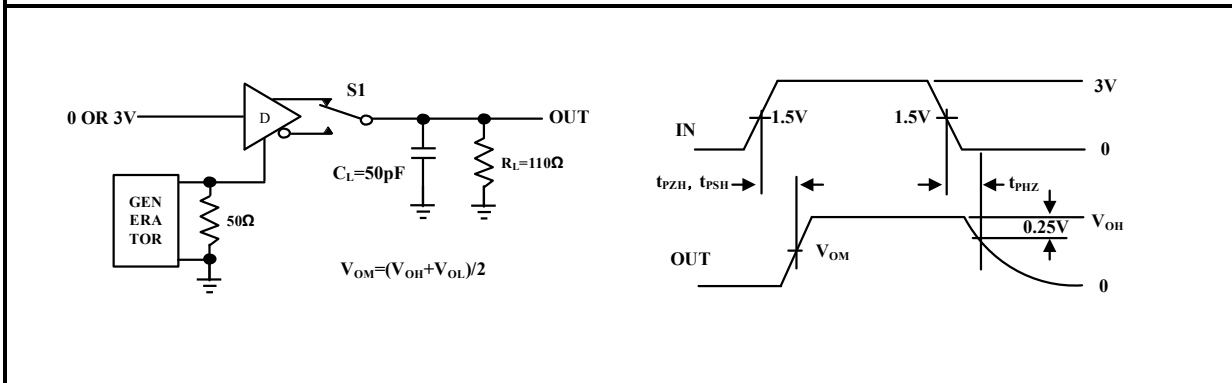


Fig 5 Driver Enable and Disable Times

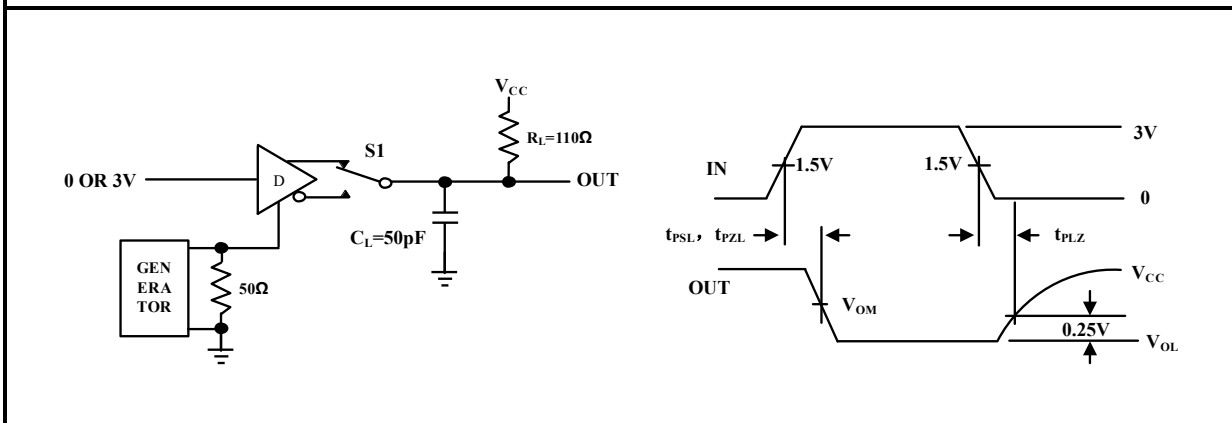


Fig 6 Driver Enable and Disable Times

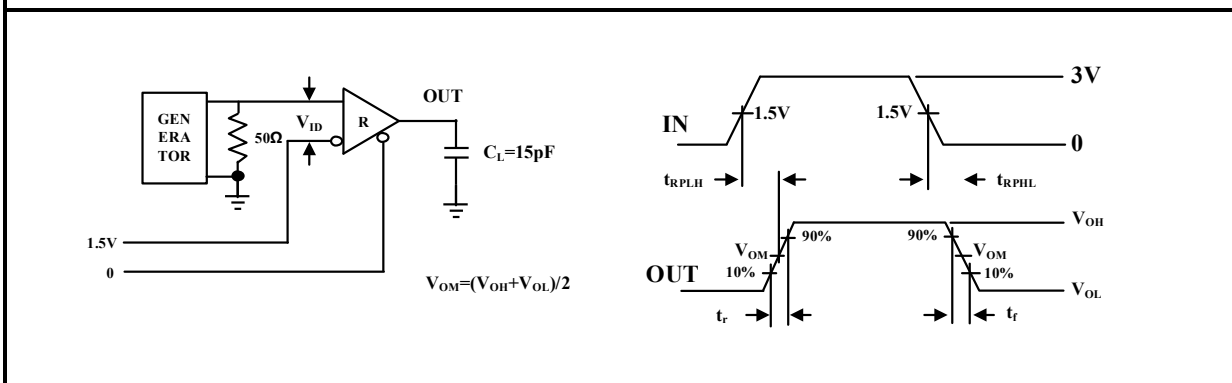
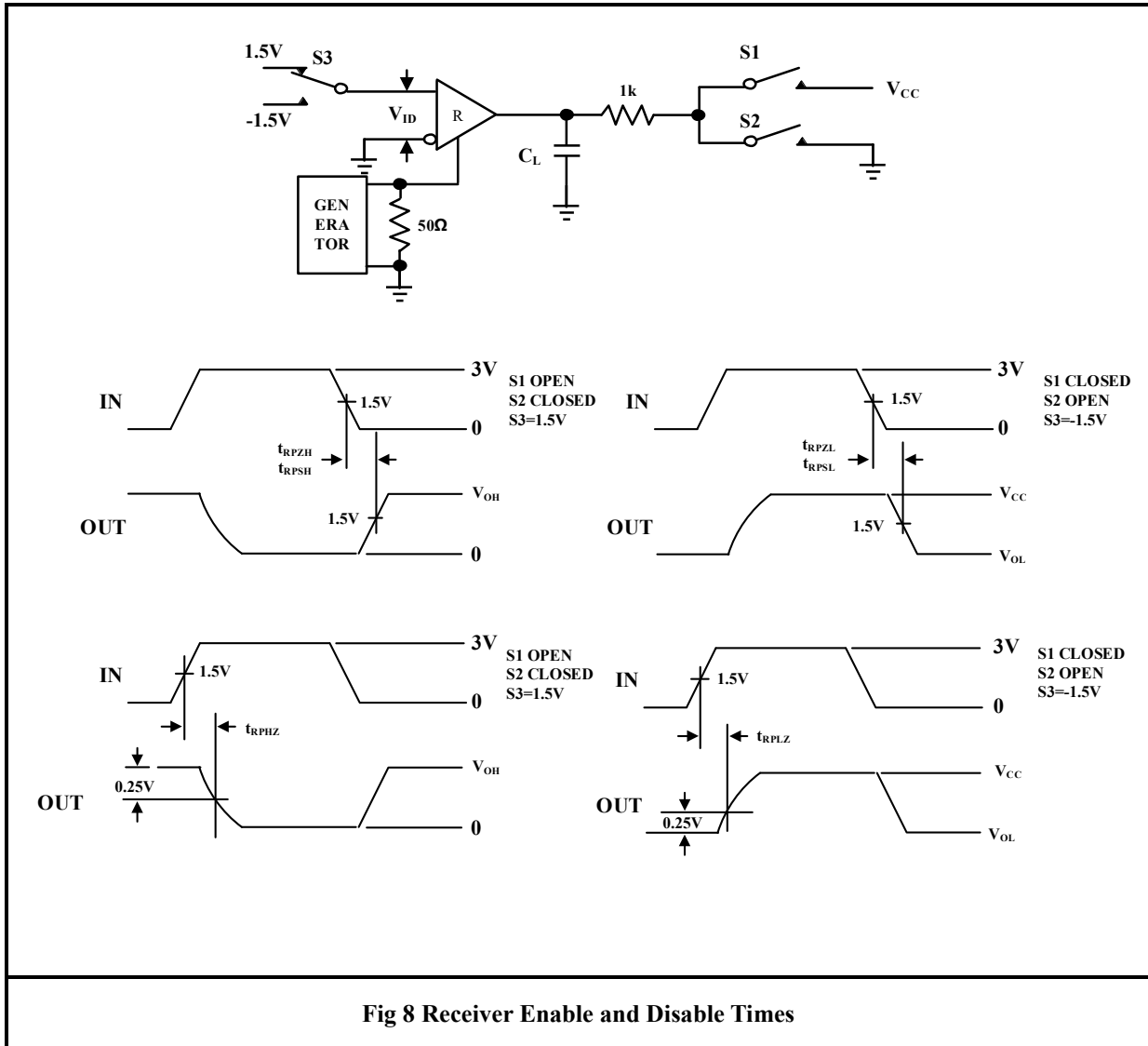


Fig 7 Receiver Propagation Delay





## ADDITIONAL DESCRIPTION

### 1 Sketch

KRN3088E is a half-duplex high-speed transceiver with 3.0~5.5V wide power supply,  $\pm 16\text{kV}$  contact discharge capacity and bus DC withstand voltage of more than  $\pm 15\text{V}$ , used for RS-485/RS-422 communication, including a driver and a receiver. It has the function of fail-safe, overvoltage protection, over-current protection and over temperature protection. The KRN3088E allows error-free data transmission up to 10Mbps.

### 2 Connecting 256 Transceivers on one Bus

The standard RS-485 receiver input impedance is  $12\text{k}\Omega$  (1 unit load), the standard driver can drive up to 32 unit loads. Receiver KRN3088E transceiver has a  $1/8$  unit load receiver input impedance ( $96\text{k}\Omega$ ), allowing up to 256 transceivers to be connected in parallel on one bus. These devices can be any combination, or in combination with other RS-485 transceiver combination, as long as the total load does not load more than 32 units, can be connected on the same bus.

### 3 Drive Output Protection

Two mechanisms prevent excessive output current and power dissipation caused by faults or by bus contention. First, over-current protection, fast short circuit protection in the mode voltage range (refer to typical operating characteristics). Second, when the temperature of the tube core exceeds  $140^\circ\text{C}$ , the output of the driver is forced into the high resistance state.

### 4 Typical Application

**4.1 Bus Networking:** KRN3088E RS485 transceiver is designed for bidirectional data communication on multi-point bus transmission line. Fig 9 shows a typical network application circuit. These devices can also be used as linear repeaters with cables longer than 4,000 feet. In order to reduce the reflection, terminal matching should be carried out at both ends of the transmission line with its characteristic impedance, and the length of branch lines outside the main line should be as short as possible.

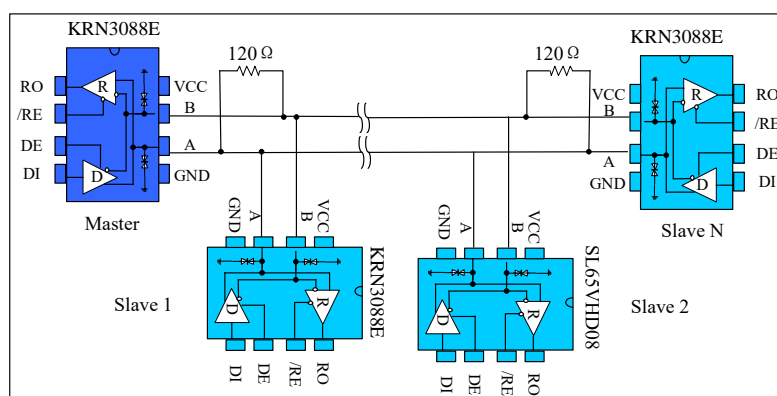


Fig 9 Bus type RS485 half-duplex communication network

**4.2 Hand in hand Networking:** Also known as daisy chain topology, is the standard and specification of RS485 bus wiring, and is the RS485 bus topology recommended by TIA and other organizations. The

wiring mode is that the main control equipment and a plurality of slave control equipment form a hand-held connection mode, as shown in Fig 10, and the hand-held mode is no branches. This wiring mode has the advantages of small signal reflection and high communication success rate.

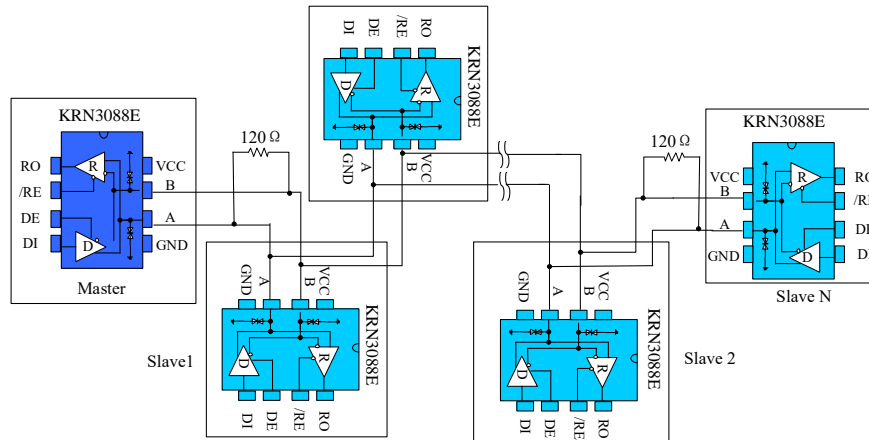


Fig 10 Hand in hand RS485 half-duplex communication network

**4.3 Bus port protection:** in severe environment, RS485 communication port is usually provided with KRN3088Eatic protection, lightning surge protection and other additional protection, and even the plan to prevent 380V market electricity access is needed to avoid the damage of intelligent instrument and industrial control host. Fig 11 shows three common RS485 bus port protection schemes. The first is the scheme of three-level protection by connecting TVS devices in parallel with A, B port to the protective ground, TVS devices in parallel with A, B port, thermistor in series with A, B port, gas discharge tube in parallel to the protective ground; the second is the scheme of three-level protection by connecting TVS in parallel with A, B port to the ground, thermistor in series with A, B port, and varistor in parallel with A, B, B port; the third is the scheme of three-level protection by connecting AB with pull-up or pull-down resistor to power and ground respectively, connecting TVS between A & B, A or B port connecting thermistor.

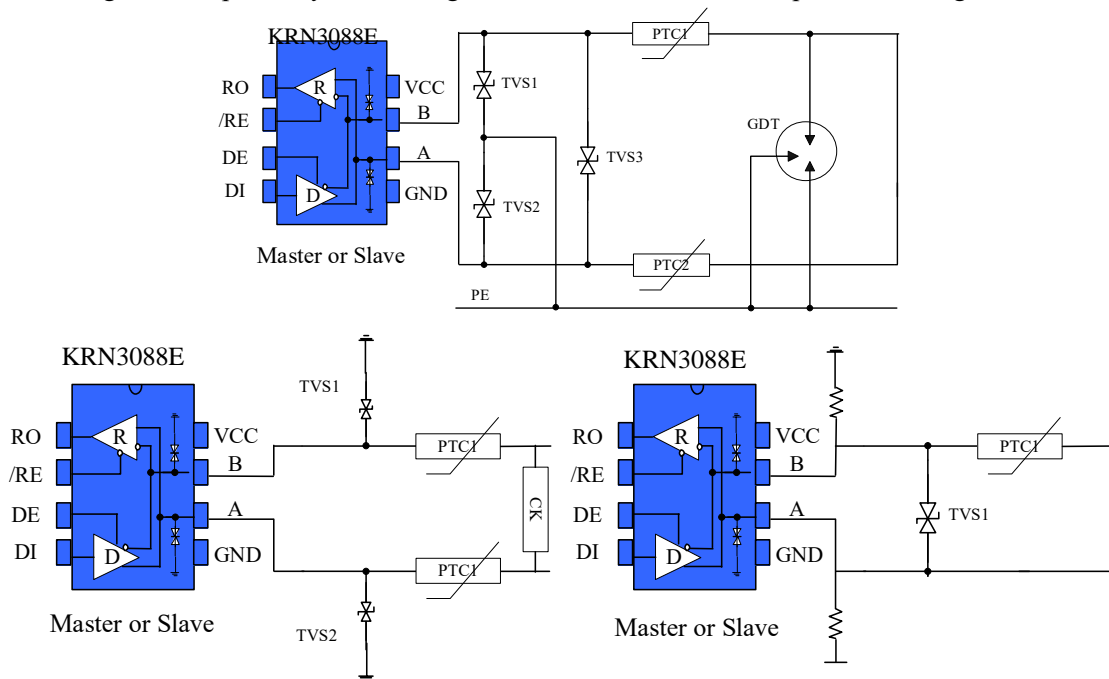
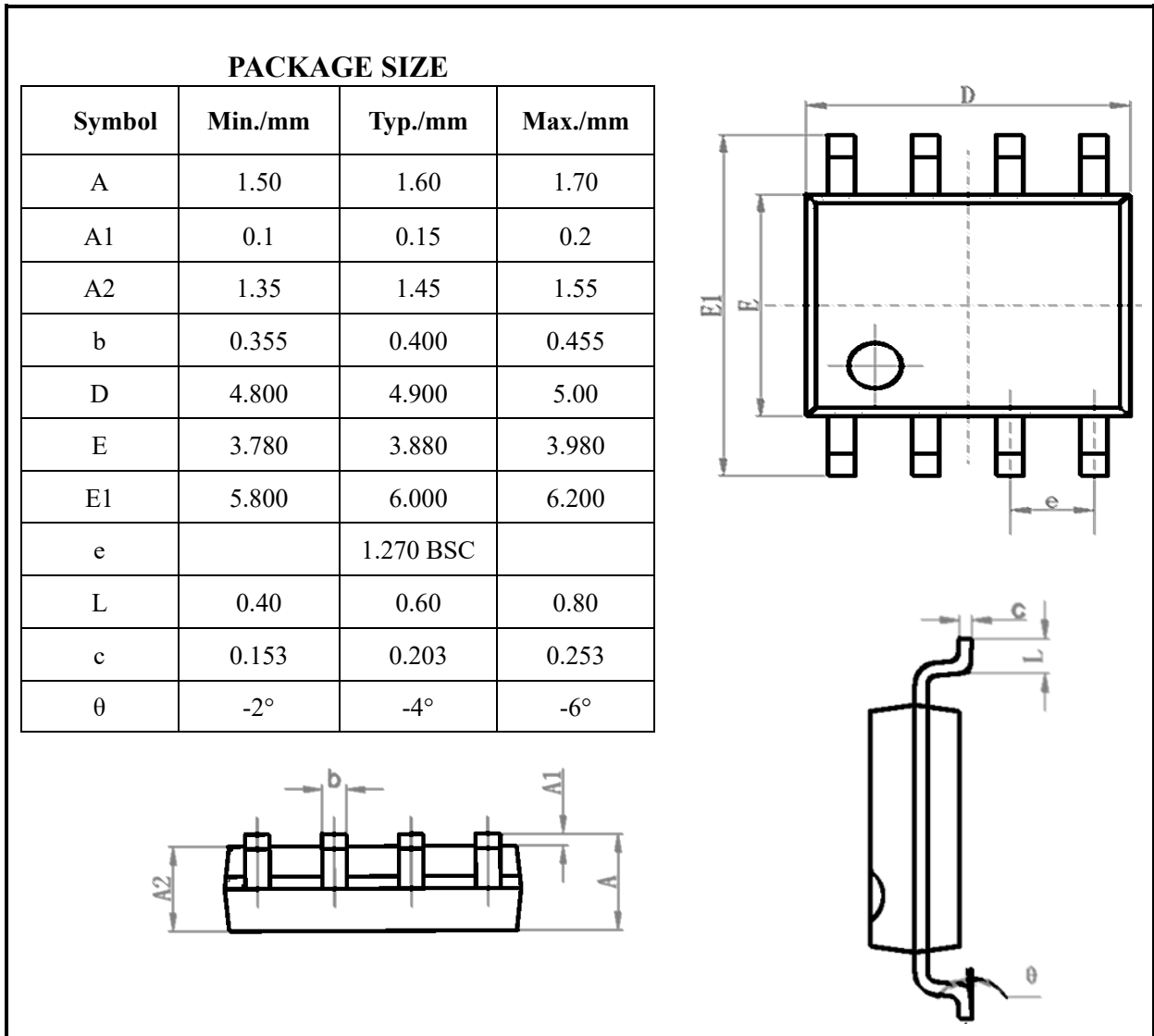


Fig 11 Port protection scheme

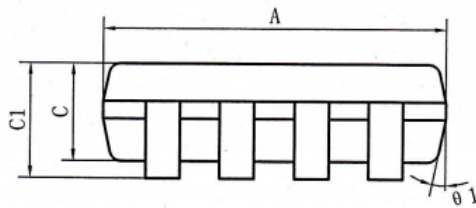
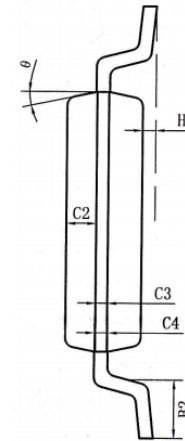
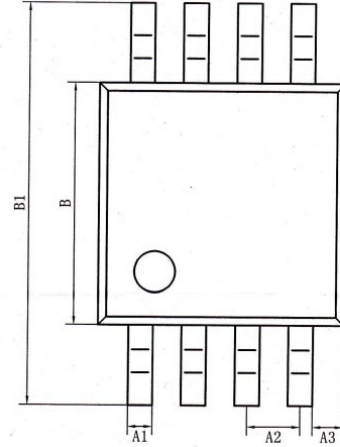
SOP8 DIMENSIONS



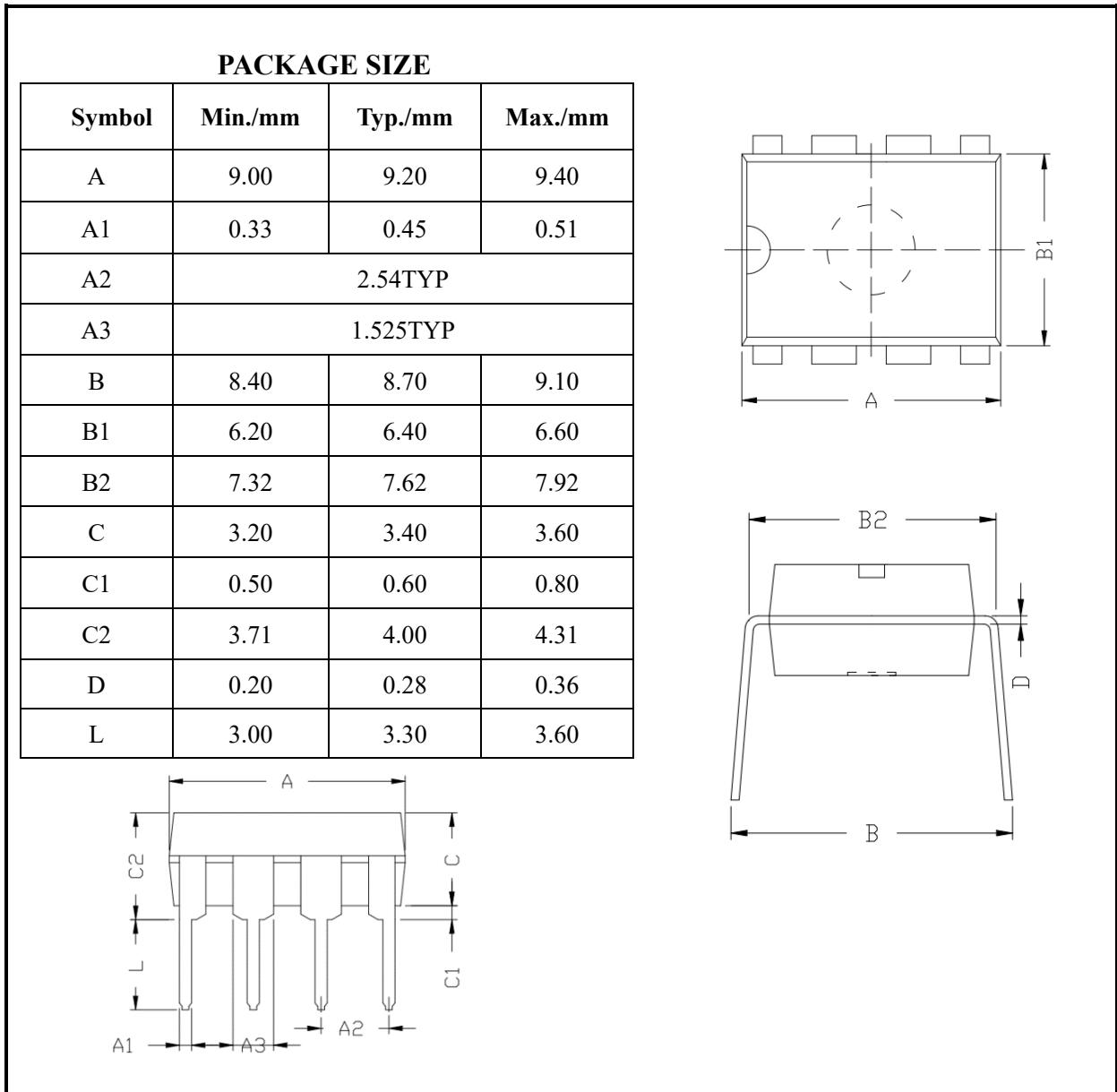
**MSOP8/8μMAX/VSSOP8 DIMENSIONS**

**PACKAGE SIZE**

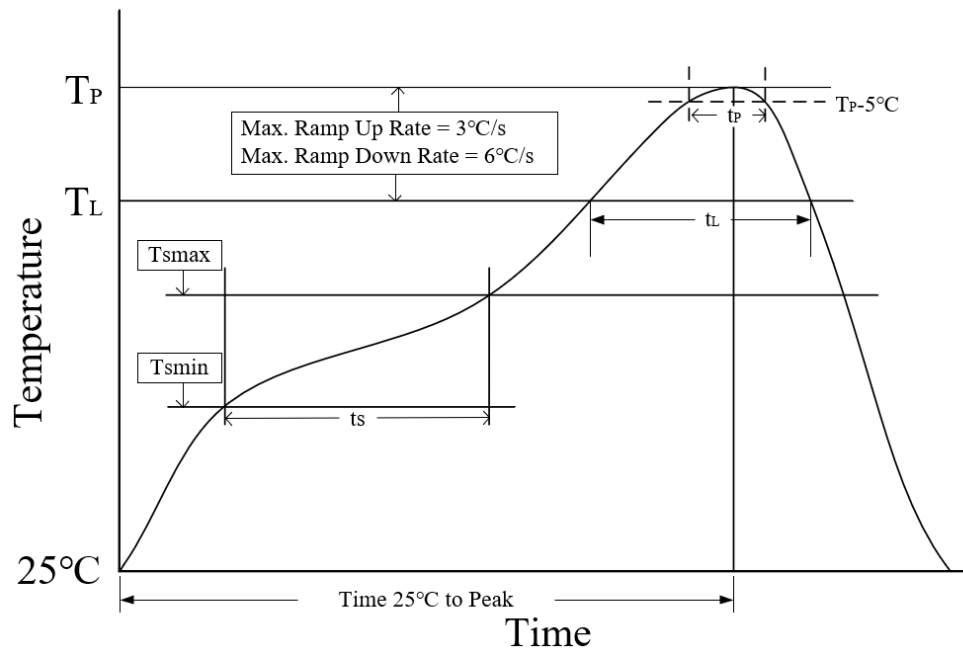
Symbol	Min./mm	Typ./mm	Max./mm
A	2.90	3.0	3.10
A1	0.28		0.35
A2	0.65 TYP		
A3	0.375 TYP		
B	2.90	3.0	3.10
B1	4.70		5.10
B2	0.45		0.75
C	0.75		0.95
C1			1.10
C2	0.328 TYP		
C3	0.152		
C4	0.15		0.23
H	0.00		0.09
θ	12° TYP		



## DIP8 DIMENSIONS



## REFLOW SOLDERING



Parameter	Lead-free soldering conditions
Ave ramp up rate ( $T_L$ to $T_P$ )	3°C/second max
Preheat time $t_s$ ( $T_{smin}=150^\circ\text{C}$ to $T_{smax}=200^\circ\text{C}$ )	60-120 seconds
Melting time $t_L$ ( $T_L=217^\circ\text{C}$ )	60-150 seconds
Peak temp $T_P$	260-265°C
5°C below peak temperature $t_p$	30 seconds
Ave cooling rate ( $T_P$ to $T_L$ )	6°C/second max
Normal temperature 25°C to peak temperature $T_P$ time	8 minutes max

## ORDERING INFORMATION

TYPE NUMBER	PACKAGE	PACKING
KRN3088EDR	SOP8	Tape and reel
KRN3088EDGK	MSOP8/VSSOP8/8 $\mu$ MAX	Tape and reel
KRN3088EP	DIP8	Tube

## REVISION HISTORY

Version number	Data sheet status	Revision date
V1.0	Initial version.	August 2018
V1.1~V1.4	Adjusted format.	February 2018 to May 2018
V1.5	Added ESD protection related content.	June 2018
V1.6	Adjusted format.	August 2018
V1.7	Updated test circuit; Added tape and reel information; Updated ordering information; Added reflow soldering; Added revision history.	February 2023