

1. General Description

The EMS4100 is a high-speed bidirectional passive switch in mux or demux configurations suited for USB Type-C™ application supporting USB 3.1 Gen 1 and Gen 2 data rates. Based on control pin SEL, the device provides switching on differential channels between Port B or Port C to Port A. The EMS4100 is a generic analog differential passive switch that can work for any high-speed interface applications requiring a common mode voltage range of 0 to 2 V and differential signaling with differential amplitude up to 1800 mVpp. It employs adaptive tracking that ensures the channel remains unchanged for the entire common mode voltage range. Excellent dynamic characteristics of the device allow high-speed switching with minimum attenuation to the signal eye diagram with very little added jitter. It consumes <2mW of power when operational and has a shutdown mode exercisable by EN pin resulting <20uW.

2. Features and Benefits

- 2-Differential Channel 1:2/2:1 Mux/DeMux
- USB 3.1 Super Speed 10Gbps Switch
- High Bandwidth: 1.35GHz @ -1dB
- Supports both AC coupled and DC coupled signals
- Isolation: -24dB @ 1.25Gbps
- Crosstalk: -34dB @ 1.25Gbps
- ESD Tolerance: 2kV HBM
- Low bit-to-bit skew, Bidirectional
- Wide VCC Operating Range: 1.5V ~ 5.0V
- Small Packaging, QFN1.8x2.6-16L and QFN2x3-18L

3.Applications

- USB Type-C Ecosystem
- Desktop and Notebook PCs
- Server/Storage Area Networks
- PCI Express Backplanes
- Shared I/O Ports
- FPD LinkII and FPD LinkIII Switching

4. Ordering Information

Table 1. Ordering information

Type number	Topside marking	Package		
		Name	Description	Quantity
EMS4100Q	ASW10	QFN1.8×2.6-16L	QFN package, 16 pins 1.8 mm × 2.6 mm; 0.6 mm (Max) height	3000
EMS4100N	A340UXYW	QFN2×3-18L	QFN package, 18 pins 2 mm × 3 mm; 0.4 mm (Max) height	3000

5. Block Diagram

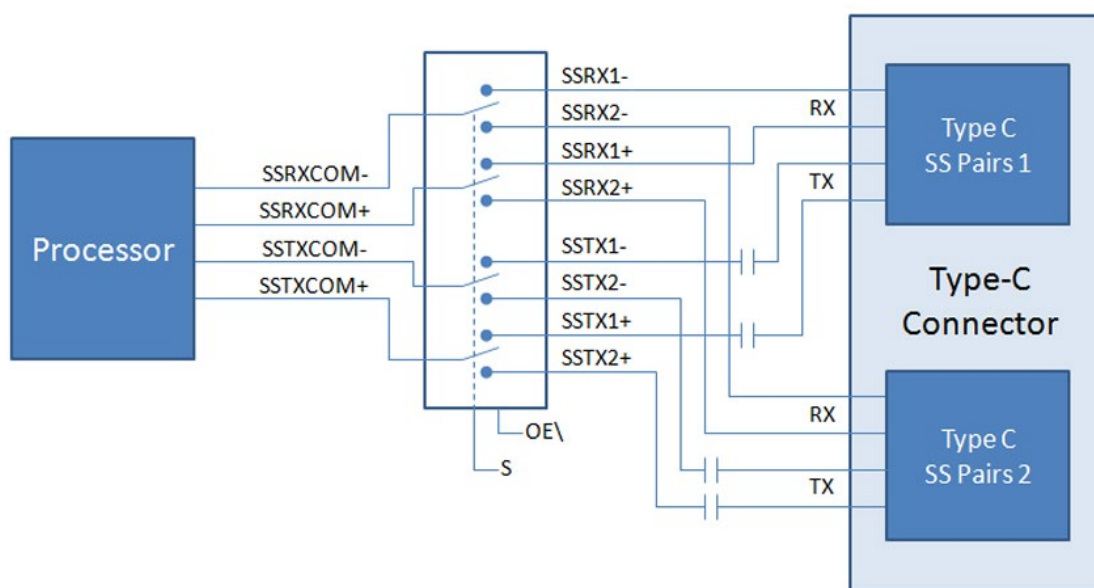


Fig 1. Block diagram

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6. Pinning Information

6.1. Pin map

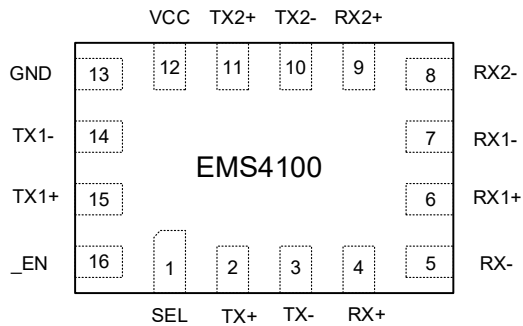


Fig 2. Top view pin configuration QFN1.8x2.6-16L

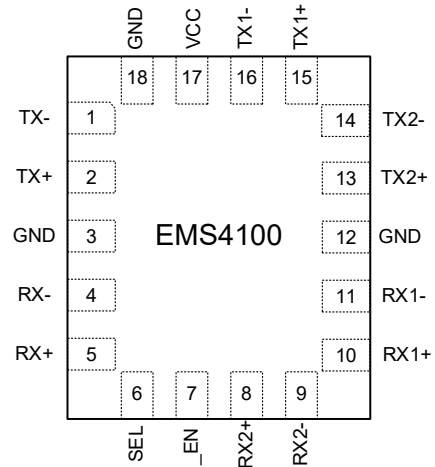


Fig 3. Top view pin configuration QFN2x3-18L

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6.2. Pin description

Table 2. Pin description

Symbol	Pin		Signal Type	Description
	QFN1.8x2.6-16L	QFN2x3-18L		
SEL	1	6	I	Switch logic control
TX+	2	2	I/O	Super Speed TX+ Common
TX-	3	1	I/O	Super Speed TX- Common
RX+	4	5	I/O	Super Speed RX+ Common
RX-	5	4	I/O	Super Speed RX- Common
RX1+	6	10	I/O	Super Speed RX1+
RX1-	7	11	I/O	Super Speed RX1-
RX2-	8	9	I/O	Super Speed RX2-
RX2+	9	8	I/O	Super Speed RX2+
TX2-	10	14	I/O	Super Speed TX2-
TX2+	11	13	I/O	Super Speed TX2+
VCC	12	17	Power	Supply Voltage
GND	13	3, 12, 18	GND	Ground
TX1-	14	16	I/O	Super Speed TX1-
TX1+	15	15	I/O	Super Speed TX1+
_EN	16	7	I	Chip Enable, Active Low

7.Functional Description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = Don't care; Z = high-impedance.

Input		Switch
_EN	SEL	
H	X	Switch off
L	L	RX to RX1, TX to TX1
L	H	RX to RX2, TX to TX2

8. Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Table 4. Absolute Maximum Ratings

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND.

Symbol	Parameter	Conditions	Min	Max	Unit
V _{CC}	supply voltage		-0.5	5.5	V
V _I	DC input voltage	[1]	-0.5	V _{CC}	V
V _{TX/RX}	Super Speed Data Channel TX / RX input voltage	[1]	-0.5	3.8	V
I _O	DC output current			50	mA
P _{tot}	total power dissipation	T _{amb} = -40 °C to + 125 °C		300	mW
T _J	Junction temperature		-40	125	°C
T _{stg}	storage temperature		-65	150	°C

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

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9. Electrical Characteristics

Table 5. Static characteristics

$T_a=25^{\circ}\text{C}$, $V_{CC}=1.8\text{V}$, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
POWER SUPPLY						
I_Q	VCC Quiescent Current	SEL=0 or VCC, _EN=0		28		μA
I_{PD}	Power-down Current	SEL=0 or VCC, _EN=VCC			1	μA
DC CHARACTERISTICS						
V_{IH}	Input logic high	$V_{CC}=1.8\sim 4.5\text{V}$	1.6			V
V_{IL}	Input logic low	$V_{CC}=1.8\sim 4.5\text{V}$			0.4	V
R_{UP}	_EN Internal pull-up resistor			2		$\text{M}\Omega$
R_{DN}	SEL Internal pull-down resistor			2		$\text{M}\Omega$
R_{ON_HS}	On-Resistance for TX/RX	$V_{IS}=0.2\text{V}$ $I_{ON}=8\text{mA}$		6.7	8	Ω
R_{FLAT_LP}	R_{ON} Flatness for TX/RX	$V_{IS}=0$ to 1.2V $I_{ON}=8\text{mA}$		0.8	1	Ω
R_{FLAT_LP}	R_{ON} Flatness for TX/RX	$V_{IS}=0$ to 0.2V $I_{ON}=8\text{mA}$		0.2	0.3	Ω
R_{MATCH}	R_{ON} Matching Between Channels	$V_{IS}=0$ to 1.2V $I_{ON}=8\text{mA}$		0.1		Ω
I_{OFF}	Switch Off Leakage Current	_EN=VCC, Tx, Rx =VCC TX1, TX2, RX1, RX2=0	-0.5		0.5	μA
AC CHARACTERISTICS						
t_{EN}	Enable Time _EN to Output	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		200	300	μS
t_{DIS}	Disable Time _EN to Output	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		40	60	nS
t_{ON}	Turn-On Time SEL to Output	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		400	600	nS
t_{OFF}	Turn-Off Time SEL to Output	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		40	60	nS
t_{BBM}	Break-Before-Make Time	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		250	500	nS
t_{PD}	Propagation Delay	$R_L=50\Omega$ $C_L=0\text{pF}$ $V_{IS}=0.6\text{V}$		0.25		nS
Off	Off Isolation	$R_L=50\Omega$ $f=1.25\text{GHz}$ $V_{IS}=0.2\text{V}_{PP}$		-24		dB

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X_{TALK}	Crosstalk	$R_L = 50\Omega$ $f = 1.25\text{GHz}$ $V_{IS} = 0.2V_{PP}$		-34		dB
BW_{-3dB}	-3dB Bandwidth	$R_L = 50\Omega$ $C_L = 0pF$ Signal 0dBm		4.5		GHz
CAPACITANCE						
C_{ON}	Switch On Capacitance	$V_{Bias} = 0.2V$, $f = 1.5\text{GHz}$		1.5		pF
C_{OFF}	Switch Off Capacitance	$V_{Bias} = 0.2V$, $f = 1.5\text{GHz}$		1.0		pF

[1] Flatness is defined as the difference between maximum and minimum value of ON-resistance at the specified analog signal voltage points.

[2] R_{ON} matching between channels is calculated by subtracting the channel with the lowest max R_{ON} value from the channel with the highest max R_{ON} value.

[3] Crosstalk is inversely proportional to source impedance.

10. Application Information

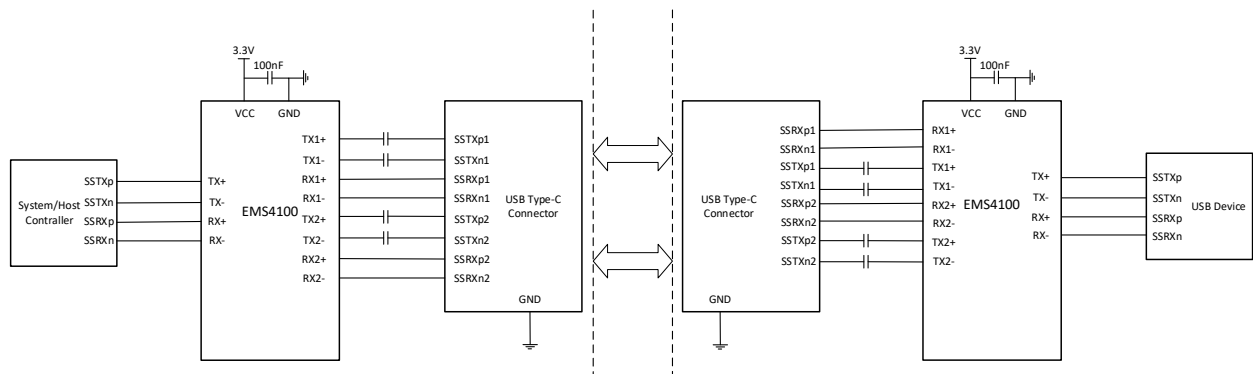


Fig 4. AC Coupling Capacitors for USB Type-C

11. PCB Layout

11.1. Layout Example

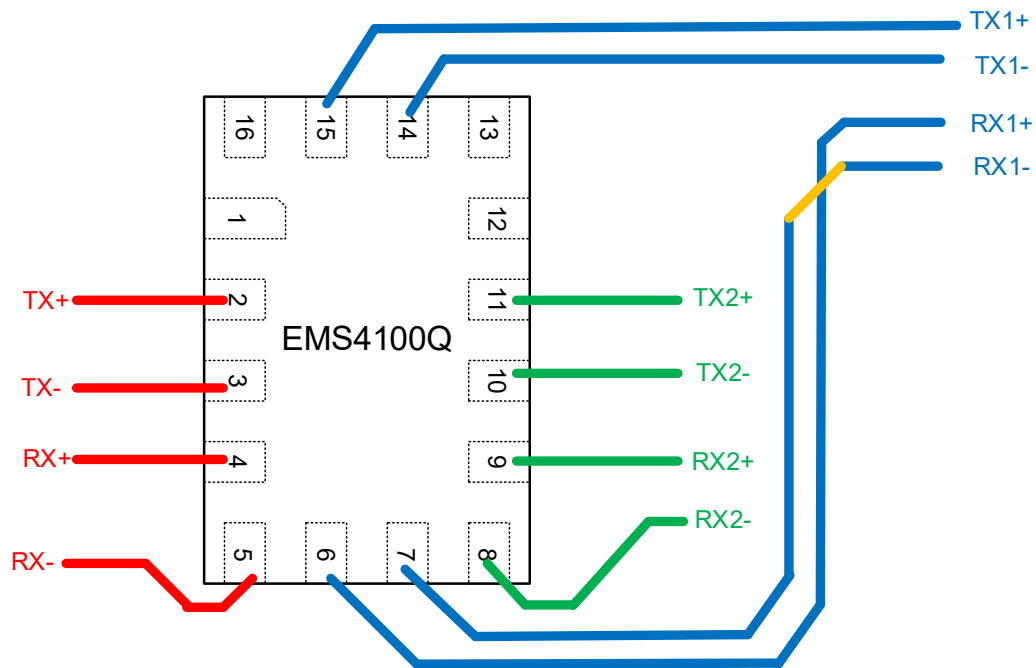


Fig 5. Layout example 1

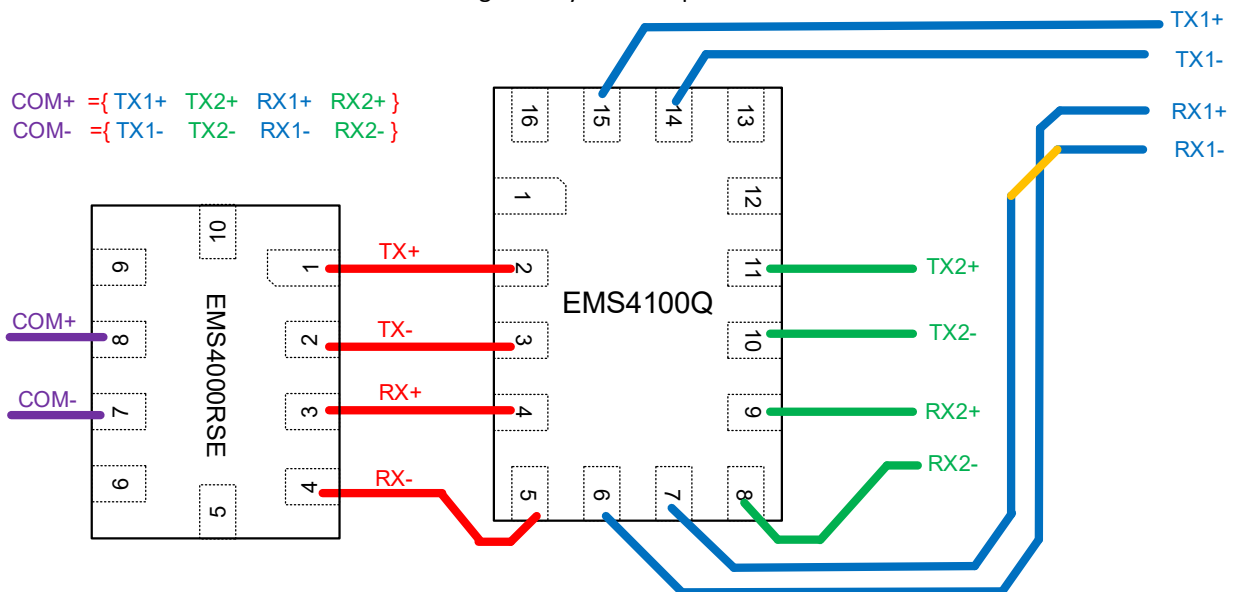
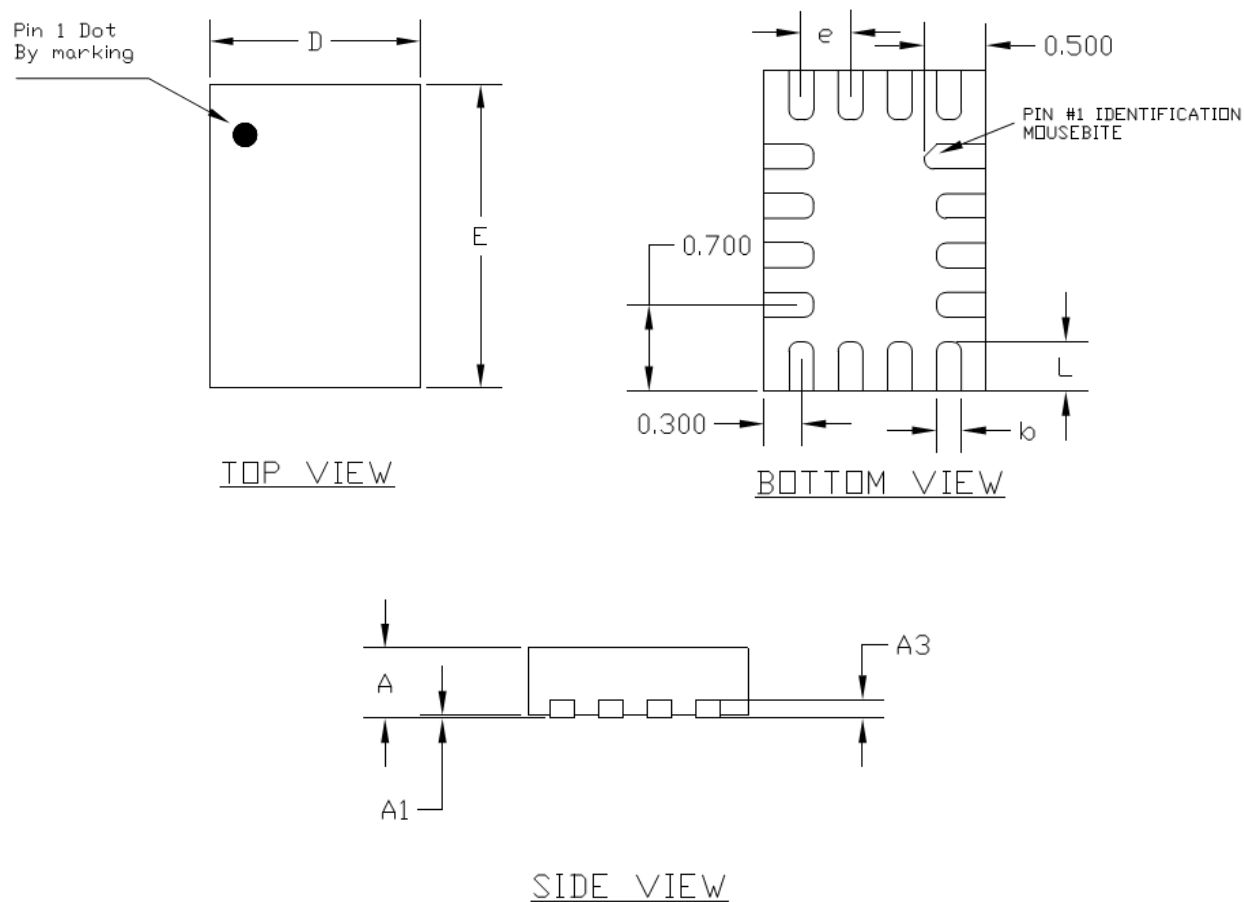


Fig 6. Layout example 2

12. Package Outline

QFN1.8x2.6-16L

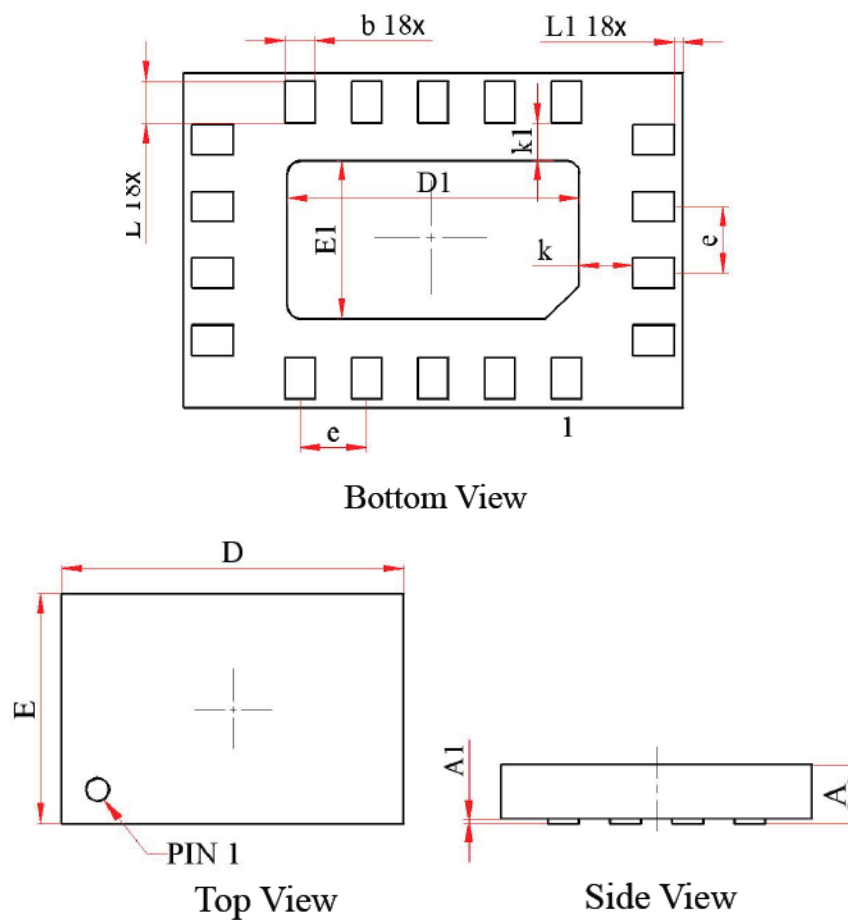


Symbol	Dimension in Millimeters		
	Min.	Typ.	Max.
A	0.50	0.55	0.60
A1	0.00	-	0.05
A3	0.15 Typ.		
D	1.75	1.80	1.85
E	2.55	2.60	2.65
L	0.30	0.40	0.50
b	0.15	0.20	0.25
e	0.40 Typ.		

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QFN2x3-18L



Symbol	Dimension In Millimeters			Dimension In Inches		
	Normal	Min	Max	Normal	Min	Max
A	--	0.340	0.400	--	0.013	0.016
A1	--	0.010	0.050	--	0.000	0.002
D	3.000	2.950	3.050	0.118	0.116	0.120
E	2.000	1.950	2.050	0.079	0.077	0.081
D1	1.750	1.700	1.800	0.069	0.067	0.071
E1	0.950	0.900	1.000	0.037	0.035	0.039
b	0.180	0.150	0.210	0.007	0.006	0.008
L	0.250	0.200	0.300	0.010	0.008	0.012
L1	0.050	0.010	0.090	0.002	0.000	0.004
k	0.325 REF			0.013 REF		
k1	0.225 REF			0.009 REF		
e	0.400 BSC			0.016 BSC		

13. Abbreviations

Table 6. Abbreviations

Acronym	Description
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

14. Revision History

Table 7. Revision history

Document ID	Release Date	Data sheet status	Change notice	Supersedes
EMS4100 Rev1.1	Oct 30, 2024	Product datasheet		EMS4100 Rev1.0
Modifications:	- Added QFN2x3-18L package. - AC Characteristics updated.			
EMS4100 Rev1.0	Oct 30, 2023	Product datasheet		