T1E1 Layout Guideline

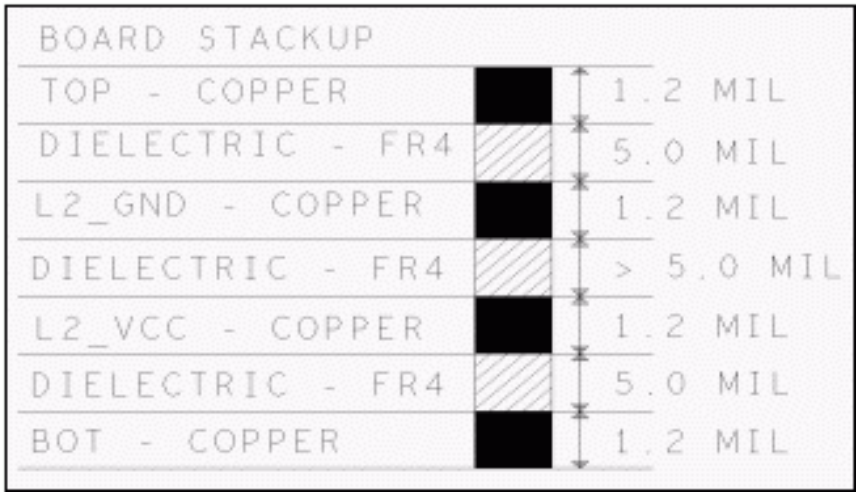
This application note shows the layout considerations, trace widths calculations, and different scenario, for designing products using Dallas Semiconductor/Maxim's T1/E1 products.

Overview

This application note provides guidelines for circuit board layouts of network interfaces using Dallas Semiconductor multi-port T1/E1 transceivers. The guideline uses the DS26528 part as an example, with different scenarios and conditions but is applicable to other Dallas Semiconductor T1/E1 products. The DS26528 is a single-chip 8-port combination framer and line interface unit (LIU) for T1, E1, and J1 applications. Each port is independently configurable, supporting both long-haul and short-haul lines.

Each layout shows the routing between the DS26528, the transformer and the connector. In particular, each layout shows the recommended trace widths to ensure the proper impedance for a given network interface. All layout board stack-ups are the same.

Layout board stackup:

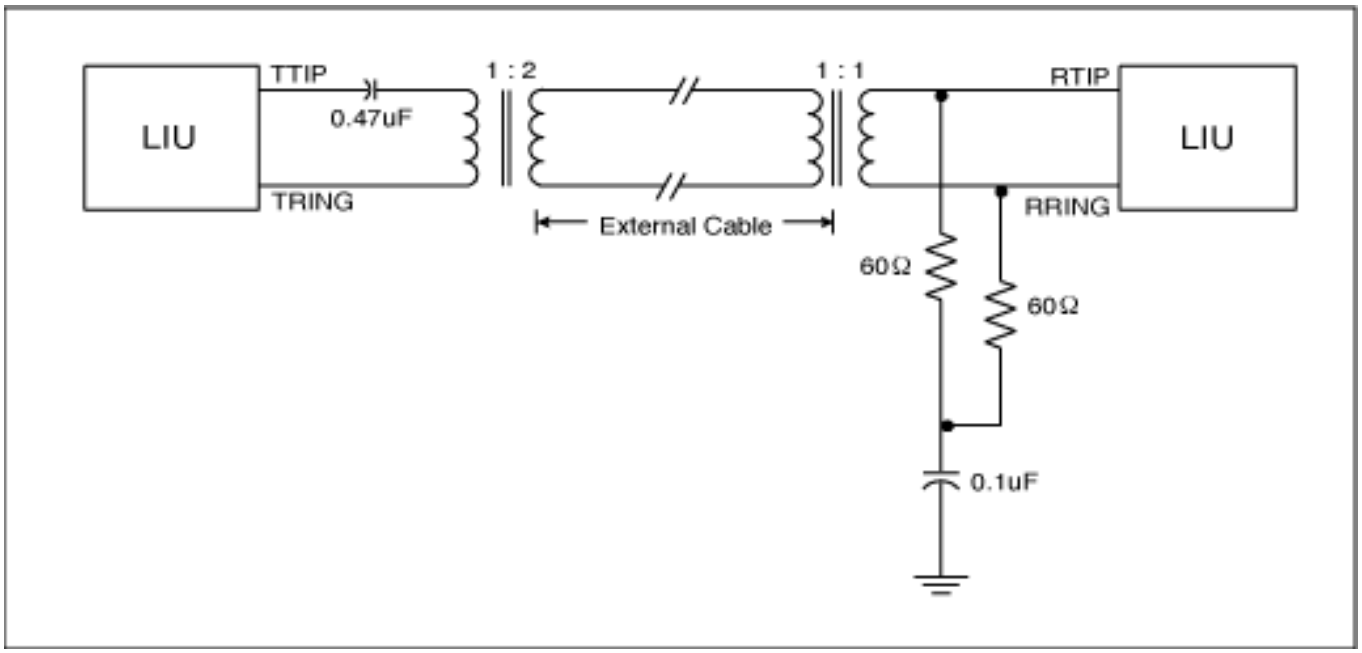


Layout Considerations:

1. Impedance
2. Location -- keep the signal on the same layer
3. Route TTIP & TRING and RTIP & RRING in parallel to each other
4. Trace widths -- keep traces as short as possible from the DS26528 to the transformer, and

from the transformer to the connector

Basic Network Interface:



Below is an example of the trace width calculation for a T1 interface with 100Ω impedance:

Surface Materials	Thickness	Dielectric Constant	Line Widths	Impedance
TTIP and TRING @ 25Ω				
Top Conductor Cooper	1.2MIL	N/A	25 MIL	25Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A
RTIP and RRING @ 50Ω				
Top Conductor Cooper	1.2MIL	N/A	8.5 MIL	50Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A

Below is an example of the trace width calculation for an E1 interface with 75Ω impedance:

Surface Materials	Thickness	Dielectric Constant	Line Widths	Impedance
TTIP and TRING @ 18.75Ω				
Top Conductor Cooper	1.2MIL	N/A	35 MIL	18.75Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A
RTIP and RRING @ 37.5Ω				

Top Conductor Cooper	1.2MIL	N/A	14 MIL	37.5Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A

Below is an example of the trace width calculation for an E1 interface with 120Ω impedance:

Surface Materials	Thickness	Dielectric Constant	Line Widths	Impedance
TTIP and TRING @ 30Ω				
Top Conductor Cooper	1.2MIL	N/A	20 MIL	30Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A
RTIP and RRING @ 60Ω				
Top Conductor Cooper	1.2MIL	N/A	6 MIL	60Ω
Dielectric FR-4	5MIL	4.5	N/A	N/A
L2_GND Conductor Copper	1.2MIL	N/A	N/A	N/A

Note: The impedance was calculated with Cadence® Allegro.

Layout Examples

1. The layout of a single E1 port interfacing to BNC connector with 75Ω impedance. All figures are twice the actual size.

Table 1. Layout Components

Name	Qty	Description	Supplier	Part Number
C1	1	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2	1	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1, J2	2	Connector BNC 75Ω RA 5 Pin	Trompetor	UCBJR220
R1, R2	2	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R3, R4	2	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1	1	Transformer, 1CT to 1CT & 1CT to 2CT, 16P SMT	Pulse	T1094
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

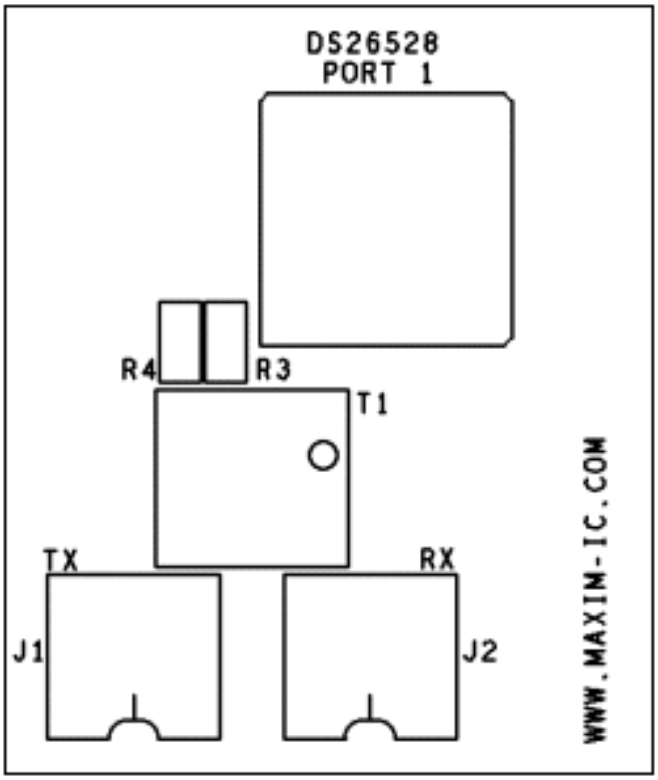


Figure 1.1 E1x1 75Ω impedance -- Silkscreen top layer layout

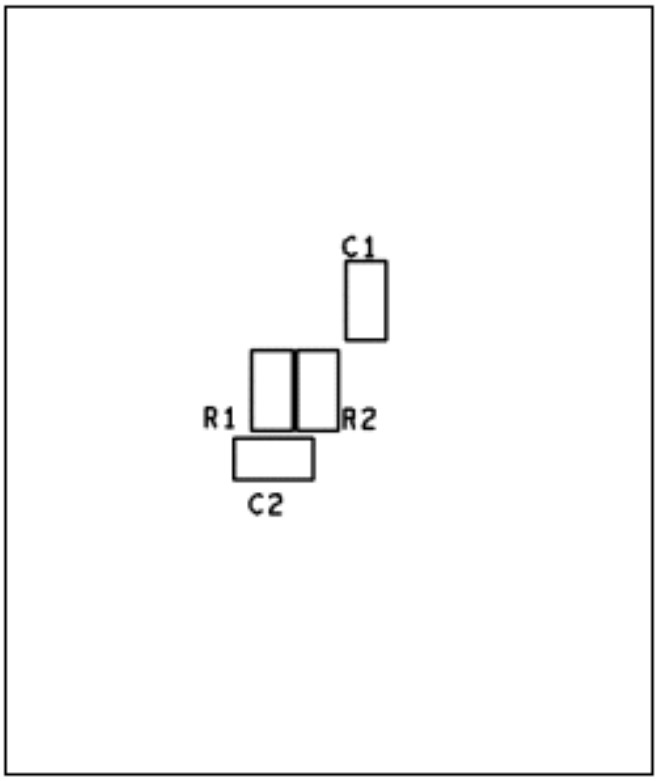


Figure 1.2 E1x1 75Ω impedance -- Silkscreen bottom layer layout (view mirrored)

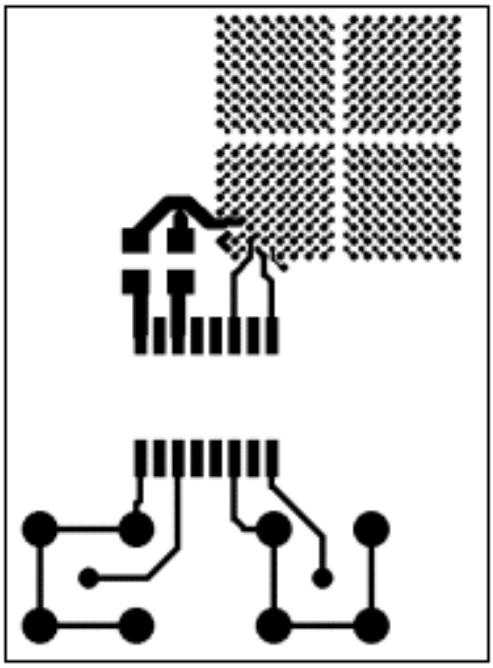


Figure 1.3 E1x1 75Ω impedance -- Top conducting layer layout

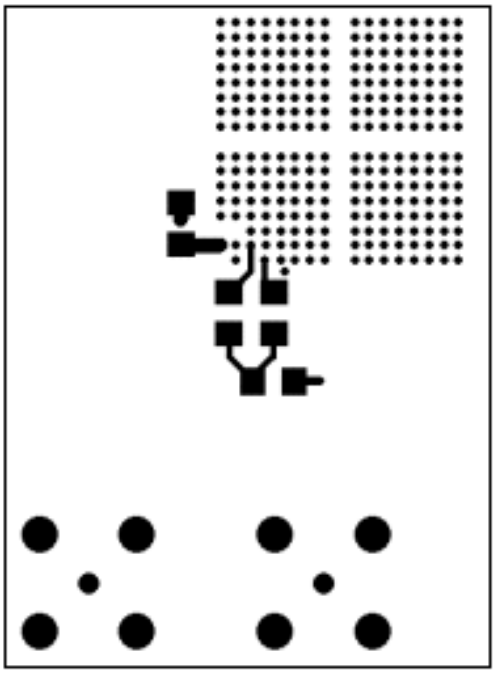


Figure 1.4 E1x1 75Ω impedance -- Bottom conducting layer layout

2. The layout of a single T1 port interfacing to RJ48 connector with 100Ω impedance. All figures

are twice the actual size.

Table 2. Layout Components

Ref Des	Qty	Description	Supplier	Part Number
C1	1	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2	1	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1	1	RJ48 8 Pin Single Port Connector	Molex	15-43-8588
R1, R2	2	Resistor 1206 60.4W 1/8W 1%	Panasonic	ERJ-8ENF60R4V
T1	1	Transformer, 1CT to 1CT & 1CT to 2CT, 16P SMT	Pulse	T1094
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

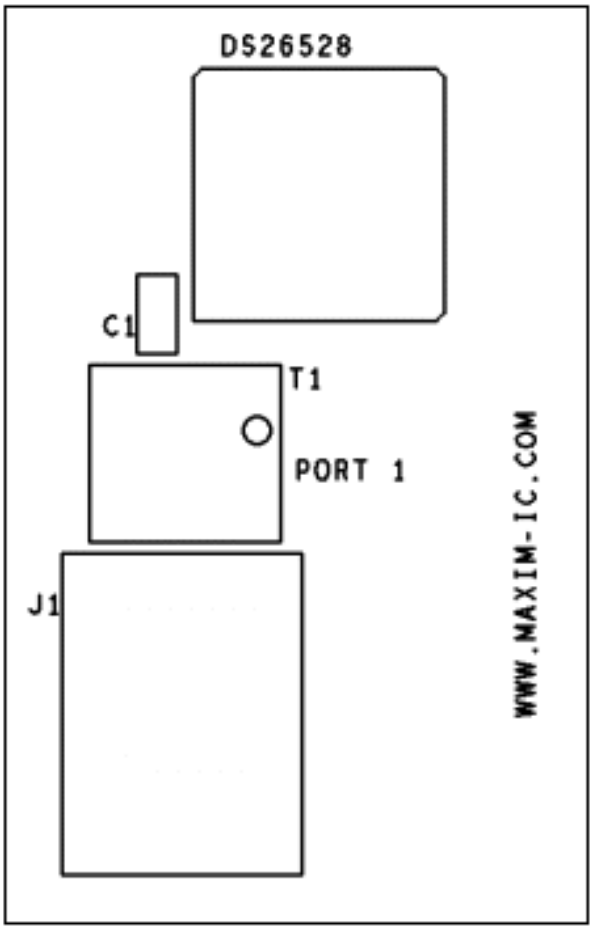


Figure 2.1 T1x1 100Ω impedance -- Silkscreen top layer layout

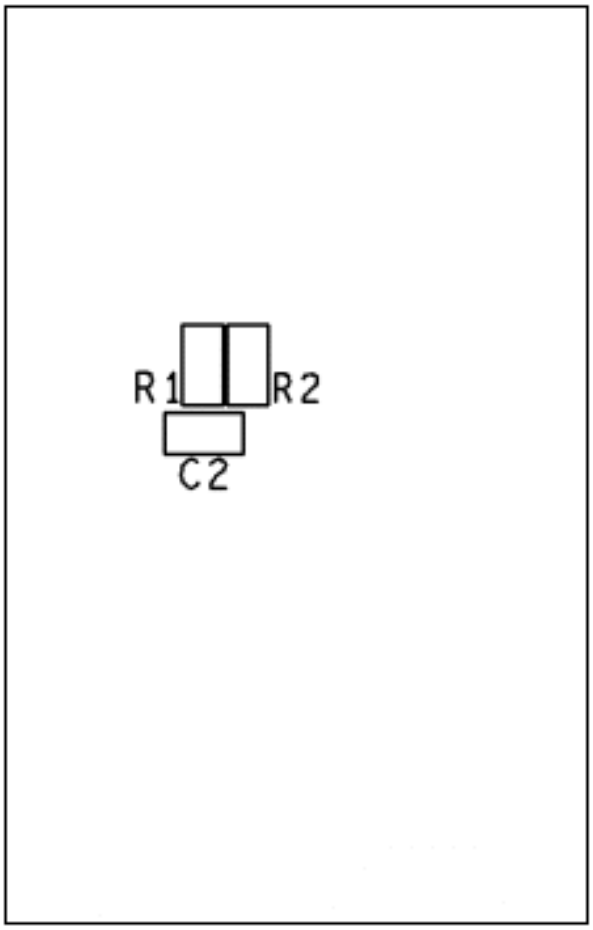


Figure 2.2 T1x1 100Ω impedance -- Silkscreen bottom layer layout (view mirrored)

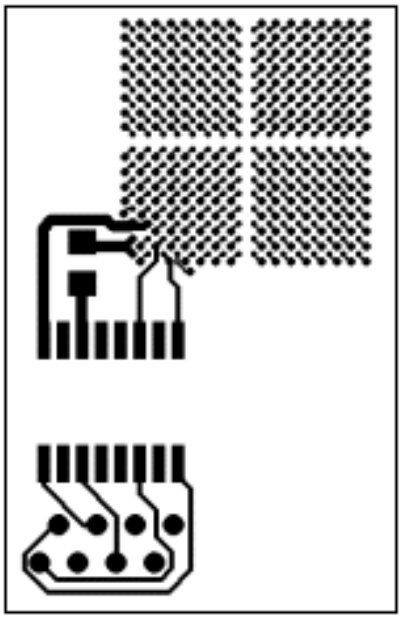


Figure 2.3 T1x1 100Ω impedance -- Top conducting layer layout

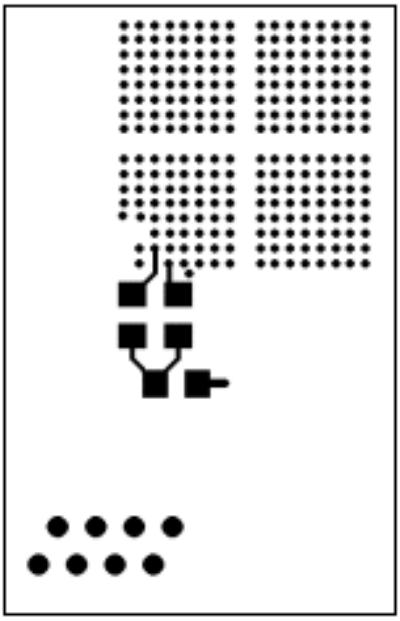


Figure 2.4 T1x1 100Ω impedance -- Bottom conducting layer layout

3. The layout of a single E1 port interfacing to RJ45 connector with 120Ω impedance. All figures are twice the actual size.

Table 3. Layout Components

Name	Qty	Description	Supplier	Part Number
C1	1	1206 Ceram 1uF 16v 10%	Panasonic	ECJ-3YB1C105K
C2	1	1206 Ceram .1uF 50v 10%	Panasonic	ECJ-3VB1H104K
J1	1	RJ48 8 pin single port connector	Molex	15-43-8588
R1, R2	2	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R3, R4	2	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1	1	Transformer, 1CT_1CT & 1CT_2CT, 16P SMT	Pulse	T1094
U1	1	Octal Transceiver 0-70c 256p BGA	Dallas Semiconductor	DS26528

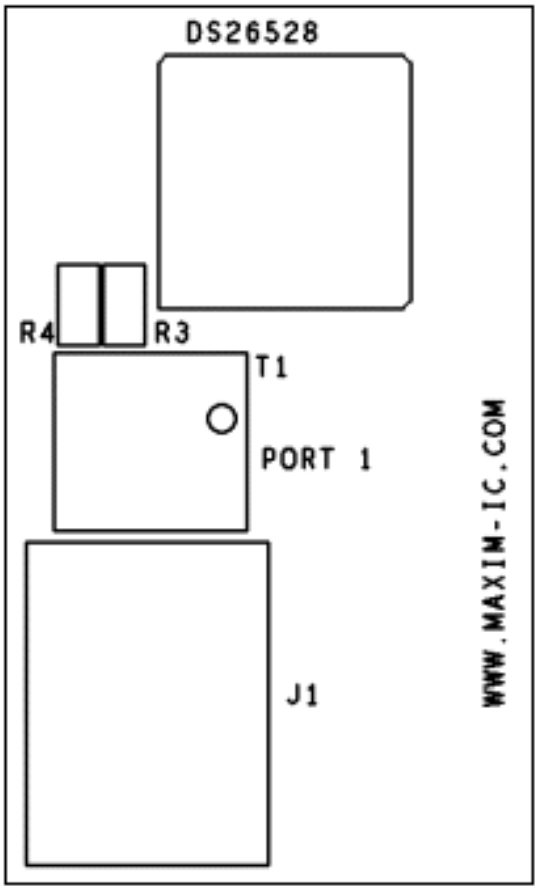


Figure 3.1 E1x1 120Ω impedance -- Silkscreen top layer layout

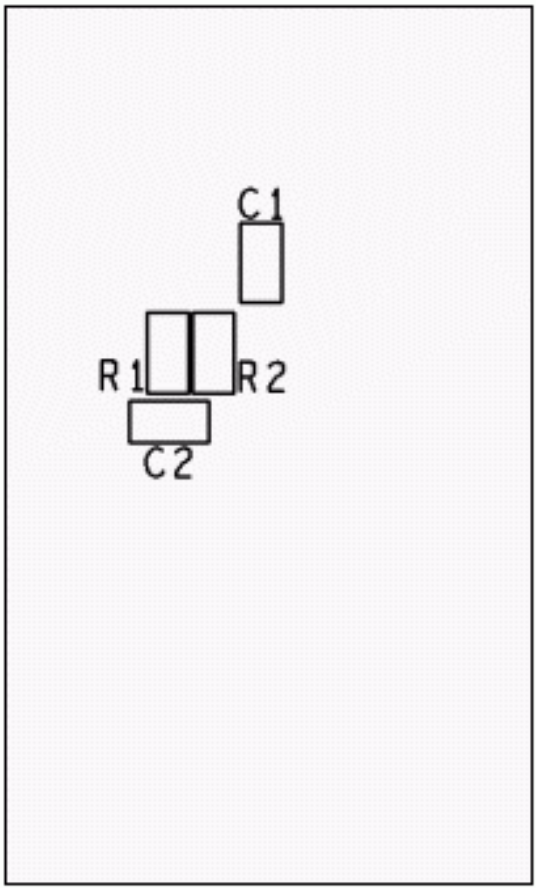


Figure 3.2 E1x1 120Ω impedance -- Silkscreen bottom layer layout (view mirrored)

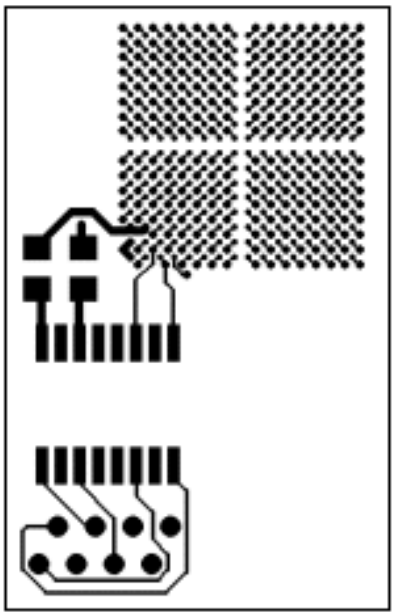


Figure 3.3 E1x1 120Ω impedance -- Top conducting layer layout

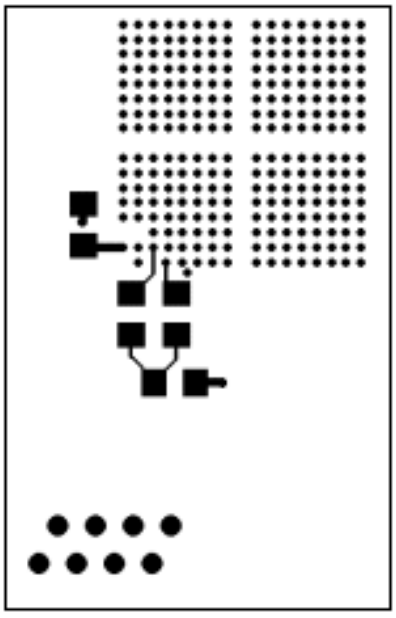


Figure 3.4 E1x1 120Ω impedance -- Bottom conducting layer layout

4. The layout of four E1 ports interfacing to BNC connectors with 75Ω impedance. All figures are actual size.

Table 4. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7	4	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8	4	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1, J3, J5, J6	4	Connector BNC 75Ω RA 5 Pin	Trompetor	UCBJR22
J2, J4, J7, J8	4	Connector BNC 75Ω Vertical 5Pin	Cambridge	CP-BNCPC-004
R1, R2, R5, R6, R9-R12	8	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R3, R4, R7, R8, R13-R16	8	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1	1	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 Pin	Pulse	TX1475
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

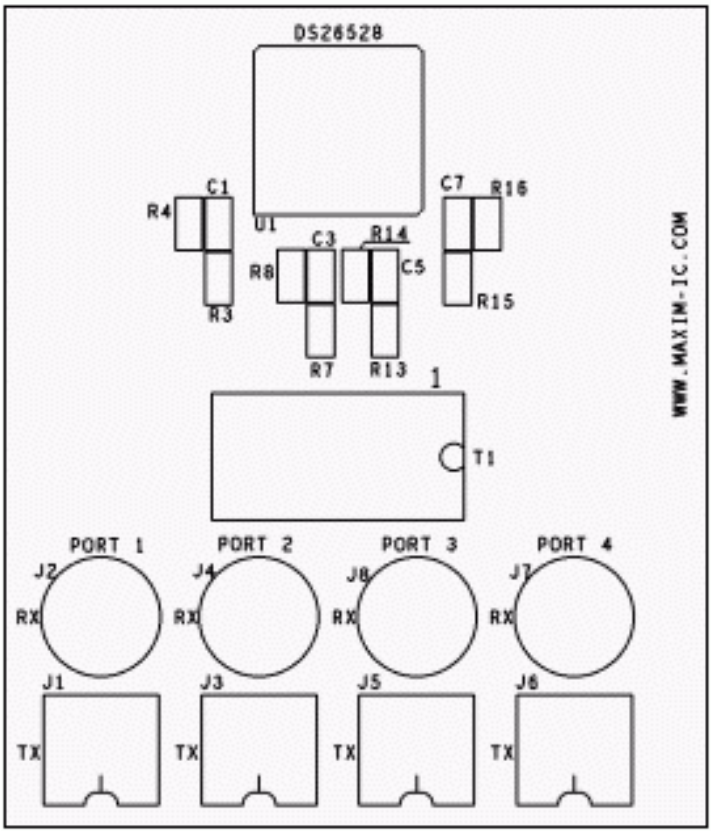


Figure 4.1 E1x4 75Ω impedance -- Silkscreen top layer layout

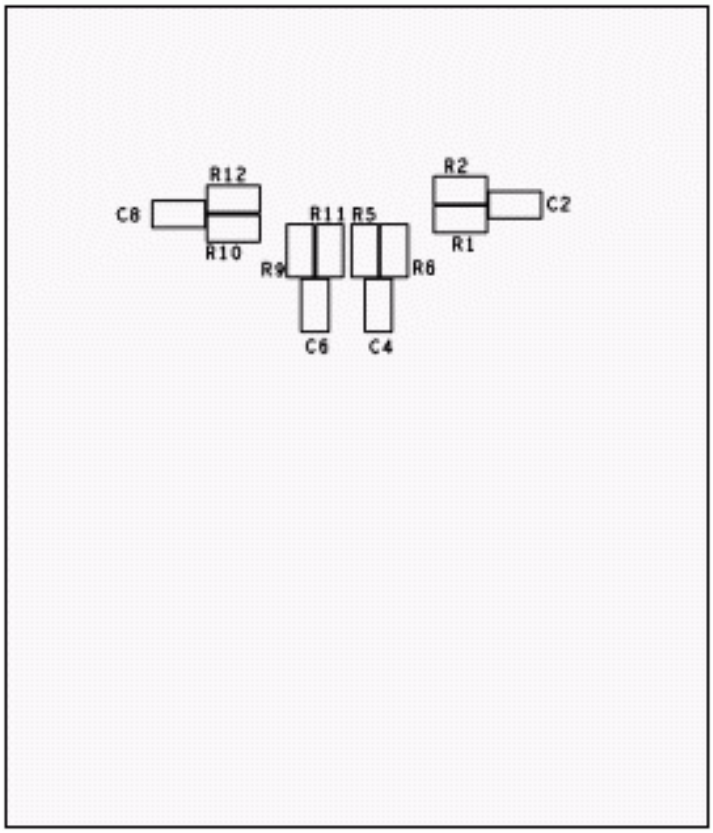


Figure 4.2 E1x4 75Ω impedance -- Silkscreen bottom layer layout (view

mirrored)

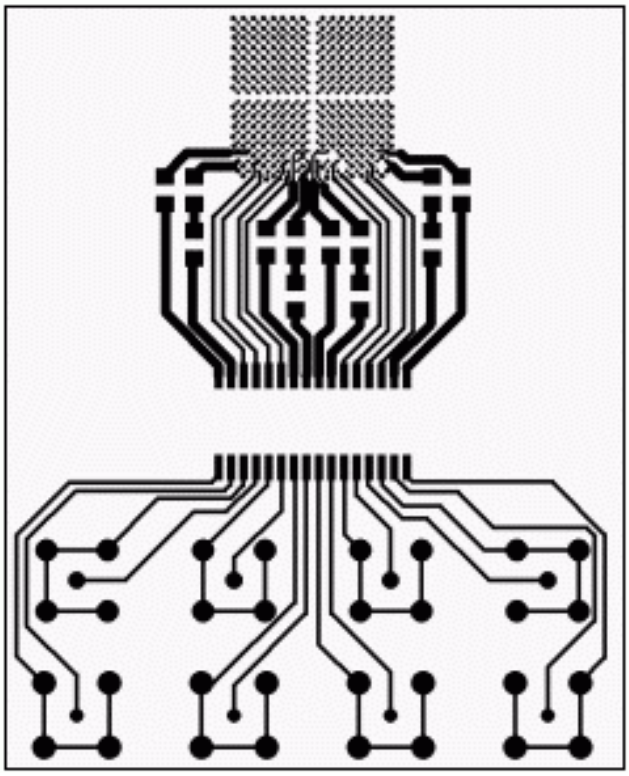


Figure 4.3 E1x4 75Ω impedance -- Top conducting layer layout

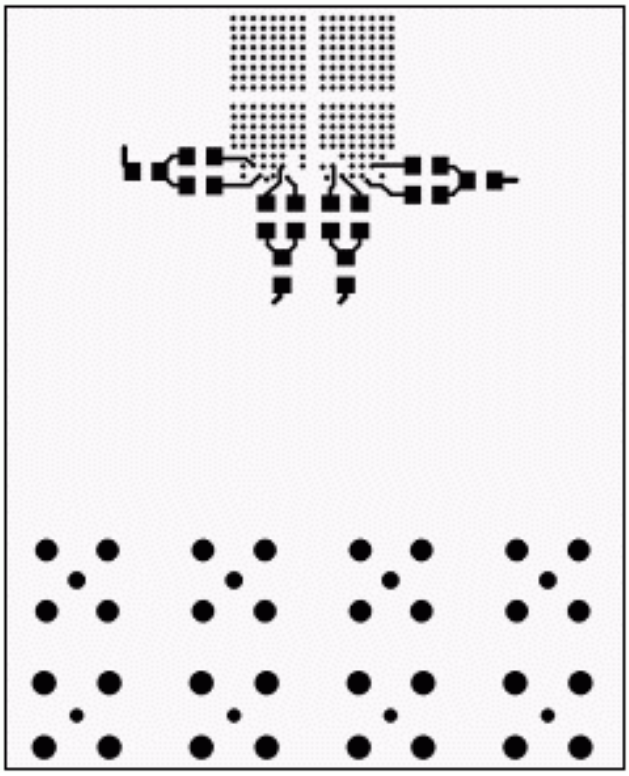


Figure 4.4 E1x4 75Ω impedance -- Bottom conducting layer layout

5. The layout of four T1 ports interfacing to RJ45 connectors with 100Ω impedance. All figures are actual size.

Table 5. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7	4	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8	4	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1	1	RA RJ45 8Pin 4 Port Jack	Molex	43223-8140
R1, R2, R5, R6, R9-R12	8	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
T1	1	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 Pin	Pulse	TX1475
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

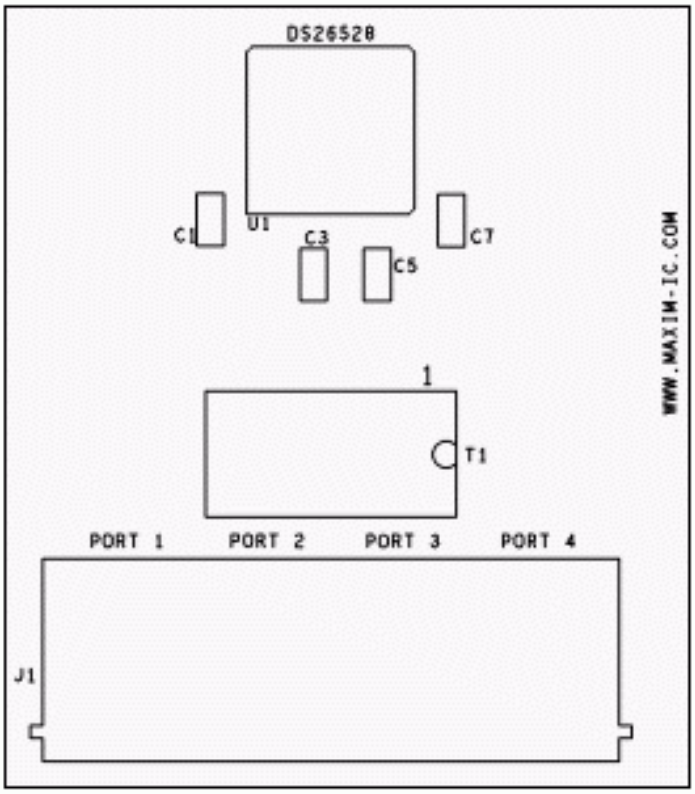


Figure 5.1 T1x4 100Ω impedance -- Silkscreen top layer layout

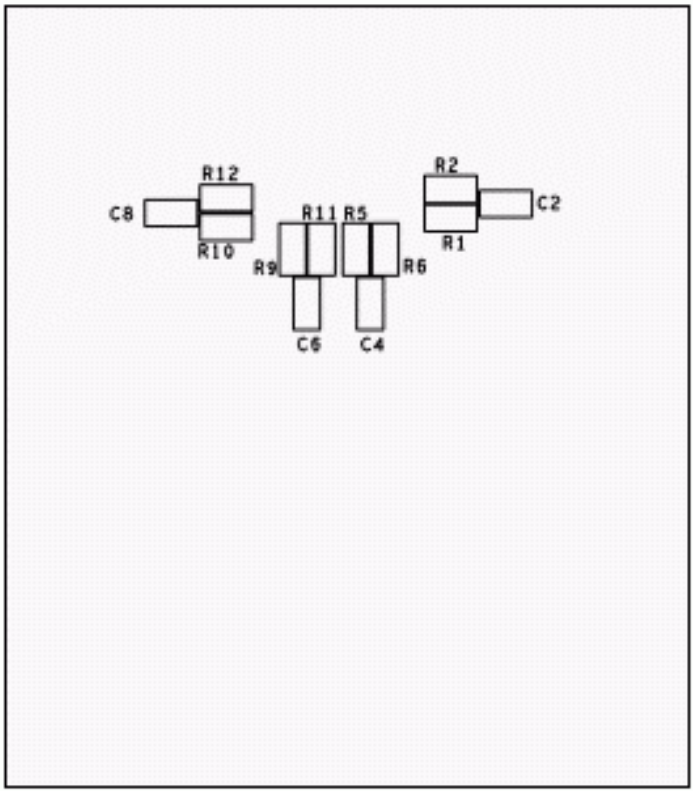


Figure 5.2 T1x4 100Ω impedance -- Silkscreen bottom layer layout (view mirrored)

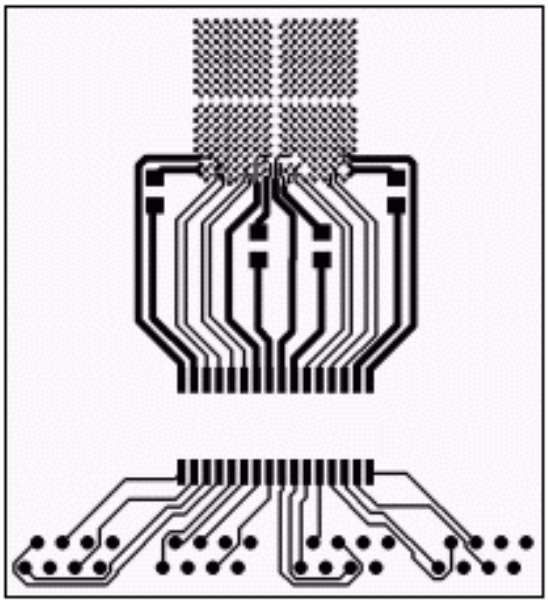


Figure 5.3 T1x4 100Ω impedance -- Top conducting layer layout

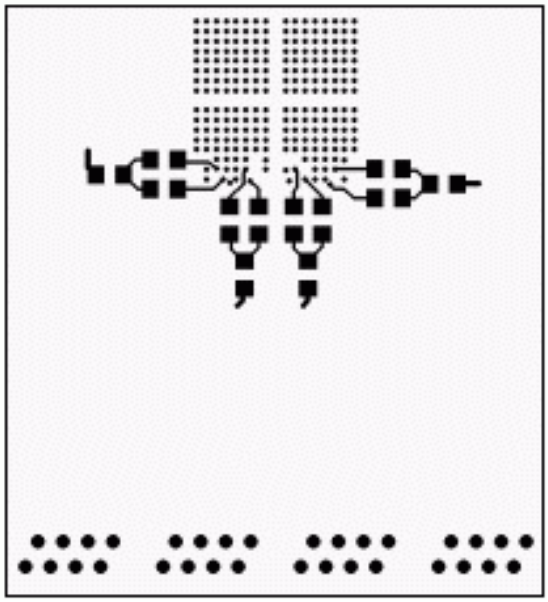


Figure 5.4 T1x4 100Ω impedance -- Bottom conducting layer layout

6. The layout of four E1 ports interfacing to RJ45 connectors with 120Ω impedance. All figures are actual size.

Table 6. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7	4	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8	4	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1	1	RA RJ45 8Pin 4Port Jack	Molex	43223-8140
R3, R4, R7, R8, R13-R16	8	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1	1	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 Pin	Pulse	TX1475
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

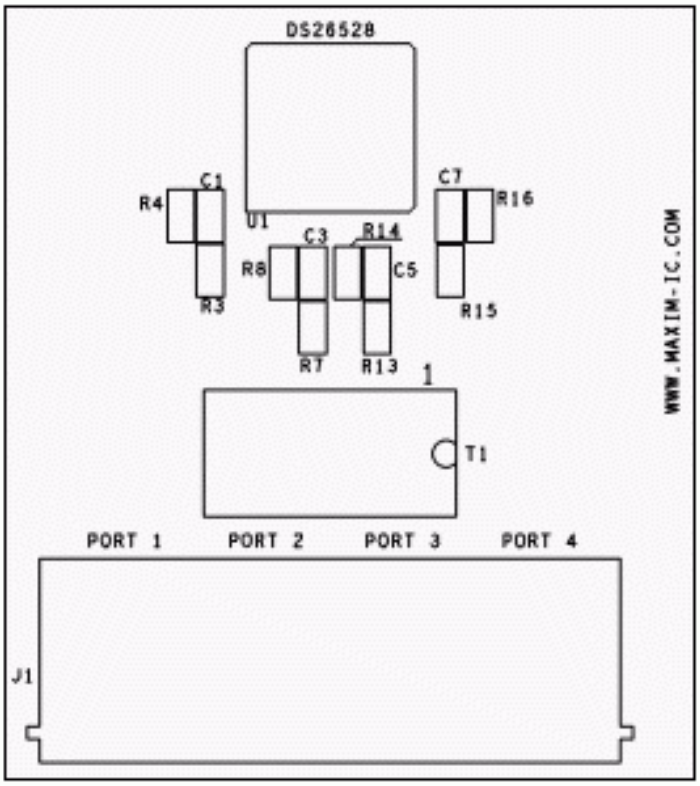


Figure 6.1 E1x4 120Ω impedance -- Silkscreen top layer layout

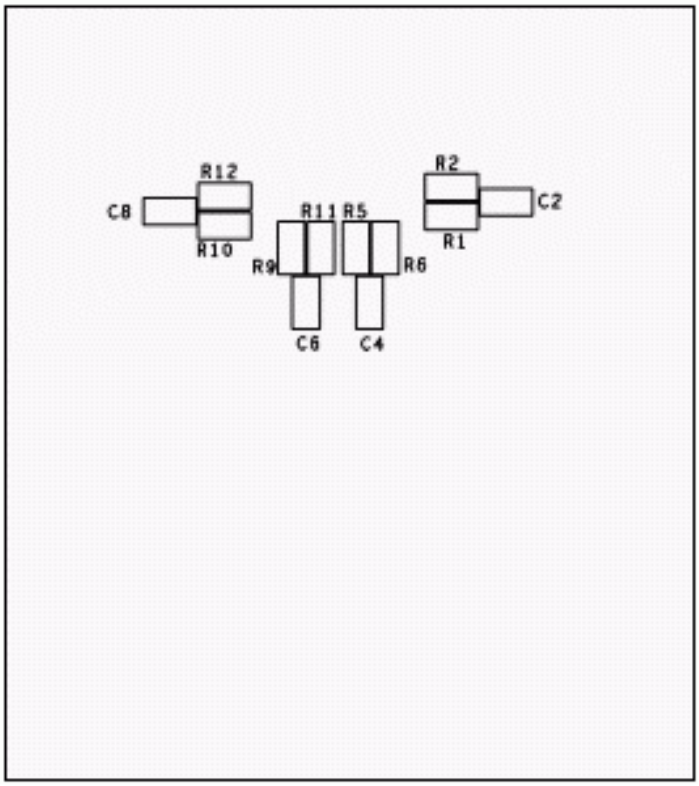


Figure 6.2 E1x4 120Ω impedance -- Silkscreen bottom layer layout (view mirrored)

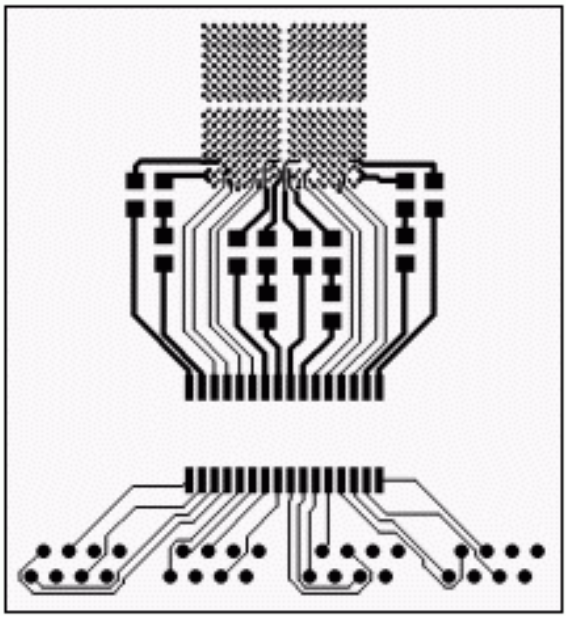


Figure 6.3 E1x4 120Ω impedance -- Top conducting layer layout

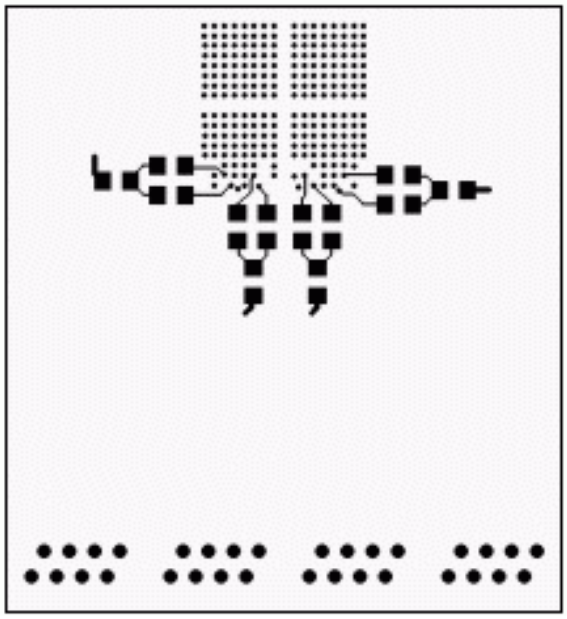


Figure 6.4 E1x4 120Ω impedance -- Bottom conducting layer layout

7. The layout of eight E1 ports interfacing to BNC connectors with 75Ω impedance. All figures are actual size.

Table 7. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7, C9, C11,C13, C15	8	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8, C10, C12,C14, C16	8	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1, J4, J6, J8, J10, J12, J14, J15	8	Connector BNC 75Ω Vertical 5 Pin	Cambridge	CP-BNCPC-004
J2, J3, J5, J7, J9, J11, J13, J16	8	Connector BNC 75Ω RA 5 Pin	Trompetor	UCBJR220
R1, R2, R5, R6, R9-R12,R17, R18, R20, R23, R25-R28	16	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R3, R4, R7, R8, R13-R16,R19, R21, R22, R24,R29-R32	16	Resistor 1206 0W 1/8Ω 5%	Panasonic	ERJ-8GEYJ0R00V
T1, T2	2	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 PIN	Pulse	TX1475

U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

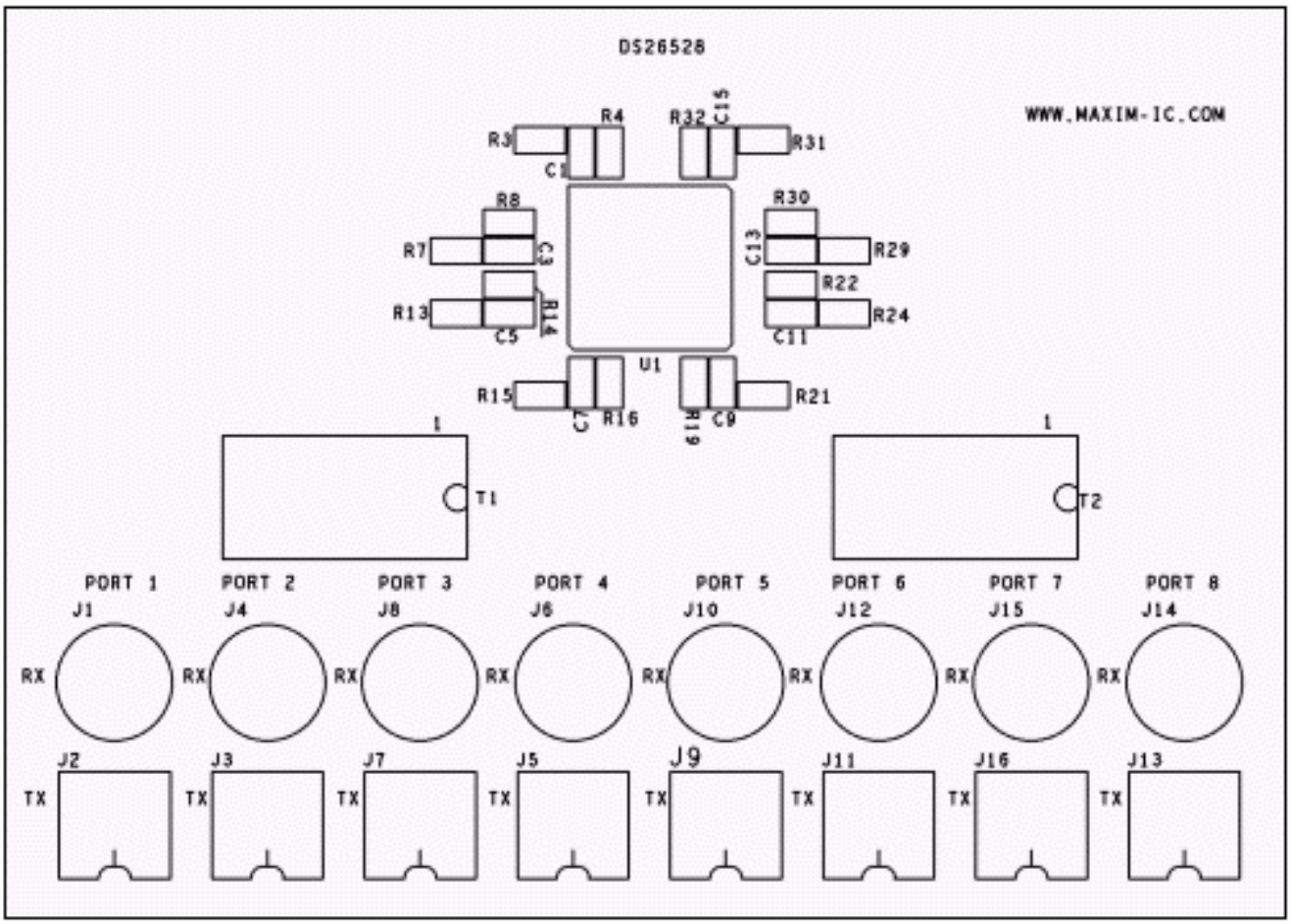


Figure 7.1 E1x8 75Ω impedance -- Silkscreen top layer layout

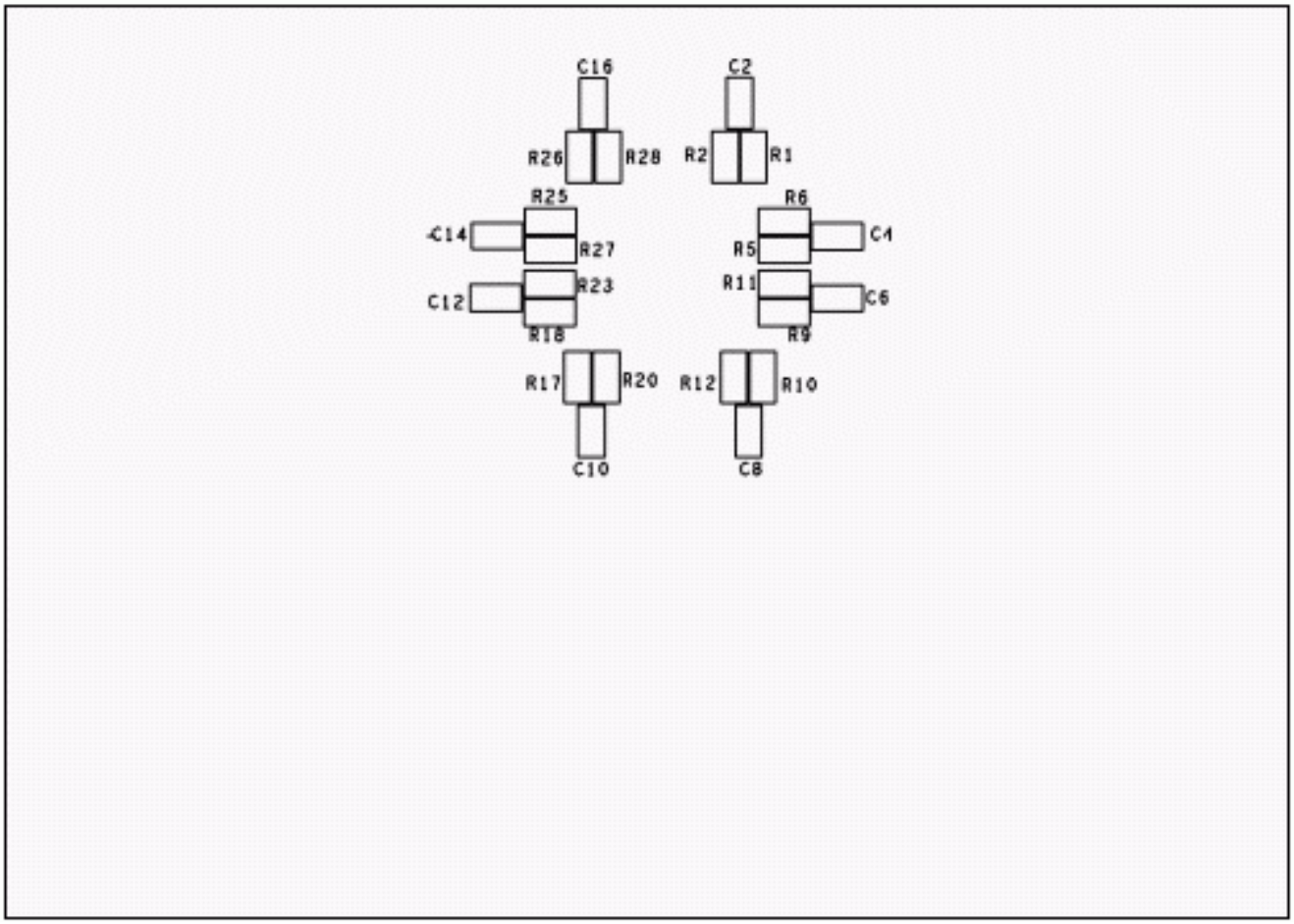


Figure 7.2 E1x8 75Ω impedance -- Silkscreen bottom layer layout (view mirrored)

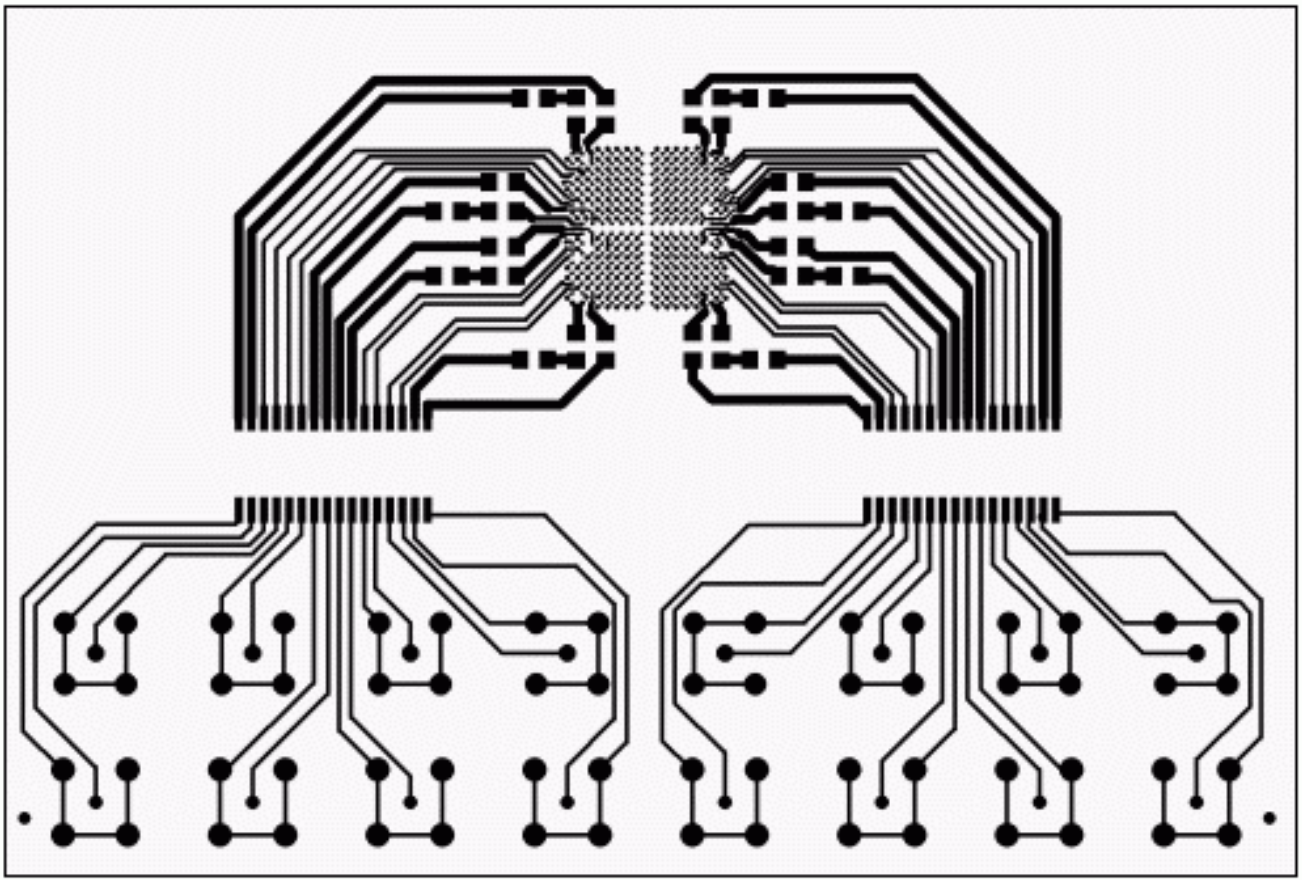


Figure 7.3 E1x8 75Ω impedance -- Top conducting layer layout

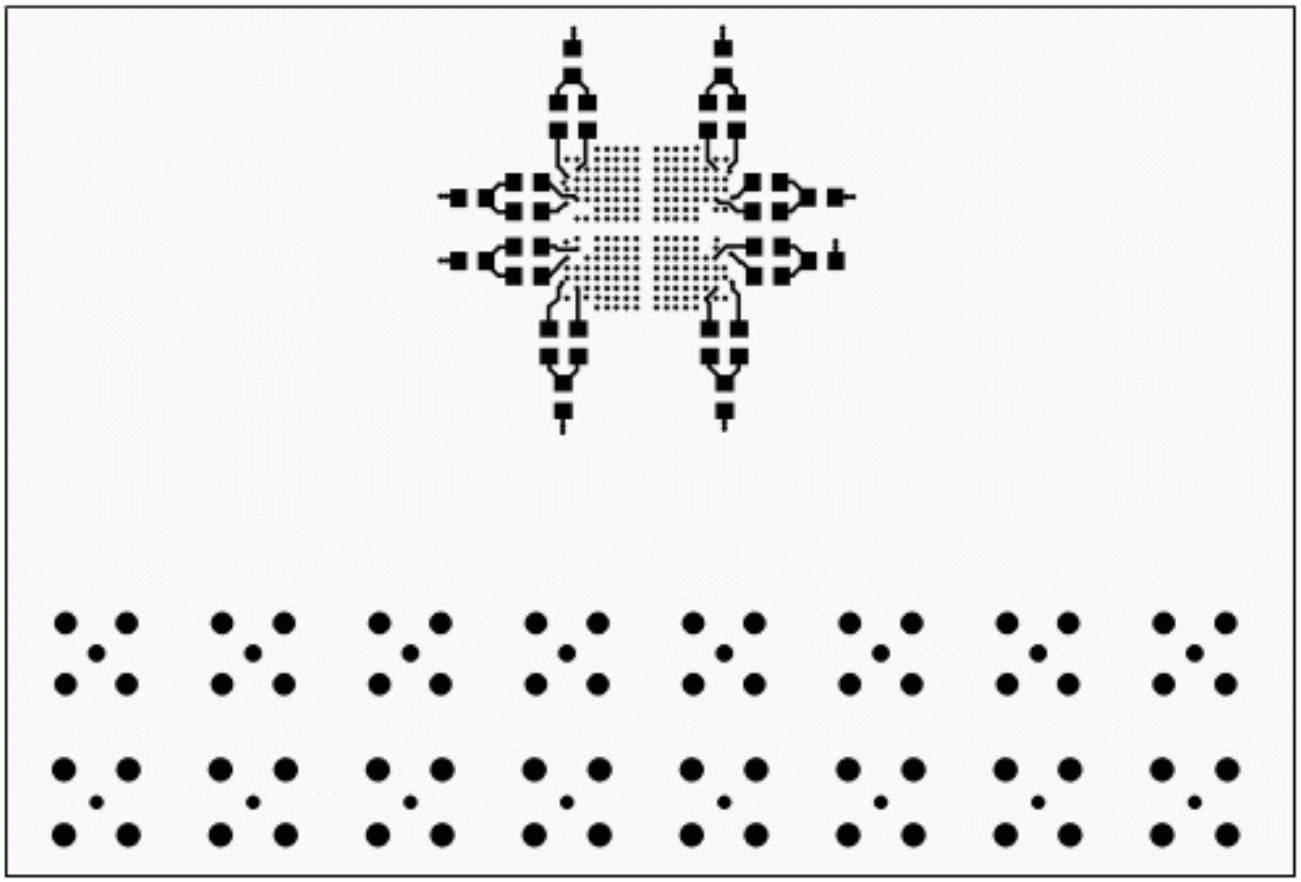


Figure 7.4 E1x8 75Ω impedance -- Bottom conducting layer layout

8. The layout of eight T1 ports interfacing to RJ45 connectors with 100Ω impedance. All figures are actual size.

Table 8. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7, C9, C11, C13, C15	8	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8, C10, C12, C14, C16	8	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1, J2	2	RA RJ45 8Pin 4 Port Jack	Molex	43223-8140
R1, R2, R5, R6, R9-R12, R17, R18, R20, R23, R25-R28	16	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
T1, T2	2	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 Pin	Pulse	TX1475

U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

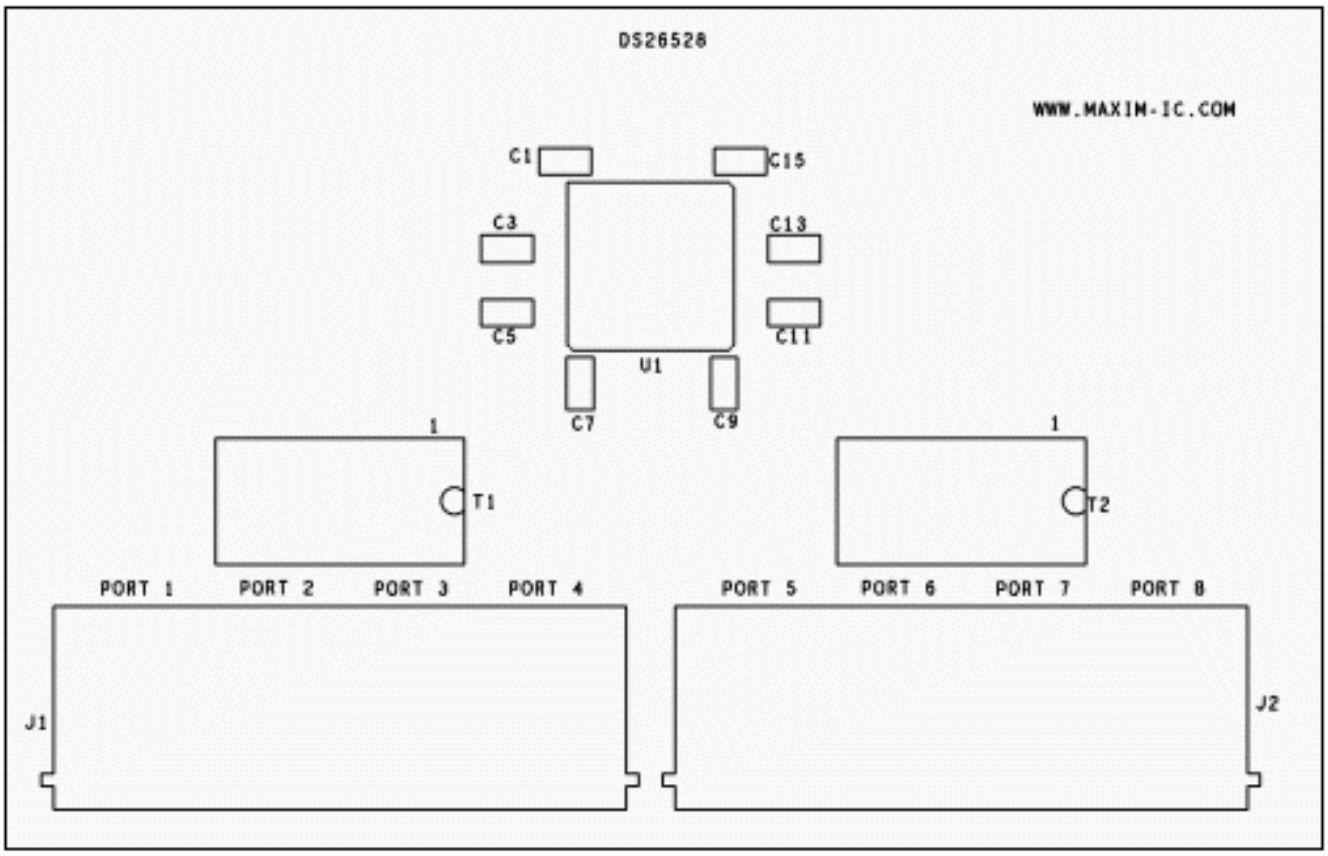


Figure 8.1 T1x8 100Ω impedance -- Silkscreen top layer layout

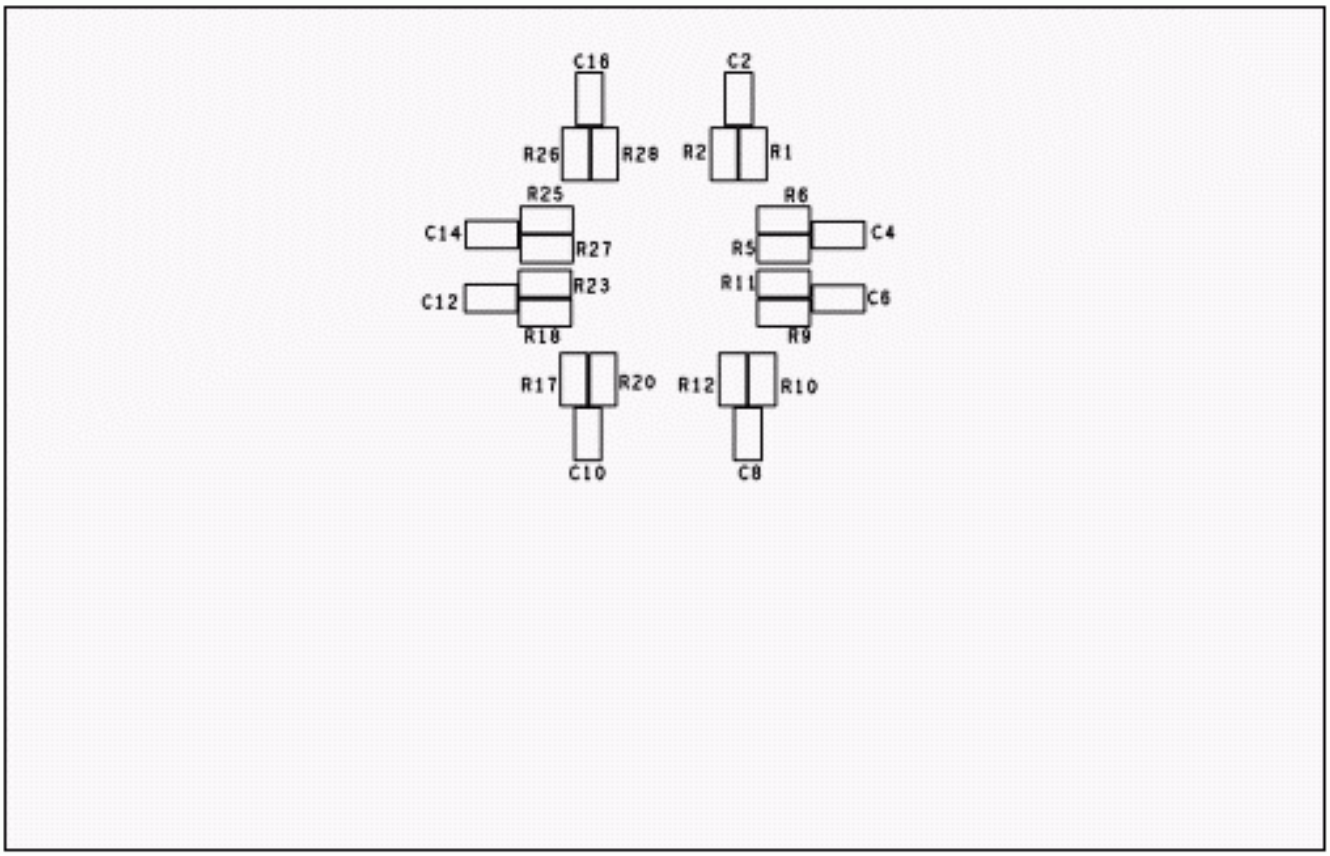


Figure 8.2 T1x8 100Ω impedance -- Silkscreen bottom layer layout (view mirrored)

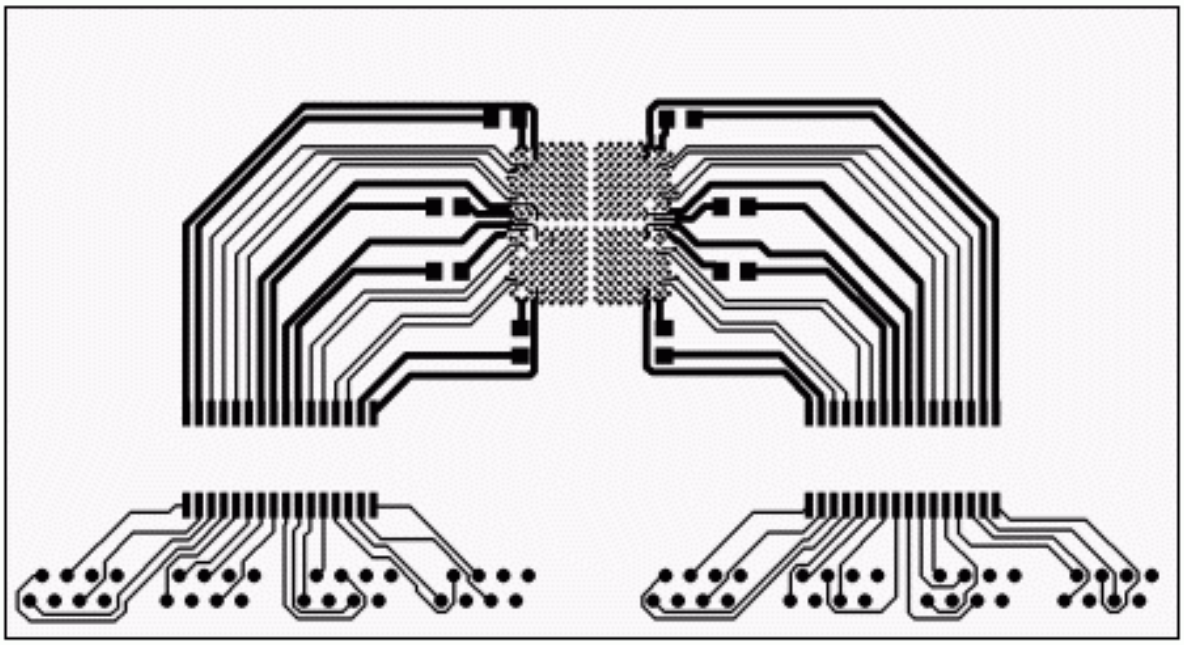


Figure 8.3 T1x8 100Ω impedance -- Top conducting layer layout

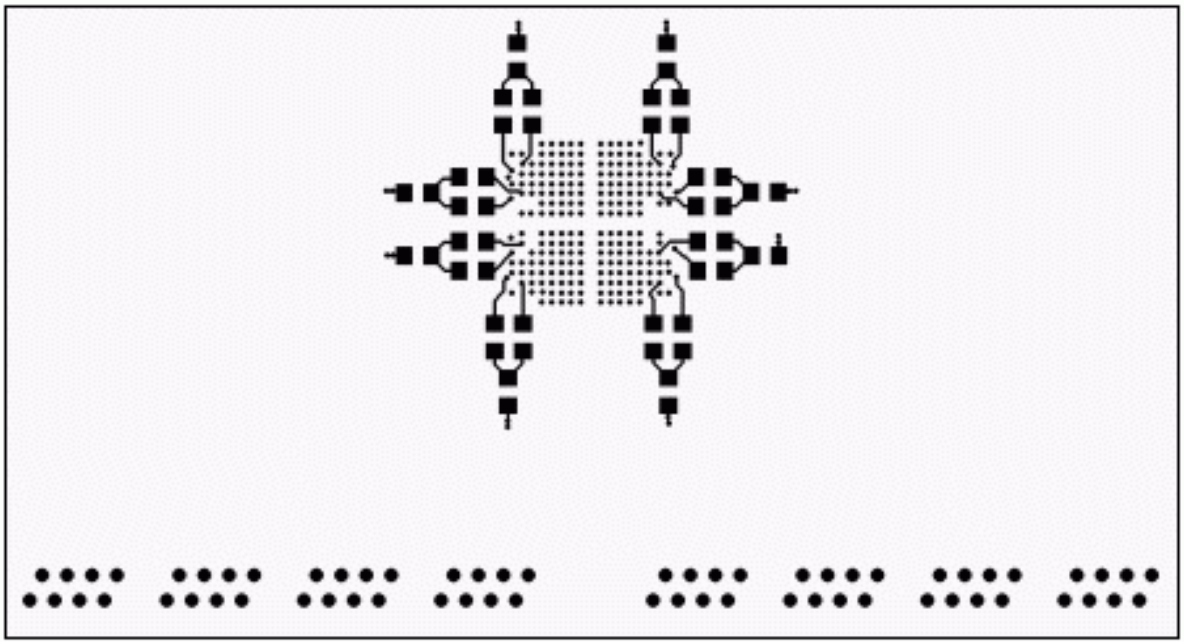


Figure 8.4 T1x8 100Ω impedance -- Bottom conducting layer layout

9. The layout of eight E1 ports interfacing to RJ45 connectors with 120Ω impedance. All figures are actual size.

Table 9. Layout Components

Name	Qty	Description	Supplier	Part Number

C1, C3, C5, C7, C9, C11, C13, C15	8	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8, C10, C12, C14, C16	8	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J1, J2	2	RA RJ45 8Pin 4 Port Jack	Molex	43223-8140
R1, R2, R5, R6, R9-R12, R17, R18, R20, R23, R25-R28	16	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R3, R4, R7, R8, R13-R16, R19, R21, R22, R24, R29-R32	16	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1, T2	2	Transformer, XMIT/RCV, 1 to 2 & 1 to 1, SMT 32 Pin	Pulse	TX1475
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

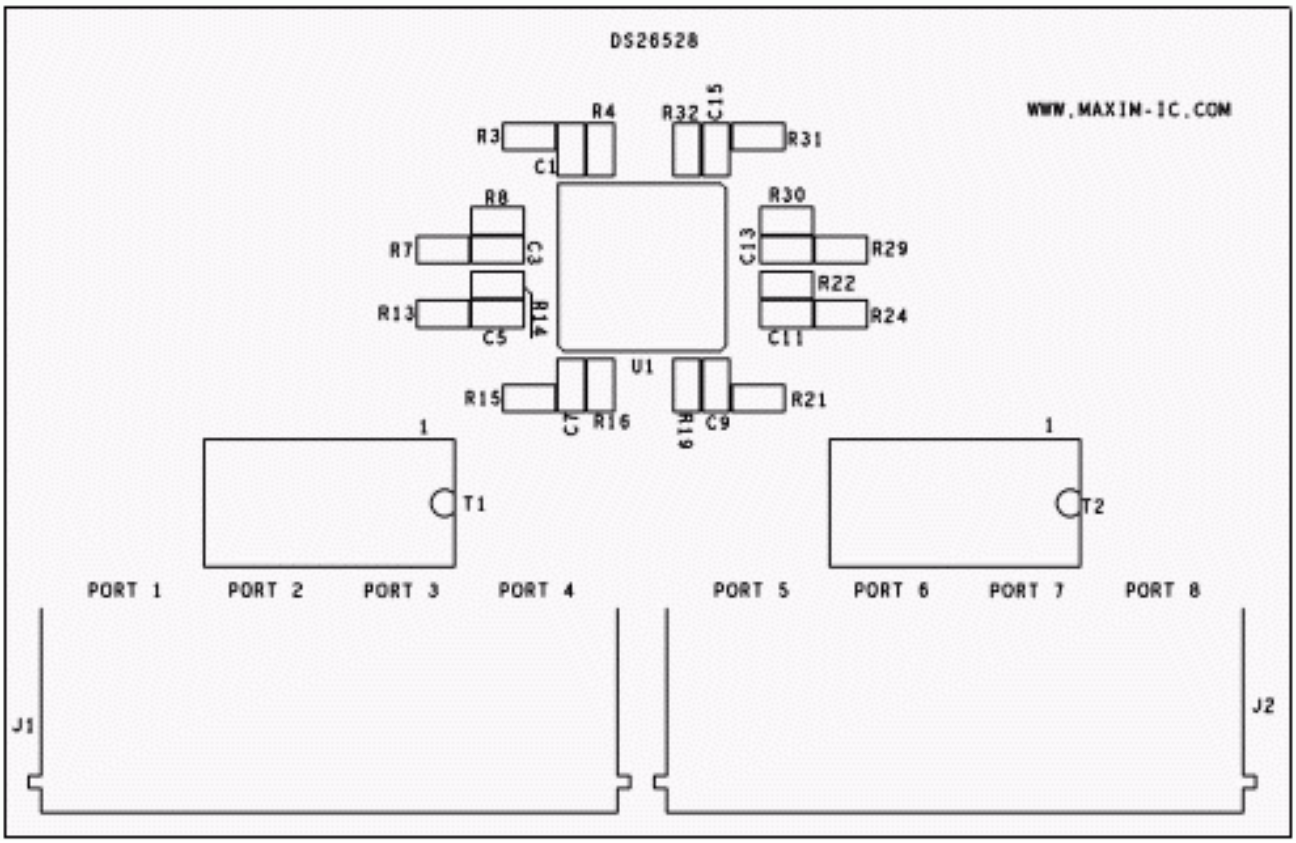


Figure 9.1 E1x8 120Ω impedance -- Silkscreen top layer layout

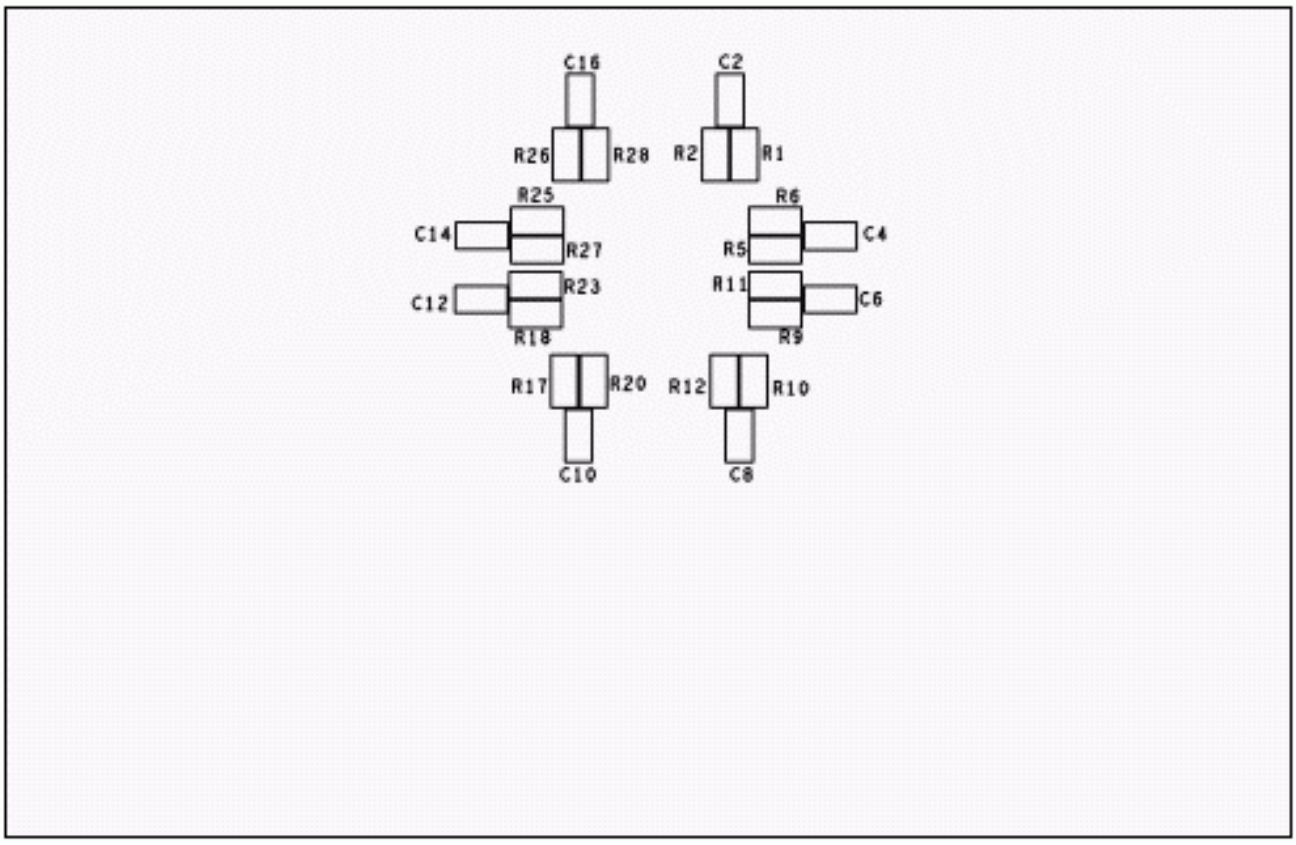


Figure 9.2 E1x8 120Ω impedance -- Silkscreen bottom layer layout (view mirrored)

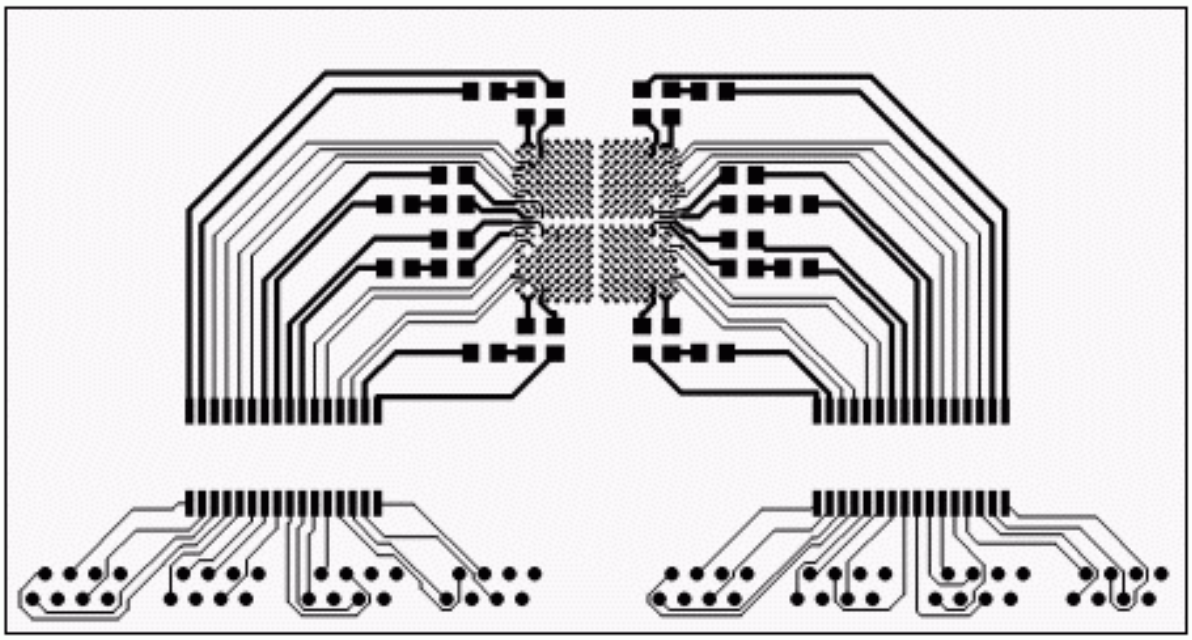


Figure 9.3 E1x8 120Ω impedance -- Top conducting layer layout

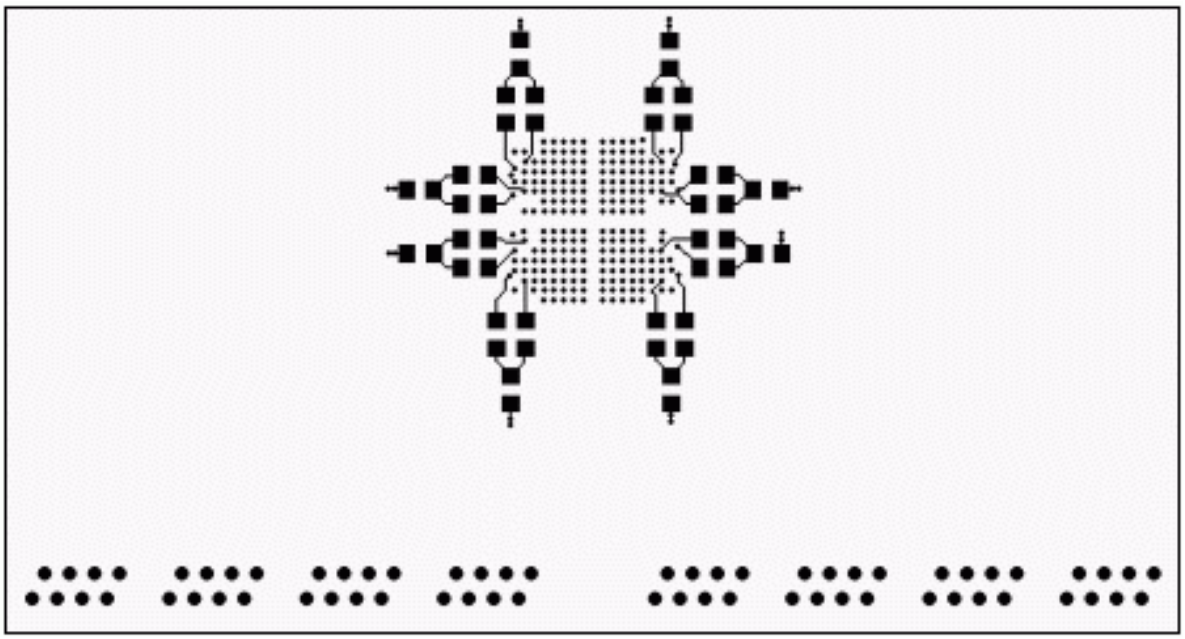


Figure 9.3 E1x8 120Ω impedance -- Bottom conducting layer layout

10. The interfacing layout of four T1 ports to RJ45 connectors with 100Ω impedance and four E1 ports to BNC connectors with 75Ω impedance. All figures are actual size.

Table 10. Layout Components

Name	Qty	Description	Supplier	Part Number
C1, C3, C5, C7, C9, C11, C13, C15	8	1206 Ceram 1uF 16V 10%	Panasonic	ECJ-3YB1C105K
C2, C4, C6, C8, C10, C12, C14, C16	8	1206 Ceram .1uF 50V 10%	Panasonic	ECJ-3VB1H104K
J10, J12, J14, J15	4	Connector BNC 75Ω Vertical 5 Pin	Cambridge	CP-BNCPC-004
J9, J11, J13, J16	4	Connector BNC 75Ω RA 5 Pin	Trompetor	UCBJR220
R1, R2, R5, R6, R9-R12, R17, R18, R20, R23, R25-R28	16	Resistor 1206 60.4Ω 1/8W 1%	Panasonic	ERJ-8ENF60R4V
R19, R21, R22, R24,R29-R32	8	Resistor 1206 0Ω 1/8W 5%	Panasonic	ERJ-8GEYJ0R00V
T1, T2	2	Transformer, XMIT/RCV, 1 to 2 & 1 to 1 SMT 32 Pin	Pulse	TX1475
U1	1	Octal Transceiver 0-70C 256P BGA	Dallas Semiconductor	DS26528

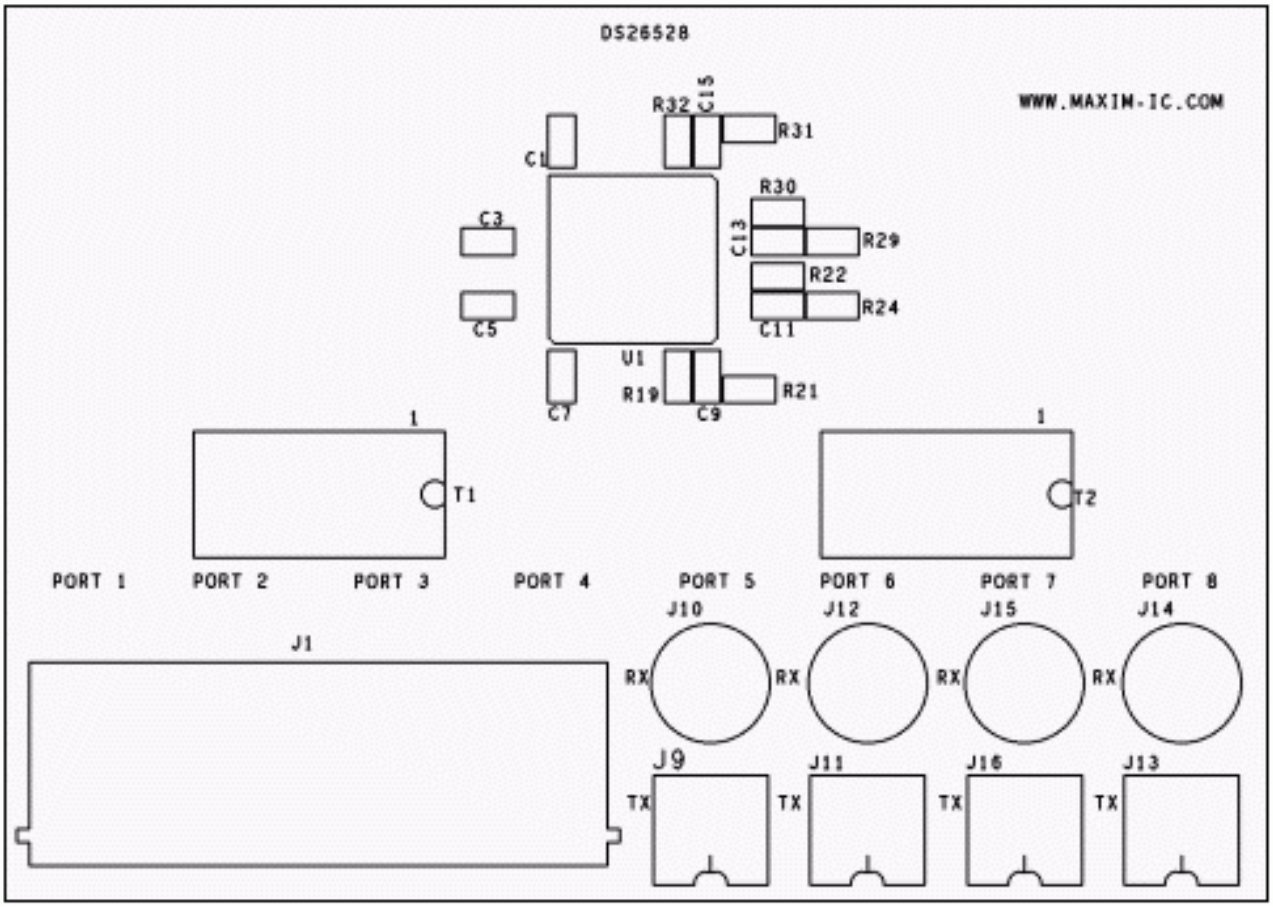


Figure 10.1 T1x4 (Ports 1-4) 100Ω and E1x4 (Ports 5-8) 75Ω impedance -- Silkscreen top layer layout

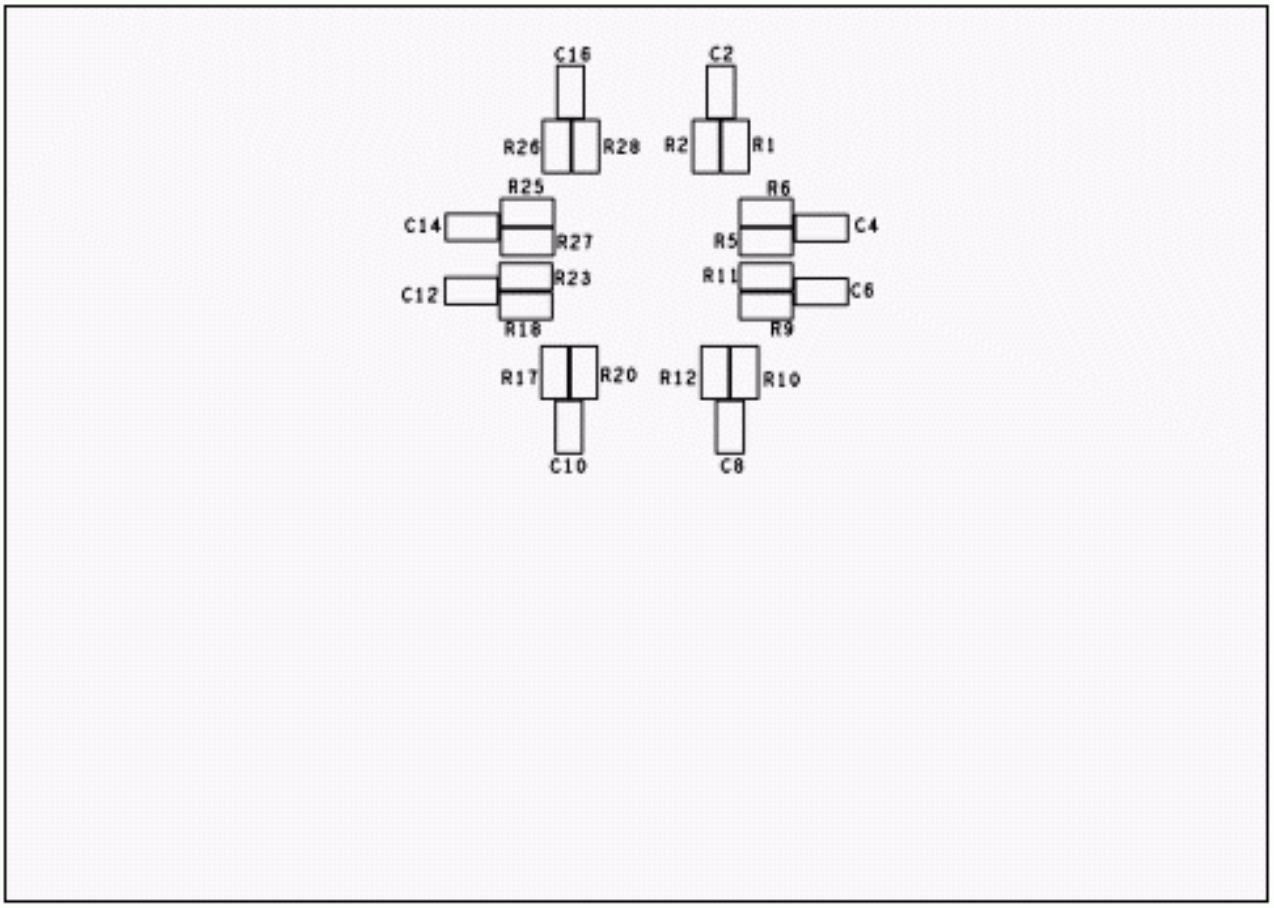


Figure 10.2 T1x4 (Ports 1-4) 100Ω and E1x4 (Ports 5-8) 75Ω impedance -- Silkscreen bottom layer layout (view mirrored)

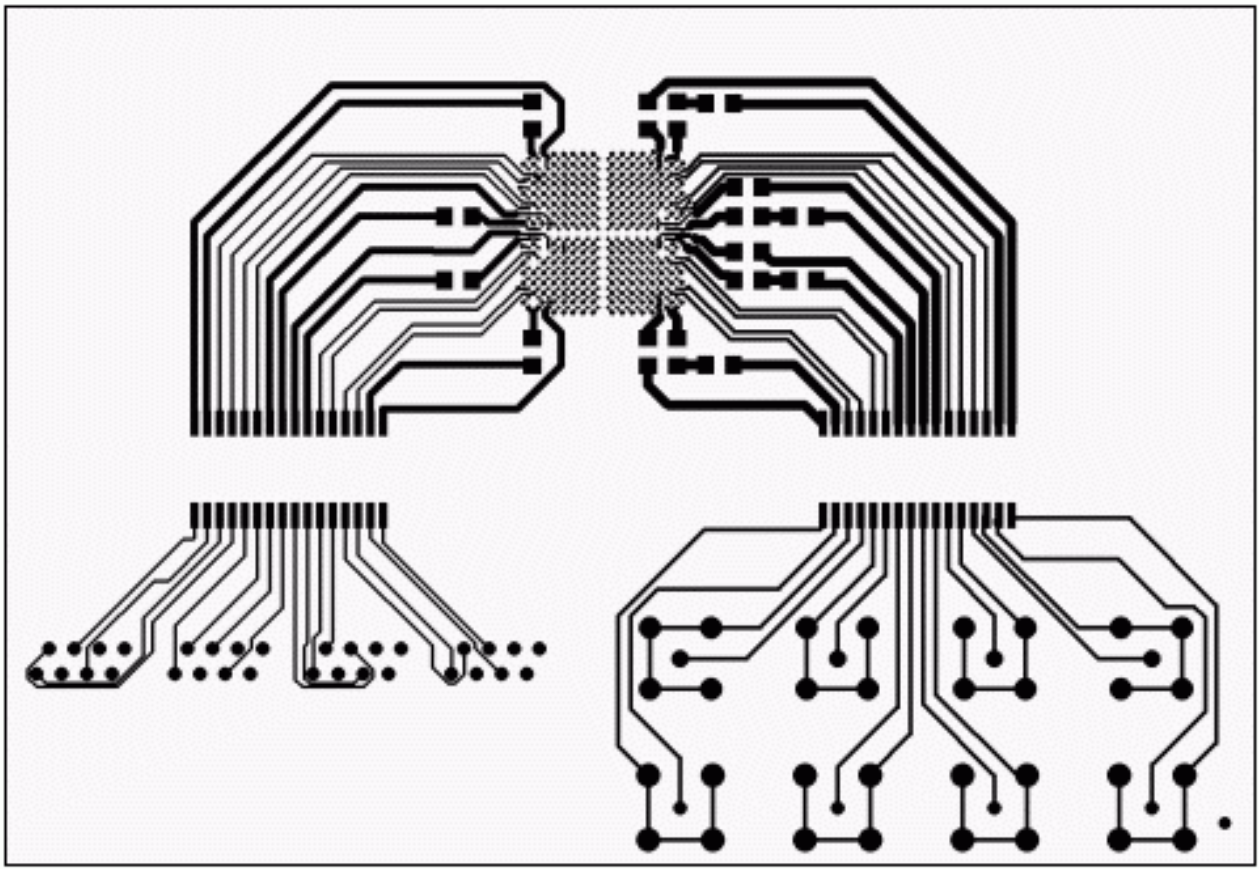


Figure 10.3 T1x4 (Ports 1-4) 100Ω and E1x4 (Ports 5-8) 75Ω impedance -- Top conducting layer

layout

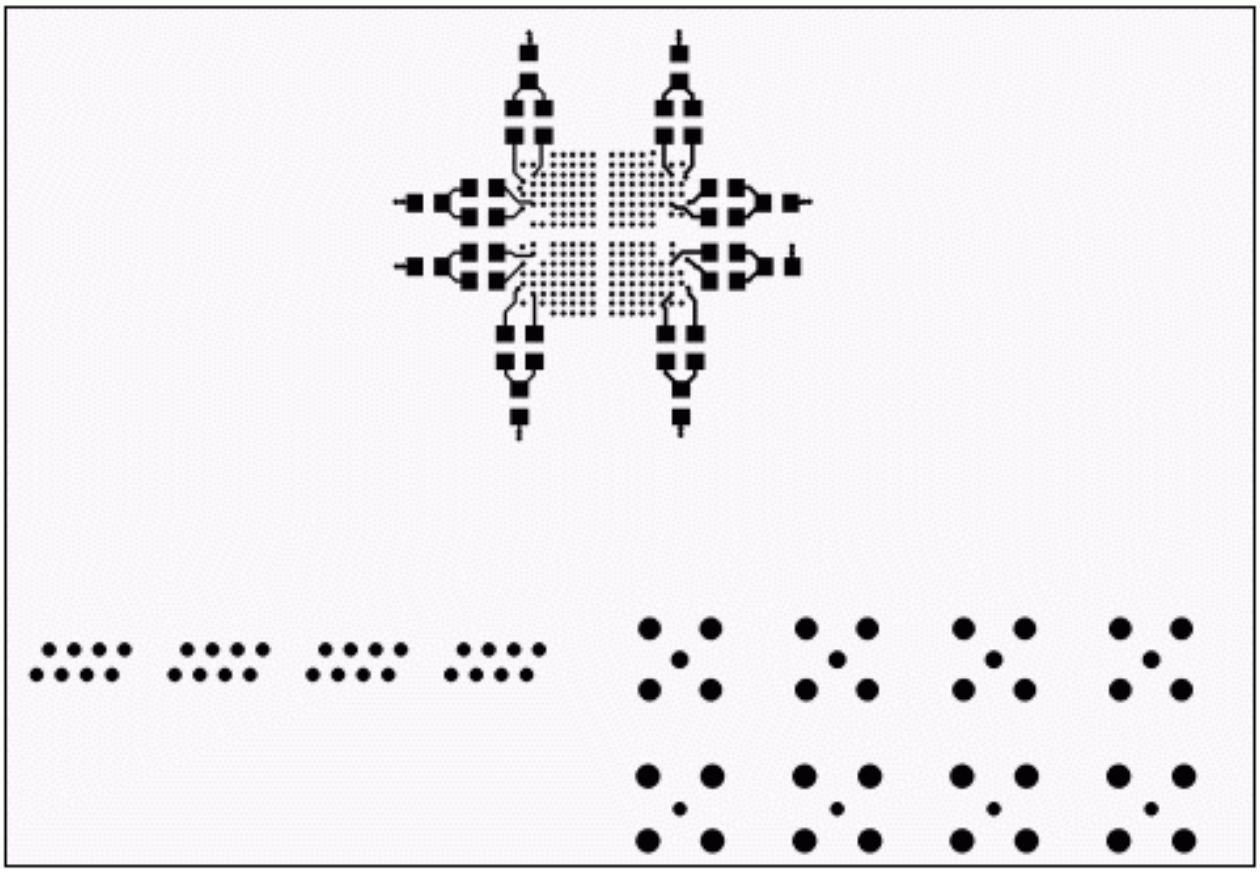


Figure 10.4 T1x4 (Ports 1-4) 100Ω and E1x4 (Ports 5-8) 75Ω impedance -- Bottom conducting layer layout

Conclusion

This application note shows the layout considerations, trace widths calculation and different scenario as a guideline of T1/E1 network interface with DS26528. The guideline is applicable for other Dallas Semiconductor T1/E1 products.

If you have further questions about our T1/E1 products, please contact the Telecommunication Applications support team via email telecom.support@dalsemi.com or call 972-371-6555.

More Information

DS21348: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21349: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21352: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21354: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21448: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21455: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21458: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2148: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2149: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2152: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2154: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2155: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21552: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21554: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2156: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS2196: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21FF42: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21FF44: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21FT42: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21FT44: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q348: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q352: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q354: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q42: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q44: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q48: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q50: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q55: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q552: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q554: QuickView -- Full (PDF) Data Sheet -- Free Samples

DS21Q58: QuickView -- Full (PDF) Data Sheet -- Free Samples

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