8-Bit Bidirectional Voltage-Level Translator for Open-Drain and Push-Pull Application

UM3288H *CSP20 2.4×1.9*
UM3288UK *TSSOP20*
UM3288QA *QFN20 4.5×3.5*

General Description

The UM3288 is 8-channel ESD-protected level translator provides the level shifting necessary to allow data transfer in a multi-voltage system. Externally applied voltages, V_{CCB} and V_{CCA}, set the logic levels on either side of the device. A low-voltage logic signal present on the V_{CCA} side of the device appears as a low-voltage logic signal on the V_{CCB} side of the device, and vice-versa. The UM3288 bidirectional level translator utilizes a transmission-gate based design to allow data translation in either direction (V_{CCA}↔V_{CCB}) on any single data line. The UM3288 accepts V_{CCA} from +1.2V to +3.6V and V_{CCB} from +1.65V to +5.5V, making it ideal for data transfer between low-voltage ASICs / PLDs and higher voltage systems.

The UM3288 enters a three-state output mode to reduce supply current when output enable (OE) is low. The UM3288 is designed so that the OE input circuit is supplied by V_{CCA}. ±5kV ESD protection on the V_{CCB} side for greater protection in applications that route signals externally.

The UM3288H is available in CSP20 2.4×1.9 bump package. The UM3288UK is available in TSSOP20 package and the UM3288QA is available in QFN20 4.5×3.5 package.

Applications

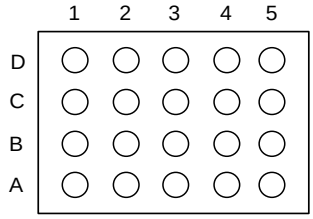
- SPI, MICROWIRE, and I^2C Level Translation
- Handsets
- Smart phones
- Tablets
- Desktop PCs

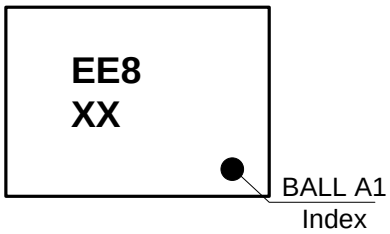
Features

- Max Data Rates
  - 60Mbps(Push Pull)
  - 2Mbps(Open Drain)
- 1.2V to 3.6V on A port and 1.65V to 5.5V on B port(V_{CCA}≤V_{CCB})
- No Direction-Control Signal Needed
- No Power-Supply Sequencing Required V_{CCA} or V_{CCB} Can Be Ramped First
- Low Power Consumption
- ±5kV ESD Protection on B port
- Latch-Up Performance Exceeds 100mA

Pin Configurations **Top View**

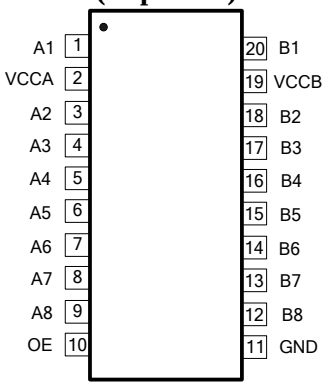
(Bottom View)

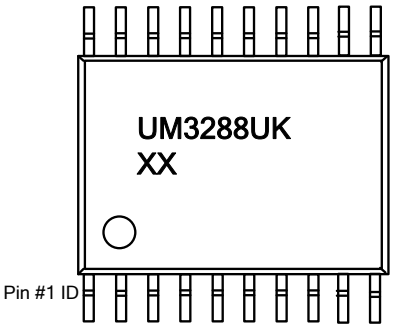




XX: Week Code
UM3288H
CSP20 2.4×1.9

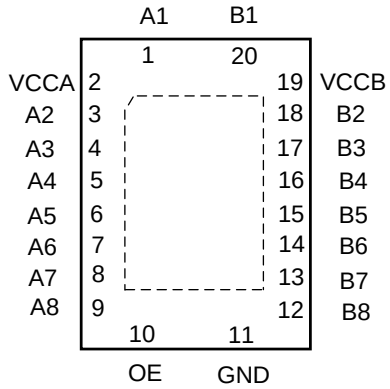
(Top View)

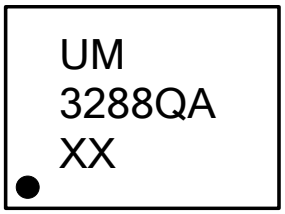




XX: Week Code
UM3288UK
TSSOP20

(Top View)





XX: Week Code
UM3288QA
QFN20 4.5×3.5

Ball Mapping for UM3288H

	5	4	3	2	1
D	B8	B6	B4	B2	V_{CCB}
C	GND	B7	B5	B3	B1
B	OE	A7	A5	A3	A1
A	A8	A6	A4	A2	V_{CCA}

Transparent Top View

Pin Description

Pin Name	Function
A1	Input/Output 1. Referenced to V_{CCA}
V_{CCA}	A-Port supply voltage $1.2V \le V_{CCA} \le 3.6V$ and $V_{CCA} \le V_{CCB}$
A2	Input/Output 2. Referenced to V_{CCA}
A3	Input/Output 3. Referenced to V_{CCA}
A4	Input/Output 4. Referenced to V_{CCA}
A5	Input/Output 5. Referenced to V_{CCA}
A6	Input/Output 6. Referenced to V_{CCA}
A7	Input/Output 7. Referenced to V_{CCA}
A8	Input/Output 8. Referenced to V_{CCA}
OE	3-state output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V_{CCA}
GND	Ground
B8	Input/Output 8. Referenced to V_{CCB}
B7	Input/Output 7. Referenced to V_{CCB}
B6	Input/Output 6. Referenced to V_{CCB}
B5	Input/Output 5. Referenced to V_{CCB}
B4	Input/Output 4. Referenced to V_{CCB}
B3	Input/Output 3. Referenced to V_{CCB}
B2	Input/Output 2. Referenced to V_{CCB}
V_{CCB}	B-Port supply voltage. $1.65V \le V_{CCB} \le 5.5V$
B1	Input/Output 1. Referenced to V_{CCB}

Ordering Information

Part Number	Packaging Type	Marking Code	Shipping Qty
UM3288H	CSP20 2.4×1.9	EE8	3000pcs/7Inch Tape & Reel
UM3288UK	TSSOP20	UM3288UK	3000pcs/13Inch Tape & Reel
UM3288QA	QFN20 4.5×3.5	UM3288QA	

Absolute Maximum Ratings (Note 1, 2)

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter		Value	Unit
V_{CCA}	Supply Voltage Range		-0.5 to +4.5	V
V_{CCB}	Supply Voltage Range		-0.5 to +6.5	V
V_I	Input Voltage Range	A ports	-0.5 to +4.5	V
		B ports	-0.5 to +6.5	
V_O	Voltage Range applied to any output in the high-impedance or power-off state	A ports	-0.5 to +4.5	V
		B ports	-0.5 to +6.5	
V_O	Voltage Range applied to any output in the high or low state (Note 2)	A ports	-0.5 to (V_{CCA}+0.5)	V
		B ports	-0.5 to (V_{CCB}+0.5)	
I_{IK}	Input Clamp Current	V_I＜0	-50	mA
I_{OK}	Output Clamp Current	V_O＜0	-50	mA
I_O	Continuous Output Current		±50	mA
	Continuous Current through V_{CCA}, V_{CCB}, or GND		±100	mA
T_{OP}	Operating Temperature Range		-40 to +85	℃
T_J	Junction Temperature Range		-40 to +150	℃
T_{STG}	Storage Temperature Range		-65 to +150	℃

Note1. Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note2. The value of V_{CCA} and V_{CCB} are provided in the recommended operating conditions table.

Thermal Information

Symbol	Parameter		Value	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	CSP20 2.4×1.9	66.2	℃/W
		TSSOP20	101.5	
		QFN20 4.5×3.5	34.7	
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	CSP20 2.4×1.9	0.4	℃/W
		TSSOP20	35.9	
		QFN20 4.5×3.5	39.5	
$R_{\theta JB}$	Junction-to-board thermal resistance	CSP20 2.4×1.9	52.0	℃/W
		TSSOP20	52.4	
		QFN20 4.5×3.5	12.7	

Recommended Operating Conditions (Note 1, 2)

Symbol	Parameter		V_{CCA}	V_{CCB}	Min	Max	Unit
V_{CCA}	Supply Voltage				1.2	3.6	V
V_{CCB}					1.65	5.5	
V_{IH}	High Level Input Voltage	A- Port	1.2V to 1.95V	1.65V to 5.5V	V_{CCI}-0.2	V_{CCI}	
			1.95V to 3.6V		V_{CCI}-0.4	V_{CCI}	
		B- Port	1.2V to 3.6V	1.65V to 5.5V	V_{CCI}-0.4	V_{CCI}	
		OE			V_{CCA}×0.65	5.5	
V_{IL}	Low Level Input Voltage	A- Port	1.2V to 3.6V	1.65V to 5.5V	0	0.15	
		B- Port			0	0.15	
		OE			0	V_{CCA}×0.35	
Δt/Δv	Input Transition Rise or Fall Time	A-Port push-pull driving	1.2V to 3.6V	1.65V to 5.5V		10	ns/V
		B-Port push-pull driving				10	
		Control input				10	

Note1. V_{CCI} is the supply voltage associated with the input port.
Note2. V_{CCO} is the supply voltage associated with the output port.

Electrical Characteristics: T_A= -40℃ to 85℃

Over recommended operating free-air temperature range (unless otherwise noted)

Parameter		Test Conditions	V_{CCA}	V_{CCB}	T_A=25℃	-40℃ to 85℃		Unit
					Min Typ Max	Min	Max	
V_{OHA}		I_{OH}=-20μA V_{IB}≥V_{CCB}-0.4V	1.2V	1.65V to 5.5V	V_{CCA} ×0.67			V
V_{OLA}		I_{OL}=135uA,V_{IB}≤0.15V	1.2V	1.65V to 5.5V			0.4	V
		I_{OL}=180uA,V_{IB}≤0.15V	1.4V	1.65V to 5.5V			0.4	
		I_{OL}=220uA,V_{IB}≤0.15V	1.65V	1.65V to 5.5V			0.4	
		I_{OL}=300uA,V_{IB}≤0.15V	2.3V	1.65V to 5.5V			0.4	
		I_{OL}=400uA,V_{IB}≤0.15V	3V	1.65V to 5.5V			0.55	
V_{OHB}		I_{OH}=-20μA V_{IA}≥V_{CCA}-0.2V	1.2V	1.65V to 5.5V	V_{CCB} ×0.67			V
V_{OLB}		I_{OL}=220uA,V_{IA}≤0.15V	1.2V to 3.6V	1.65			0.4	V
		I_{OL}=300uA,V_{IA}≤0.15V	1.2V to 3.6V	2.3			0.4	
		I_{OL}=400uA,V_{IA}≤0.15V	1.2V to 3.6V	3			0.55	
		I_{OL}=620uA,V_{IA}≤0.15V	1.2V to 3.6V	4.5			0.55	
I_I	OE	V_I=V_{CCI} or GND	1.2V to 3.6V	1.65V to 5.5V	±1		±2	μA
I_{OZ}	A or B Port	OE=V_{IL} V_I=V_{CCI} or GND	1.2V to 3.6V	1.65V to 5.5V	±1		±2	μA
I_{CCA}		V_I=V_O=open, I_O=0	1.2V	1.65V to 5.5V	1.5		±2	μA
			1.5V to 3.6V	2.3V to 5.5V			2	
			3.6V	0V			2	
			0V	5.5V			-1	
I_{CCB}		V_I=V_O=open, I_O=0	1.2V	1.65V to 5.5V	1.5			μA
			1.5V to 3.6V	2.3V to 5.5V			6	
			3.6V	0V			-1	
			0V	5.5V			1.2	
I_{CCA} +I_{CCB}		V_I=V_{CCI} or GND I_O=0	1.2V	2.3V to 5.5V	3			μA
			1.5V to 3.6V	2.3V to 5.5V			8	
I_{CCZA}		V_I=V_O=open, I_O=0, OE=GND	1.2V	1.65V to 5.5V	0.05			μA
I_{CCZB}		V_I=V_O=open, I_O=0, OE=GND	1.2V	1.65V to 5.5V	4			μA
C_i	OE		3.3V	3.3V	4.5		5.5	pF
C_{iO}	A Port		3.3V	3.3V	8		10	pF
	B Port				10		12	

Timing Requirements

Over recommended operating free-air temperature range, V_{CCA}= 1.2V (unless otherwise noted)

			V_{CCB}(V)			Unit
			1.8(TYP)	2.5(TYP)	3.3(TYP)	
Data Rate	Push-pull		20	20	20	Mbps
	Open-drain		2	2	2	
t_w Pulse duration	Push-pull	Data inputs	50	50	50	ns
	Open-drain		500	500	500	

Timing Requirements

Over recommended operating free-air temperature range, V_{CCA}= 1.5V ±0.1V (unless otherwise noted)

			V_{CCB}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
Data Rate	Push-pull			30		60		60		50	Mbps
	Open-drain			1		1.2		1.5		2	
t_w Pulse duration	Push-pull	Data inputs	33.3		16.7		16.7		20		ns
	Open-drain		1000		833		666		500		

Timing Requirements

Over recommended operating free-air temperature range, V_{CCA}= 1.8V ±0.15V (unless otherwise noted)

			V_{CCB}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
Data Rate	Push-pull			40		60		60		60	Mbps
	Open-drain			1		1.2		1.5		2	
t_w Pulse duration	Push-pull	Data inputs	25		16.7		16.7		16.7		ns
	Open-drain		1000		833		666		500		

Timing Requirements

Over recommended operating free-air temperature range, V_{CCA}= 2.5V ±0.2V (unless otherwise noted)

			V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	
Data Rate	Push-pull			60		60		60	Mbps
	Open-drain			1		1.2		1.5	
t_w Pulse duration	Push-pull	Data inputs	16.7		16.7		16.7		ns
	Open-drain		1000		833		666		

Timing Requirements

Over recommended operating free-air temperature range, V_{CCA}= 3.3V ±0.3V (unless otherwise noted)

			V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	
Data Rate	Push-pull			60		60	Mbps
	Open-drain			1.2		1.5	
t_w Pulse duration	Push-pull	Data inputs	16.7		16.7		ns
	Open-drain		500		500		

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 1.2V (unless otherwise noted)

Parameter	Test Conditions		V_{CCB}=1.8V ±0.15V	V_{CCB}=2.5V ±0.2V	V_{CCB}=3.3V ±0.3V	V_{CCB}=5V ±0.5V	Unit
			TYP	TYP	TYP	TYP	
t_{PHL}	A-B	Push-pull	6.5	5.9	5.7	5.5	ns
		Open-drain	11.9	11.1	11	11.1	
t_{PLH}	A-B	Push-pull	7.1	6.3	6.2	6.6	
		Open-drain	293	236	197	152	
t_{PHL}	B-A	Push-pull	6.4	6	5.8	5.6	ns
		Open-drain	8.5	6.8	6.2	5.9	
t_{PLH}	B-A	Push-pull	5.6	4.1	3.6	3.2	
		Open-drain	312	248	192	132	
t_{en}	OE-A OE-B	Push-pull	200	200	200	200	ns
t_{dis}	OE-A OE-B	Push-pull	150	150	150	150	ns
t_{rA}	A port rise time	Push-pull	7.9	6.7	6.5	6.4	ns
		Open-drain	296	238	185	127	
t_{rB}	B port rise time	Push-pull	6.3	3.3	1.8	1.5	ns
		Open-drain	236	164	115	60	
t_{fA}	A port fall time	Push-pull	5.8	4.8	4.3	3.8	ns
		Open-drain	5.9	4.7	4.1	3.5	
t_{fB}	B port fall time	Push-pull	4.6	2.8	2.2	1.9	ns
		Open-drain	4.5	2.7	2.2	1.9	
$t_{SK(O)}$	Channel-to-Channel	Push-pull	1	1	1	1	ns
Max data rate	A or B	Push-pull	20	20	20	20	Mbps
		Open-drain	2	2	2	2	

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 1.5V±0.1V (unless otherwise noted)

Parameter	Test Conditions		V_{CCB}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PHL}	A-B	Push-pull		12.3		9.5		8.6		8.6	ns
		Open-drain	4	14.4	3.6	12.8	3.2	12.2	2.9	12	
t_{PLH}	A-B	Push-pull		12		10		9.8		9.7	
		Open-drain	182	800	143	647	114	523	81	384	
t_{PHL}	B-A	Push-pull		12.7		11.1		11		12	ns
		Open-drain	2.9	13.2	2.6	9.6	2.3	8.5	2.0	7.5	
t_{PLH}	B-A	Push-pull		9.5		6.2		5.1		3.7	
		Open-drain	186	817	147	661	118	535	84	407	
t_{en}	OE-A OE-B	Push-pull		200		200		200		200	ns
t_{dis}	OE-A OE-B	Push-pull		150		150		150		150	ns
t_{rA}	A port rise time	Push-pull	3.5	13.1	3	9.8	3.1	9	3.2	8.3	ns
		Open-drain	147	982	115	716	92	592	66	481	
t_{rB}	B port rise time	Push-pull	2.9	11.4	1.9	7.4	0.9	4.7	0.7	2.6	ns
		Open-drain	135	1020	91	756	58	653	20	370	
t_{fA}	A port fall time	Push-pull	2.3	9.9	1.5	7.7	0.9	6.8	0.9	6	ns
		Open-drain	2.4	10	2.1	7.9	1.5	7	1.2	6.2	
t_{fB}	B port fall time	Push-pull	2	10.3	1.3	6.3	0.9	3.8	0.8	3.1	ns
		Open-drain	1.2	11.5	1.3	8.6	1	9.6	0.5	7.7	
$t_{SK(O)}$	Channel-to-Channel	Push-pull		1		1		1.1		1	ns
Max data rate	A or B	Push-pull	30		60		60		50		Mbps
		Open-drain	1		1.2		1.5		2		

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 1.8V±0.15V (unless otherwise noted)

Parameter	Test Conditions		V_{CCB}=1.8V ±0.15V		V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
t_{PHL}	A-B	Push-pull		10.4		7.7		6.7		5.9	ns
		Open-drain	3.6	11.4	3.2	9.9	2.4	9.3	1.9	8.9	
t_{PLH}	A-B	Push-pull		9.5		6.8		6.5		6.3	
		Open-drain	194	865	155	693	126	560	90	399	
t_{PHL}	B-A	Push-pull		9.8		8		7.4		7	ns
		Open-drain	2.9	12.1	2.3	8.5	2.0	7.3	1.6	6.2	
t_{PLH}	B-A	Push-pull		10.2		7		5.8		5	
		Open-drain	197	870	159	708	129	568	93	411	
t_{en}	OE-A OE-B	Push-pull		200		200		200		200	ns
t_{dis}	OE-A OE-B	Push-pull		150		150		150		150	ns
t_{rA}	A port rise time	Push-pull	3.1	11.9	2.6	8.6	2.7	7.8	2.8	7.2	ns
		Open-drain	155	996	124	691	100	508	72	350	
t_{rB}	B port rise time	Push-pull	2.8	10.5	1.7	7.2	1.2	5.2	0.7	2.7	ns
		Open-drain	132	1001	106	677	73	546	32	323	
t_{fA}	A port fall time	Push-pull	2.1	8.8	1.6	6.6	1	5.7	0.9	4.9	ns
		Open-drain	2.2	9	1.7	6.7	1.4	5.8	1.5	5.2	
t_{fB}	B port fall time	Push-pull	2	9.3	1.3	5.4	0.9	4.2	0.7	3	ns
		Open-drain	0.8	10.5	0.7	10.7	1	9.6	0.6	7.8	
$t_{SK(O)}$	Channel-to-Channel	Push-pull		1		1		1.1		1	ns
Max data rate	A or B	Push-pull	40		60		60		60		Mbps
		Open-drain	1		1.2		1.5		2		

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 2.5V±0.2V (unless otherwise noted)

Parameter	Test Conditions		V_{CCB}=2.5V ±0.2V		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	Min	Max	
t_{PHL}	A-B	Push-pull		6.3		5.2		4.5	ns
		Open-drain	2.2	6.9	1.3	6.3	0.9	5.8	
t_{PLH}	A-B	Push-pull		5.6		4.6		4.1	
		Open-drain	149	801	125	661	93	477	
t_{PHL}	B-A	Push-pull		5.4		4.7		4.2	ns
		Open-drain	2.0	7.3	1.7	6	1.3	4.9	
t_{PLH}	B-A	Push-pull		5.9		4.4		3.5	
		Open-drain	150	804	126	671	94	487	
t_{en}	OE-A OE-B	Push-pull		200		200		200	ns
t_{dis}	OE-A OE-B	Push-pull		150		150		150	ns
t_{rA}	A port rise time	Push-pull	2	7.3	2.1	6.4	2.2	5.8	ns
		Open-drain	110	692	93	529	68	369	
t_{rB}	B port rise time	Push-pull	1.8	6.5	1.3	5.1	0.7	3.4	ns
		Open-drain	107	693	79	483	41	304	
t_{fA}	A port fall time	Push-pull	1.5	5.7	1.2	4.7	0.9	3.8	ns
		Open-drain	1.5	5.6	1.2	4.7	1.1	4	
t_{fB}	B port fall time	Push-pull	1.4	5.4	0.9	4.1	0.7	3	ns
		Open-drain	0.4	14.2	0.5	19.4	0.4	3	
$t_{SK(O)}$	Channel-to-Channel	Push-pull		1		1.2		1	ns
Max data rate	A or B	Push-pull	60		60		60		Mbps
		Open-drain	1		1.2		1.5		

Switching Characteristics

Over recommended operating free-air temperature range, V_{CCA}= 3.3V±0.3V (unless otherwise noted)

Parameter	Test Conditions		V_{CCB}=3.3V ±0.3V		V_{CCB}=5V ±0.5V		Unit
			Min	Max	Min	Max	
t_{PHL}	A-B	Push-pull		4.8		4.2	ns
		Open-drain	0.9	5.3	0.4	4.8	
t_{PLH}	A-B	Push-pull		4.2		3.7	
		Open-drain	111	755	87	559	
t_{PHL}	B-A	Push-pull		4.2		3.8	ns
		Open-drain	1.6	5.5	1.2	4.5	
t_{PLH}	B-A	Push-pull		4		4.3	
		Open-drain	112	756	86	567	
t_{en}	OE-A OE-B	Push-pull		200		200	ns
t_{dis}	OE-A OE-B	Push-pull		150		150	ns
t_{rA}	A port rise time	Push-pull	1.8	5.7	1.9	5	ns
		Open-drain	75	550	57	403	
t_{rB}	B port rise time	Push-pull	1.5	5	1	3.6	ns
		Open-drain	72	555	40	349	
t_{fA}	A port fall time	Push-pull	1.2	4.5	1	3.5	ns
		Open-drain	1.1	4.4	1	3.7	
t_{fB}	B port fall time	Push-pull	1.1	4.2	0.8	3.1	ns
		Open-drain	1	4.2	0.8	3.1	
$t_{SK(O)}$	Channel-to-Channel	Push-pull		1		1	ns
Max data rate	A or B	Push-pull	60		60		Mbps
		Open-drain	1.2		1.5		

Operating Characteristics: V_{CCA} = 1.5 V to 2.5 V, V_{CCB} = 1.5V to 2.5 V

T_A = 25°C

Parameter	Test Conditions		V_{CCA}=1.5V, V_{CCB}=1.5V	V_{CCA}=1.8V, V_{CCB}=1.8V	V_{CCA}=2.5V, V_{CCB}=2.5V	Unit
			Min Typ Max	Min Typ Max	Min Typ Max	
C_{pdA}	C_L = 0, f = 10 MHz, tr= tf= 1 ns, OE = V_{CCA} (outputs enabled)	A-port input, B-port output	4.8	4.5	4.2	pF
		B-port input, A-port output	17.7	17.3	18.2	
C_{pdB}		A-port input, B-port output	28.8	28.5	29.2	
		B-port input, A-port output	15.4	15.5	15.9	

Operating Characteristics: V_{CCA} = 3.3V to 3.6V, V_{CCB} = 3.3V to 5.0 V

T_A = 25°C

Parameter	Test Conditions		V_{CCA}=3.3V, V_{CCB}=3.3V	V_{CCA}=3.6V, V_{CCB}=5.0V	Unit
			Min Typ Max	Min Typ Max	
C_{pdA}	C_L = 0, f = 10 MHz, tr= tf= 1 ns, OE = V_{CCA} (outputs enabled)	A-port input, B-port output	4.4	5.5	pF
		B-port input, A-port output	19.5	20.7	
C_{pdB}		A-port input, B-port output	31.8	37.2	
		B-port input, A-port output	16.9	19.5	

Typical Characteristics

V_{CCA} = 2.3 V , $V_{IL(A)}$ = 0.15 V

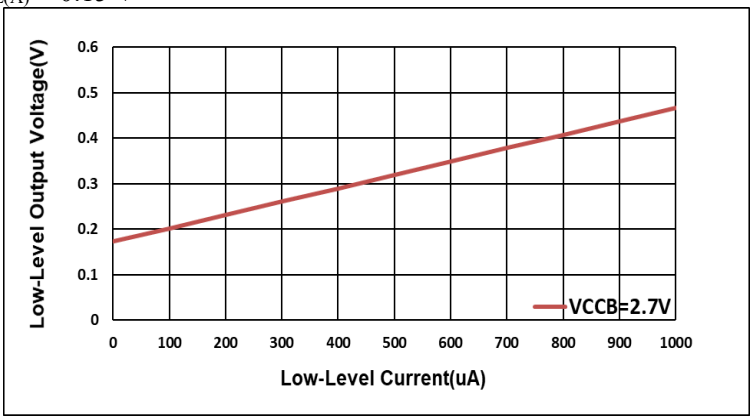


Figure 1. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

V_{CCA} = 3.0 V , $V_{IL(A)}$ = 0.15 V

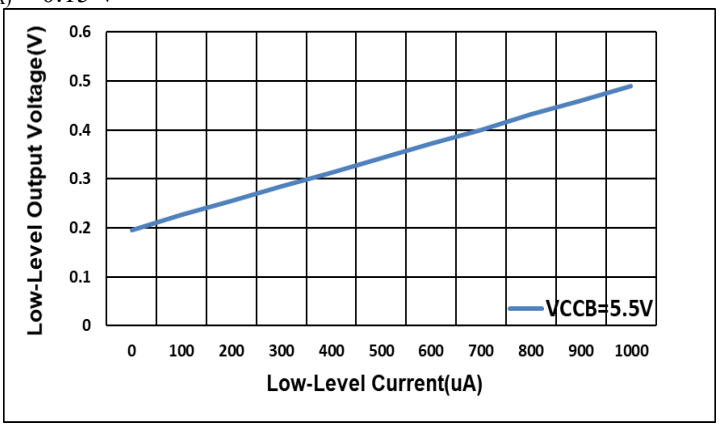


Figure 2. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

V_{CCA} = 1.4 V , $V_{IL(A)}$ = 0.15 V

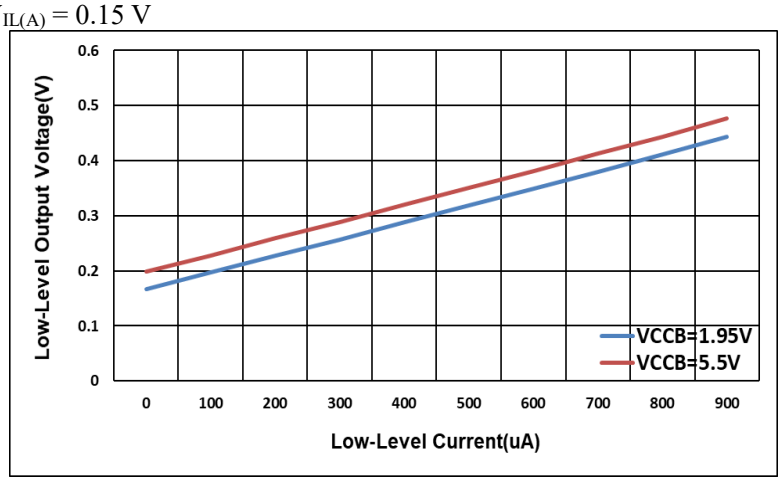
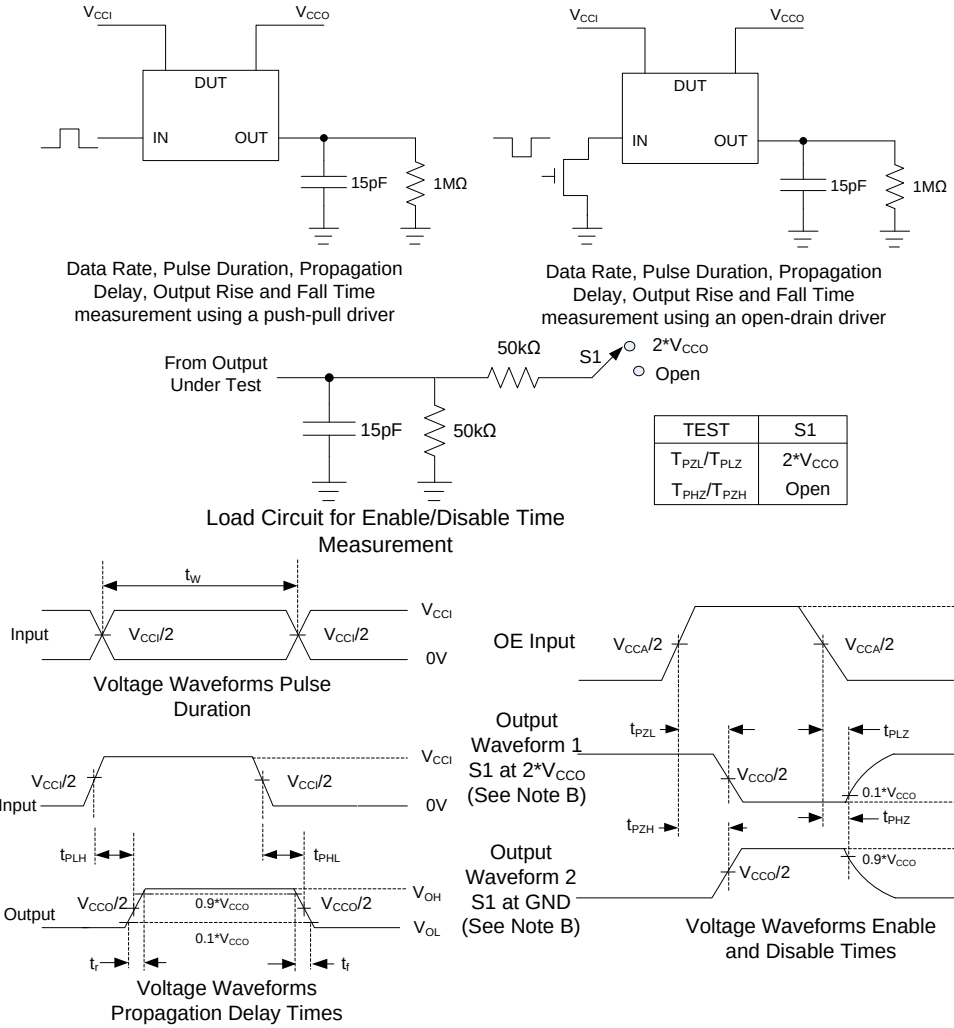


Figure 3. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

Test Circuits



A. C_L includes probe and jig capacitances.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control.
Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR≤10MHz, Z_O=50Ω, dv/dt≥1V/ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. T_{PLZ} and T_{PHZ} are the same as tdis.
F. T_{PZL} and T_{PZH} are the same as ten.
G. V_{CCI} is the V_{CC} associated with the input port.
H. V_{CCO} is the V_{CC} associated with the output port.
I. All parameters and waveforms are not applicable to all devices.

Figure 4. Load Circuits and Voltage Waveforms

Applications Information

The UM3288 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The A-port accepts I/O voltages ranging from 1.4 V to 3.6 V. The B-port accepts I/O voltages from 1.65 V to 5.5 V. The device is ideal for use in application where an open-drain driver is connected to the data I/Os and can also be used in applications where a push-pull driver is connected to the data I/Os. The device has edge rate accelerators (one shots) to improve the data rate. The pull-up resistors (R_{PU}), commonly used in open-drain applications, have been conveniently integrated so that an external resistor is not needed.

Block Diagram

The UM3288 (block diagram see Figure 5) does not require a direction-control signal to control the direction of data flow from A to B or from B to A, and every device has 8-channel bidirectional voltage level translator. Each A-port I/O has a pull-up resistor (R_{PUA}) to V_{CCA} and each B-port I/O has a pull-up resistor (R_{PUB}) to V_{CCB}. R_{PUA} and R_{PUB} are smart and changeable to decrease the power dissipation. R_{PUA} and R_{PUB} have a value of 40kΩ when the output is driving low. R_{PUA} and R_{PUB} have a value of 4kΩ when the output is driving high. R_{PUA} and R_{PUB} are disabled when OE = Low.

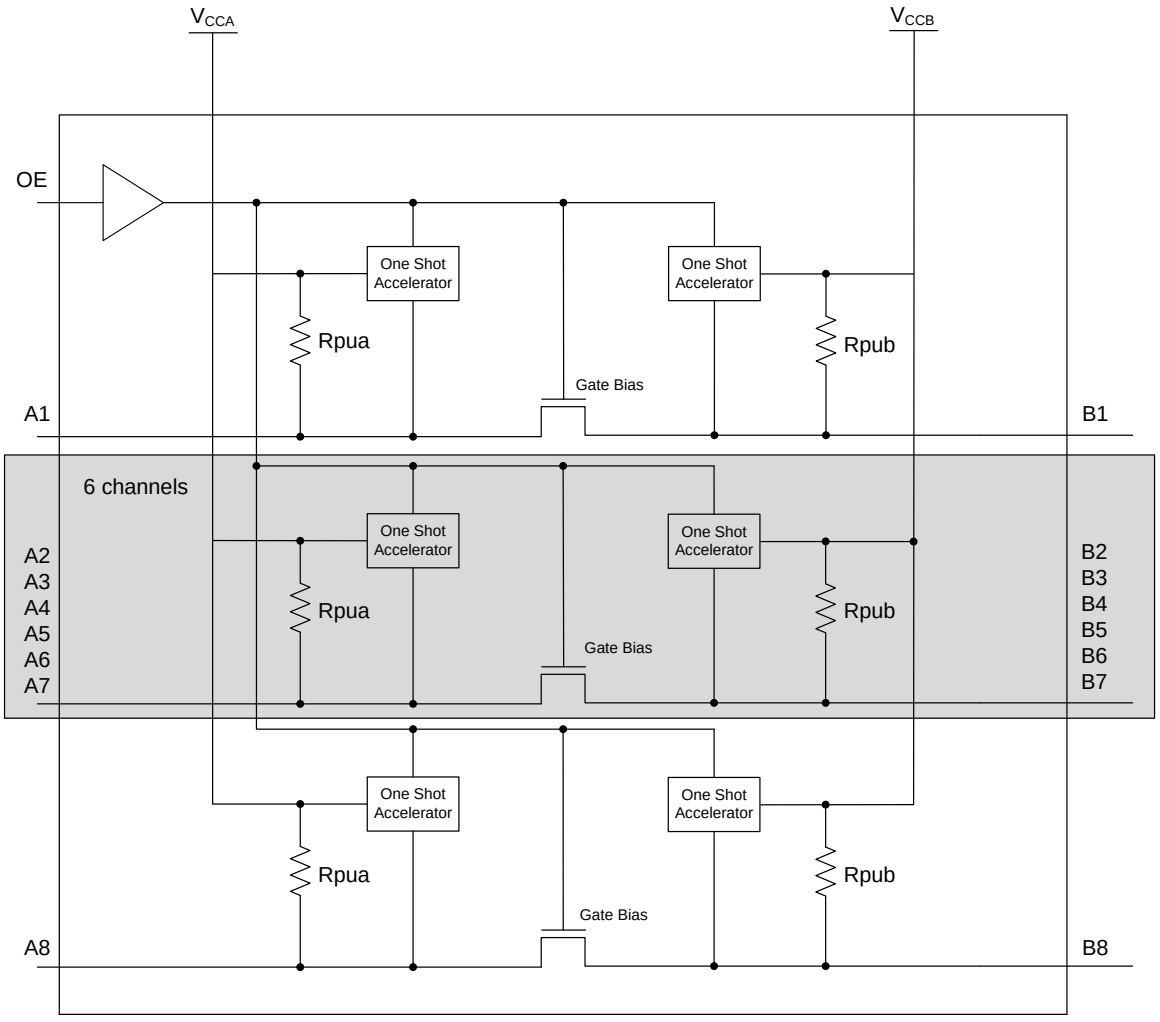


Figure 5. Block Diagram of UM3288 I/O Cell

Architecture

The UM3288 is Semi-Buffered Architecture (Figure 6). Each-channel has edge-rate accelerator circuitry (for both the high-to-low and low-to-high edges), a high-on-resistance N-pass MOSFET (on the order of 300 Ω to 500 Ω) and pull-up resistors (to provide DC-bias and drive capabilities). In a high state, the N-pass MOSFET switch off and the output can maintain high by R_{PU}. While in a low state, the N-pass MOSFET switch on and the output is driven to low by external driver. In both states, the output is designed to weak, so that they can be overdriven by an external driver when data on the bus starts flowing to the opposite direction.

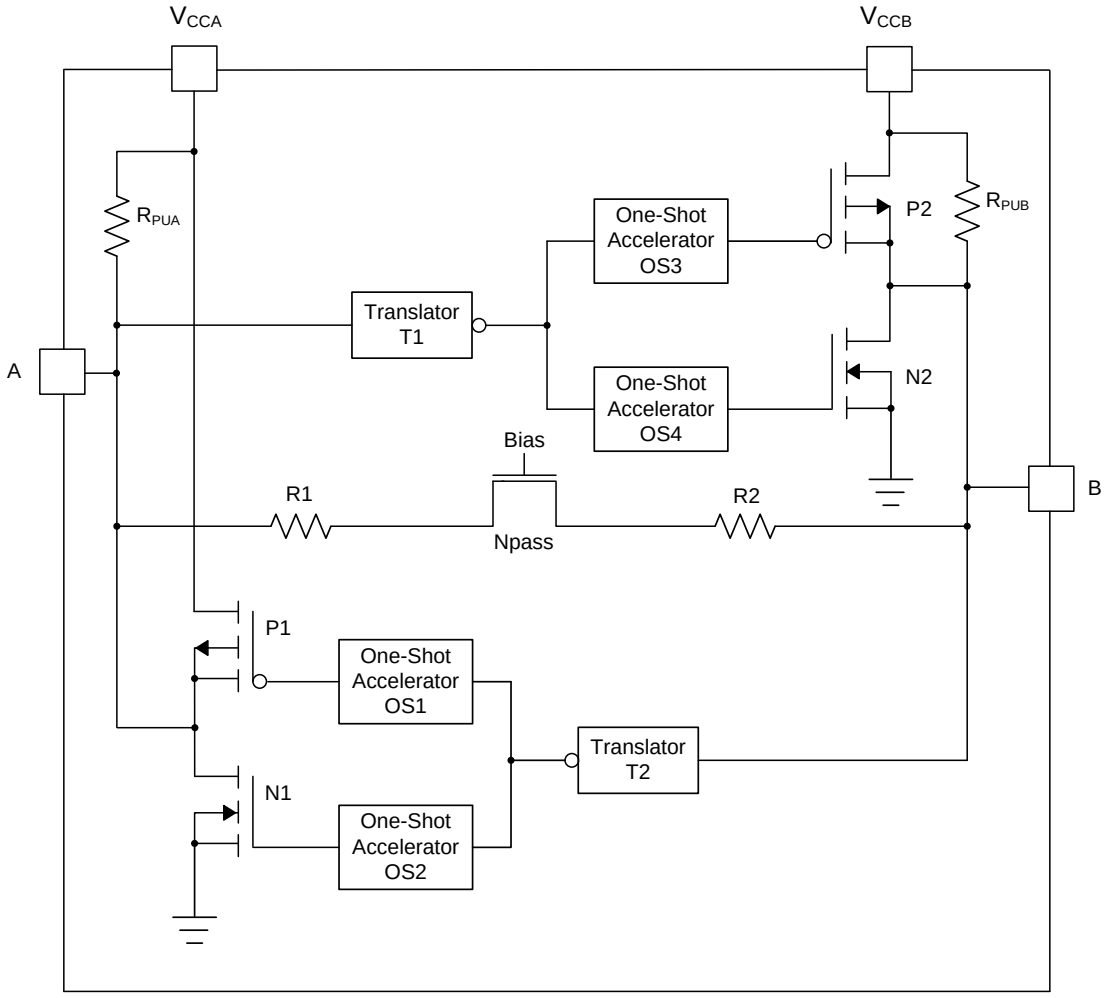


Figure 6. Architecture of UM3288 I/O Cell

The output one shot detects rising or falling edges on the A or B ports. During a rising edge, the one shot turns on the PMOS transistors (P1, P2) for a short duration, which speeds up the low-to-high transition. Similarly, during a falling edge, the one shot turns on the NMOS transistors (N1, N2) for a short duration, which speeds up the high-to-low transition.

Input Driver Requirements

The fall time (t_{fA}, t_{fB}) of a signal depends on the edge-rate and output impedance of the external device driving UM3288 data I/Os, as well as the capacitive loading on the data lines.
Similarly, the t_{PHL} and maximum data rates also depend on the output impedance of the external driver. The values for t_{fA}, t_{fB}, t_{PHL}, and maximum data rates in the data sheet assume that the output impedance of the external driver is less than 50Ω.

Output Load Considerations

The PCB layout should be practiced carefully with short PCB trace lengths to avoid excessive capacitive loading and to ensure that proper one-shot triggering takes place. PCB signal trace-lengths should be kept short enough such that the round trip delay of any reflection is less than the one-shot duration. This improves signal integrity by ensuring that any reflection sees a low impedance at the driver.
The maximum capacitance of the lumped load that can be driven also depends directly on the one-shot duration, also depends on the one-shot output resistance. It is recommend less than 100pF.With very heavy capacitive loads, the one-shot cannot drive fully to the positive rail, retriggering may take place.

Enable and Disable

The UM3288 has an OE pin input that is used to disable the device by setting the OE pin low, which places all I/Os in the Hi-Z state. The disable time (tdis) indicates the delay between the time when the OE pin goes low and when the outputs actually get disabled (Hi-Z). The enable time (ten) indicates the amount of time the design must allow for the one-shot circuitry to become operational after the OE pin goes high.

Pull-up or Pull-down Resistors on I/O Lines

The UM3288 has the smart pull-up resistors dynamically change value based on whether a low or a high is being passed through the I/O line. Each A-port I/O has a pull-up resistor (R_{PUA}) to V_{CCA} and each B-port I/O has a pull-up resistor (R_{PUB}) to V_{CCB}. R_{PUA} and R_{PUB} have a value of 40kΩ when the output is driving low. R_{PUA} and R_{PUB} have a value of 4kΩ when the output is driving high. R_{PUA} and R_{PUB} are disabled when OE=Low. This feature provides lower static power consumption (when the I/Os are passing a low), and supports lower VOL values for the same size pass-gate transistor, and helps improve simultaneous switching performance

When an open-drain driver is connected to the data I/Os , Each port is at a low level with an internal pull-up resistance of 40KΩ, that seriously affecting the T_R of the input signal, and the communication speed. It is recommended adding an external pull-up resistor in the input pin, that can decrease T_R and improve communication rate. Normally, an additional 4K pull-up resistor is added to the input side to increase the communication rate by 1Mbps, and so on.

Typical Operating Circuit

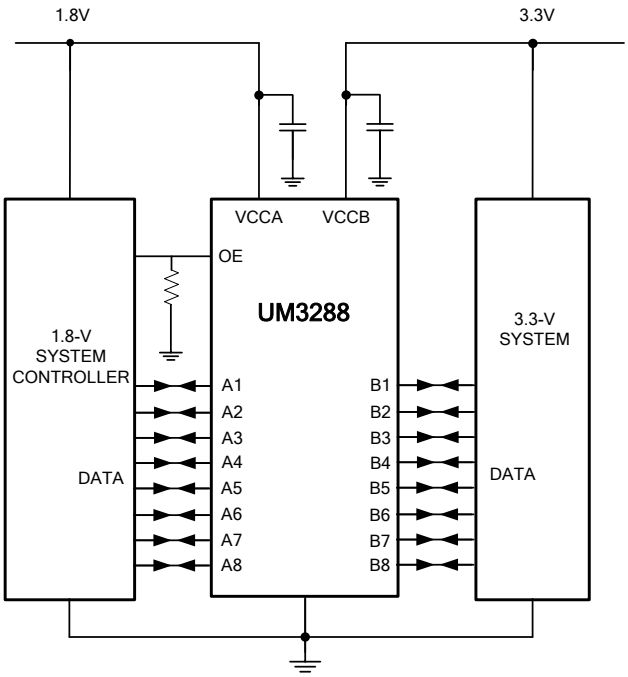
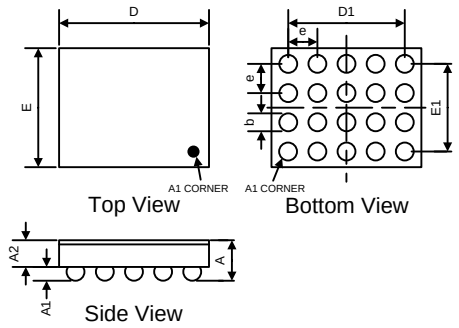


Figure 7. Typical Operating Circuit

Package Information

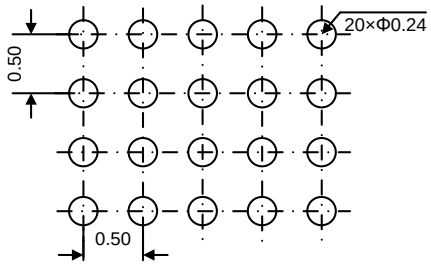
CSP20 2.4×1.9

Outline Drawing



DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	0.68	-	-	0.027
A1	0.21	0.231	0.24	0.0083	0.0091	0.0094
A2	0.40	0.42	0.44	0.0157	0.0165	0.0173
b	0.27	0.30	0.32	0.011	0.012	0.013
D	2.32	2.35	2.40	0.091	0.093	0.094
D1	2.00BSC			0.079BSC		
E	1.82	1.85	1.90	0.072	0.073	0.075
E1	1.50BSC			0.059BSC		
e	0.50BSC			0.020BSC		

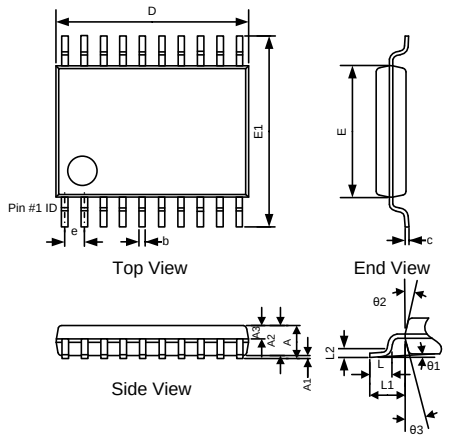
Land Pattern



NOTES:
1. Bump is Lead Free Sn/Ag/Cu.
2. Unit: mm.
3. Non-solder mask defined copper landing pad.
4. Laser Mark on silicon die back; back-lapped.

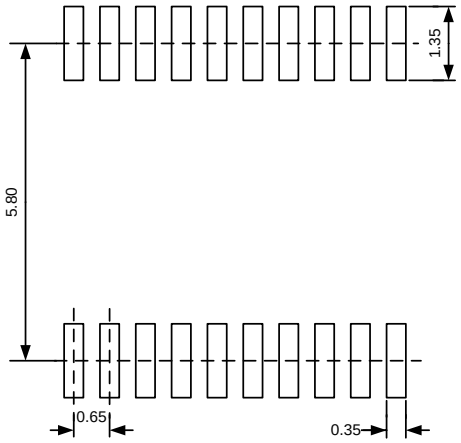
TSSOP20

Outline Drawing



Symbol	DIMENSIONS					
	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	-	-	1.20	-	-	0.047
A1	0.05	-	0.15	0.002	-	0.006
A2	0.80	-	1.05	0.031	-	0.041
A3	0.34	0.44	0.54	0.013	0.017	0.021
b	0.19	-	0.30	0.007	-	0.012
c	0.09	-	0.20	0.004	-	0.008
D	6.40	6.50	6.60	0.252	0.256	0.260
E	4.30	4.40	4.50	0.169	0.173	0.177
E1	6.20	6.40	6.60	0.244	0.252	0.260
e	0.65BSC			0.026BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00REF			0.039REF		
L2	0.25BSC			0.010BSC		
θ1	0°	-	8°	0°	-	8°
θ2	10°	12°	14°	10°	12°	14°
θ3	10°	12°	14°	10°	12°	14°

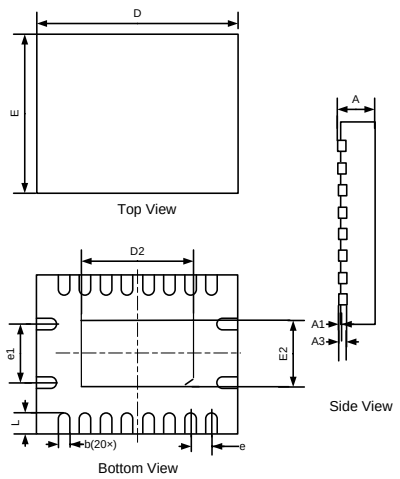
Land Pattern



NOTES:
1. Compound dimension: 6.50×4.40.
2. Unit: mm.
3. General tolerance ±0.05mm unless otherwise specified.
4. The layout is just for reference.

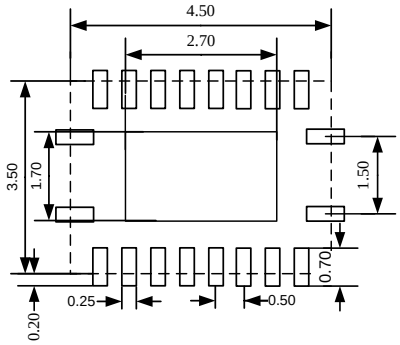
QFN20 4.5×3.5

Outline Drawing



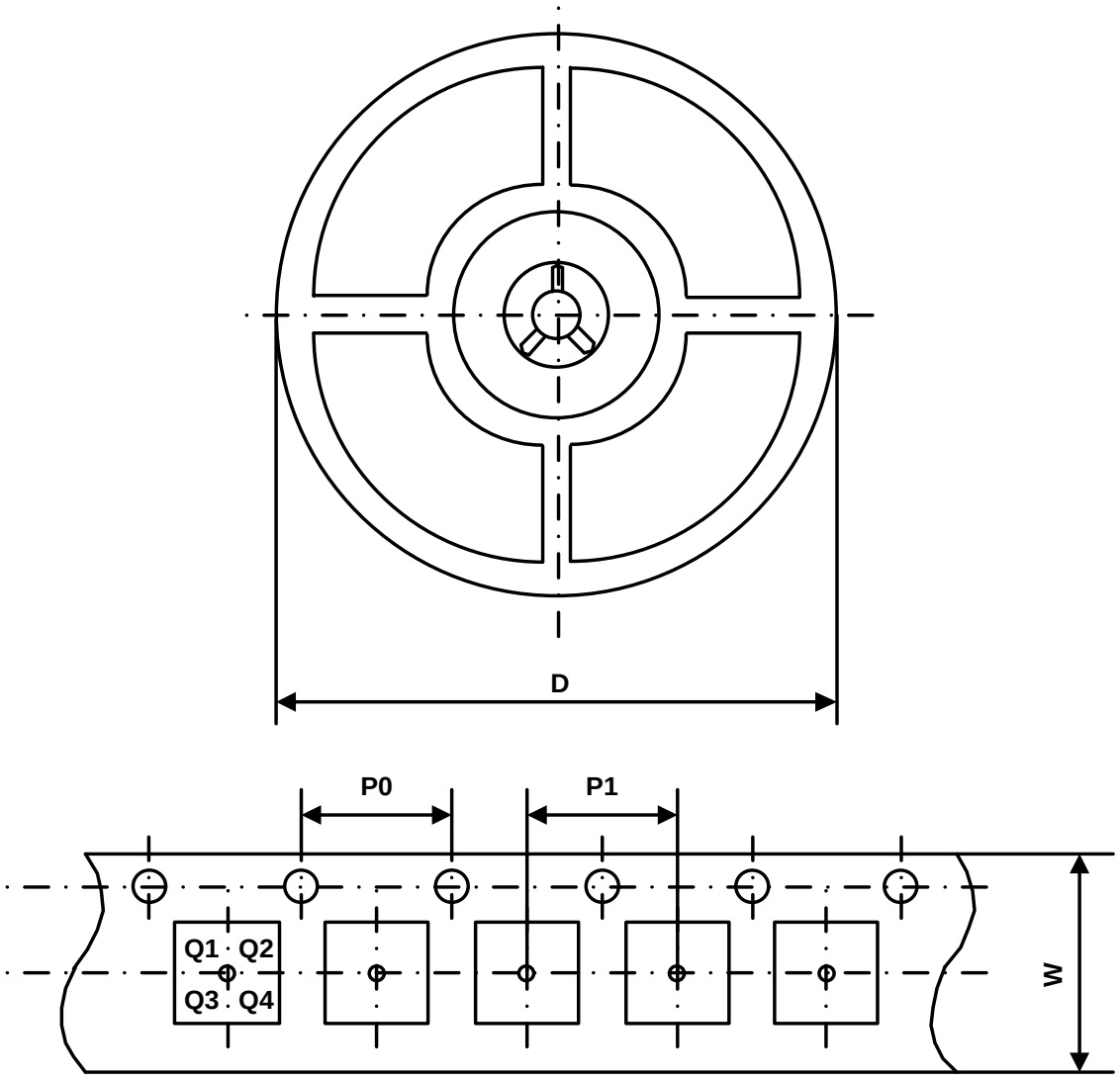
DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	0.70	0.75	0.80	0.028	0.030	0.032
A1	-	0.02	0.05	-	0.0008	0.002
A3	-	0.20	-	-	0.008	-
b	0.20	0.25	0.30	0.008	0.010	0.012
D	4.50BSC			0.180BSC		
D2	2.60	2.70	2.80	0.104	0.108	0.112
E	3.50BSC			0.140BSC		
E2	1.60	1.70	1.80	0.064	0.068	0.072
e	0.50BSC			0.020BSC		
e1	1.50BSC			0.060BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020

Land Pattern



NOTES:
1. Compound dimension: 4.50×3.50;
2. Unit: mm;
3.General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Packing Information



Part Number	Package Type	Carrier Width (W)	Pitch (P0)	Pitch (P1)	Reel Size (D)	PIN 1 Quadrant
UM3288H	CSP20 2.4×1.9	8 mm	4 mm	4 mm	180 mm	Q2
UM3288UK	TSSOP20	16 mm	4 mm	12 mm	330 mm	Q1
UM3288QA	QFN20 4.5×3.5	12 mm	4 mm	8 mm	330 mm	Q1

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