High-Speed USB 2.0 480Mbps Switch

General Description

The ET7228 is a 2CH single-pole/double-throw (SPDT) switches. Their wide bandwidth and low bit-to-bit skew allow them to pass high-speed differential signals with good signal integrity.

Each switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. Industry-leading advantages include a propagation delay of less than 250 ps, resulting from its low channel resistance and low I/O capacitance. Their high channel-to-channel crosstalk rejection results in minimal noise interference. Their bandwidth is wide enough to pass High-Speed USB 2.0 differential signals (480 Mb/s).

ET7228 is offered in a QFN10L package.

Features

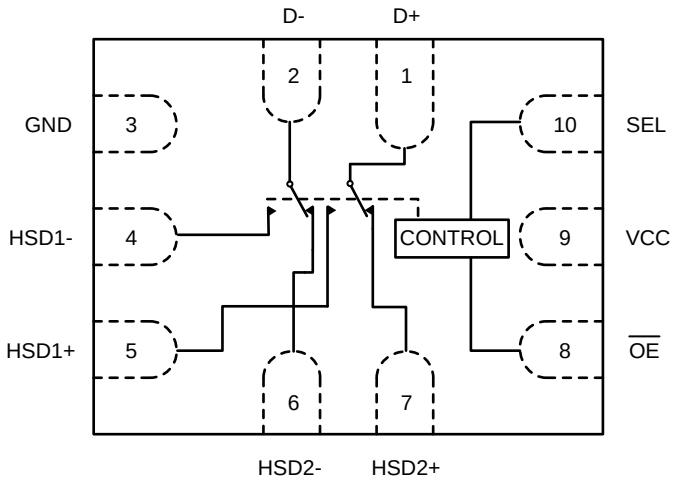
- R_{ON} is typically 6.0 Ω @ V_{CC} = 3.3 V
- Low Bit-to-Bit skew is typically 50 ps
- Low current consumption is 1.0 μA typical
- Near-zero propagation delay is typical 250 ps
- Channel on-capacitance is 4.0 pF typical
- V_{CC} operating range from 1.65 V to 4.5 V
- Part No. and package

Part No.	Package	MSL
ET7228	QFN10L(1.8 mm×1.4 mm)	Level 1

Applications

- Differential Signal Data Routing
- USB 2.0 Signal Routing

Pin Configuration



Top View

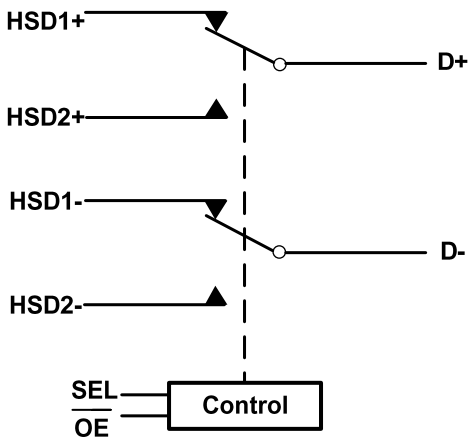
Pin Function

Pin No.	Pin Name	Pin Function
1	D+	Data Ports
2	D-	Data Ports
3	GND	Ground
4	HSD1-	Data Ports
5	HSD1+	Data Ports
6	HSD2-	Data Ports
7	HSD2+	Data Ports
8	$\overline{OE}$	Output Enable
9	VCC	Power supply
10	SEL	Select Input

Truth Table

$\overline{OE}$	SEL	HSD1+ to D+, HSD1- to D-	HSD2+ to D+, HSD2- to D-
1	X	OFF	OFF
0	0	ON	OFF
0	1	OFF	ON

Analog Symbol



Analog Symbol

Absolute Maximum Ratings

Symbol	Pins	Parameters	Value	Unit
V_{CC}	VCC	Positive DC Supply Voltage	-0.5 to +6.0	V
V_{IS}	HSD1+,HSD1-,HSD2+,HSD2-	Analog Signal Voltage	-0.5 to V_{CC}	V
	D+,D-		-0.5 to +5.5	
V_{IN}	$\overline{OE}$	Control Input Voltage	-0.5 to +6.0	V
I_{CC}	VCC	Positive DC Supply Current	50	mA
I_{IS_CON}	HSD1+,HSD1-,HSD2+,HSD2- D+,D-	Analog Signal Continuous Current	±100	mA
I_{IS_PK}	HSD1+,HSD1-,HSD2+,HSD2- D+,D-	Analog Signal Continuous Current 10% Duty Cycle	±150	mA
I_{IN}	$\overline{OE}$	Control Input Current	±20	mA
T_J		Junction Temperature Range	-40 to +150	˚C
T_{STG}		Storage Temperature	-65 to +150	˚C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions

Symbol	Pins	Parameter	Min	Max	Unit
V_{CC}	VCC	Positive DC Supply Voltage	1.65	4.5	V
V_{IS}	HSD1+,HSD1-,HSD2+,HSD2-	Analog Signal Voltage	GND	V_{CC}	V
	D+,D-		GND	4.5	
V_{IN}	$\overline{OE}$	Digital Select Input Voltage	GND	V_{CC}	V
T_A		Operating Temperature Range	-40	+85	˚C

Minimum and maximum values are guaranteed through test or design across the Recommended Operating Conditions, where applicable. Typical values are listed for guidance only and are based on the particular conditions listed for section, where applicable. These conditions are valid for all values found in the characteristics tables unless otherwise specified in the test conditions.

DC Electrical Characteristics

Control Input (Typical: T_A = 25 °C, V_{CC} = 3.3 V)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	-40°C to +85°C			unit
					Min	Typ	Max	
V_{IH}	SEL $\overline{OE}$	Control Input High Voltage(1)		2.7 3.4 4.2	1.0 1.1 1.12	-	-	V
V_{IL}	SEL $\overline{OE}$	Control Input Low Voltage(1)		2.7 3.4 4.2	-		0.4 0.4 0.5	V
I_{IN}		Control Input Leakage Current	0 ≤ V_{IS} ≤V_{CC}	1.65 ~ 4.5	-	-	±1.0	μA

Note1: V_{IH} level is recommended to be consistent with V_{CC} and V_{IL} level is GND to reduce I_{CC} current.

Supply And Leakage Current (Typical: T_A = 25 °C, V_{CC} = 3.3 V, $\overline{OE}$ = V_{CC} or GND, S = V_{CC} or GND)

Symbol	Pins	Parameter	Test Conditions	V_{CC} (V)	-40°C to +85°C		unit
					Min	Max	
I_{CC}	V_{CC}	Quiescent Supply Current	V_{IS} = V_{CC} or GND; I_{OUT} = 0A	1.65 ~ 4.5	-	1.0	μA
I_{CCT}	V_{CC}	Increase in I_{CC} per Control Voltage	V_{IN} = 2.6V	3.6	-	10	μA
I_{OZ}	HSD1+ HSD1- HSD2+ HSD2-	OFF Stage Leakage Current	0 ≤ V_{IS} ≤ V_{CC}	1.65 ~ 4.5	-	±1.0	μA
I_{OFF}	D+, D-	Power OFF Leakage Current	0 ≤ V_{IS} ≤ 4.5V	0	-	±1.0	μA

High Speed On Resistance (Typical: T_A = 25 °C, V_{CC} = 3.3 V)

Symbol	Parameter	Test Conditions	V_{CC} (V)	-40°C to +85°C			unit
				Min	Typ	Max	
R_{ON}	On-Resistance	V_{IS} = 0.2V, 0.4V I_{ON} = 8mA	2.7	-	6.5	12	Ω
			3.3		6.0	10	
			4.2		5.5	8	
R_{FLAT}	On-Resistance Flatness		2.7	-	0.3	1.5	Ω
			3.3		0.2	1	
			4.2		0.1	0.5	
$\triangle R_{ON}$	On-Resistance Matching		2.7	-	0.25	0.5	Ω
			3.3		0.2	0.45	
			4.2		0.15	0.4	

Full Speed On Resistance (Typical: T_A = 25 °C, V_{CC} = 3.3 V)

Symbol	Parameter	Test Conditions	V_{CC} (V)	-40°C to +85°C			unit
				Min	Typ	Max	
R_{ON}	On-Resistance	V_{IS} = 0.2V_{CC},0.5V_{CC}, 0.8V_{CC}, V_{CC} I_{ON} = 8mA	2.7	-	9.0	13	Ω
			3.3		7.5	11	
			4.2		6.0	9	
$\triangle R_{ON}$	On-Resistance Matching		2.7	-	0.5	0.8	Ω
			3.3		0.4	0.7	
			4.2		0.3	0.6	
R_{FLAT}	On-Resistance Flatness	V_{IS} = 0.2V,0.4V, 0.7V,1.0V I_{ON} = 8mA	2.7	-	1.0	3	Ω
			3.3		0.5	1.5	
			4.2		0.4	1.2	

AC Electrical Characteristics[(2)]

Timing / Frequency (Typical: T_A = 25 °C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, f = 1 MHz)

Symbol	Parameter	Test Conditions	V_{CC} (V)	-40°C to +85°C			unit
				Min	Typ	Max	
t_{ON}	Turn-ON Time		2.7 ~ 4.5	-	14	20	ns
t_{OFF}	Turn-OFF Time		2.7 ~ 4.5	-	21	25	ns
t_{BBM}	Break-Before-Make Delay	V_{IS} = 0V to V_{CC}	2.7 ~ 4.5	2	8	-	ns
BW	-3 dB Bandwidth	C_L = 5pF	2.7 ~ 4.5	-	550	-	MHz
		C_L = 0pF		-	900	-	

Isolation (Typical: T_A = 25 °C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Conditions	V_{CC} (V)	-40°C to +85°C			unit
					Min	Typ	Max	
O_{IRR}	Open	OFF-Isolation	f = 250MHz	1.65 ~ 4.5	-	-30	-	dB
X_{TALK}	HSD1+ to HSD1-	Non-Adjacent Channel Crosstalk	f = 250MHz	1.65 ~ 4.5	-	-45	-	dB

Capacitance (Typical: T_A = 25 °C, V_{CC} = 3.3 V, R_L = 50 Ω, C_L = 5 pF, f = 1 MHz)

Symbol	Pins	Parameter	Conditions	V_{CC} (V)	-40°C to +85°C			unit
					Min	Typ	Max	
C_{IN}	$\overline{OE}$	Control Pin Input Capacitance		0		2.0		pF
C_{ON}	D+ to HSD1/2+	ON Capacitance	V_{OE}= 0V	3.3		8.0		pF
C_{OFF}	HSD2+, HSD2-	OFF Capacitance	V_{IS} = 3.3V V_{OE}= 3.3V	3.3		3.5		pF

Note2: AC parameter is guaranteed by design.

Typical Characteristics

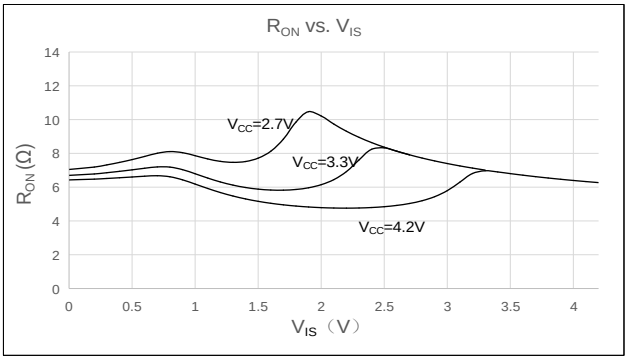


Figure 1. On-Resistance vs. V_{IS}

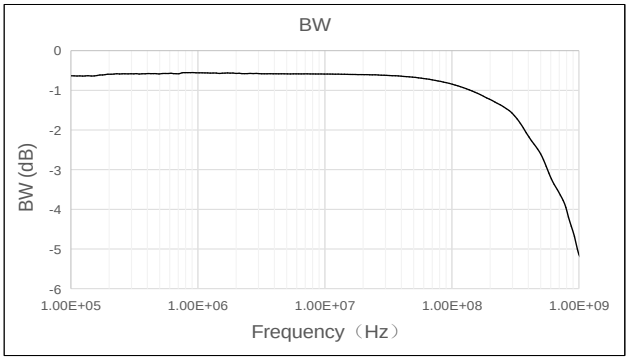


Figure 2. Bandwidth vs. Frequency @V_{CC}=3.3V

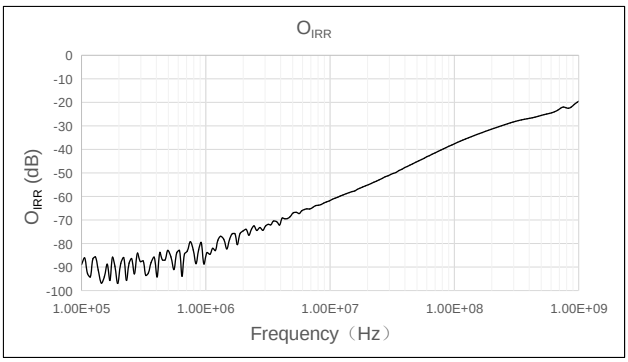


Figure 3. O_{IRR} vs. Frequency @V_{CC}=3.3V

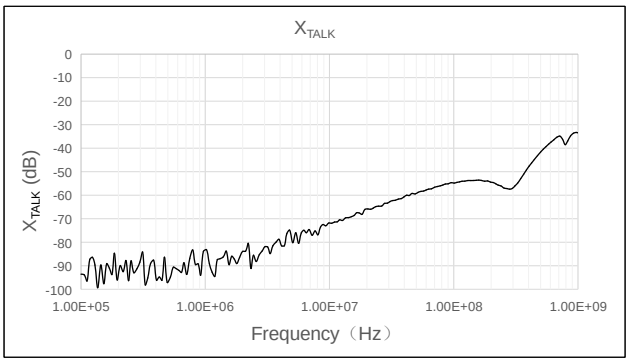


Figure 4. X_{TALK} vs. Frequency @V_{CC}=3.3V

Test Circuit and Waveform

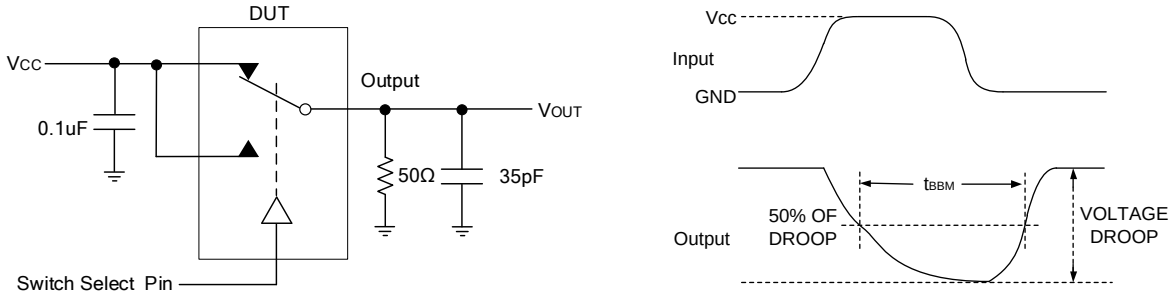


Figure 5. t_{BBM} (Time Break-Before-Make)

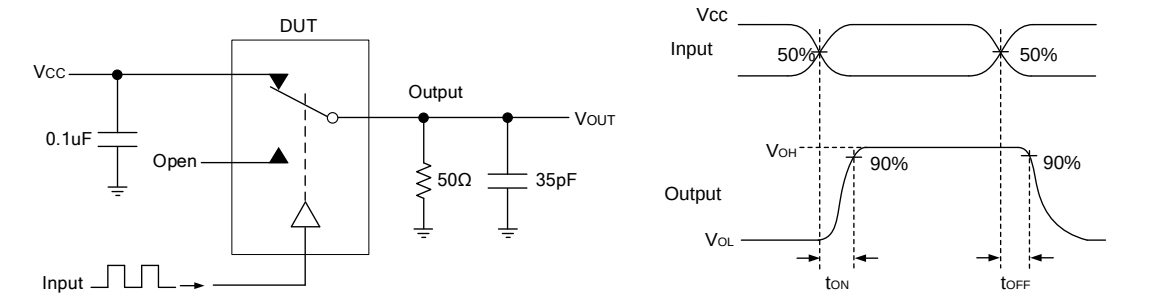


Figure 6. t_{ON} / t_{OFF}

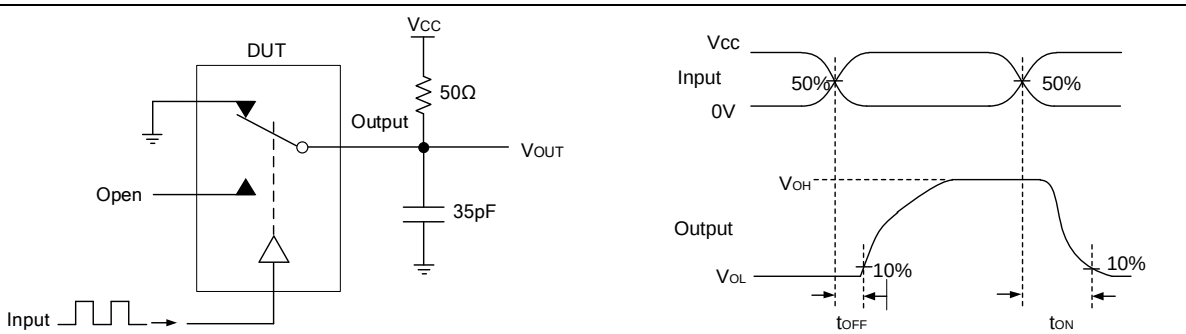


Figure 7. t_{ON} / t_{OFF}

Test Circuit and Waveform(Continued)

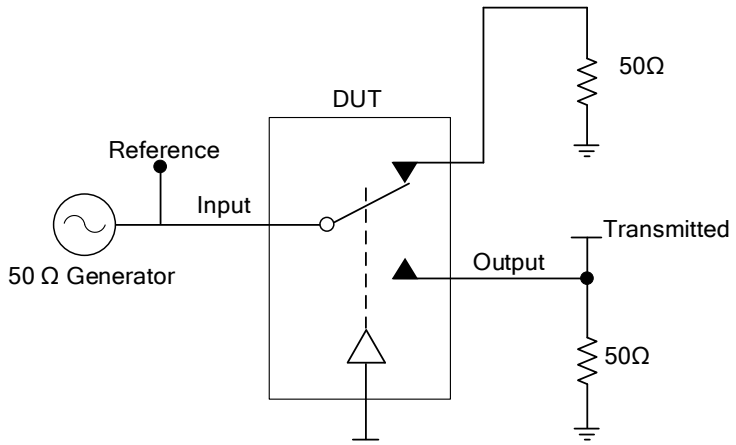


Figure 8. Off Channel Isolation/On Channel Loss(BW)/Crosstalk

(On Channel to Off Channel)/V_{ONL}

Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch. V_{ISO}, Bandwidth and V_{ONL} are independent of the input signal direction.

V_{ISO} = Off Channel Isolation = 20 lg (V_{OUT} / V_{IN}) for V_{IN} at 100 kHz.

V_{ONL} = On Channel Loss = 20 lg (V_{OUT} / V_{IN}) for V_{IN} at 100 kHz to 50 MHz.

Bandwidth (BW) = the frequency 3 dB below V_{ONL}.

V_{CT} = Use V_{ISO} setup and test to all other switch analog input/outputs terminated with 50 Ω.

Typical Performance Curves

T_A = +25 °C, Unless Otherwise Specified

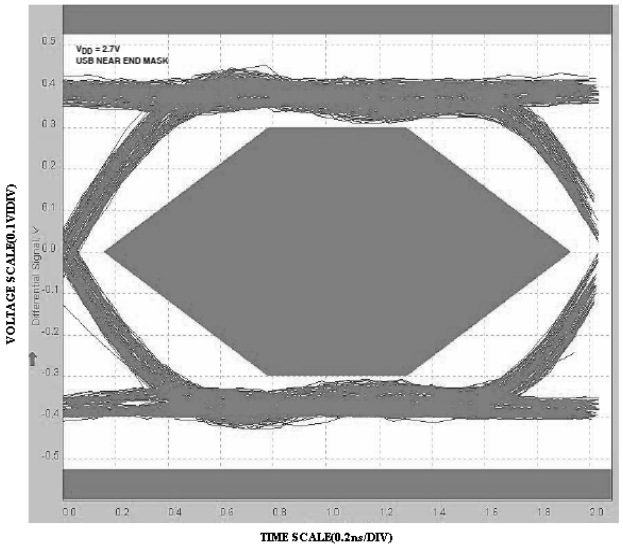


Figure 9. Eye Pattern : 480 Mbps with USB Switch in the Signal Path (near end mask)

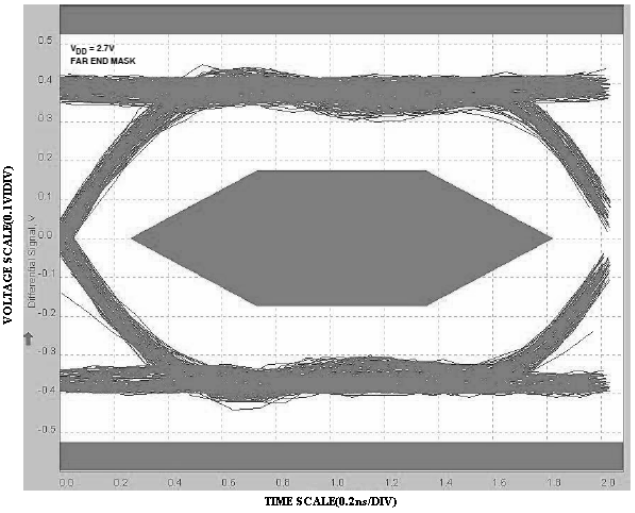
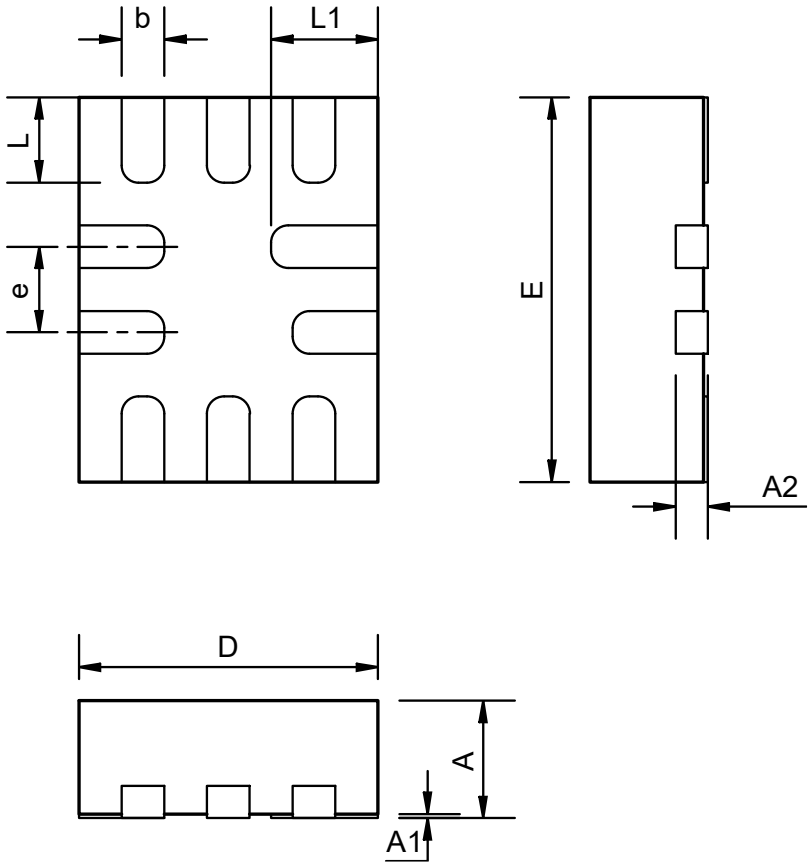


Figure 10. Eye Pattern : 480 Mbps with USB Switch in the Signal Path (far end mask)

Package Dimension

QFN10L



COMMON DIMENSIONS

(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0	0.02	0.05
A2		0.15 REF	
b	0.15	0.20	0.25
D	1.35	1.40	1.45
E	1.75	1.80	1.85
e		0.40 BSC	
L	0.30	0.40	0.50
L1	0.40	0.50	0.60

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2015-09-20	Original Version	Liu Xiao Min	Liu Xiao Min	Zhu Jun Li
1.1	2016-08-02	Update some parameters	Liu Xiao Min	Liu Xiao Min	Zhu Jun Li
1.2	2020-03-16	Documents check and formalize	Shib	Shib	Liujy
1.3	2022-11-15	Update Typeset and EC table	Qinpl	Qinpl	Liujy
1.4	2024-1-3	Add Tj	Shib	Shib	Liujy
1.5	2025-4-15	Update Typical Characteristics	Yinp	Yinp	Liujy