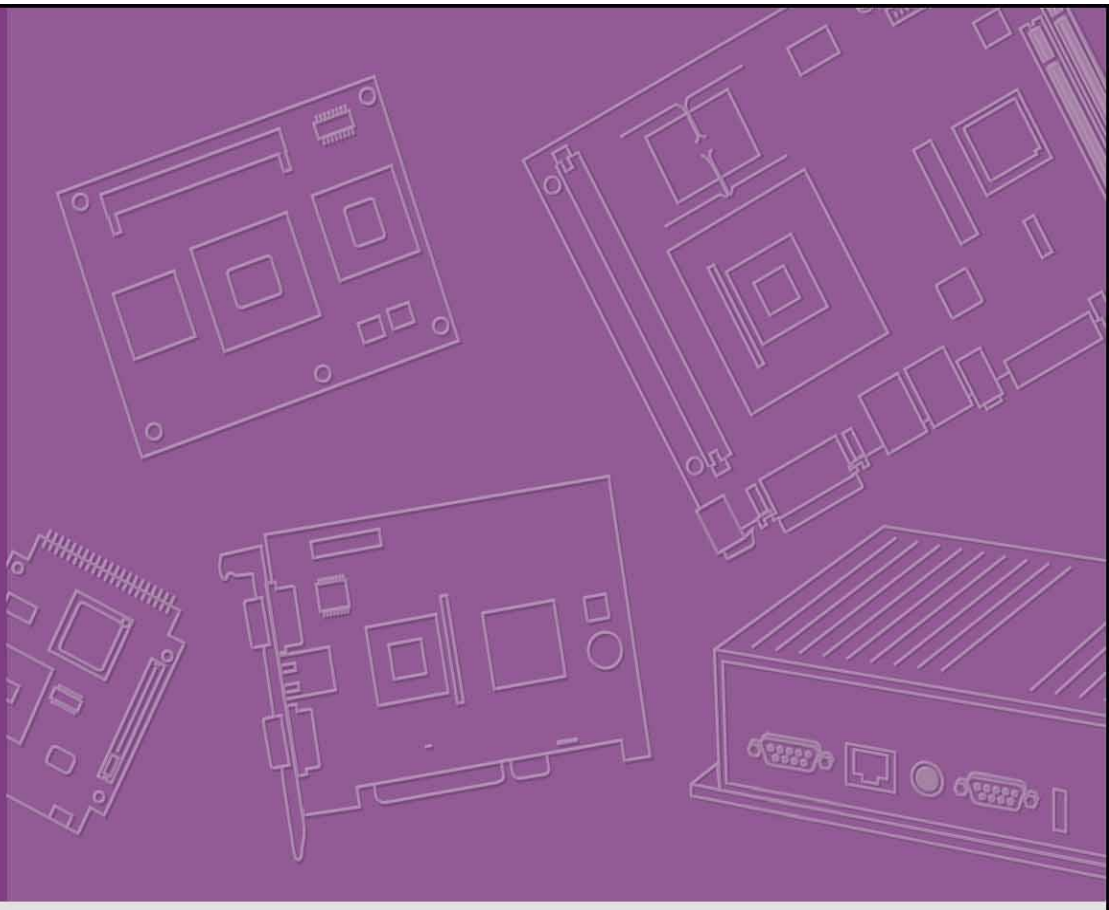
Embedded - IoT



CarrierBoard Design Guide

COM Express®

SOM-5898 COMe TYPE6

R140 2019'10'25

ADVANTECH
Enabling an Intelligent Planet

Contents

1. Introduction 7
1.1. About This Document 7
1.2. Signal Table Terminology 7
1.3. Terminology 8
1.4. Reference Documents 12
1.5. Revision History 12
1.6. SOM-5898 Block Diagram 13
2. COM Express Type 6 Interfaces 14
2.1. COM Express Type 6 Connector Layout 14
2.2. COM Express Type 6 Connector Pin-out 15
2.3. PCI Express 23
2.3.1. COM Express A-B Connector and C-D Connector PCIe Groups 23
2.3.2. General Purpose PCIe Signal Definitions 23
2.3.3. PCI Express Lane Configurations – Per COM Express Spec 28
2.3.4. PCI Express* General Routing Guidelines 29
2.3.4.1. PCI Express Insertion Loss Budget with Slot Card 29
2.3.4.2. PCI Express Insertion Loss Budget with Carrier Board PCIE Device 31
2.3.5. PCI Express* Trace Length Guidelines 33
2.4 PEG (PCI Express Graphics) 35
2.4.1 PEG Signal Definitions 35
2.4.2. PEG* General Routing Guidelines 41
2.4.3. PEG* Trace Length Guidelines 42
2.5 Digital Display Interfaces (DDI) 44
2.5.1. DDI Signal Definitions 44
2.5.2 Digital Display Interfaces (DDI) Routing Guidelines 52
2.5.2.1. DisplayPort Routing Guidelines 52
2.5.2.2. HDMI / DVI Routing Guidelines 54
2.5.3. HDMI / DVI Level Shifter Requirements 56
2.5.4. ESD Protection 56
2.6. LAN Interface 57
2.6.1. LAN Signal Definitions 57
2.6.2. LAN Routing Guidelines 59
2.6.3. LAN Trace Length Guidelines 60
2.6.4. Reference Ground Isolation and Coupling 61

2.7. USB2.0 Ports 6 2
2.7.1. USB2.0 Signal Definitions 6 2
2.7.1.1. USB Over-Current Protection (USB_x_y_OC#) 6 5
2.7.1.2. Powering USB devices during S5 ..... 6 5
2.7.2. USB2.0 Routing Guidelines 6 6
2.7.2.1. USB 2.0 General Design Considerations and Optimization 6 7
2.7.2.2. USB 2.0 Port Power Delivery 6 7
2.7.2.3. USB 2.0 Common Mode Chokes 6 8
2.7.2.4. EMI / ESD Protection 6 9
2.7.3. USB2.0 Trace Length Guidelines 7 0
2.8. USB3.0 ..... 7 1
2.8.1. USB3.0 Signal Definitions 7 1
2.8.1.1. USB Over-Current Protection (USB_x_y_OC#) 7 4
2.8.1.2. EMI / ESD Protection 7 4
2.8.2. USB3.0 Routing Guidelines 7 5
2.8.3. USB3.0 Trace Length Guidelines 7 6
2.9. SATA 7 7
2.9.1. SATA Signal Definitions 7 7
2.9.2. SATA Routing Guidelines 7 9
2.9.2.1. General SATA Routing Guidelines 8 0
2.9.3. SATA Trace Length Guidelines 8 1
2.10. LVDS 8 2
2.10.1. Signal Definitions 8 2
2.10.1.1. Display Timing Configuration 8 5
2.10.1.2. Backlight Control 8 5
2.10.2. LVDS Routing Guidelines 8 6
2.10.3. LVDS Trace Length Guidelines 8 7
2.11. Embedded DisplayPort (eDP) *SOM-5898 is Option function 8 8
2.11.1 eDP Signal Definitions 8 8
2.11.2. eDP Trace Length Guidelines 9 0
2.12. VGA 9 1
2.12.1. VGA Signal Definitions 9 1
2.12.2. VGA Routing Guidelines 9 3
2.12.2.1. RGB Analog Signals 9 3
2.12.2.2. HSYNC and VSYNC Signals 9 3
2.12.2.3. DDC Interface 9 3
2.12.2.4. ESD Protection/EMI 9 3

2.12.3. VGA Trace Length Guidelines 94
2.13. Digital Audio Interfaces 95
2.13.1. Audio Codec Signal Descriptions 95
2.13.2. Audio Routing Guidelines 97
2.13.3. Audio Trace Length Guidelines 98
2.14. LPC Bus – Low Pin Count Interface 99
2.14.1. LPC Signal Definition 99
2.14.2. LPC Routing Guidelines 100
2.14.2.1 General Signals 100
2.14.2.2 Bus Clock Routing 101
2.14.3. LPC Trace Length Guidelines 101
2.15. SPI – Serial Peripheral Interface Bus 102
2.15.1. SPI Signal Definition 102
2.15.2. SPI Routing Guidelines 104
2.15.3. SPI Trace Length Guidelines 104
2.16. General Purpose I2C Bus Interface 105
2.16.1. Signal Definitions 105
2.16.2. I2C Routing Guidelines 106
2.16.3. I2C Trace Length Guidelines 107
2.16.4. Connectivity Considerations 107
2.17. System Management Bus (SMBus) 108
2.17.1. SMB Signal Definitions 109
2.17.2. SMB Routing Guidelines 110
2.17.3. SMB Trace Length Guidelines 110
2.18. General Purpose Serial Interface 111
2.18.1. Serial interface Signal Definitions 111
2.18.2. Serial interface Routing Guidelines 112
2.18.3. Serial interface Trace Length Guidelines 112
2.19. CAN Interface *SOM-5898 is not support CAN Interface. 113
2.19.1. CAN interface Signal Definitions 113
2.19.2. CAN interface Routing Guidelines 113
2.19.3. CAN interface Trace Length Guidelines 114
2.20. Miscellaneous Signals 115
2.20.1. Miscellaneous Signals 115
2.20.2. Power Management Signals 118
2.20.3. Thermal Interface 120
2.20.4. Miscellaneous Signals Routing Guidelines 120

2.20.5. Miscellaneous Signals Trace Length Guidelines 120
3. Power 121
3.1. General Power requirements 121
3.2. VCC5_SBY Routing 121
3.3. ATX and AT Power Sequencing Diagrams 121
3.4. Input Power - Rise Time 125
3.5. Design Considerations for Carrier Boards containing FPGAs/CPLDs ... 126
4. Electrical Characteristics 127
4.1. Absolute Maximum Ratings 127
4.2. DC Characteristics 127
4.3. Inrush Current 127

List of Tables

Table 1: Signal Table Terminology Descriptions 7
Table 2: Conventions and Terminology 8
Table 3: COM Express Type6 Pin-out 15
Table 4: General Purpose PCI Express Signal Descriptions 23
Table 5: PCI Express* Slot Card / Device Down Trace Length Guidelines 34
Table 6: PEG Signal Description 35
Table 7: PCI Express* Slot Card / Device Down Trace Length Guidelines 43
Table 8: Port / HDMI / DVI Pin-out of Type 6 44
Table 9: DDI1 Signal Description 45
Table 10: DDI2 Signal Description 47
Table 11: DDI3 Signal Description 49
Table 12: DisplayPort Insertion Loss Budget 52
Table 13: DisplayPort Connector / Device Down Trace Length Guidelines 53
Table 14: HDMI / DVI (TMDS) Insertion Loss Budget 54
Table 15: HDMI / DVI Connector / Device Down Trace Length Guidelines 55
Table 16: LAN Interface Signal Descriptions 57
Table 17: 10/100/1000 Ethernet Insertion Loss Budget, 100 MHz 59
Table 18: Ethernet Trace Length Guidelines 60
Table 19: USB Signal Descriptions 62
Table 20: USB Insertion Loss Budget, 400 MHz 66
Table 21: USB2.0 Trace Length Guidelines 70
Table 22: USB3.0 Signal Definitions 71
Table 23: USB3.0 Insertion Loss Budget 75
Table 24: USB3.0 Trace Length Guidelines 76
Table 25: SATA Signal Definitions 77
Table 26: SATA Insertion Loss Budge 79
Table 27: SATA Trace Length Guidelines 81
Table 28: LVDS Signal Definitions 82
Table 29: LVDS Trace Length Guidelines 87
Table 30: eDP Signal Definitions 88
Table 31: DisplayPort Connector / Device Down Trace Length Guidelines 90
Table 32: VGA Signal Definitions 91
Table 33: VGA Trace Length Guidelines 94

Table 34: Audio Codec Signal Descriptions 95
Table 35: Audio Trace Length Guidelines 98
Table 36: LPC Interface Signal Definition 99
Table 37: LPC Trace Length Guidelines 101
Table 38: SPI Interface Signal Definition 102
Table 39: Effect of the BIOS disable signals 104
Table 40: SPI Trace Length Guidelines 104
Table 41: General Purpose I2C Interface Signal Descriptions 106
Table 42: I2C Trace Length Guidelines 107
Table 43: SMB Signal Definitions 109
Table 44: SMB Trace Length Guidelines 110
Table 45: Serial interface Signal Definitions 111
Table 46: Serial interface Trace Length Guidelines 112
Table 47: CAN interface Signal Definitions 113
Table 48: CAN interface Trace Length Guidelines 114
Table 49: Miscellaneous Signal Definitions 115
Table 50: Power Management Signal Definitions 118
Table 51: Thermal Management Signal Definitions 120
Table 52: Power Management Timings 124
Table 53: Absolute Maximum Ratings 127
Table 54: Input Power Consumption of 8.5V / 12V / 20V 127
Table 55: Inrush Current 127

List of Figures

Figure 1: COM Express Type6 Connector Layout 14
Figure 2: Topology for PCI Express Slot Card. 33
Figure 3: Topology for PCI Express Device Down. 33
Figure 4: Topology for PCI Express Slot Card. 42
Figure 5: Topology for PCI Express Device Down. 42
Figure 6: DisplayPort Loss Budget 52
Figure 7: Topology for DisplayPort 53
Figure 8: HDMI / DVI (TMDS) Loss Budget 54
Figure 9: Topology for HDMI / DVI 55
Figure 10: 10/100/1000 Ethernet Insertion Loss Budget 59
Figure 11: Topology for Ethernet Jack 60
Figure 12: USB Insertion Loss Budget 66
Figure 13: USB 2.0 Good Downstream Power Connection 68
Figure 14: USB 2.0 A Common Mode Choke 68
Figure 15: Topology for USB2.0 70
Figure 16: USB3.0 Insertion Loss Budget 75
Figure 17: Topology for USB3.0 76
Figure 18: SATA Insertion Loss Budge 79
Figure 19: Topology for SATA 81
Figure 20: Topology for LVDS 87
Figure 21: Topology for eDP 90
Figure 22: Topology for VGA 94
Figure 23: Topology for Audio 98
Figure 24: Topology for LPC 101
Figure 25: Topology for SPI 104
Figure 26: Topology for I2C 107
Figure 27: Topology for SMB 110
Figure 28: Topology for Serial interface 112
Figure 29: Topology for CAN interface 114
Figure 30: ATX Style Power Up Boot – Controlled by Power Button 122
Figure 31: AT Style Power Up Boot 124

1. Introduction

1.1. About This Document

This design guide provides information for designing a custom system Carrier Board for COM Express Type 6 Module. It includes Signal Descriptions, Routing Guidelines and Trace Length Guidelines. The main purpose is designing Carrier Board for helping customers fast and easy using the module of Advantech to be designed.

1.2. Signal Table Terminology

Table 1 below describes the terminology used in this section for the Signal Description tables.

The "#" symbol at the end of the signal name indicates that the active or asserted state occurs when the signal is at a low voltage level. When "#" is not present, the signal is asserted when at a high voltage level.

The terms "Input" and "Output" and their abbreviations in Table 1 below refer to the Module's view, i.e. an input is an input for the Module and not for the Carrier-Board.

Table 1: Signal Table Terminology Descriptions

Term	*Description*
I/O 3.3V	Bi-directional signal 3.3V tolerant
I/O 5V	Bi-directional signal 5V tolerant
I 3.3V	Input 3.3V tolerant
I 5V	Input 5V tolerant
I/O 3V3_SBY	Bi-directional 3.3V tolerant active during Suspend and running state.
O 3.3V	Output 3.3V signal level
O 5V	Output 5V signal level
OD	Open drain output
P	Power input/output
*_S0	Signal active during running state.
PCIE	In compliance with PCI Express Base Specification
USB	In compliance with the Universal Serial Bus Specification
GbE	In compliance with IEEE 802.3ab 1000BASE-T Gigabit Ethernet
SATA	In compliance with Serial ATA specification
REF	Reference voltage output. May be sourced from a Module power plane.
PDS	Pull-down strap. A Module output pin that is either tied to GND or is not connected. Used to signal Module capabilities (pin-out type) to the Carrier Board.

1.3. Terminology

Table 2: Conventions and Terminology

Terminology	*Description*
AC ‘97 / HDA	Audio CODEC '97/High Definition Audio
ACPI	Advanced Configuration Power Interface – standard to implement power saving modes in PCAT systems
ADD2	Advanced Digital Display, 2nd Generation
ADD2/MEC	Advanced Digital Display, 2nd Generation, Media Expansion Card
Basic Module	COM ExpressR 125mm x 95mm Module form factor.
BIOS	Basic Input Output System – firmware in PC-AT system that is used to initialize system components before handing control over to the operating system.
CAN	Controller-area network (CAN or CAN-bus) is a vehicle bus standard designed to allow microcontrollers to communicate with each other within a vehicle without a host computer.
Carrier Board	An application specific circuit board that accepts a COM ExpressR Module.
Compact Module	COM ExpressR 95mm x 95mm Module form factor
CRT	Cathode Ray Tube
DAC	Digital Analog Converter
DDC	Display Data Control – VESA (Video Electronics Standards Association) standard to allow identification of the capabilities of a VGA monitor
DDI	Digital Display Interface– containing DisplayPort, HDMI/DVI and SDVO
DNI	Do Not Install
DP	DisplayPort is a digital display interface standard put forth by the Video Electronics StandardsAssociation (VESA). It defines a new license free, royalty free, digital audio/videointerconnect, intended to be used primarily between a computer and its display monitor.
DP	DisplayPort is a digital display interface standard put forth by the Video Electronics StandardsAssociation (VESA). It defines a new license free, royalty free, digital audio/videointerconnect, intended to be used primarily between a computer and its display monitor.
DVI	Digital Visual Interface - a Digital Display Working Group (DDWG) standard that defines a standard video interface supporting both digital and analog video signals. The digital signals use TMDS.

Terminology	*Description*
EAPI	Embedded Application Programming Interface Software interface for COM ExpressR specific industrial functions • System information • Watchdog timer • I2C Bus • Flat Panel brightness control • User storage area • GPIO
EDID	Extended Display Identification Data
EDP	Embedded DisplayPort (eDP) is a digital display interface standard produced by the Video Electronics Standards Association (VESA) for digital interconnect of Audio and Video.
EEPROM	Electrically Erasable Programmable Read-Only Memory
EFT	Electrical Fast Transient
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
ExpressCard	A PCMCIA standard built on the latest USB 2.0 and PCI Express buses.
Extended Module	COM ExpressR 155mm x 110mm Module form factor.
FR4	A type of fiber-glass laminate commonly used for printed circuit boards.
Gb	Gigabit
GbE	Gigabit Ethernet
GPI	General Purpose Input
GPIO	General Purpose Input Output
GPO	General Purpose Output
HDA	Intel High Definition Audio (HD Audio) refers to the specification released by Intel in 2004 for delivering high definition audio that is capable of playing back more channels at higher quality than AC97.
HDMI	High Definition Multimedia Interface
I2C	Inter Integrated Circuit – 2 wire (clock and data) signaling scheme allowing communication between integrated circuits, primarily used to read and load register values.
DE	Integrated Device Electronics – parallel interface for hard disk drives – also known as PATA
Legacy Device	Relics from the PC-AT computer that are not in use in contemporary PC systems: primarily the ISA bus, UART-based serial ports, parallel printer ports, PS-2 keyboards, and mice.

	Definitions vary as to what constitutes a legacy device. Some definitions include IDE as a legacy device.

Terminology	*Description*
LAN	Local Area Network
LPC	Low Pin-Count Interface: a low speed interface used for peripheral circuits such as Super I/O controllers, which typically combine legacy-device support into a single IC.
LS	Least Significant
LVDS	Low-Voltage Differential Signaling – widely used as a physical interface for TFT flat panels. LVDS can be used for many high-speed signaling applications. In this document, it refers only to TFT flat-panel applications.
MEC	Media Expansion Card
Mini Module	COM ExpressR 84x55mm Module form factor
MS	Most Significant
NA	Not available
NC	Not connected
OBD-II	On-Board Diagnostics 2nd generation
OEM	Original Equipment Manufacturer
PATA	Parallel AT Attachment – parallel interface standard for hard-disk drives – also known as IDE,AT Attachment, and as ATA
PC-AT	“Personal Computer – Advanced Technology” – an IBM trademark term used to refer to Intel x86 based personal computers in the 1990s
PCB	Printed Circuit Board
PCI	Peripheral Component Interface
PCI Express (PCIe)	Peripheral Component Interface Express – next-generation high speed Serialized I/O bus
PCI Express Lane	One PCI Express Lane is a set of 4 signals that contains two differential lines for Transmitter and two differential lines for Receiver. Clocking information is embedded into the data stream.
PD	Pull Down
PEG	PCI Express Graphics
PHY	Ethernet controller physical layer device
Pin-out Type	A reference to one of seven COM ExpressR definitions for the signals that appear on the COM ExpressR Module connector pins.
PS2 PS2 Keyboard	“Personal System 2” - an IBM trademark term used to refer to Intel x86 based personal computers in the 1990s. The term survives as a reference to

PS2 Mouse	the style of mouse and keyboard interface that were introduced with the PS2 system.

Terminology	*Description*
PU	Pull Up
ROM	Read Only Memory – a legacy term – often the device referred to as a ROM can actually be written to, in a special mode. Such writable ROMs are sometimes called Flash ROMs. BIOS is stored in ROM or Flash ROM.
RTC	Real Time Clock – battery backed circuit in PC-AT systems that keeps system time and dateas well as certain system setup parameters
S0, S1, S2, S3, S4, S5	Sleep States defined by the ACPI specificationS0 Full power, all devices powered S1Sleep State, all context maintained S2 Sleep State, CPU and Cache context lost S3 Suspend to RAM System context stored in RAM; RAM is in standby S4 Suspend to Disk System context stored on disk S5 Soft Off Main power rail off, only standby power rail present
SATA	Serial AT Attachment: serial-interface standard for hard disks
SDVO	Serial Digital Video Out is a proprietary technology introduced by IntelR to add additional video signaling interfaces to a system. Being phased out
SMBus	System Management Bus
SO-DIMM	Small Outline Dual In-line Memory Module
SPI	Serial Peripheral Interface
TBD	To be determined
TMDS	Transition Minimized Differential Signaling - a digital signaling protocol between the graphics subsystem and display. TMDS is used for the DVI digital signals. DC coupled
TPM	Trusted Platform Module, chip to enhance the security features of a computer system.
UIM	User Identity Module
USB	Universal Serial Bus
VESA	Video Electronics Standards Association
WDT	Watch Dog Timer

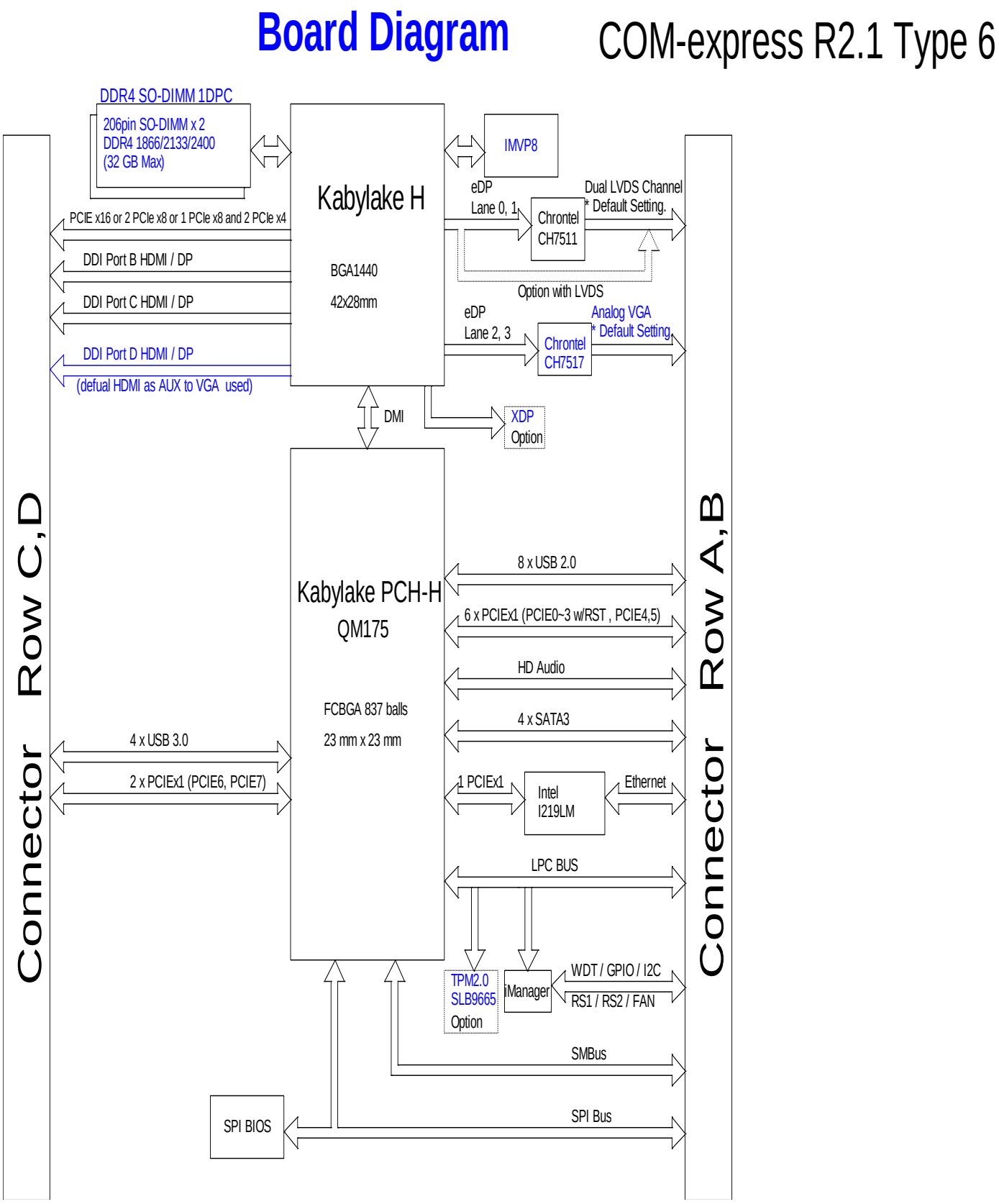
1.4. Reference Documents

Document
COM Express Carrier Design Guide Rev. 2.0
Intel EDS Document
Intel Layout Guide Document
ATX12V Power Supply Design Guide Rev. 2.01

1.5. Revision History

Revision	Date	PCB Rev.	Changes
1.00	09 15, 2017	A101-1	
1.10	Jun. 04, 2018	A101-1	1. Modify description of HDA_SDOUT.
1.20	09 25, 2018	A101-1	1. Modify LPC Clock output to 24MHz.
1.30	09 27, 2019	A101-1	1. RTC current changed 14u to 4.64u at G3 mode.
1.40	10 25, 2019	A101-1	1. Modify PWR_BTN# description. 2. Modify power sequence request. 3. Add Input Power –Rise Time

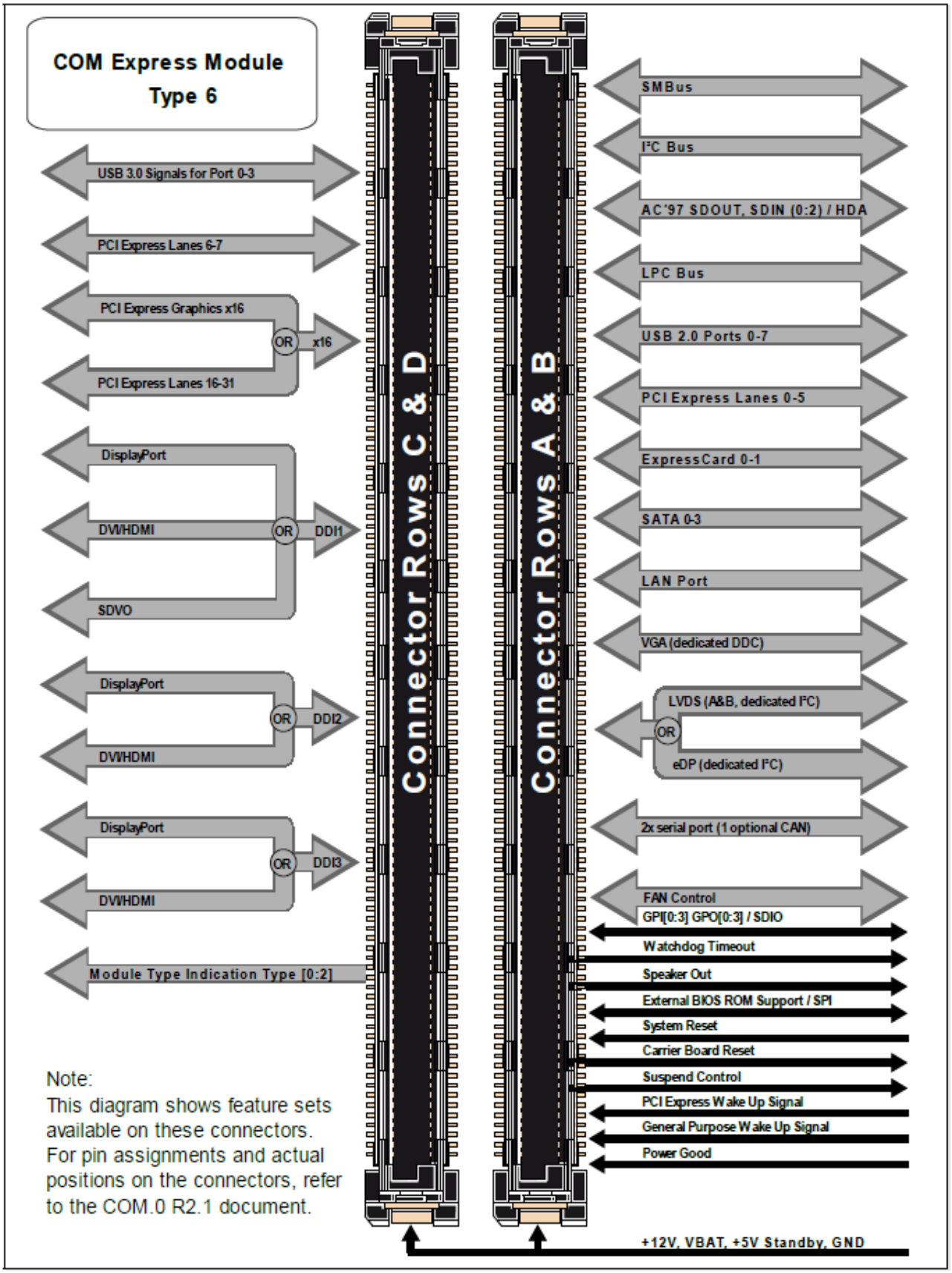
1.6. SOM-5898 Block Diagram



2. COM Express Type 6 Interfaces

2.1. COM Express Type 6 Connector Layout

Figure 1: COM Express Type6 Connector Layout



2.2. COM Express Type 6 Connector Pin-out

Table 3: COM Express Type6 Pin-out

Connector Rows A and B

Pin#	Type 6 Description	Pin#	Type 6 Description
A1	GND	B1	GND
A2	GBE0_MDI3-	B2	GBE0_ACT#
A3	GBE0_MDI3+	B3	LPC_FRAME#
A4	GBE0_LINK100#	B4	LPC_AD0
A5	GBE0_LINK1000#	B5	LPC_AD1
A6	GBE0_MDI2-	B6	LPC_AD2
A7	GBE0_MDI2+	B7	LPC_AD3
A8	GBE0_LINK#	B8	LPC_DRQ0#
A9	GBE0_MDI1-	B9	LPC_DRQ1#
A10	GBE0_MDI1+	B10	LPC_CLK
A11	GND	B11	GND
A12	GBE0_MDI0-	B12	PWRBTN#
A13	GBE0_MDI0+	B13	SMB_CK
A14	GBE0_CTREF	B14	SMB_DAT
A15	SUS_S3#	B15	SMB_ALERT#
A16	SATA0_TX+	B16	SATA1_TX+
A17	SATA0_TX	B17	SATA1_TX
A18	SUS_S4#	B18	SUS_STAT#
A19	SATA0_RX+	B19	SATA1_RX+
A20	SATA0_RX	B20	SATA1_RX-
A21	GND	B21	GND
A22	SATA2_TX+	B22	SATA3_TX+
A23	SATA2_TX	B23	SATA3_TX-
A24	SUS_S5#	B24	PWR_OK
A25	SATA2_RX+	B25	SATA3_RX+
A26	SATA2_RX	B26	SATA3_RX-
A27	BATLOW#	B27	WDT
A28	(S)ATA_ACT#	B28	AC/HDA_SDIN2
A29	AC/HDA_SYNC	B29	AC/HDA_SDIN1
A30	AC/HDA_RST#	B30	AC/HDA_SDIN0
A31	GND	B31	GND
A32	AC/HDA_BITCLK	B32	SPKR

Connector Rows A and B

Pin#	Type 6 Description	Pin#	Type 6 Description
A33	AC/HDA_SDOUT	B33	I2C_CK
A34	BIOS_DIS0#	B34	I2C_DAT
A35	THRMTRIP#	B35	THRM#
A36	USB6-	B36	USB7-
A37	USB6+	B37	USB7+
A38	USB_6_7_OC#	B38	USB_4_5_OC#
A39	USB4-	B39	USB5-
A40	USB4+	B40	USB5+
A41	GND	B41	GND
A42	USB2-	B42	USB3-
A43	USB2+	B43	USB3+
A44	USB_2_3_OC#	B44	USB_0_1_OC#
A45	USB0-	B45	USB1-
A46	USB0+	B46	USB1+
A47	VCC_RTC	B47	EXCD1_PERST#
A48	EXCD0_PERST#	B48	EXCD1_CPPE#
A49	EXCD0_CPPE#	B49	SYS_RESET#
A50	LPC_SERIRQ	B50	CB_RESET#
A51	GND	B51	GND
A52	PCIE_TX5+	B52	PCIE_RX5+
A53	PCIE_TX5-	B53	PCIE_RX5-
A54	GPI0	B54	GPO1
A55	PCIE_TX4+	B55	PCIE_RX4+
A56	PCIE_TX4-	B56	PCIE_RX4-
A57	GND	B57	GPO2
A58	PCIE_TX3+	B58	PCIE_RX3+
A59	PCIE_TX3-	B59	PCIE_RX3-
A60	GND	B60	GND
A61	PCIE_TX2+	B61	PCIE_RX2+
A62	PCIE_TX2-	B62	PCIE_RX2-
A63	GPI1	B63	GPO3
A64	PCIE_TX1+	B64	PCIE_RX1+
A65	PCIE_TX1-	B65	PCIE_RX1-
A66	GND	B66	WAKE0#
A67	GPI2	B67	WAKE1#

Connector Rows A and B

Pin#	Type 6 Description	Pin#	Type 6 Description
A68	PCIE_TX0+	B68	PCIE_RX0+
A69	PCIE_TX0-	B69	PCIE_RX0-
A70	GND	B70	GND
A71	LVDS_A0+	B71	LVDS_B0+
A72	LVDS_A0-	B72	LVDS_B0-
A73	LVDS_A1+	B73	LVDS_B1+
A74	LVDS_A1-	B74	LVDS_B1-
A75	LVDS_A2+	B75	LVDS_B2+
A76	LVDS_A2-	B76	LVDS_B2-
A77	LVDS_VDD_EN	B77	LVDS_B3+
A78	LVDS_A3+	B78	LVDS_B3-
A79	LVDS_A3-	B79	LVDS_BKLT_EN
A80	GND	B80	GND
A81	LVDS_A_CK+	B81	LVDS_B_CK+
A82	LVDS_A_CK-	B82	LVDS_B_CK-
A83	LVDS_I2C_CK	B83	LVDS_BKLT_CTRL
A84	LVDS_I2C_DAT	B84	VCC_5V_SBY
A85	GPI3	B85	VCC_5V_SBY
A86	RSVD	B86	VCC_5V_SBY
A87	eDP_HPD	B87	VCC_5V_SBY
A88	PCIE_CLK_REF+	B88	BIOS_DIS1#
A89	PCIE_CLK_REF-	B89	VGA_RED
A90	GND	B90	GND
A91	SPI_POWER	B91	VGA_GRN
A92	SPI_MISO	B92	VGA_BLU
A93	GPO0	B93	VGA_HSYNC
A94	SPI_CLK	B94	VGA_VSYNC
A95	SPI_MOSI	B95	VGA_I2C_CK
A96	TPM_PP	B96	VGA_I2C_DAT
A97	TYPE10#	B97	SPI_CS#
A98	SER0_TX	B98	RSVD
A99	SER0_RX	B99	RSVD
A100	GND	B100	GND
A101	SER1_TX	B101	FAN_PWMOUT
A102	SER1_RX	B102	FAN_TACHIN

Connector Rows A and B

Pin#	Type 6 Description	Pin#	Type 6 Description
A103	LID#	B103	SLEEP#
A104	VCC_12V	B104	VCC_12V
A105	VCC_12V	B105	VCC_12V
A106	VCC_12V	B106	VCC_12V
A107	VCC_12V	B107	VCC_12V
A108	VCC_12V	B108	VCC_12V
A109	VCC_12V	B109	VCC_12V
A110	GND	B110	GND

Connector Rows C and D

Pin#	Type 6 Description	Pin#	Type 6 Description
C1	GND	D1	GND
C2	GND	D2	GND
C3	USB_SSRX0-	D3	USB_SSTX0-
C4	USB_SSRX0+	D4	USB_SSTX0+
C5	GND	D5	GND
C6	USB_SSRX1-	D6	USB_SSTX1-
C7	USB_SSRX1+	D7	USB_SSTX1+
C8	GND	D8	GND
C9	USB_SSRX2-	D9	USB_SSTX2-
C10	USB_SSRX2+	D10	USB_SSTX2+
C11	GND	D11	GND
C12	USB_SSRX3-	D12	USB_SSTX3-
C13	USB_SSRX3+	D13	USB_SSTX3+
C14	GND	D14	GND
C15	DDI1_PAIR6+	D15	DDI1_CTRLCLK_AUX+
C16	DDI1_PAIR6-	D16	DDI1_CTRLCLK_AUX-
C17	RSVD	D17	RSVD
C18	RSVD	D18	RSVD
C19	PCIE_RX6+	D19	PCIE_TX6+
C20	PCIE_RX6-	D20	PCIE_TX6-
C21	GND	D21	GND
C22	PCIE_RX7+	D22	PCIE_TX7+
C23	PCIE_RX7-	D23	PCIE_TX7-
C24	DDI1_HPD	D24	RSVD
C25	DDI1_PAIR4 +	D25	RSVD
C26	DDI1_PAIR4 -	D26	DDI1_PAIR0+
C27	RSVD	D27	DDI1_PAIR0-
C28	RSVD	D28	RSVD
C29	DDI1_PAIR5+	D29	DDI1_PAIR1+
C30	DDI1_PAIR5-	D30	DDI1_PAIR1-
C31	GND	D31	GND
C32	DDI2_CTRLCLK_AUX+	D32	DDI1_PAIR2+
C33	DDI2_CTRLCLK_AUX-	D33	DDI1_PAIR2-
C34	DDI2_DDC_AUX_SEL	D34	DDI1_DDC_AUX_SEL
C35	RSVD	D35	RSVD
C36	DDI3_CTRLCLK_AUX+	D36	DDI1_PAIR3+

Connector Rows C and D

Pin#	Type 6 Description	Pin#	Type 6 Description
C37	DDI3_CTRLCLK_AUX-	D37	DDI1_PAIR3-
C38	DDI3_DDC_AUX_SEL	D38	RSVD
C39	DDI3_PAIR0+	D39	DDI2_PAIR0+
C40	DDI3_PAIR0-	D40	DDI2_PAIR0-
C41	GND	D41	GND
C42	DDI3_PAIR1+	D42	DDI2_PAIR1+
C43	DDI3_PAIR1-	D43	DDI2_PAIR1-
C44	DDI3_HPD	D44	DDI2_HPD
C45	RSVD	D45	RSVD
C46	DDI3_PAIR2+	D46	DDI2_PAIR2+
C47	DDI3_PAIR2-	D47	DDI2_PAIR2-
C48	RSVD	D48	RSVD
C49	DDI3_PAIR3+	D49	DDI2_PAIR3+
C50	DDI3_PAIR3-	D50	DDI2_PAIR3-
C51	GND	D51	GND
C52	PEG_RX0+	D52	PEG_TX0+
C53	PEG_RX0-	D53	PEG_TX0-
C54	TYPE0#	D54	PEG_LANE_RV#
C55	PEG_RX1+	D55	PEG_TX1+
C56	PEG_RX1-	D56	PEG_TX1-
C57	TYPE1#	D57	TYPE2#
C58	PEG_RX2+	D58	PEG_TX2+
C59	PEG_RX2-	D59	PEG_TX2-
C60	GND	D60	GND
C61	PEG_RX3+	D61	PEG_TX3+
C62	PEG_RX3-	D62	PEG_TX3-
C63	RSVD	D63	RSVD
C64	RSVD	D64	RSVD
C65	PEG_RX4+	D65	PEG_TX4+
C66	PEG_RX4-	D66	PEG_TX4-
C67	RSVD	D67	GND
C68	PEG_RX5+	D68	PEG_TX5+
C69	PEG_RX5-	D69	PEG_TX5-
C70	GND	D70	GND
C71	PEG_RX6+	D71	PEG_TX6+

Connector Rows C and D

Pin#	Type 6 Description	Pin#	Type 6 Description
C72	PEG_RX6-	D72	PEG_TX6-
C73	GND	D73	GND
C74	PEG_RX7+	D74	PEG_TX7+
C75	PEG_RX7-	D75	PEG_TX7-
C76	GND	D76	GND
C77	RSVD	D77	RSVD
C78	PEG_RX8+	D78	PEG_TX8+
C79	PEG_RX8-	D79	PEG_TX8-
C80	GND	D80	GND
C81	PEG_RX9+	D81	PEG_TX9+
C82	PEG_RX9-	D82	PEG_TX9-
C83	RSVD	D83	RSVD
C84	GND	D84	GND
C85	PEG_RX10+	D85	PEG_TX10+
C86	PEG_RX10-	D86	PEG_TX10-
C87	GND	D87	GND
C88	PEG_RX11+	D88	PEG_TX11+
C89	PEG_RX11-	D89	PEG_TX11-
C90	GND	D90	GND
C91	PEG_RX12+	D91	PEG_TX12+
C92	PEG_RX12-	D92	PEG_TX12-
C93	GND	D93	GND
C94	PEG_RX13+	D94	PEG_TX13+
C95	PEG_RX13-	D95	PEG_TX13-
C96	GND	D96	GND
C97	RSVD	D97	RSVD
C98	PEG_RX14+	D98	PEG_TX14+
C99	PEG_RX14-	D99	PEG_TX14-
C100	GND	D100	GND
C101	PEG_RX15+	D101	PEG_TX15+
C102	PEG_RX15-	D102	PEG_TX15-
C103	GND	D103	GND
C104	VCC_12V	D104	VCC_12V
C105	VCC_12V	D105	VCC_12V
C106	VCC_12V	D106	VCC_12V

Connector Rows C and D

Pin#	Type 6 Description	Pin#	Type 6 Description
C107	VCC_12V	D107	VCC_12V
C108	VCC_12V	D108	VCC_12V
C109	VCC_12V	D109	VCC_12V
C110	GND	D110	GND

2.3. PCI Express

2.3.1. COM Express A-B Connector and C-D Connector PCIe Groups

COM Express Type 6 Modules have two groups of PCIe lanes. There is a group of up to eight lanes; six are located on COM Express A-B connector and two on C-D connector that are intended for general purpose use, such as interfacing the COM Express Module to Carrier Board PCIe peripherals. A second group of PCIe lanes is defined on the COM Express C-D connector.

This group is intended primarily for the PCIe Graphics interfaces (also referred to as the PEG interface), and is typically 16 PCIe lanes wide. For some Modules, the PEG lanes may be used for general purpose PCIe lanes if the external graphics interface is not in use. This usage is Module and Module chipset dependent.

2.3.2. General Purpose PCIe Signal Definitions

The general purpose PCI Express interface of the COM Express Type 6 Module on the COM Express A-B connector consists of up to 6 lanes plus 2 lanes on connector C-D, each with a receive and transmit differential signal pair designated from PCIE_RX0 (+ and -) to PCIE_RX7 (+ and -) and correspondingly from PCIE_TX0 (+ and -) to PCIE_TX7 (+ and -). The 8 lanes may be grouped into various link widths as defined in the COM Express spec.

Table 4: General Purpose PCI Express Signal Descriptions

Signal	Pin#	Description	I/O	Note
PCIE_RX0+ PCIE_RX0-	B68 B69	PCIe channel 0. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near COME to PCIE0 x1 device PETp/n0. Slot - Connect to PCIE0 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX0+ PCIE_TX0-	A68 A69	PCIe channel 0. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE0 x1 device PERp/n0. Slot - Connect to PCIE0 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Note
PCIE_RX1+ PCIE_RX1-	B64 B65	PCIe channel 1. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE1 x1 device PETp/n0. Slot - Connect to PCIE1 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX1+ PCIE_TX1-	A64 A65	PCIe channel 1. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE1 x1 device PERp/n0. Slot - Connect to PCIE1 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_RX2+ PCIE_RX2-	B61 B62	PCIe channel 2. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near COME to PCIE2 x1 device PETp/n0. Slot - Connect to PCIE2 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX2+ PCIE_TX2-	A61 A62	PCIe channel 2. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE2 x1 device PERp/n0. Slot - Connect to PCIE2 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_RX3+ PCIE_RX3-	B58 B59	PCIe channel 3. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE3 x1 device PETp/n0. Slot - Connect to PCIE3 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	

Signal	Pin#	Description	I/O	Note
PCIE_TX3+ PCIE_TX3-	A58 A59	PCIe channel 3. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE3 x1 device PERp/n0. Slot - Connect to PCIE3 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_RX4+ PCIE_RX4-	B55 B56	PCIe channel 4. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE4 x1 device PETp/n0. Slot - Connect to PCIE4 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX4+ PCIE_TX4-	A55 A56	PCIe channel 4. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE4 x1 device PERp/n0. Slot - Connect to PCIE4 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_RX5+ PCIE_RX5-	B52 B53	PCIe channel 5. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE5 x1 device PETp/n0. Slot - Connect to PCIE5 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX5+ PCIE_TX5-	A52 A53	PCIe channel 5. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE5 x1 device PERp/n0. Slot - Connect to PCIE5 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Note
PCIE_RX6+ PCIE_RX6-	C19 C20	PCIe channel 6. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE5 x1 device PETp/n0. Slot - Connect to PCIE5 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX6+ PCIE_TX6-	D19 D20	PCIe channel 6. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE6 x1 device PERp/n0. Slot - Connect to PCIE6 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_RX7+ PCIE_RX7-	C22 C23	PCIe channel 7. Receive Input differential pair. Carrier Board: Device - Connect AC Coupling cap 0.22uF near to PCIE6 x1 device PETp/n0. Slot - Connect to PCIE6 x1 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PCIE_TX7+ PCIE_TX7-	D22 D23	PCIe channel 7. Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Carrier Board: Device - Connect to PCIE7 x1 device PERp/n0. Slot - Connect to PCIE7 x1 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PCIE_CLK_REF+ PCIE_CLK_REF-	A88 A89	PCIe Reference Clock for all COM Express PCIe lanes, and for PEG lanes. Carrier Board: Connect 0Ω in series to Device - PCIE device REFCLK+, REFCLK-. Slot - PCIE Conn pin A13 REFCLK+, A14 REFCLK-. *Connect to PCIE Clock Buffer input to provide PCIE clocks output for more than one PCIE devices or slots. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Note
EXCD0_CPPE#	A49	PCI ExpressCard0: PCI Express capable card request, active low, one per card. Module has integrated PU resistor to 3.3V Express Card's CPPE# connects to Power Switch CPPE# input pin N/C if not used.	I 3.3V CMOS	
EXCD0_PERST#	A48	PCI ExpressCard0: reset, active low, one per card Express Card's PERST# and Express Card's PERST# connects to Power Switch PERST# output pin. N/C if not used.	O 3.3V CMOS	
EXCD1_CPPE#	B48	PCI ExpressCard1: PCI Express capable card request, active low, one per card. Module has integrated PU resistor to 3.3V Express Card's CPPE# connects to Power Switch CPPE# input pin N/C if not used.	I 3.3V CMOS	
EXCD1_PERST#	B47	PCI ExpressCard1: reset, active low, one per card Express Card's PERST# connects to Power Switch PERST# output pin. N/C if not used	O 3.3V CMOS	
CB_RESET#	B50	Reset output from Module to Carrier Board. Active low. Issued by Module chipset and may result from a low SYS_RESET# input, a low PWR_OK input, a VCC_12V power input that falls below the minimum specification, a watchdog timeout, or may be initiated by the Module software. Module has integrated 3.3V buffer and series resistor. Connect to reset pin of devices except PCI slots or devices. N/C if not used.	O 3.3V Suspend CMOS	

Signal	Pin#	Description	I/O	Note
WAKE0#	B66	PCI Express wake up event signal. Module has integrated PU resistor to 3.3VDUAL Device - Connect to WAKE# pin of PCIE device. Slot - Connect to WAKE# pin B11 of PCIE slot. Express Card - Connect to WAKE# pin 11 of Express Card socket. N/C if not used.	I 3.3V Suspend CMOS	

Notes:

2.3.3. PCI Express Lane Configurations – Per COM Express Spec

According to the COM Express specification, the general purpose PCIe lanes on the A-B connector can be configured as up to eight PCI Express x1 links or may be combined into various combinations of x8, x4, x2 and x1 links that add up to a total of 8 lanes. These configuration possibilities are based on the COM Express Module's chip-set capabilities.

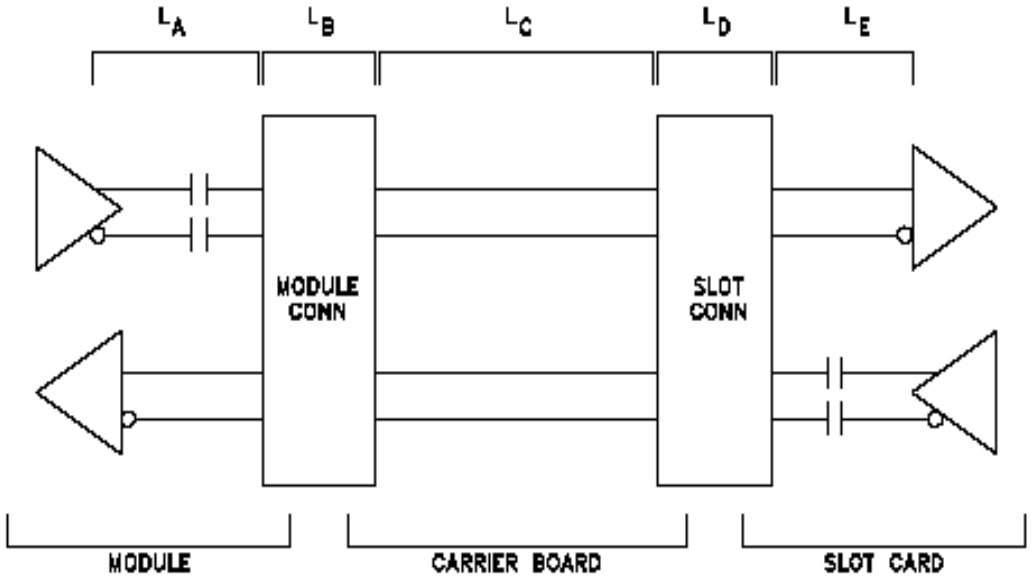
The COM Express specification defines a "fill order" from mapping PCIe links that are wider than x1 onto the COM Express pins. For example, the spec requires that a x4 PCI Express link be mapped to COM Express PCI Express lanes 0,1,2 and 3. Refer to the COM Express specification for details.

Note: All PCI Express devices are required to work in x1 mode as well as at their full capability. A x4 PCIe card for example is required by the PCI Express specification to be usable in x4 and / or x1 mode.

2.3.4. PCI Express* General Routing Guidelines

2.3.4.1. PCI Express Insertion Loss Budget with Slot Card

PCI Express Insertion Loss Budget, 1.25 GHz with Carrier Board Slot Card



The module transmit and receive insertion loss budgets are different due to the presence of the coupling caps in the module transmit path. The module transmit path insertion loss budget shall be 4.65 dB (3.46 dB + 1.19 dB). The module receive path insertion loss budget shall be 3.46 dB. COM ExpressTM connector loss is accounted for separately.

The Carrier Board transmit and receive insertion loss budgets are the same in this case. The Carrier Board insertion loss budget shall be 4.40 dB. COM ExpressTM connector and slot card connector losses are accounted for separately.

The slot card transmit and receive insertion loss budgets are different due to the presence of the coupling caps in the slot card's transmit path. The slot card's transmit path insertion loss budget is 3.84 dB (2.65 dB + 1.19 dB) per the PCI Express Card Electromechanical Specification Revision 1.1. The slot card's receive path insertion loss budget is 2.65 dB per the same specification. Slot card connector loss is accounted for separately.

Segment	**Loss (dB) max. Length [mm/inches]**	Notes
L_A	3.46 130/5.15	Allowance for 5.15 inches of module trace 3.45 dB loss @ 0.28 dB / GHz / inch and 1.66 dB crosstalk allowance. Coupling caps not included.
Coupling Caps	1.19	1.19 dB loss. From PCI Express Card Electromechanical Spec., Rev. 1.1, parameters (L_{ST} – L_{SR}). Includes crosstalk allowance of 0.79 dB.
L_B	0.25	COM Express™ connector at 1.25 GHz measured value: 0.25 dB loss.
L_C	4.4 228/9.0	Allowance for 9 inches of Carrier Board trace 4.40 db loss @ 0.28 dB / GHz / inch and a 1.25 dB crosstalk allowance.
L_D	1.25	1.25 dB loss. PCI Express Card Electromechanical Spec Rev 1.1 “guard band” allowance for slot connector – includes 1.0 dB connector loss.
L_E	2.65	2.65 dB loss. From PCI Express Card Electromechanical Spec., Rev. 1.1(without coupling caps; L_{AR}). Implied crosstalk allowance is 1.25 dB.
Total	13.20	13.20 dB loss.

PCI Express Insertion Loss Budget, 2.5 GHz with Carrier Board Slot Card

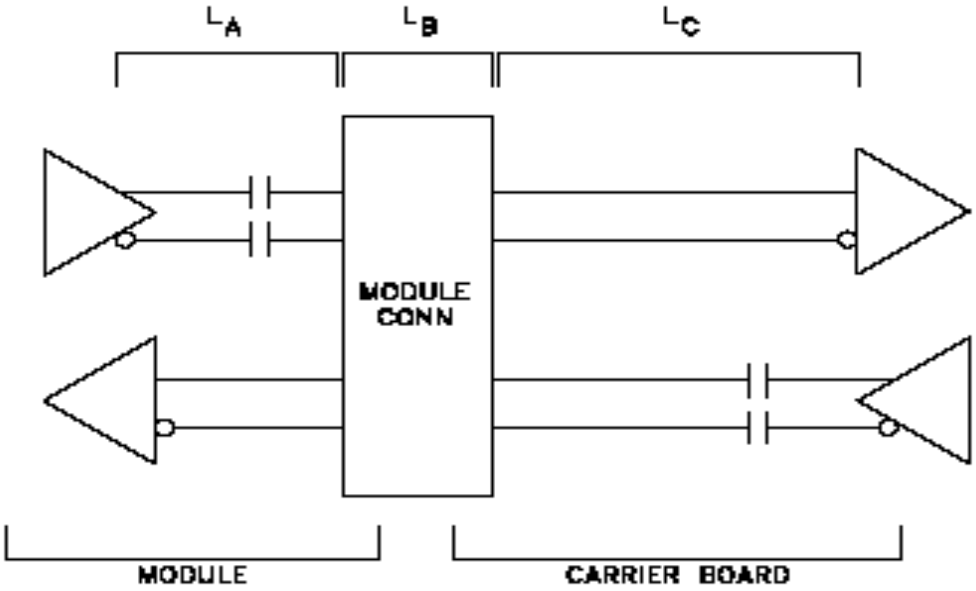
For “device up” PCIe Gen 2 operation, the Module PCIe maximum trace length is restricted to 5.0 inches and the Carrier Board maximum trace to 4.45 inches. Shorter lengths will yield additional margin and are encouraged where possible. Results assumed FR4 dielectrics.
Other dielectrics with lower losses could be considered, but were not simulated.

It should be noted that a use case exists that might result in reduced PCI Express bandwidth. This use case is tied to Carrier boards with a PCI Express slot (device up). PCI Express Gen 1 and Gen 2 signaling rates use the same PCI Express connector – there is no mechanical keying mechanism to identify the capabilities of the PCI Express slot or the PCI Express board plugged into the slot. This can lead to the situation where the Module and PCI Express board attempt a PCI Express Gen2 signaling rate connection over a Carrier that does not meet the routing guidelines for Gen 2 signaling rates. In a worst case scenario the devices might connect at Gen2 signaling rate with a high number of errors impacting the actual data throughput. It should be noted that there is a Carrier EEPROM on the Carrier which would allow the Module to determine the Carrier board capabilities but this is not a requirement in COM.0.

Segment	max. Length [mm/inches]	Notes
L_A	127/5.0	Allowance for module trace. Coupling cap effects included within simulation.
L_B		COM Express™ connector simulated at 2.5 GHz.
L_C	113/4.45	Allowance for Carrier Board.
L_D		PCI Express Card slot connector simulated at 2.5 GHz.
L_E	80/3.15	Slot Card trace length from PCI Express Card Electromagnetical Spec., Rev. 1.1
Total	320/12.6	PCIe GEN2 Data clocked architecture

2.3.4.2. PCI Express Insertion Loss Budget with Carrier Board PCIE Device

PCI Express Insertion Loss Budget, 1.25 GHz with Carrier Board PCIE Device



The module transmit and receive insertion loss budgets are different due to the presence of the coupling caps in the module transmit path. The module transmit path insertion loss budget shall be 4.65 dB (3.46 dB + 1.19 dB). The module receive path insertion loss budget shall be 3.46 dB. COM ExpressTM connector loss is accounted for separately.

The Carrier Board transmit and receive insertion loss budgets are different due to the presence of the coupling caps in the Carrier Board transmit path. The Carrier Board transmit path insertion loss budget shall be 9.49 dB (8.30 dB + 1.19 dB). The Carrier Board receive path insertion loss shall be 8.30 dB. COM ExpressTM connector loss is accounted for separately.

Segment	**Loss (dB)** **max. Length [mm/inches]**	Notes
L_A	3.46 131/5.15	Allowance for 5.15 inches of module trace 3.46 dB loss @ 0.28 dB / GHz / inch and 1.66 dB crosstalk allowance. Coupling caps not included.
Coupling Caps	1.19	1.19 dB loss. From PCI Express Card Electromechanical Spec., Rev. 1.1, parameters (LST– LSR). Includes crosstalk allowance of 0.79 dB.
L_B	0.25	COM Express™ connector at 1.25 GHz measured value: 0.25 dB loss.
L_C	8.3 113/4.45	Allowance for 15.85 inches of Carrier Board trace 8.30 dB loss @ 0.28 dB / GHz / inch and a 2.75 dB crosstalk allowance.
Total	13.2	13.2dB loss

PCI Express Insertion Loss Budget, 2.5 GHz with Carrier Board PCIE Device

For “device down” PCIe Gen 2 operation, the Module PCIe maximum trace length is restricted to 5.0 inches and the Carrier Board maximum trace to 8.0 inches. Shorter lengths will yield additional margin and are encouraged where possible. Results assumed FR4 dielectrics. Other dielectrics with lower losses could be considered, but were not simulated.

Segment	**max. Length [mm/inches]**	Notes
L_A	127/5	Allowance for module trace. Coupling cap effects included within simulation.
L_B		COM Express™ connector simulated at 2.5 GHz.
L_C	203/8	Allowance for Carrier Board trace.
Total	330/13.0	PCIe GEN2 Data clocked architecture

2.3.5. PCI Express* Trace Length Guidelines

Figure 2: Topology for PCI Express Slot Card.

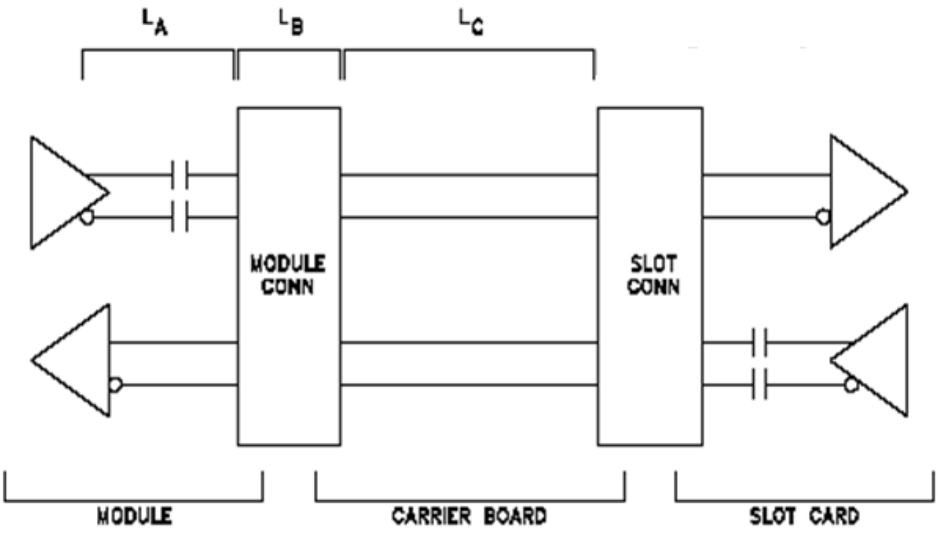


Figure 3: Topology for PCI Express Device Down.

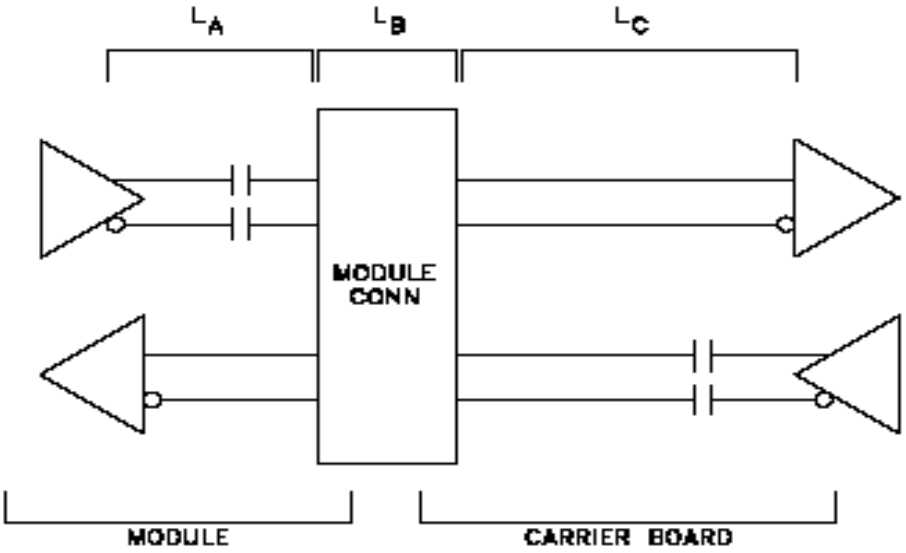


Table 5: PCI Express* Slot Card / Device Down Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	PCI Express* expansion	
Differential Impedance Target	85Ω±10%	
Single End	50Ω±10%	
Isolation to equivalent pairs	20 mils (MS) and 15 mils (DS)	
Isolation to other signal groups	20 mils (MS) and 15 mils (DS)	
Tx/Rx Spacing	20 mils	
LA + LB	Please see the SOM-5898 Layout Checklist	
Lc	Carrier Board Length	
Max length of LA+LB+LC	Slot Card: 8” Device Down: 9”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils REFCLK+ and REFCLK- (intra-pair):Max. ±5mils	
Reference Plane	GND referencing preferred Min 40-mil trace edge-to-major plane edge spacing GND stitching vias required next to signal vias if transitioning layers between GND layers Power referencing acceptable if stitching caps are used	
Carrier Board Via Usage	Max. 2 vias per TX trace, Max. 4 vias per RX trace	
AC coupling	The AC coupling capacitors for the TX lines are incorporated on the COM Express Module. The AC coupling capacitors for RX signal lines have to be implemented on the customer COM Express Carrier Board. Capacitor type: X7R, 220nF ±10%, 16V, shape 0402.	1

Notes:

1. AC caps are recommended to be placed close to PCIe device side (avoid placing AC cpas on mid-bus).

2.4 PEG (PCI Express Graphics)

2.4.1 PEG Signal Definitions

The PEG Port can utilize COM Express PCIe lanes 16-31 and is suitable to drive a link for an external high-performance PCI Express Graphics card, if implemented on the COM Express Module. Graphics Cards implemented as x16 use COM Express PCIe lanes 16-31; Graphics Cards implemented as x8 lanes should use COM Express PCIe lanes 16-23. Each lane of the PEG Port consists of a receive and transmit differential signal pair designated 'PEG_RX0' (+ and -) to 'PEG_RX15' (+ and -) and correspondingly from 'PEG_TX0' (+ and -) to 'PEG_TX15' (+ and -). The corresponding signals can be found on the Module connector rows C and D.

Table 6: PEG Signal Description

Signal	Pin#	Description	I/O	Notes
PEG_RX0+ PEG_RX0-	C52 C53	PEG channel 0, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n0. Slot - Connect to PCIE x16 Conn pin A16, A17 PERp/n0. N/C if not used.	I PCIE	
PEG_TX0+ PEG_TX0-	D52 D53	PEG channel 0, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n0. Slot - Connect to PCIE x16 Conn pin B14, B15 PETp/n0. N/C if not used.	O PCIE	
PEG_RX1+ PEG_RX1-	C55 C56	PEG channel 1, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n1. Slot - Connect to PCIE x16 Conn pin A21, A22 PERp/n1. N/C if not used	I PCIE	
PEG_TX1+ PEG_TX1-	D55 D56	PEG channel 1, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n1. Slot - Connect to PCIE x16 Conn pin B14, B15 PETp/n1. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Notes
PEG_RX2+ PEG_RX2-	C58 C59	PEG channel 2, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n2. Slot - Connect to PCIE x16 Conn pin A25, A26 PERp/n2. N/C if not used	I PCIE	
PEG_TX2+ PEG_TX2-	D58 D59	PEG channel 2, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n2. Slot - Connect to PCIE x16 Conn pin B23, B24 PETp/n2. N/C if not used.	O PCIE	
PEG_RX3+ PEG_RX3-	C61 C62	PEG channel 3, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp3. Slot - Connect to PCIE x16 Conn pin A29, A30 PERp3. N/C if not used	I PCIE	
PEG_TX3+ PEG_TX3-	D61 D62	PEG channel 3, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n3. Slot - Connect to PCIE x16 Conn pin B27, B28 PETp/n3. N/C if not used.	O PCIE	
PEG_RX4+ PEG_RX4-	C65 C66	PEG channel 4, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n4. Slot - Connect to PCIE x16 Conn pin A35, A36 PERp/n4. N/C if not used	I PCIE	
PEG_TX4+ PEG_TX4-	D65 D66	PEG channel 4, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n4. Slot - Connect to PCIE x16 Conn pin B33, B34 PETp/n4. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Notes
PEG_RX5+ PEG_RX5-	C68 C69	PEG channel 5, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n5. Slot - Connect to PCIE x16 Conn pin A39, A40 PERp/n5. N/C if not used	I PCIE	
PEG_TX5+ PEG_TX5-	D68 D69	PEG channel 5, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n5. Slot - Connect to PCIE x16 Conn pin B37, B38 PETp/n5. N/C if not used.	O PCIE	
PEG_RX6+ PEG_RX6-	C71 C72	PEG channel 6, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n6. Slot - Connect to PCIE x16 Conn pin A43, A44 PERp/n6. N/C if not used	I PCIE	
PEG_TX6+ PEG_TX6-	D71 D72	PEG channel 6, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n6. Slot - Connect to PCIE x16 Conn pin B37, B38 PETp/n6. N/C if not used	O PCIE	
PEG_RX7+ PEG_RX7-	C74 C75	PEG channel 7, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n7. Slot - Connect to PCIE x16 Conn pin A47, A48 PERp/n7. N/C if not used	I PCIE	
PEG_TX7+ PEG_TX7-	D74 D75	PEG channel 7, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n7. Slot - Connect to PCIE x16 Conn pin B45, B46 PETp/n7. N/C if not used	O PCIE	

Signal	Pin#	Description	I/O	Notes
PEG_RX8+ PEG_RX8-	C78 C79	PEG channel 8, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n8. Slot - Connect to PCIE x16 Conn pin A52, A53 PERp/n8. N/C if not used	I PCIE	
PEG_TX8+ PEG_TX8-	D78 D79	PEG channel 8, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n8. Slot - Connect to PCIE x16 Conn pin B50, B51 PETp/n8. N/C if not used	O PCIE	
PEG_RX9+ PEG_RX9-	C81 C82	PEG channel 9, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n9. Slot - Connect to PCIE x16 Conn pin A56, A57 PERp/n9. N/C if not used	I PCIE	
PEG_TX9+ PEG_TX9-	D81 D82	PEG channel 9, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n9. Slot - Connect to PCIE x16 Conn pin B54, B55 PETp/n9. N/C if not used	O PCIE	
PEG_RX10+ PEG_RX10-	C85 C86	PEG channel 10, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n10. Slot - Connect to PCIE x16 Conn pin A60, A61 PERp/n10. N/C if not used	I PCIE	
PEG_TX10+ PEG_TX10-	D85 D86	PEG channel 10, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n10. Slot - Connect to PCIE x16 Conn pin B58, B59 PETp/n10. N/C if not used	O PCIE	

Signal	Pin#	Description	I/O	Note
PEG_RX11+ PEG_RX11-	C88 C89	PEG channel 11, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n11. Slot - Connect to PCIE x16 Conn pin A64, A65 PERp/n11. N/C if not used	I PCIE	
PEG_TX11+ PEG_TX11-	D88 D89	PEG channel 11, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n11. Slot - Connect to PCIE x16 Conn pin B62, B63 PETp/n11. N/C if not used	O PCIE	
PEG_RX12+ PEG_RX12-	C91 C92	PEG channel 12, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n12. Slot - Connect to PCIE x16 Conn pin A68, A69 PERp/n12. N/C if not used	I PCIE	
PEG_TX12+ PEG_TX12-	D91 D92	PEG channel 12, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n12. Slot - Connect to PCIE x16 Conn pin B66, B67 PETp/n12. N/C if not used	O PCIE	
PEG_RX13+ PEG_RX13-	C94 C95	PEG channel 13, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n13. Slot - Connect to PCIE x16 Conn pin A72, A73 PERp/n13. N/C if not used	I PCIE	
PEG_TX13+ PEG_TX13-	D94 D95	PEG channel 13, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n13. Slot - Connect to PCIE x16 Conn pin B70, B71 PETp/n13. N/C if not used	O PCIE	

Signal	Pin#	Description	I/O	Note
PEG_RX14+ PEG_RX14-	C98 C99	PEG channel 14, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n14. Slot - Connect to PCIE x16 Conn pin A76, A77 PERp/n14. N/C if not used	I PCIE	
PEG_TX14+ PEG_TX14-	D98 D99	PEG channel 14, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n14. Slot - Connect to PCIE x16 Conn pin B74, B75 PETp/n14. N/C if not used	O PCIE	
PEG_RX15+ PEG_RX15-	C101 C102	PEG channel 15, Receive Input differential pair. Device - Connect AC Coupling cap 0.22uF near COME to PCIE x16 device PETp/n15. Slot - Connect to PCIE x16 Conn pin A80, A81 PERp/n15. N/C if not used	I PCIE	
PEG_TX15+ PEG_TX15-	D101 D102	PEG channel 15, Transmit Output differential pair. Module has integrated AC Coupling Capacitor. Device - Connect to PCIE x16 device PERp/n15. Slot - Connect to PCIE x16 Conn pin B78, B79 PETp/n15. N/C if not used	O PCIE	
PEG_LANE_RV#	D54	PCI Express Graphics lane reversal input strap. Pull low on the carrier board to reverse lane order. Module has integrated PU resistor to 3.3V. Carrier Board: Normal - N/C Reverse - PD 1KΩ to GND N/C if not used.	I 3.3V CMOS	

Notes:

2.4.2. PEG* General Routing Guidelines

PEG Configuration

The COM Express PCIe Graphics (PEG) Port is comprised of COM Express PCIe lanes 16-31.

The primary use of this set of signals is to interface to off-Module graphics controllers or cards.

If the PEG interface is not used for an external graphics card SDVO, it may be possible to use these PCIe lanes for other Carrier Board PCIe devices. The details of this usage are Module and Module chip-set dependent. Operation in a x1 link is also supported. Wider links (x2, x4, x8, x16) are chip-set dependent. Refer to the Module product documentation for details.

The COM Express specification defines a fill order for this set of PCIe lanes. Larger link widths go to the lower lanes. Refer to the COM Express specification for details.

Using PEG Pins for General Purpose PCIe Lanes

The COM Express PEG lanes may be used for general-purpose use if the PEG port is not being used as an interface to an external graphics device. The characteristics of this usage are Module and chip-set dependent.

Modules that employ desktop and mobile chip-sets with PEG capability can usually be set up to allow the COM Express PEG lanes to be configured as a single general purpose PCIe link, with link width possibilities of x1, x4, x8 or x16. The x1 configuration should always work; the wider links may be Module and chip-set dependent. Check with your vendor.

Modules based on server-class chip-sets may allow multiple links over the PEG lanes – for example, a x8 link on COM Express PCIe lanes 16 through 23 and a x4 link over lanes 24 through 27. This is Module and chip-set dependent.

2.4.3. PEG* Trace Length Guidelines

Figure 4: Topology for PCI Express Slot Card.

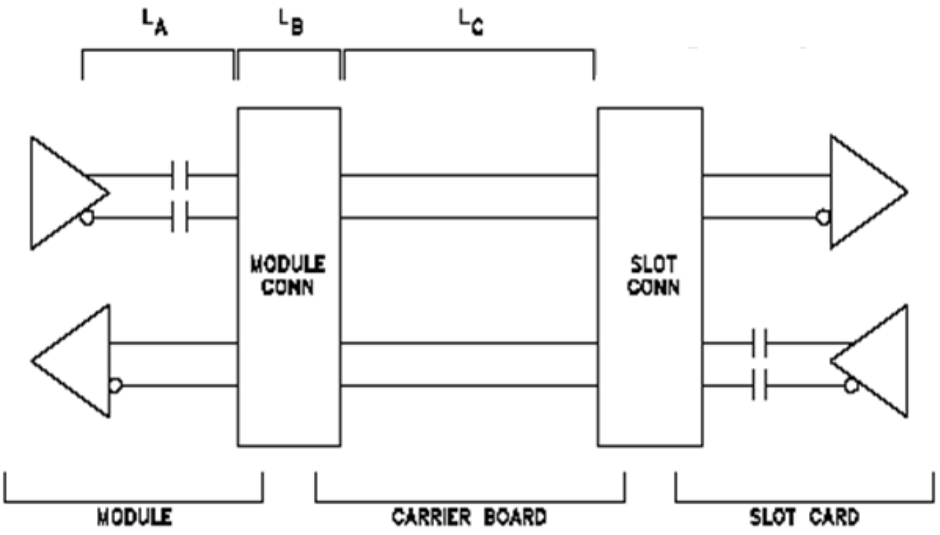


Figure 5: Topology for PCI Express Device Down.

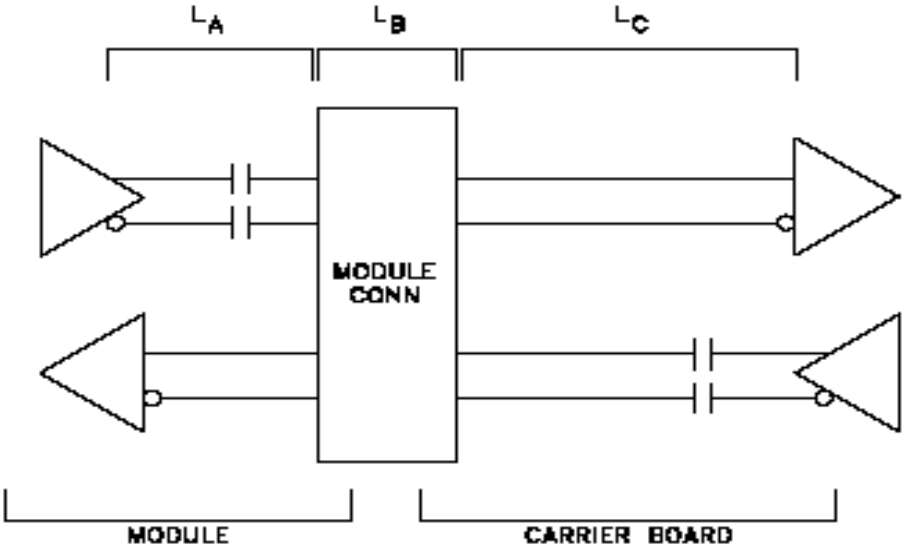


Table 7: PCI Express* Slot Card / Device Down Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	PCI Express* expansion	
Differential Impedance Target	85Ω±10%	
Single End	50Ω±10%	
Isolation to equivalent pairs	20 mils (MS) and 15 mils (DS)	
Isolation to other signal groups	20 mils (MS) and 15 mils (DS)	
Tx/Rx Spacing	20 mils	
LA + LB	Please see the SOM-5898 Layout Checklist	
Lc	Carrier Board Length	
Max length of LA+LB+LC	Slot Card: 7’ Device Down: 8’	
Length matching	Differential pairs (intra-pair): Max. ±5 mils REFCLK+ and REFCLK- (intra-pair):Max. ±5 mils	
Reference Plane	GND referencing preferred Min 40-mil trace edge-to-major plane edge spacing GND stitching vias required next to signal vias if transitioning layers between GND layers Power referencing acceptable if stitching caps are used	
Carrier Board Via Usage	Max. 2 vias per TX trace, Max. 4 vias per RX trace	
AC coupling	The AC coupling capacitors for the TX lines are incorporated on the COM Express Module. The AC coupling capacitors for RX signal lines have to be implemented on the customer COM Express Carrier Board. Capacitor type: X7R, 220nF ±10%, 16V, shape 0402.	1

Notes:

1. AC caps are recommended to be placed close to PCIe device side (avoid placing AC cpas on mid-bus).

2.5 Digital Display Interfaces (DDI)

Module Types 6 use Digital Display Interfaces (DDI) to provide DisplayPort, HDMI/DVI, and SDVO interfaces. Type 6 Modules can contain up to 3 DDIs (DDI[1:3]) of which DDI[1:3] can support DisplayPort, HDMI/DVI and DDI[1] can support DisplayPort, HDMI/DVI, and SDVO.
The main difference is that SDVO is only supported DDI[1] for Type 6 Modules.

DisplayPort / HDMI / DVI

DisplayPort was developed by the Video Electronics Standard Association (VESA) in order to create a new digital display port interface to connect a video source to a display device.
DisplayPort can be used to transfer audio and video at the same time, but each one is optional and can be transmitted without the other. A bi-directional, half-duplex auxiliary channel carries device anagement and device control data for the Main Link, such as VESA EDID.
DisplayPort is nowadays on almost all COM Express Modules available as Dual-mode DisplayPort, that can directly emit single-link HDMI and DVI signals using an adapter, which contains a level shifter to adjust for the lower voltages required by DisplayPort. These adapters can be directly implemented on the Carrier Board to have an easy, simple and future proof implementation of HDMI and/or DVI or an inexpensive cable adapter can be directly connectedon the Carrier Board's DisplayPort connector.

2.5.1. DDI Signal Definitions

Type 6 Modules up to 3 DisplayPort interfaces.
Each DisplayPort interface consists of 4 differential lanes, 1 auxiliary lane and 1 hot-plug-detect signal. The DDC_AUX_SEL pin should be routed to pin 13 of the DisplayPort connector, to enable Dual-Mode. When HDMI/DVI is directly done on the Carrier Board, this pin shall be pulled to 3.3V with a 100k Ohm resistor to configure the AUX pairs as DDC channels.

Table 8: Port / HDMI / DVI Pin-out of Type 6

Pin Name	DDI1 Pin#	DDI2 Pin#	DDI3 Pin#	Function (DDIX) DisplayPort	Function (DDIX) HDMI / DVI
DDIX_PAIR0+	D26	D39	C39	DPX_LANE0+	TMDSX_DATA2+
DDIX_PAIR0-	D27	D40	C40	DPX_LANE0-	TMDSX_DATA2-
DDIX_PAIR1+	D29	D42	C42	DPX_LANE1+	TMDSX_DATA1+
DDIX_PAIR1-	D30	D43	C43	DPX_LANE1-	TMDSX_DATA1-
DDIX_PAIR2+	D32	D46	C46	DPX_LANE2+	TMDSX_DATA0+
DDIX_PAIR2-	D33	D47	C47	DPX_LANE2-	TMDSX_DATA0-
DDIX_PAIR3+	D36	D49	C49	DPX_LANE3+	TMDSX_CLK+
DDIX_PAIR3-	D37	D50	C50	DPX_LANE3-	TMDSX_CLK-
DDIX_HPD	C24	D44	C44	DPX_HPD	HDMIX_HPD
DDIX_CTRLCLK_AUX+	D15	C32	C36	DPX_AUX+	HDMIX_CTRLCLK

DDIX_CTRLCLK_AUX-	D16	C33	C37	DPX_AUX-	HDMIX_CTRLDATA
DDIX_DDC_AUX_SEL	D34	C34	C38		

Note: Please verify in the Module's specification if DisplayPort or Dual-Mode DisplayPort is supported.

Table 9: DDI1 Signal Description

Signal	Pin#	Description	I/O	Notes
DDI1_PAIR0+ DDI1_PAIR0-	D26 D27	DDI channel 1, differential pairs 0. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI1_PAIR1+ DDI1_PAIR1-	D29 D30	DDI channel 1, differential pairs 1. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI1_PAIR2+ DDI1_PAIR2-	D32 D33	DDI channel 1, differential pairs 2. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI1_PAIR3+ DDI1_PAIR3-	D36 D37	DDI channel 1, differential pairs 3. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Notes
DDI1_HPD	C24	DDI channel 1, Hot-Plug Detect. Module has integrated current blocking circuit and PD resistor to GND Carrier Board: For DP, connector to device or DP connector HP pin. For HDMI / DVI, connect 3.3V to 5V Level Shifter to device, HDMI or DVI PD ping. NC if not used.	I 3.3V COMS	
DDI1_CTRLCLK_AUX+ DDI1_CTRLCLK_AUX-	D15 D16	DDI channel1, DP AUX function. DDC_AUX_SEL is no connect. Half-duplex bi-directional AUX channel for services such as link configuration or maintenance and EDID access. Module has integrated AC Coupling Capacitor and PD resistor to GND. Carrier Board: Connect to device or DP connector. N/C if not used.	I/O PCIE	
		DDI channel1, HDMI / DVI I²C function. DDC_AUX_SEL is pulled high. Carrier Board: Connect 3.3V-5V Level Shifter to device, HDMI or DVI connector. N/C if not used.	I/O OD 3.3V COMS	
DDI1_DDC_AUX_SEL	D34	Selects the function of DDI1_CTRLCLK_AUX+ and DDI1_CTRLDATA_AUX-. If this input is floating the AUX pair is used for the DP AUX+/- signals. If pulled-high the AUX pair contains the CRTLCLK and CTRLDATA signals. Module has integrated PD resistor to GND. Carrier Board: DP1 AUX+/- - N/C HDMI1: PU 100K to 3.3V N/C if not used.	I 3.3V COMS	

Table 10: DDI2 Signal Description

Signal	Pin#	Description	I/O	Notes
DDI2_PAIR0+ DDI2_PAIR0-	D39 D40	DDI channel 2, differential pairs 0. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI2_PAIR1+ DDI2_PAIR1-	D42 D43	DDI channel 2, differential pairs 1. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI2_PAIR2+ DDI2_PAIR2-	D46 D47	DDI channel 2, differential pairs 2. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI2_PAIR3+ DDI2_PAIR3-	D49 D50	DDI channel 2, differential pairs 3. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Notes
DDI2_HPD	D44	DDI channel 2, Hot-Plug Detect. Module has integrated current blocking circuit and PD resistor to GND Carrier Board: For DP, connector to device or DP connector HP pin. For HDMI / DVI, connect 3.3V to 5V Level Shifter to device, HDMI or DVI PD ping. NC if not used.	I 3.3V COMS	
DDI2_CTRLCLK_AUX+ DDI2_CTRLCLK_AUX-	C32 C33	DDI channel12 DP AUX function. DDC_AUX_SEL is no connect. Half-duplex bi-directional AUX channel for services such as link configuration or maintenance and EDID access. Module has integrated AC Coupling Capacitor and PD resistor to GND. Carrier Board: Connect to device or DP connector. N/C if not used.	I/O PCIE	
		DDI channel2, HDMI / DVI I²C function. DDC_AUX_SEL is pulled high. Carrier Board: Connect 3.3V-5V Level Shifter to device, HDMI or DVI connector. N/C if not used.	I/O OD 3.3V COMS	
DDI2_DDC_AUX_SEL	C34	Selects the function of DDI2_CTRLCLK_AUX+ and DDI2_CTRLDATA_AUX-. If this input is floating the AUX pair is used for the DP AUX+/- signals. If pulled-high the AUX pair contains the CRTLCLK and CTRLDATA signals. Module has integrated PD resistor to GND. Carrier Board: DP2 AUX+/- - N/C HDMI2: PU 100K to 3.3V N/C if not used.	I 3.3V COMS	

Notes:

Table 11: DDI3 Signal Description

Signal	Pin#	Description	I/O	Notes
DDI3_PAIR0+ DDI3_PAIR0-	C39 C40	DDI channel 3, differential pairs 0. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI3_PAIR1+ DDI3_PAIR1-	C42 C43	DDI channel 3, differential pairs 1. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI3_PAIR2+ DDI3_PAIR2-	C46 C47	DDI channel 3, differential pairs 2. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	

Signal	Pin#	Description	I/O	Notes
DDI3_PAIR3+ DDI3_PAIR3-	C49 C50	DDI channel 3, differential pairs 3. Carrier Board: For DP, connect AC Coupling Capacitors 75~200 nF near COME to device or DP connector. For HDMI / DVI, connect AC Coupling Capacitors 75~200 nF near COME and Level Shifter to HDMI or DVI connector. N/C if not used.	O PCIE	
DDI3_HPD	C44	DDI channel 3, Hot-Plug Detect. Module has integrated current blocking circuit and PD resistor to GND Carrier Board: For DP, connector to device or DP connector HP pin. For HDMI / DVI, connect 3.3V to 5V Level Shifter to device, HDMI or DVI PD ping. NC if not used.	I 3.3V COMS	
DDI3_CTRLCLK_AUX+ DDI3_CTRLCLK_AUX-	C36 C37	DDI channel 3, DP AUX function. DDC_AUX_SEL is no connect. Half-duplex bi-directional AUX channel for services such as link configuration or maintenance and EDID access. Module has integrated AC Coupling Capacitor, AUX+ PD resistor to GND and AUX- Pull up to 3.3V. Carrier Board: Connect to device or DP connector. N/C if not used.	I/O PCIE	1
		DDI channel1, HDMI / DVI I²C function. DDC_AUX_SEL is pulled high. Carrier Board: Connect 3.3V-5V Level Shifter to device, HDMI or DVI connector. N/C if not used.	I/O OD 3.3V COMS	

Signal	Pin#	Description	I/O	Notes
DDI3_DDC_AUX_SEL	C38	Selects the function of DDI3_CTRLCLK_AUX+ and DDI3_CTRLDATA_AUX-. If this input is floating the AUX pair is used for the DP AUX+/- signals. If pulled-high the AUX pair contains the CRTLCLK and CTRLDATA signals. Module has integrated PD resistor to GND. Carrier Board: DP3 AUX+/- - N/C HDMI3: PU 100K to 3.3V N/C if not used.	I 3.3V COMS	

Notes:

1. DDI3 AUX, default HDMI as AUX to VGA used.

2.5.2 Digital Display Interfaces (DDI) Routing Guidelines

2.5.2.1. DisplayPort Routing Guidelines

Carriers that support DisplayPort (DisplayPort only or dual mode):

- DC blocking capacitors shall be placed on the Carrier for the DDI[n]_PAIR[0:3] signals.
- The Carrier shall include a blocking FET on DDI[n]_HPD to prevent back-drive current from damaging the Module.

When implementing DisplayPort on the Carrier Board, the DP_AUX+ line shall have a pulldown resistor to GND. The resistor value should be 100kΩ. The DP_AUX- line shall have a pull-up resistor to 2.5V. The resistor value should be 100kΩ. The resistors shall be placed on the DisplayPort connector side of the AC coupling capacitors. The DP_HP signal shall include a blocking FET to prevent back-drive current damage. The DP_HP signal shall be pulled-down to GND with a 110kΩ resistor.

The DDI signals can be used to support a variety of video interfaces. The circuits required to realize the different video interfaces will be determined by a future PICMG Carrier Design Guide subcommittee. At this time, they only requirement placed on Modules for the DDI signals is the maximum trace length specified below.

Figure 6: DisplayPort Loss Budget

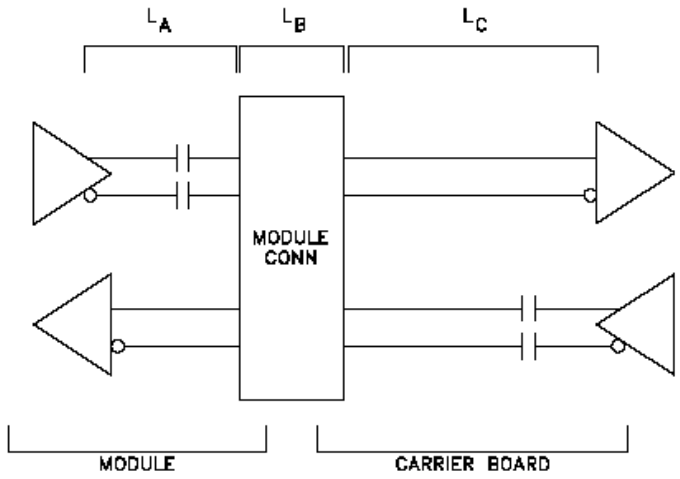


Table 12: DisplayPort Insertion Loss Budget

Segment	max. Length [mm/inches]	Notes
L_A	127/5.0	Allowance for module trace. Coupling cap effects included within simulation.
L_B		COM Express™ connector simulated at 2.5 GHz.
L_C	TBD	Allowance for Carrier Board trace.
Total	TBD	

Figure 7: Topology for DisplayPort

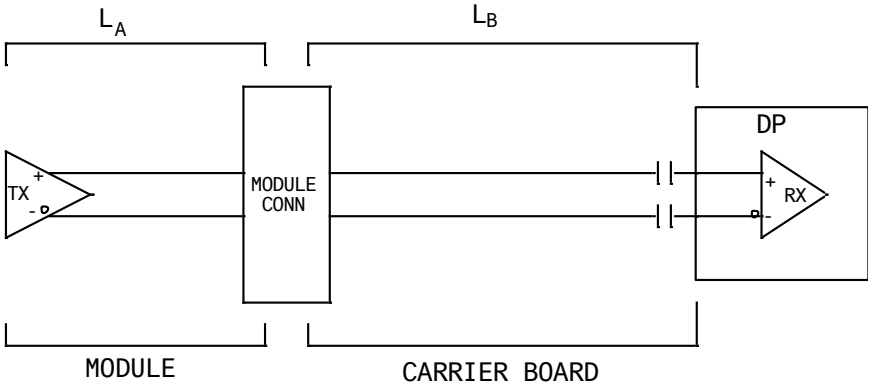


Table 13: DisplayPort Connector / Device Down Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	DisplayPort	
Differential Impedance Target	85 Ω ±10%	
Single End	50Ω ±10%	
Isolation to equivalent pairs	20 mils (MS) and 15 mils (DS)	
Isolation to other signal groups	20 mils (MS) and 15 mils (DS)	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	DDI differential pairs to DP connector: 5.5” DDI differential pairs to Device Down: 5.5” AUX channel: 14”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils For each channel, match the lengths of the differential pairs (Inter-Pair) to be within a 2-inch window (max length – min length < 1 inch (2.54 cm)).	
Reference Plane	GND referencing preferred. Min 40-mil trace edge-to-major plane edge spacing.	
Carrier Board Via Usage	Max. 2 vias.	
AC coupling	Min = 75 nF Max = 200 nF	1

Notes:

1. AC caps are recommended to be placed close to device side (avoid placing AC cpas on mid-bus).

2.5.2.2. HDMI / DVI Routing Guidelines

When implementing HDMI level shifters shall be used on the TMDS signals. Bi-directional level shifters shall be used between the 3.3V and 5V CTRLCLK and CTRLDATA signals with 2.2kΩ pull-ups to 3.3V and 5V.

Carriers that support TMDS (DVI/HDMI):

- DDI[n]_DDC_AUX_SEL shall be pulled to 3.3V on the Carrier with a 100K Ohm resistor to configure the DDI[n]_AUX pair as the DDC channel.
- Bi-directional level translators shall be placed on the Carrier DDI[n]_CTRLDATA_AUX- and DDI[n]_CTRLCLK_AUX+ to convert the 3.3V DDC channel on the Module to the 5V DDC channel for the TMDS display.
- Pull-up resistors shall be placed on the Carrier from 3.3V (Module side of level translator) and 5V (display side of level translator) and the [n]_CTRLDATA_AUX- and DI[n]_CTRLCLK_AUX+ signals. The pull-up resistor should be 2k.
- Level translators Shall be placed on the Carrier DDI[n]_PAIR[0:3] signals.
- DC blocking capacitors shall be placed on the Carrier for the DDI[n]_PAIR[0:3] signals.
- The Carrier shall include a blocking FET on DDI[n]_HPD to prevent back-drive current from damaging the module.

The DDI signals can be used to support a variety of video interfaces. The circuits required to realize the different video interfaces will be determined by a future PICMG Carrier Design Guide subcommittee. At this time, they only requirement placed on Modules for the DDI signals is the maximum trace length specified below.

Figure 8: HDMI / DVI (TMDS) Loss Budget

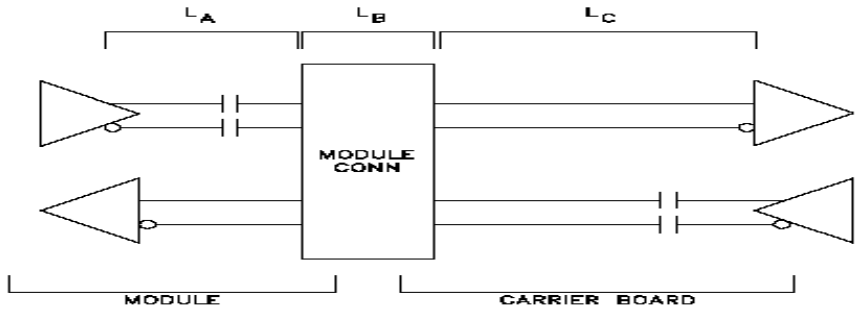


Table 14: HDMI / DVI (TMDS) Insertion Loss Budget

Segment	max. Length [mm/inches]	Notes
L_A	127/5.0	Allowance for module trace. Coupling cap effects included within simulation.
L_B		COM Express™ connector simulated at 2.5 GHz.
L_C	TBD	Allowance for Carrier Board trace.
Total	TBD	

Figure 9: Topology for HDMI / DVI

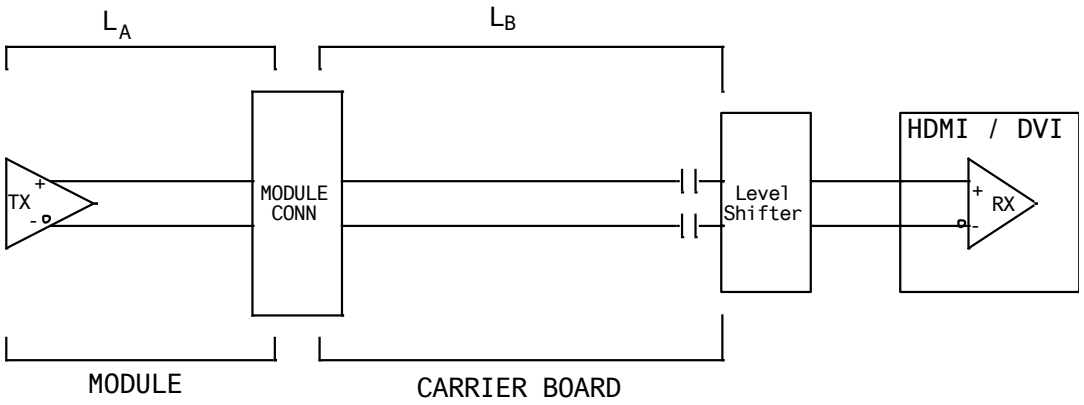


Table 15: HDMI / DVI Connector / Device Down Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	HDMI / DVI (TMDS)	
Differential Impedance Target	85 Ω ±5%	
Single End	50Ω ±5%	
Isolation to equivalent pairs	20 mils (MS) and 15 mils (DS)	
Isolation to other signal groups	20 mils (MS) and 15 mils (DS)	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	DDI differential pairs to HDMI/DVI connector: 6.5” DDI differential pairs to Device Down: 6.5” AUX channel: 12”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils For each channel, match the lengths of the differential pairs (Inter-Pair) to be within a 2-inch window (max length – min length < 1 inch (2.54 cm)). CTRDATA - CTRCLK < 1000	
Reference Plane	GND referencing preferred. Min 40-mil trace edge-to-major plane edge spacing.	
Carrier Board Via Usage	Max. 2 vias.	
AC coupling	Min = 75 nF Max = 200 nF	1

Notes:

1. AC caps are recommended to be placed close to device side (avoid placing AC cpas on mid-bus).

2.5.3. HDMI / DVI Level Shifter Requirements

The HDMI specification requires the receiver to be terminated to AVCC (nominally 3.3 V) through Rt (nominally 50 Ω). The HDMI receiver requirements require the native HDMI signals from the SOC to be level shifted. This prevents electrical overstress of the driver and ensure that the receiver is operational within the receiver specifications defined in the *High Definition Multimedia Interface Specification 1.4a*.

2.5.4. ESD Protection

HDMI signals are subjected to ESD strikes due to plugging in of the devices through the HDMI cable and frequent human contact that can destroy both the HDMI host and devices on the platform. Therefore these ports need to be protected.

There are a wide variety of ESD protection devices and ESD suppressors readily available in the market such as Metal Oxide Varistors (MOVs), Zener Diode, Transient Voltage Suppressor (TVS), Polymer devices and ESD diode arrays. With 1.65 Gbps of data rate, HDMI is very sensitive to parasitic capacitance. Excessive parasitic capacitance can severely degrade the signal integrity and lead to a compliance or operational failure. To maintain signal integrity, Intel recommends to use ESD suppressors or diode arrays having a low junction capacitance.

Recommended characteristics of an ideal ESD Protection Diode for HDMI:

- Able to withstand at least 8 kV of ESD strikes.
- Low capacitance <1 pF to minimize signal distortion at high data rates as higher capacitance degrade the HDMI signal quality.
- Fast response/rise time to protect from the fast rise time of ESD surge pulses.
- Low-leakage current to minimize static power consumption.
- Ensure the selected ESD solution will not violate HDMI Voff spec. In a low power state a power rail ESD diode can become forward biased as a result on the HDMI sink (panel) termination of 50 Ω to 3.3 V
- Some ESD devices may impact the trace impedance. Care should be taken while choosing such devices so that the differential-impedance target in the *HDMI 1.4 Specification* is not violated.

The *HDMI 1.4a Specification* requires that 8 kV of ESD strikes be tolerated.

The ESD protection devices should be placed as close to the HDMI connector as possible so that when ESD strikes occur, the discharges can be quickly absorbed or diverted to the ground/power plane before it is coupled to another signal path nearby.
Footprints for ESD components or diode arrays can be provided on board with no stubs and no more than 750 mils (19.05 mm) from the connector. The ESD components can be stuffed depending on the requirement.

2.6. LAN Interface

All COM Express Modules provide at least one LAN port. The 8-wire 10/100/1000BASE-T Gigabit Ethernet interface compliant to the IEEE 802.3-2005 specification is the preferred interface for this port, with the COM Express Module PHY responsible for implementing auto-negotiation of 10/100BASE-TX vs 10/100/1000BASE-T operation. The carrier may also support a 4-wire 10/100BASE-TX interface from the COM Express Module on an exception basis. Check with your vendor for 10/100 only implementations.

2.6.1. LAN Signal Definitions

The LAN interface of the COM Express Module consists of 4 pairs of low voltage differential pair signals designated from *'GBE0_MDI0'* (+ and -) to *'GBE0_MDI3'* (+ and -) plus additional control signals for link activity indicators. These signals can be used to connect to a 10/100/1000BASE-T RJ45 connector with integrated or external isolation magnetics on the Carrier Board. The corresponding LAN differential pair and control signals can be found on rows A and B of the Module's connector.

Table 16: LAN Interface Signal Descriptions

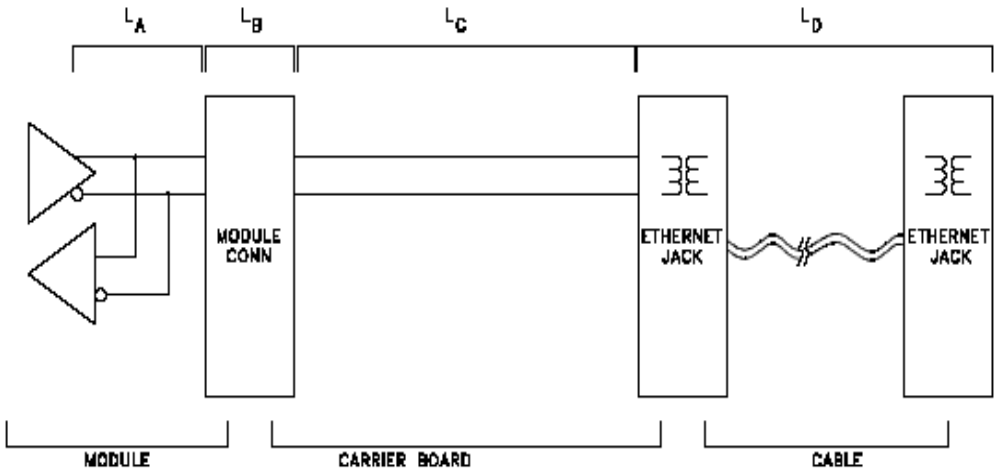
Signal	Pin#	Description	I/O	Note
GBE0_MDI0+ GBE0_MDI0-	A13 A12	Media Dependent Interface (MDI) differential pair 0. The MDI can operate in 1000, 100, and 10Mbit/sec modes. Module has integrated termination. Carrier Board: Connect to Magnetics Module MDI0+/- N/C if not used.	I/O GBE	
GBE0_MDI1+ GBE0_MDI1-	A10 A9	Media Dependent Interface (MDI) differential pair 1. The MDI can operate in 1000, 100, and 10Mbit/sec modes. Module has integrated termination. Carrier Board: Connect to Magnetics Module MDI0+/- N/C if not used	I/O GBE	

Signal	Pin#	Description	I/O	Note
GBE0_MDI2+ GBE0_MDI02	A7 A6	Media Dependent Interface (MDI) differential pair 2. The MDI can operate in 1000, 100, and 10Mbit/sec modes. Module has integrated termination. Carrier Board: Connect to Magnetics Module MDI2+/- N/C if not used.	I/O GBE	
GBE0_MDI3+ GBE0_MDI3-	A3 A2	Media Dependent Interface (MDI) differential pair 3. The MDI can operate in 1000, 100, and 10Mbit/sec modes. Module has integrated termination. Carrier Board: Connect to Magnetics Module MDI3+/- N/C if not used	I/O GBE	
GBE0_CTREF	A14	Reference voltage for Carrier Board Ethernet channel 0 magnetics center tap. Carrier Board: 0.1uF to ground. N/C if not used.	REF	
GBE0_LINK#	A8	Ethernet controller 0 link indicator, active low.	O 3.3V Suspend / 3.3V OD CMOS	
GBE0_LINK100#	A4	Ethernet controller 0 100Mbit/sec link indicator, active low.	O 3.3V Suspend / 3.3V OD CMOS	
GBE0_LINK1000#	A5	Ethernet controller 0 1000Mbit/sec link indicator, active low.	O 3.3V Suspend / 3.3V OD CMO	
GBE0_ACT#	B2	Ethernet controller 0 activity indicator, active low.	O 3.3V Suspend / 3.3V OD CMO	

2.6.2. LAN Routing Guidelines

10/100/1000 Ethernet Insertion Loss Budget

Figure 10: 10/100/1000 Ethernet Insertion Loss Budget



COM ExpressTM Ethernet implementations should conform to insertion loss values less than or equal to those shown in the table above. The insertion loss values shown account for frequency dependent material losses only. Cross talk losses are separate from material losses in the Gb Ethernet pecification.

“Device Down” implementations, in which the Ethernet target device is implemented on the Carrier Board (for instance, an Ethernet switch), may add the insertion loss for the RJ45 Ethernet jack and integrated magnetics to the Carrier Board budget. This insertion loss value is typically 1 dB. The Carrier Board insertion loss budget then becomes LC + 1 dB, or 1.15 dB.

Table 17: 10/100/1000 Ethernet Insertion Loss Budget, 100 MHz

Segment	Loss (dB)	Notes
L_A	0.08	Up to 3 inches of module trace @ 0.28 dB / GHz / inch
L_B	0.02	COM Express™ connector at 100 MHz measured value
L_C	0.15	Up to 5 inches of Carrier Board trace @ 0.28 dB / GHz / inch
L_D	24.00	Cable and cable connectors, integrated magnetics, per source spec.
Total	24.25	

2.6.3. LAN Trace Length Guidelines

Figure 11: Topology for Ethernet Jack

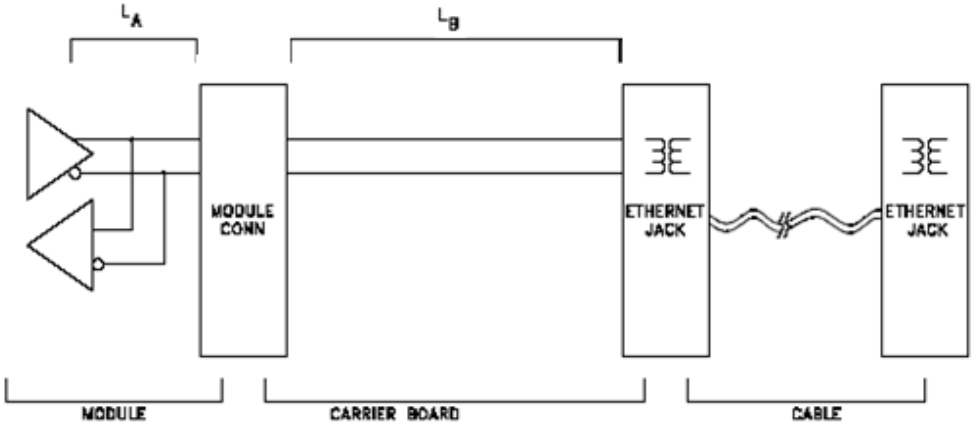


Table 18: Ethernet Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	GBE0_MDIx+, GBE0_MDIx-	
Differential Impedance Target	100 Ω ±10%	
Single End	50Ω ±10%	
Spacing between RX and TX pairs (inter-pair) (s)	Min. 50mils	
Spacing between differential pairs and high-speed periodic signals	Min. 300mils	
Spacing between differential pairs and low-speed non periodic signals	Min. 100mils	
Spacing between digital ground and analog ground plane (between the magnetics Module and RJ45 connector)	Min. 60mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	COM Express Module to the magnetics Module - 7 inches. Magnetics Module to RJ45 connector - Max. 1.0 inches.	
Length matching	Differential pairs (intra-pair): Max. ±2.5 mils RX and TX pairs (inter-pair) - Max. ±15mils	
Reference Plane	GND referencing preferred..	
Spacing from edge of plane	Min. 40mils	
Carrier Board Via Usage	Max. 2 vias.	

Notes:

2.6.4. Reference Ground Isolation and Coupling

The Carrier Board should maintain a well-designed analog ground plane around the components on the primary side of the transformer between the transformer and the RJ-45 receptacle. The analog ground plane is bonded to the shield of the external cable through the RJ-45 connector housing.

The analog ground plane should be coupled to the carrier's digital logic ground plane using a capacitive coupling circuit that meets the ground plane isolation requirements defined in the 802.3-2005 specification. It is recommended that the Carrier Board PCB design maintain a minimum 30 mil gap between the digital logic ground plane and the analog ground plane.

It's recommended to place an optional GND to SHIELDGND connection near the RJ-45 connector to improve EMI and ESD capabilities.

2.7. USB2.0 Ports

A COM Express Module must support a minimum of 4 USB Ports and can support up to 8 USB Ports. All of the USB Ports must be USB2.0 compliant. There are 4 over-current signals shared by the 8 USB Ports. A Carrier must current limit the USB power source to minimize disruption of the Carrier in the event that a short or over-current condition exists on one of the USB Ports. A Module must fill the USB Ports starting at Port 0. The USB SuperSpeed ports 0, 1, 2 and 3, if used, are to be paired with USB 2.0 ports 0, 1, 2 and 3 in the same order. The USB SuperSpeed ports use the same over current signaling mechanism as the USB 2.0 ports, but USB 3.0 allows up to 1A current per port instead of 500mA allowed in USB 2.0. Although USB 2.0 signals use differential signaling, the USB specification also encodes single ended state information in the differential pair, making EMI filtering somewhat challenging. Ports that are internal to the Carrier do not need EMI filters. A USB Port can be powered from the Carrier Main Power or from the Carrier Suspend Power. Main Power is used for USB devices that are accessed when the system is powered on. Suspend Power (VCC_5V_SBY) is used for devices that need to be powered when the Module is in Sleep-State S5. This would typically be for USB devices that support Wake-on-USB. The amount of current available on VCC_5V_SBY is limited so it should be used sparingly.

2.7.1. USB2.0 Signal Definitions

Table 19: USB Signal Descriptions

Signal	Pin#	Description	I/O	Note
USB0+ USB0-	A46 A45	USB Port 0, data + or D+ USB Port 0, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB1+ USB1-	B46 B45	USB Port 1, data + or D+ USB Port 1, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	

Signal	Pin#	Description	I/O	Note
USB2+ USB2-	A43 A42	USB Port 2, data + or D+ USB Port 2, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB3+ USB3-	B43 B42	USB Port 3, data + or D+ USB Port 3, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB4+ USB4-	A40 A39	USB Port 4, data + or D+ USB Port 4, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB5+ USB5-	B40 B39	USB Port 5, data + or D+ USB Port 5, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB6+ USB6-	A37 A36	USB Port 6, data + or D+ USB Port 6, data + or D- Carrier board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	

Signal	Pin#	Description	I/O	Note
USB7+ USB7-	B37 B36	USB Port 7, data + or D+ USB Port 7, data + or D- Carrier Board: Device - Connect to D+/- Conn. - Connect 90Ω @100MHz Common Choke in series and ESD suppressors to GND to Pin 3 D+ / Pin 2 D- N/C if not used	I/O USB	
USB_0_1_OC#	B44	USB over-current sense, USB ports 0 and 1. Carrier Board: Connect to Overcurrent of Power Distribution Switch and Bypass 0.1uF to GND N/C if not used	I 3.3V CMOS	
USB_2_3_OC#	A44	USB over-current sense, USB ports 2 and 3. Carrier Board: Connect to Overcurrent of Power Distribution Switch and Bypass 0.1uF to GND N/C if not used	I 3.3V CMOS	
USB_4_5_OC#	B38	USB over-current sense, USB ports 4 and 5. Carrier Board: Connect to Overcurrent of Power Distribution Switch and Bypass 0.1uF to GND N/C if not used	I 3.3V CMOS	
USB_6_7_OC#	A38	USB over-current sense, USB ports 6 and 7. Carrier Board: Connect to Overcurrent of Power Distribution Switch and Bypass 0.1uF to GND N/C if not used	I 3.3V CMOS	

Notes:

2.7.1.1. USB Over-Current Protection (USB_x_y_OC#)

The USB Specification describes power distribution over the USB port, which supplies power for USB devices that are directly connected to the Carrier Board. Therefore, the host must implement over-current protection on the ports for safety reasons. Should the aggregate current drawn by the downstream ports exceed a permitted value, the over-current protection circuit removes power from all affected downstream ports. The over-current limiting mechanism must be resettable without user mechanical intervention. For more detailed information about this subject, refer to the 'Universal Serial Bus Specifications Revision 2.0', which can be found on the website http://www.usb.org.

Over-current protection for USB ports can be implemented by using power distribution switches on the Carrier Board that monitor the USB port power lines. Power distribution switches usually have a soft-start circuitry that minimizes inrush current in applications where highly capacitive loads are employed. Transient faults are internally filtered.

Additionally, they offer a fault status output that is asserted during over-current and thermal shutdown conditions. These outputs should be connected to the corresponding COM Express Modules USB over-current sense signals. Fault status signaling is an option at the USB specification. If you don't need the popup message in your OS you may leave the signals USB_0_1_OC#, USB_2_3_OC#, USB_4_5_OC# and USB_6_7_OC# unconnected.

Simple resettable PolySwitch devices are capable of fulfilling the requirements of USB overcurrent protection and therefore can be used as a replacement for power distribution switches.
Fault status signals are connected by a pullup resistor to VCC_3V3_SBY on COM Express Module. Please check your tolerance on a USB port with VCC_5V supply.

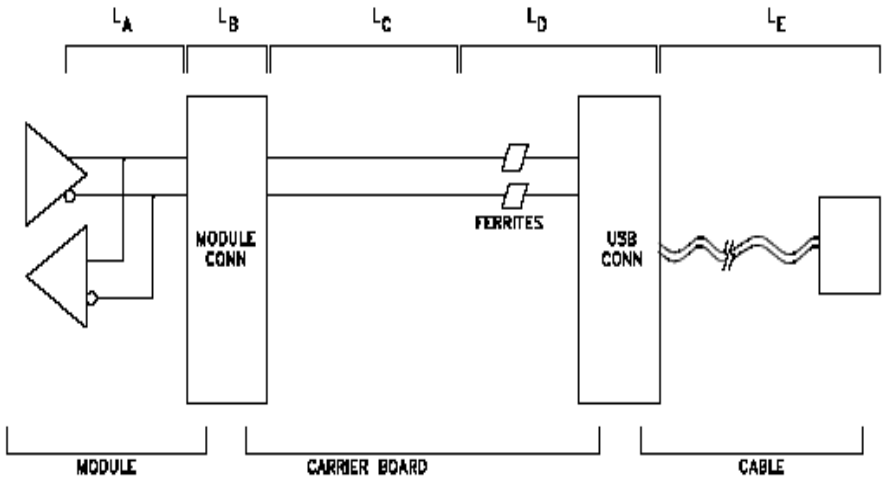
2.7.1.2. Powering USB devices during S5

The power distribution switches and the ESD protection shown in the schematics can be powered from Main Power or Suspend Power (VCC_5V_SBY). Ports powered by Suspend Power are powered during the S3 and S5 system states. This provides the ability for the COM Express Module to generate system wake-up events over the USB interface.

2.7.2. USB2.0 Routing Guidelines

USB Insertion Loss Budget

Figure 12: USB Insertion Loss Budget



COM ExpressTM USB implementations should conform to insertion loss values less than or equal to those shown in the table above. The insertion loss values shown account for frequency dependent material losses only. Cross talk losses are separate from material losses in the USB specification.

"Device Down" implementations, in which the USB target device is implemented on the Carrier Board, may add the ferrite and USB connector insertion loss values to the Carrier Board budget.

The Carrier Board insertion loss budget then becomes LC + LD, or 2.68 dB.

Table 20: USB Insertion Loss Budget, 400 MHz

Segment	Loss (dB)	Notes
L_A	0.67	Up to 6 inches of module trace @ 0.28 dB / GHz / inch
L_B	0.05	COM ExpressTM connector at 400 MHz measured value
L_C	1.68	Up to 14 inches of Carrier Board trace @ 0.28 dB / GHz / inch
L_D	1.00	USB connector and ferrite loss
L_E	5.80	USB cable and far end connector loss, per source specification
Total	9.20	

2.7.2.1. USB 2.0 General Design Considerations and Optimization

Use the following general routing and placement guidelines when laying out a new design. These guidelines help minimize signal quality and EMI problems.

- Do not route USB 2.0 traces under crystals, oscillators, clock synthesizers, magnetic devices or ICs that use and/or duplicate clocks.
- Separate signal traces into similar categories, and route similar signal traces together (such as routing differential-pairs together).
- Keep USB 2.0 signals clear of the core logic set. High current transients are produced during internal state transitions and can be very difficult to filter out.
- Follow the 20 x h rule by keeping traces at least [20 x (height above the plane)] mils away from the edge of the plane (VCC or GND). For an example stackup, the height above the plane is 4.5 mils (0.114 mm). This calculates to a 90-mil (2.286-mm) spacing requirement from the edge of the plane. This helps prevent the coupling of the signal onto adjacent wires and also helps prevent free radiation of the signal from the edge of the PCB.
- Avoid stubs on high-speed USB signals because stubs cause signal reflections and affect signal quality. If a stub is unavoidable in the design, the total of all the stubs on a particular line should not be greater than 200 mils (5.08 mm).

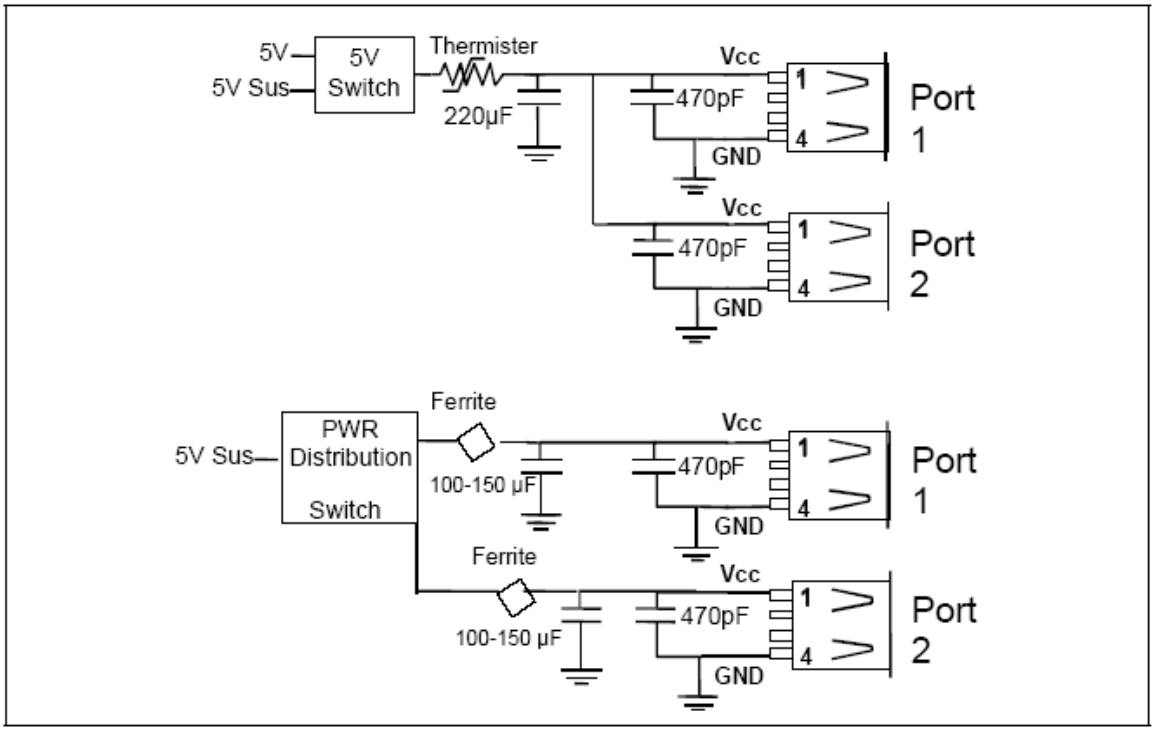
2.7.2.2. USB 2.0 Port Power Delivery

The following is a suggested topology for power distribution of VBUS to USB ports.

These circuits provide two types of protection during dynamic attach and detach situations on the bus: inrush current limiting (droop) and dynamic detach flyback protection. These two types require both bulk capacitance (droop) and filtering capacitance (for dynamic detach flyback voltage filtering). Intel recommends the following:

- Minimize the inductance and resistance between the coupling capacitors and the USB ports.
- Place capacitors as close as possible to the port and the power-carrying traces should be as wide as possible, preferably, a plane.
- Make the power-carrying traces wide enough that the system fuse blows on an over current event. If the system fuse is rated at 1 A, then the power-carrying traces should be wide enough to carry at least 1.5 A.

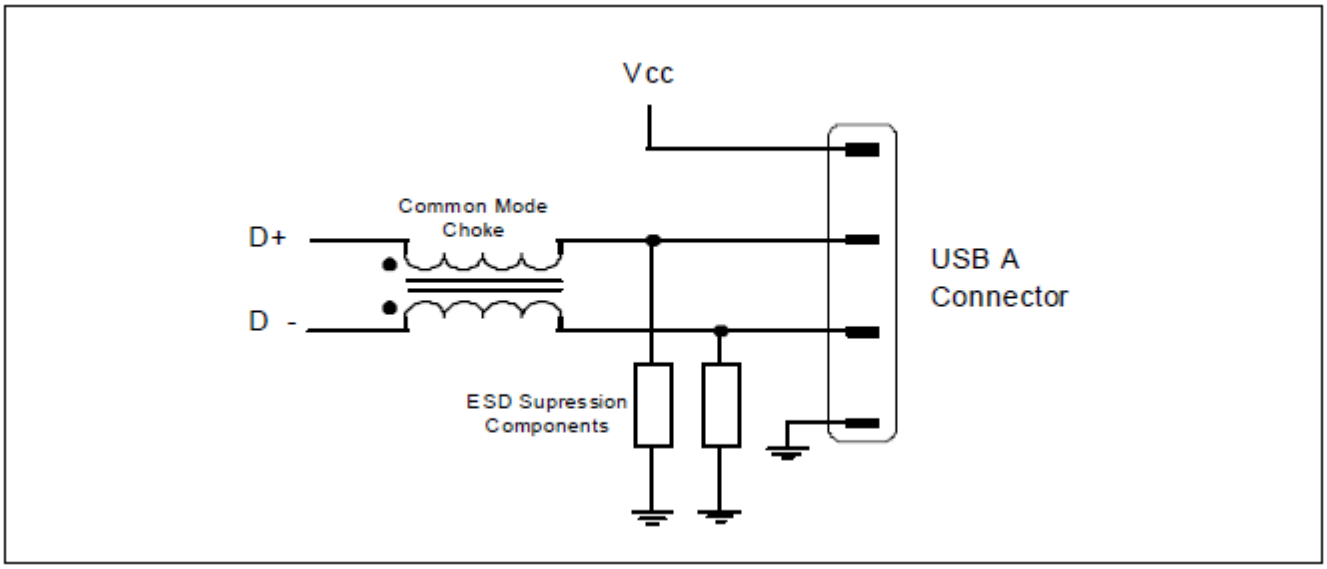
Figure 13: USB 2.0 Good Downstream Power Connection



2.7.2.3. USB 2.0 Common Mode Chokes

Testing has shown that common mode chokes can provide required noise attenuation. A design should include a common mode choke footprint to provide a stuffing option in the event the choke is needed to pass EMI testing. Below figure shows the schematic of a typical common mode choke and ESD suppression components. Place the choke as close as possible to the USB connector signal pins.

Figure 14: USB 2.0 A Common Mode Choke



Common mode chokes distort full-speed and high-speed signal quality. As the common mode impedance increases the distortion increases, therefore test the effects of the common mode choke on full speed and high-speed signal quality. Common mode chokes with a target impedance of 80 Ω to 90 Ω, at 100 MHz, generally provide adequate noise attenuation.

Finding a common mode choke that meets the designer's needs is a two-step process:

1. Choose a part with the impedance value that provides the required noise attenuation. This is a function of the electrical and mechanical characteristics of the part chosen and the frequency and strength of the noise present on the USB traces that should be suppressed.
2. After obtaining a part that gives passing EMI results, the second step is to test the effect this part has on signal quality. Higher impedance common mode chokes generally have a greater damaging effect on signal quality, so care must be used when increasing the impedance without doing thorough testing. Thorough testing means that the signal quality must be checked for low-speed, full-speed, and highspeed USB operation.

Further common mode choke information can be found on the high-speed USB Platform Design Guides available at www.usb.org.

2.7.2.4. EMI / ESD Protection

To improve the EMI behavior of the USB interface, a design should include common mode chokes, which have to be placed as close as possible to the USB connector signal pins.
Common mode chokes can provide required noise attenuation but they also distort the signal quality of full-speed and high-speed signaling. Therefore, common mode chokes should be chosen carefully to meet the requirements of the EMI noise filtering while retaining the integrity of the USB signals on the Carrier Board design.

To protect the USB host interface of the Module from over-voltage caused by electrostatic discharge (ESD) and electrical fast transients (EFT), low capacitance steering diodes and transient voltage suppression diodes have to be implemented on the Carrier Board design. In the USB reference schematics Figure 29 above, this is implemented by using 'SR05 RailClampR' surge rated diode arrays from Semtech (http://semtech.com).

2.7.3. USB2.0 Trace Length Guidelines

Figure 15: Topology for USB2.0

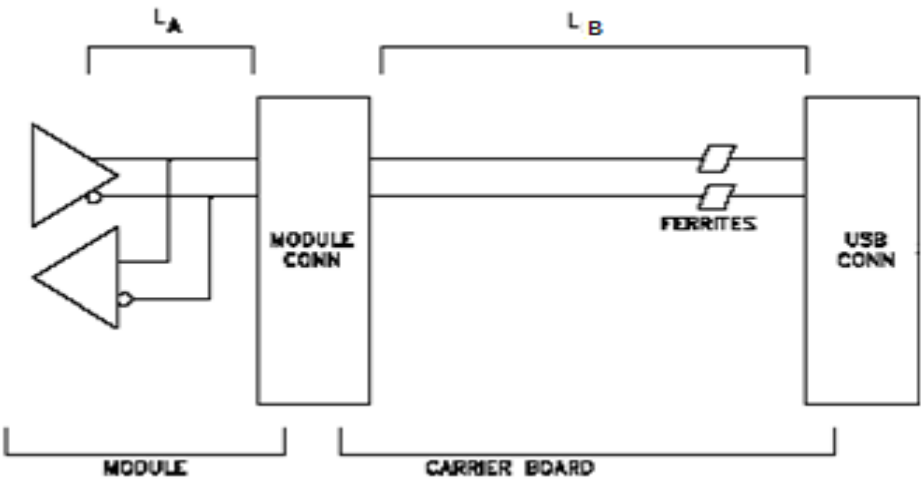


Table 21: USB2.0 Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	USB[7:0]+, USB[7:0]-	
Differential Impedance Target	85 Ω ±10%	
Single End	50Ω ±10%	
Spacing between pairs-to-pairs (inter-pair) (s)	Min. 20 mils	
Spacing between differential pairs and high-speed periodic signals	Min. 50 mils	
Spacing between differential pairs and low-speed non periodic signals	Min. 20 mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	9”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils	
Reference Plane	GND referencing preferred	
Spacing from edge of plane	Min. 40mils	
Carrier Board Via Usage	Try to minimize number of vias	

Notes:

2.8. USB3.0

USB 3.0 is the third major revision of the Universal Serial Bus (USB) standard for computer connectivity. It adds a new transfer speed called SuperSpeed (SS) to the already existing LowSpeed (LS), FullSpeed (FS) and HighSpeed (HS).

USB 3.0 leverages the existing USB 2.0 infrastructure by adding two additional data pair lines to allow a transmission speed up to 5 Gbit/s, which is 10 times faster than USB 2.0 with 480 Mbit/s.

The additional data lines are unidirectional instead of the bidirectional USB 2.0 data lines. USB 3.0 is fully backward compatible to USB 2.0. USB 3.0 connectors are different from USB 2.0 connectors. The USB 3.0 connector is a super set of a USB 2.0 connector, with 4 additional pins that are invisible to USB 2.0 connectors. A USB 2.0 Type A plug may be used in a USB 3.0 Type A receptacle, but the USB 3.0 SuperSpeed functions will not be available.

2.8.1. USB3.0 Signal Definitions

Table 22: USB3.0 Signal Definitions

Signal	Pin#	Description	I/O	Note
USB_SSTX0+ USB_SSTX0-	D4 D3	USB Port 0, SuperSpeed TX + USB Port 0, SuperSpeed TX – Module has integrated AC Coupling Capacitors Carrier Board: Device - Connect to StdA_SSRX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 9 StdA_SSTX+ / Pin 8 StdA_SSTX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	O PCIE	
USB_SSTX1+ USB_SSTX1-	D7 D6	USB Port 1, SuperSpeed TX + USB Port 1, SuperSpeed TX – Module has integrated AC Coupling Capacitors Carrier Board: Device - Connect to StdA_SSRX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 9 StdA_SSTX+ / Pin 8 StdA_SSTX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	O PCIE	

Signal	Pin#	Description	I/O	Note
USB_SSTX2+ USB_SSTX2-	D10 D9	USB Port 2, SuperSpeed TX + USB Port 2, SuperSpeed TX – Module has integrated AC Coupling Capacitors Carrier Board: Device - Connect to StdA_SSRX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 9 StdA_SSTX+ / Pin 8 StdA_SSTX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	O PCIE	
USB_SSTX3+ USB_SSTX3-	D13 D12	USB Port 3, SuperSpeed TX + USB Port 3, SuperSpeed TX – Module has integrated AC Coupling Capacitors Carrier Board: Device - Connect to StdA_SSRX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 9 StdA_SSTX+ / Pin 8 StdA_SSTX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	O PCIE	
USB_SSRX0+ USB_SSRX0-	C4 C3	USB Port 0, SuperSpeed RX + USB Port 0, SuperSpeed RX – Carrier Board: Device - Connect AC Coupling Capacitors 100nF near COME to StdA_SSTX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 6 StdA_SSRX+ / Pin 5 StdA_SSRX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	I PCIE	

Signal	Pin#	Description	I/O	Note
USB_SSRX1+ USB_SSRX1-	C7 C6	USB Port 1, SuperSpeed RX + USB Port 1, SuperSpeed RX – Carrier Board: Device - Connect AC Coupling Capacitors 100nF near COME to StdA_SSTX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 6 StdA_SSRX+ / Pin 5 StdA_SSRX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	I PCIE	
USB_SSRX2+ USB_SSRX2-	C10 C9	USB Port 2, SuperSpeed RX + USB Port 2, SuperSpeed RX – Carrier Board: Device - Connect AC Coupling Capacitors 100nF near COME to StdA_SSTX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 6 StdA_SSRX+ / Pin 5 StdA_SSRX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	I PCIE	
USB_SSRX3+ USB_SSRX3-	C13 C12	USB Port 3, SuperSpeed RX + USB Port 3, SuperSpeed RX – Carrier Board: Device - Connect AC Coupling Capacitors 100nF near COME to StdA_SSTX+/- Conn. - Connect 0Ω and 90Ω @100MHz USB3.0 Common Mode Choke(NL) combined in series and USB3.0 ESD suppressors to GND to Pin 6 StdA_SSRX+ / Pin 5 StdA_SSRX-, the value of CMC depends on EMI and signal integrity performance. N/C if not used	I PCIE	

Notes:

2.8.1.1. USB Over-Current Protection (USB_x_y_OC#)

The USB Specification describes power distribution over the USB port, which supplies power for USB devices that are directly connected to the Carrier Board. Therefore, the host must implement over-current protection on the ports for safety reasons. Should the aggregate current drawn by the downstream ports exceed a permitted value, the over-current protection circuit removes power from all affected downstream ports. The over-current limiting mechanism must be resettable without user mechanical intervention. For more detailed information about this subject, refer to the 'Universal Serial Bus Specifications Revision 2.0', which can be found on the website http://www.usb.org.

Over-current protection for USB ports can be implemented by using power distribution switches on the Carrier Board that monitor the USB port power lines. Power distribution switches usually have a soft-start circuitry that minimizes inrush current in applications where highly capacitive loads are employed. Transient faults are internally filtered.

Additionally, they offer a fault status output that is asserted during over-current and thermal shutdown conditions. These outputs should be connected to the corresponding COM Express Modules USB over-current sense signals. Fault status signaling is an option at the USB specification. If you don't need the popup message in your OS you may leave the signals USB_0_1_OC#, USB_2_3_OC#, USB_4_5_OC# and USB_6_7_OC# unconnected.

Fault status signals are connected by a pullup resistor to VCC_3V3_SBY on COM Express Module. Please check your tolerance on a USB port with VCC_5V supply.

USB 2.0 port's VCC current limit should be set to 500mA. For USB 3.0 implementations, the VCC current limit is raised to 1A. A different, USB 3.0 compatible, power switch is used.

2.8.1.2. EMI / ESD Protection

To improve the EMI behavior of the USB interface, a design should include common mode chokes, which have to be placed as close as possible to the USB connector signal pins.

Common mode chokes can provide required noise attenuation but they also distort the signal quality of FullSpeed, HighSpeed and SuperSpeed signaling. Therefore, common mode chokes should be chosen carefully to meet the requirements of the EMI noise filtering while retaining the integrity of the USB signals on the Carrier Board design.

To protect the USB host interface of the Module from over-voltage caused by electrostatic discharge (ESD) and electrical fast transients (EFT), low capacitance steering diodes and transient voltage suppression diodes have to be implemented on the Carrier Board design.

2.8.2. USB3.0 Routing Guidelines

USB3.0 Insertion Loss Budget

Figure 16: USB3.0 Insertion Loss Budget

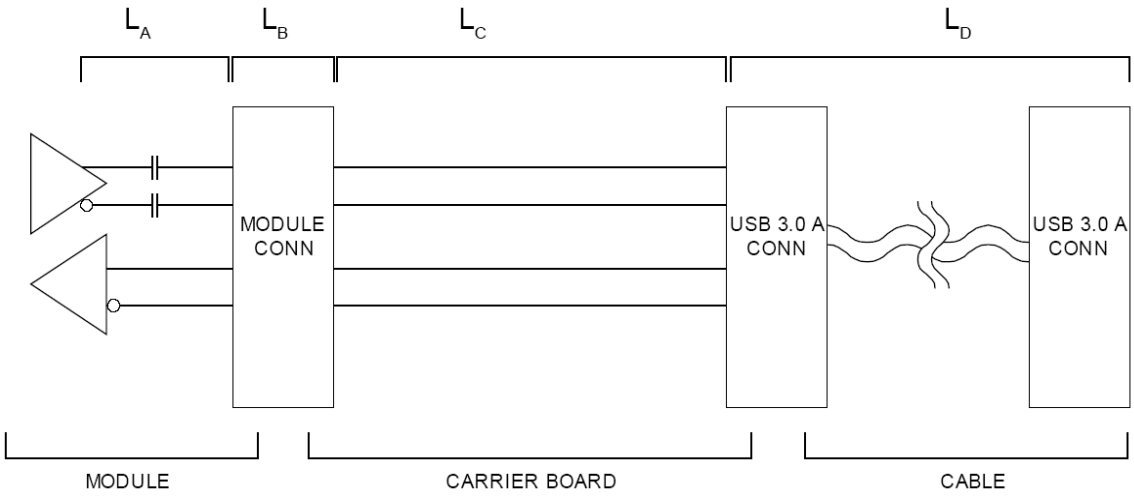


Table 23: USB3.0 Insertion Loss Budget

Segment	Loss (dB)	Notes
L_A	1.94	Up to 3 inches of Module trace @ 2.5 GHz
L_B	1.20	COM Express connector at 2.5 GHz
L_C	3.64	Up to 5 inches of Carrier Board trace @ 2.5 GHz with Common-Mode Component
Total	6.78	

COM ExpressTM USB implementations should conform to insertion loss values less than or equal to those shown in the table above. The insertion loss values shown account for frequency dependent material losses only. Cross talk losses are separate from material losses in the USB specification.

"Device Down" implementations, in which the USB target device is implemented on the Carrier Board, may add the ferrite and USB connector insertion loss values to the Carrier Board budget.

The Carrier Board insertion loss budget then becomes LC + LD, or 2.68 dB.

2.8.3. USB3.0 Trace Length Guidelines

Figure 17: Topology for USB3.0

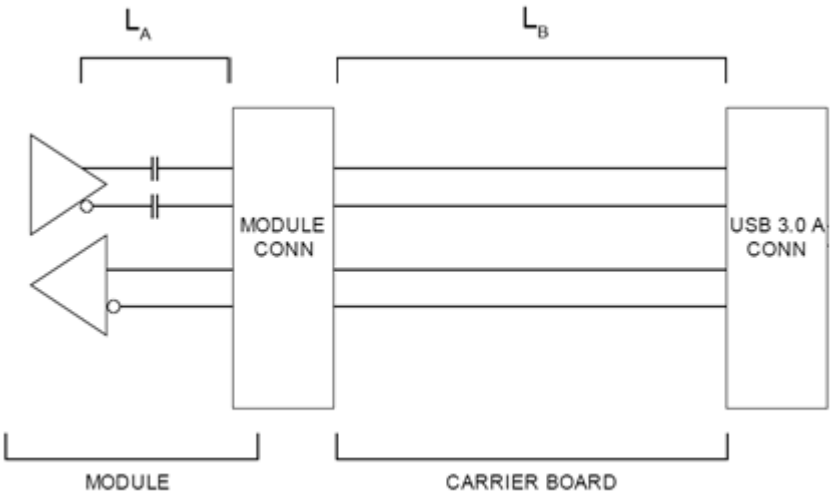


Table 24: USB3.0 Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	USB3.0	
Differential Impedance Target	85 Ω ±10%	
Single End	50Ω ±10%	
Spacing between pairs-to-pairs (inter-pair) (s)	Min. 15 mils	
Spacing between differential pairs and high-speed periodic signals	Min. 15 mils	
Spacing between differential pairs and low-speed non periodic signals	Min. 20 mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	9”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils	
Reference Plane	GND referencing preferred	
Spacing from edge of plane	Min. 40mils	
Carrier Board Via Usage	Max. 3 vias per differential signal trace	

Notes:

2.9. SATA

Support for up to four SATA ports is defined on the COM Express A-B connector. Support for a minimum of two ports is required for all Module Types. The COM Express Specification allows for both SATA-150 and SATA-300 implementations. Constraints for SATA-300 implementations are more severe than those for SATA-150. The COM Express Specification addresses both in the section on insertion losses.

SATA devices can be internal to the system or external. The eSATA specification defines the connector used for external SATA devices. The eSATA interface must be designed to prevent damage from ESD, comply with EMI limits, and withstand more insertion/removals cycles than standard SATA. A specific eSATA connector was designed to meet these needs. The Esata connector does not have the "L" shaped key, and because of this, SATA and eSATA cables cannot be interchanged.

2.9.1. SATA Signal Definitions

Table 25: SATA Signal Definitions

Signal	Pin#	Description	I/O	Note
SATA0_RX+ SATA0_RX-	A19 A20	Serial ATA channel 0, Receive input differential pair. Module has integrated AC Coupling capacitor Carrier Board: Connect to SATA0 Conn pin 6 RX+ Connect to SATA0 Conn pin 5 RX- N/C if not used.	I SATA	
SATA0_TX+ SATA0_TX-	A16 A17	Serial ATA channel 0, Transmit output differential pair. Module has integrated AC Coupling capacito Carrier Board: Connect to SATA0 Conn pin 2 TX+ Connect to SATA0 Conn pin 3 TX- N/C if not used.	O SATA	
SATA1_RX+ SATA1_RX-	B19 B20	Serial ATA channel 1, Receive input differential pair. Module has integrated AC Coupling capacitor Carrier Board: Connect to SATA1 Conn pin 6 RX+ Connect to SATA1 Conn pin 5 RX- N/C if not used.	I SATA	

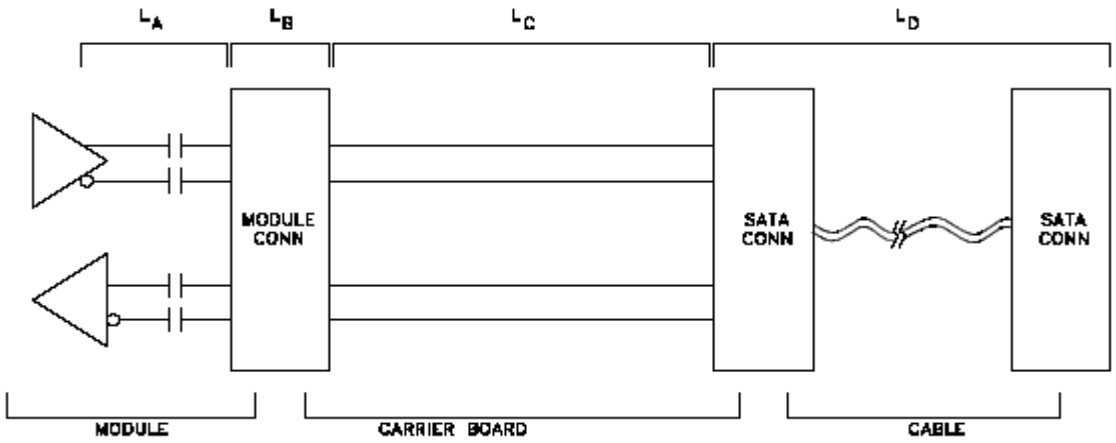
Signal	Pin#	Description	I/O	Note
SATA1_TX+ SATA1_TX-	B16 B17	Serial ATA channel 1, Transmit output differential pair. Module has integrated AC Coupling capacito Carrier Board: Connect to SATA1 Conn pin 2 TX+ Connect to SATA1 Conn pin 3 TX- N/C if not used.	O SATA	
SATA2_RX+ SATA2_RX-	A25 A26	Serial ATA channel 2, Receive input differential pair. Module has integrated AC Coupling capacitor Carrier Board: Connect to SATA2 Conn pin 6 RX+ Connect to SATA2 Conn pin 5 RX- N/C if not used.	I SATA	
SATA2_TX+ SATA2_TX-	A22 A23	Serial ATA channel 2, Transmit output differential pair. Module has integrated AC Coupling capacito Carrier Board: Connect to SATA2 Conn pin 2 TX+ Connect to SATA2 Conn pin 3 TX- N/C if not used.	O SATA	
SATA3_RX+ SATA3_RX-	B25 B26	Serial ATA channel 3, Receive input differential pair. Module has integrated AC Coupling capacitor Carrier Board: Connect to SATA3 Conn pin 6 RX+ Connect to SATA3 Conn pin 5 RX- N/C if not used.	I SATA	
SATA3_TX+ SATA3_TX-	B22 B23	Serial ATA channel 3, Transmit output differential pair. Module has integrated AC Coupling capacitor Carrier Board: Connect to SATA3 Conn pin 2 TX+ Connect to SATA3 Conn pin 3 TX- N/C if not used.	O SATA	
SATA_ACT#	A28	Serial ATA activity LED. Open collector output pin driven during SATA command activity. Module has integrated PU resistor Carrier Board: Connect to LED and current limiting resistors 250 to 330 Ω to 3.3V N/C if not used.	O 3.3V CMOS OC	Able to drive 10 mA

Notes:

2.9.2. SATA Routing Guidelines

SATA Insertion Loss Budget

Figure 18: SATA Insertion Loss Budge



The Serial ATA source specification provides insertion loss figures only for the SATA cable. There are several cable types defined with insertion losses ranging from 6 dB up to 16 dB. Cross talk losses are separate from material losses in the SATA specification.

The COM ExpressTM SATA Insertion loss budgets presented below represent the material losses and do not include cross talk losses. The COM ExpressTM SATA Insertion loss budgets are a guideline: module and Carrier Board vendors should not exceed the values shown in the tables below.

Table 26: SATA Insertion Loss Budge

SATA Gen 1 Insertion Loss Budget, 1.5 GHz

Segment	Loss (dB)	Notes
L_A	1.26	Up to 3.0 inches of module trace @ 0.28 dB / GHz / inch
Coupling Caps	0.40	
L_B	0.25	COM Express™ connector at 1.5 GHz measured value
L_C	3.07	Up to 7.2 inches of Carrier Board trace @ 0.28 dB / GHz / inch
L_D	6.00	Source specification cable and cable connector allowance
Total	10.98	

SATA Gen 2 Insertion Loss Budget, 3.0 GHz

Segment	Loss (dB)	Notes
L_A	1.68	Up to 2.0 inches of module trace @ 0.28 dB / GHz / inch
Coupling Caps	0.40	
L_B	0.38	COM Express™ connector at 3.0 GHz measured value
L_C	2.52	Up to 3.0 inches of Carrier Board trace @ 0.28 dB / GHz / inch
L_D	6.00	Source specification cable and cable connector allowance
Total	10.98	

2.9.2.1. General SATA Routing Guidelines

Use the following general routing and placement guidelines when laying out a new design.

- SATA signals must be ground referenced. If changing reference plane is completely unavoidable (that is, ground reference to power reference), proper placement of stitching caps can minimize the adverse effects of EMI and signal quality performance caused by reference plane change. Stitching capacitors are smallvalued capacitors (1 µF or lower in value) that bridge the power and ground planes close to where a high-speed signal changes layers. Stitching caps provide a high frequency current return path between different reference planes. They minimize the impedance discontinuity and current loop area that crossing different reference planes created. The maximum number allowed for SATA to change reference plane is one.
- Route all traces over continuous GND planes, with no interruptions. Avoid crossing over anti-etch if at all possible. Any discontinuity or split in the ground plane can cause signal reflections and should be avoided.
- Minimize layer changes. If a layer change is necessary, ensure that trace matching for either transmit or receive pair occurs within the same layer. Intel recommends to use SATA vias as seldom as possible.
- **DO NOT** route SATA traces under power connectors, other interface connectors, crystals, oscillators, clock synthesizers, magnetic devices or ICs that use and/or duplicate clocks.
- **DO NOT** place stubs, test points, test vias on the route to minimize reflection. Utilize vias and connector pads as test points instead.
- For testability, route the TX and RX pairs for a given port on the same layer and close to each other to help ensure that the pairs share similar signaling characteristics. If the groups of traces are similar, a measure of RX pair layout quality can be approximated by using the results from actively testing the TX pair's signal quality.
- Length matching rules are required on SATA differential signals for optimum timing margins, preventing common-mode signals and EMI.Each net within a differentialpair should be length matched on a segment-by-segment basis at the point of discontinuity. Total length mismatch must not be more than 20 mils (0.508 mm). Examples of segments might include breakout areas, routes running between two vias, routes between an AC coupling capacitor and a connector pin, etc. The points of discontinuity would be the via, the capacitor pad, or the connector pin.Matching of TX and RX within the same port and between SATA TX and RX pairs from differential ports is not required. When length matching compensation occurs, it should be made as close as possible to the point where the variation occurs.
- **DO NOT** serpentine to match RX and TX traces; there is **NO** requirement to match RX and TX traces. In addition, **DO NOT** serpentine to meet minimum length guidelines on RX and TX traces.
- Recommend keeping SATA traces 20 mils (0.508 mm) from any vias on the motherboard whenever possible.

2.9.3. SATA Trace Length Guidelines

Figure 19: Topology for SATA

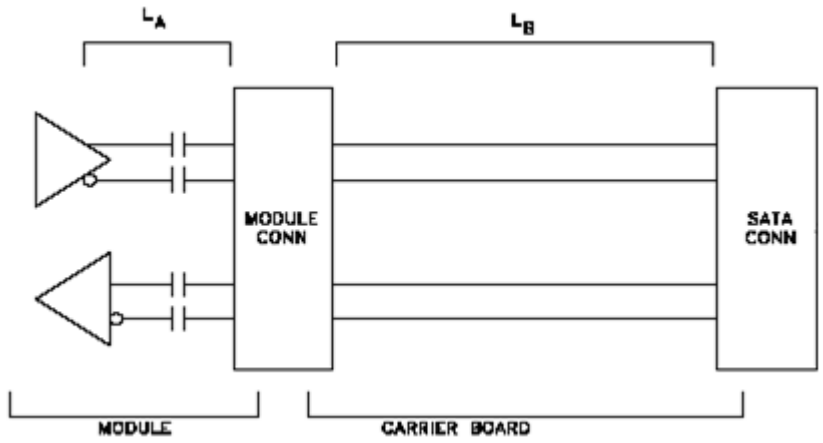


Table 27: SATA Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	SATA	
Differential Impedance Target	85 Ω ±10%	
Single End	50Ω ±10%	
Signal length available for the COM Express Carrier Board	3 inches, a redriver may be necessary for GEN3 signaling rates	
Spacing between RX and TX pairs (inter-pair) (s)	Min. 20 mils	
Spacing between differential pairs and high-speed periodic signals	Min. 50 mils	
Spacing between differential pairs and low-speed non periodic signals	Min. 20 mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	8”	
Length matching	Differential pairs (intra-pair): Max. ±5 mils	
Reference Plane	GND referencing preferred	
Spacing from edge of plane	Min. 40mils	
Carrier Board Via Usage	A maximum of 2 vias is recommended.	

Notes:

2.10. LVDS

2.10.1. Signal Definitions

The COM Express Specification provides an optional LVDS interface on the COM Express A-B connector. Module pins for two LVDS channels are defined and designated as LVDS_A and LVDS_B.

Systems use a single-channel LVDS for most displays. Dual LVDS channels are used for very high-bandwidth displays. Single-channel LVDS means that one complete RGB pixel is transmitted per display input clock. Dual-channel LVDS means that two complete RGB pixels are transmitted per display input clock. The two pixels are adjacent along a display line. Dual-channel LVDS does not mean that two LVDS displays can be driven.

Each COM Express LVDS channel consists of four differential data pairs and a differential clock pair for a total of five differential pairs per channel. COM Express Modules and Module chipsets may not use all pairs. For example, with 18-bit TFT displays, only three of the four data pairs on the LVDS_A channel are used, along with the LVDS_A clock. The LVDS_B lines are not used. The manner in which RGB data is packed onto the LVDS pairs (including packing order and color depth) is not specified by the COM Express Specification. This may be Module-dependent.

There are five single-ended signals included to support the LVDS interface: two lines are used for an I2C interface that may be used to support EDID or other panel information and identification schemes. Additionally, there are an LVDS power enable (LVDS_VDD_EN) and backlight control and enable lines (LVDS_BKLT_CTRL and LVDS_BKLT_EN).

Table 28: LVDS Signal Definitions

Signal	Pin#	Description	I/O	Note
LVDS_A0+ LVDS_A0-	A71 A72	LVDS channel A differential signal pair 0 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever - RXinO0+/- with 100Ω termination Conn. - RXinO0+/- N/C if not used	O LVDS	
LVDS_A1+ LVDS_A1-	A73 A74	LVDS channel A differential signal pair 1 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinO1+/- with 100Ω termination Conn. – RxinO1+/- N/C if not used	O LVDS	

Signal	Pin#	Description	I/O	Note
LVDS_A2+ LVDS_A2-	A75 A76	LVDS channel A differential signal pair 2 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinO2+/- with 100Ω termination Conn. – RxinO2+/- N/C if not used	O LVDS	
LVDS_A3+ LVDS_A3-	A78 A79	LVDS channel A differential signal pair 3 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinO3+/- with 100Ω termination Conn. – RxinO3+/- N/C if not used	O LVDS	
LVDS_A_CK+ LVDS_A_CK-	A81 A82	LVDS channel A differential clock pair Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever - RXOC+/- with 100Ω termination Conn. - RXOC+/- N/C if not use	O LVDS	
LVDS_B0+ LVDS_B0-	B71 B72	LVDS channel B differential signal pair 0 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever - RXinE0+/- with 100Ω termination Conn. - RXinE0+/- N/C if not used	O LVDS	
LVDS_B1+ LVDS_B1-	B73 B74	LVDS channel B differential signal pair 1 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinE1+/- with 100Ω termination Conn. – RxinE1+/- N/C if not used	O LVDS	
LVDS_B2+ LVDS_B2-	B75 B76	LVDS channel B differential signal pair 2 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinE2+/- with 100Ω termination Conn. – RxinE2+/- N/C if not used	O LVDS	

Signal	Pin#	Description	I/O	Note
LVDS_B3+ LVDS_B3-	B77 B78	LVDS channel B differential signal pair 3 Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever – RxinE3+/- with 100Ω termination Conn. – RxinE3+/- N/C if not used	O LVDS	
LVDS_B_CK+ LVDS_B_CK-	B81 B82	LVDS channel B differential clock pair Carrier Board: Connect 100Ω @100MHz Common Choke in series to Reciever - RXEC+/- with 100Ω termination Conn. - RXEC+/- N/C if not used	O LVDS	
LVDS_VDD_EN	A77	LVDS flat panel power enable. Carrier Board: Connect to enable control of LVDS panel power circuit. N/C if not used	O 3.3V, CMOS	
LVDS_BKLT_EN	B79	LVDS flat panel backlight enable high active signal Carrier Board: Connect to enable control of LVDS panel backlight power circuit. N/C if not used	O 3.3V, CMOS	
LVDS_BKLT_CTRL	B83	LVDS flat panel backlight brightness control Carrier Board: Connect to brightness control of LVDS panel backlight power circuit. N/C if not used	O 3.3V, CMOS	
LVDS_I2C_CK	A83	DDC I2C clock signal used for flat panel detection and control. Carrier Board: Connect to DDC clock of LVDS panel N/C if not used	O 3.3V, CMOS	
LVDS_I2C_DAT	A84	DDC I2C data signal used for flat panel detection and control. Carrier Board: Connect to DDC data of LVDS panel N/C if not used	I/O 3.3V, OD CMOS	

2.10.1.1. Display Timing Configuration

The graphic controller needs to be configured to match the timing parameters of the attached flat panel display. To properly configure the controller, there needs to be some method to determine the display parameters. Different Module vendors provide differing ways to access display timing parameters. Some vendors store the data in non-volatile memory with the BIOS setup screen as the method for entering the data, other vendors might use a Module or Carrier based EEPROM. Some vendors might hard code the information into the BIOS, and other vendors might support panel located timing via the signals LVDS_I2C_CK and LVDS_I2C_DAT with an EEPROM strapped to 1010 000x. Regardless of the method used to store the panel timing parameters, the video BIOS will need to have the ability to access and decode the parameters. Given the number of variables it is recommended that Carrier designers contact Module suppliers to determine the recommend method to store and retrieve the display timing parameters.

The Video Electronics Standards Association (VESA) recently released DisplayID, a second generation display identification standard that can replace EDID and other proprietary methods for storing flat panel timing data. DisplayID defines a data structure which contains information such as display model, identification information, colorimetry, feature support, and supported timings and formats. The DisplayID data allows the video controller to be configured for optimal support for the attached display without user intervention. The basic data structure is a variable length block up to 256 bytes with additional 256 byte extensions as required. The DisplayID data is typically stored in a serial EPROM connected to the LVDS_I2C bus. The EPROM can reside on the display or Carrier. DisplayID is not backwards compatible with EDID. Contact VESA (www.vesa.org) for more information.

2.10.1.2. Backlight Control

Backlight inverters are either voltage, PWM or resistor controlled. The COM Express specification provides two methods for controlling the brightness. One method is to use the backlight control and enable signals from the CPU chipset. These signals are brought on COM Express LVDS_BKLT_EN and LVDS_BKLT_CTRL. LVDS_BKLT_CTRL is a Pulse Width Modulated (PWM) output that can be connected to display inverters that accept a PWM input. The second method it to use the LVDS I2C bus to control an I2C DAC. The output of the DAC can be used to support voltage controlled inverters. The DAC can be used driving the backlight voltage control input pin of the inverter.

2.10.2. LVDS Routing Guidelines

Route LVDS signals as differential pairs (excluding the five single-ended support signals), with a 100-Ω differential impedance and a 55-Ω, single-ended impedance. Ideally, a LVDS pair is routed on a single layer adjacent to a ground plane. LVDS pairs should not cross plane splits. Keep layer transitions to a minimum. Reference LVDS pairs to a power plane if necessary. The power plane should be well-bypassed.

Length-matching between the two lines that make up an LVDS pair (“intra-pair”) and between different LVDS pairs (“inter-pair”) is required. Intra-pair matching is tighter than the inter-pair matching.
All LVDS pairs should have the same environment, including the same reference plane and the same number of vias.

2.10.3. LVDS Trace Length Guidelines

Figure 20: Topology for LVDS

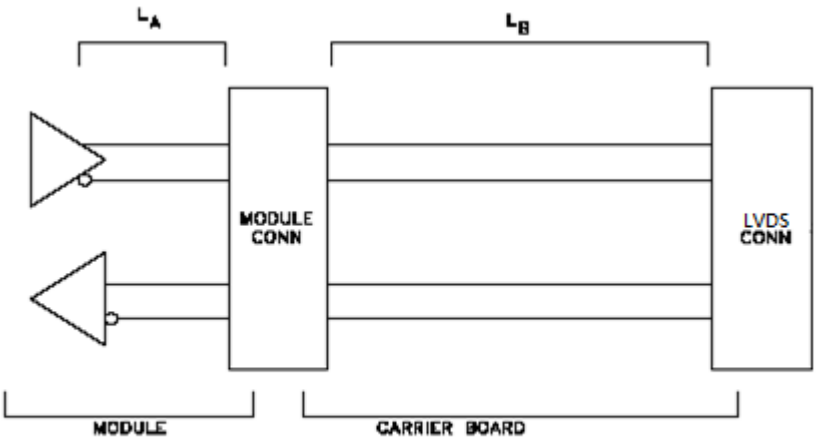


Table 29: LVDS Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	LVDS	
Differential Impedance Target	100 Ω ±10%	
Single End	55Ω ±10%	
Signal length to the LVDS connector available for the COM Express Carrier Board	6.75”	
Spacing between pair to pairs (inter-pair) (s)	Min. 20 mils	
Spacing between differential pairs and high-speed periodic signals	Min. 20 mils	
Spacing between differential pairs and low-speed non periodic signals	Min. 20 mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	As short as possible	
Length matching	Differential pairs (intra-pair): Max. ±5 mils Clock and data pairs (intra-pair): Max. ±10 mils data pairs (inter-pair) : Max. ±10 mils	
Reference Plane	GND referencing preferred	
Spacing from edge of plane	Min. 40mils	
Carrier Board Via Usage	Max. of 2 vias per line.	

Notes:

2.11. Embedded DisplayPort (eDP) *SOM-5898 is Option function

Embedded DisplayPort (eDP) is a digital display interface standard produced by the Video Electronics Standards Association (VESA) for digital interconnect of Audio and Video.

Embedded DisplayPort defines a standardized display panel interface for internal connections; e.g., graphics interfaces to notebook display panels. It supports advanced power-saving features including seamless refresh rate switching, display panel and backlight control protocol that works through the AUX channel, and Panel Self-Refresh (PSR) feature developed to save system power and further extend battery life in portable PC systems. PSR mode allows the GPU to enter power saving states in between frame updates by including framebuffer memory in the display panel controller.

Embedded DisplayPort is intended to replace LVDS as the interface to flat panel displays integrated into a product. Unlike DisplayPort, embedded DisplayPort does not define a specific connector or pin-out. The COM Express specification shares the LVDS pins with embedded DisplayPort.

2.11.1 eDP Signal Definitions

eDP is available in Type 6 and type 10 pin-outs as an alternative to the LVDS A channel. The Module can provide LVDS only, eDP only or Dual-Mode for both interfaces. Please refer to relevant Module documentation for the supported interfaces.

Table 30: eDP Signal Definitions

Signal	Pin#	Description	I/O	Note
eDP_TX0+ eDP_TX0-	A75 A76	eDP lane 0, TX +/- Carrier Board: Connect AC Coupling Capacitors 75~200 nF near eDP connector. N/C if not used	O PCIe	1
eDP_TX1+ eDP_TX1-	A73 A74	eDP lane 1, TX +/- Carrier Board: Connect AC Coupling Capacitors 75~200 nF near eDP connector. N/C if not used	O PCIe	1
eDP_TX2+ eDP_TX2-	A71 A72	eDP lane 2, TX +/- Carrier Board: Connect AC Coupling Capacitors 75~200 nF near eDP connector. N/C if not used	O PCIe	1

Signal	Pin#	Description	I/O	Note
eDP_TX3+ eDP_TX3-	A81 A82	eDP lane 3, TX +/- Carrier Board: Connect AC Coupling Capacitors 75~200 nF near eDP connector. N/C if not used	O PCIe	1
eDP_VDD_EN	A77	eDP power enable Carrier Board: Connect to enable control of eDP panel power circuit. N/C if not used	O CMOS	1
eDP_BLKT_EN	B79	eDP backlight enable Carrier Board: Connect to enable control of eDP panel backlight power circuit. N/C if not used	O CMOS	1
eDP_BLKT_CTRL	B83	EDP backlight brightness control Carrier Board: Connect to brightness control of eDP panel backlight power circuit. N/C if not used	O CMOS	1
eDP_AUX+ eDP_AUX-	A83 A84	eDP auxiliary lane +/- Carrier Board: Connect to device or eDP connector. N/C if not used.	I/O PCIe	1
eDP_HPD	A87	Detection of Hot Plug / Unplug and notification of the link layer Carrier Board: Connector to device or eDP connector HP pin.	I CMOS	1

Notes:

1. SOM-5898 default is not support eDP, it is option function. If customers want to use eDP function, please contact Advantech.

2.11.2. eDP Trace Length Guidelines

Figure 21: Topology for eDP

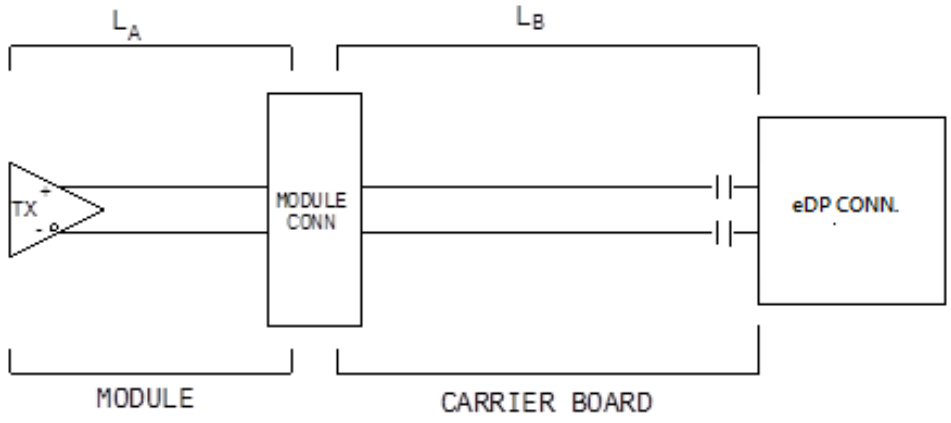


Table 31: DisplayPort Connector / Device Down Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	eDP	2
Differential Impedance Target	85 Ω ±10%	2
Single End	50Ω ±10%	2
Isolation to equivalent pairs	20 mils (MS) and 15 mils (DS)	2
Isolation to other signal groups	20 mils (MS) and 15 mils (DS)	2
LA	SOM-5898 option function	2
LB	Carrier Board Length	2
Max length of LA+LB	eDP differential pairs to eDP connector: AUX channel:	2
Length matching	Differential pairs (intra-pair): Max. ±5 mils For each channel, match the lengths of the differential pairs (Inter-Pair) to be within a 1-inch window (max length – min length < 1 inch (2.54 cm)).	2
Reference Plane	GND referencing preferred. Min 40-mil trace edge-to-major plane edge spacing.	2
Carrier Board Via Usage	Max. 2 vias.	2
AC coupling	Min = 75 nF Max = 200 nF	1, 2

Notes:

1. AC caps are recommended to be placed close to device side (avoid placing AC cpas on mid-bus).
2. SOM-5898 default is not support eDP, it is option function. If customers want to use eDP function, please contact Advantech.

2.12. VGA

2.12.1. VGA Signal Definitions

The interface consists of three analog color signals (Red, Green, Blue); digital Horizontal and Vertical Sync signals as well as a dedicated I2C bus for Display Data Control (DDC) implementation for monitor capability identification. The corresponding signals can be found on the COM Express Module connector row B.

Table 32: VGA Signal Definitions

Signal	Pin#	Description	I/O	Note
VGA_RED	B89	Red component of analog DAC monitor output, designed to drive a 37.5Ω equivalent load. Carrier Board: Connect to 1. 150Ω±1% resistor to GND 2. 2-pole filter(10 pF,bead 47 Ω @100MHz and 22 pF) 3. ESD diode protection connected to 3.3V or 5V. to VGA Conn Pin 1 RED N/C if not used	O Analog	
VGA_GRN	B91	Green component of analog DAC monitor output, designed to drive a 37.5Ω equivalent load. Carrier Board: Connect to 1. 150Ω±1% resistor to GND 2. 2-pole filter(10 pF,bead 47 Ω @100MHz and 22 pF) 3. ESD diode protection connected to 3.3V or 5V. to VGA Conn Pin 2 GREEN N/C if not used	O Analog	
VGA_BLU	B92	Blue component of analog DAC monitor output, designed to drive a 37.5Ω equivalent load. Carrier Board: Connect to 1. 150Ω±1% resistor to GND 2. 2-pole filter(10 pF,bead 47 Ω @100MHz and 22 pF) 3. ESD diode protection connected to 3.3V or 5V. to VGA Conn Pin 3 BLUE N/C if not used	O Analog	

Signal	Pin#	Description	I/O	Note
VGA_HSYNC	B93	Horizontal sync output to VGA monitor. Carrier Board: Connect 1. Bead 150~220Ω@100MHz in series 2. Bypass 22pF to GND. 3. ESD diode protection connected to 3.3V or 5V. to VGA Conn Pin 13 Hsync N/C if not used	O 3.3V CMOS	
VGA_VSYNC	B94	Vertical sync output to VGA monitor. Carrier Board: Connect 1. Bead 150~220Ω@100MHz in series 2. Bypass 22pF to GND. 3. ESD diode protection connected to 3.3V or 5V. to VGA Conn Pin 14 Vsync N/C if not used	O 3.3V CMOS	
VGA_I2C_CK	B95	DDC clock line (I2C port dedicated to identify VGA monitor capabilities). Carrier Board: Connect to VGA Conn Pin 15 SCL with ESD diode to 5V near connector N/C if not used	O 3.3V CMOS	Level shifter might be necessary
VGA_I2C_DAT	B96	DDC data line. Carrier Board: Connect to VGA Conn Pin 12 SDA with ESD diode to 5V near connector. N/C if not use	I/O 3.3V CMOS	Level shifter might be necessary

2.12.2. VGA Routing Guidelines

2.12.2.1. RGB Analog Signals

The RGB signal interface of the COM Express Module consists of three identical 8-bit digital-toanalog converter (DAC) channels. One each for the red, green, and blue components of the monitor signal. Each of these channels should have a 150Ω ±1% pull-down resistor connected from the DAC output to the Carrier Board ground. A second 150Ω ±1% termination resistor exists on the COM Express Module itself. An additional 75Ω termination resistor exists within the monitor for each analog DAC output signal. Since the DAC runs at speeds up to 350MHz, special attention should be paid to signal integrity and EMI. There should be a PI-filter placed on each RGB signal that is used to reduce highfrequency noise and EMI. The PI-filter consists of two 10pF capacitors with a 120Ω @ 100MHz ferrite bead between them. It is recommended to place the PI-filters and the terminating resistors as close as possible to the standard VGA connector.

2.12.2.2. HSYNC and VSYNC Signals

The horizontal and vertical sync signals 'VGA_HSYNC' and 'VGA_VSYNC' provided by the COM Express Module are 3.3V tolerant outputs. Since VGA monitors may drive the monitor sync signals with 5V tolerance, it is necessary to implement high impedance unidirectional buffers. These buffers prevent potential electrical over-stress of the Module and avoid that VGA monitors may attempt to drive the monitor sync signals back to the Module. For optimal ESD protection, additional low capacitance clamp diodes should be implemented on the monitor sync signals. They should be placed between the 5V power plane and ground and as close as possible to the VGA connector.

2.12.2.3. DDC Interface

COM Express provides a dedicated I2C bus for the VGA interface. It corresponds to the VESA™ defined DDC interface that is used to read out the CRT monitor specific Extended Display Identification Data (EDID™). The appropriate signals 'VGA_I2C_DAT' and 'VGA_I2C_CK' of the COM Express Module are supposed to be 3.3V tolerant. Since most VGA monitors drive the internal EDID™ EEPROM with a supply voltage of 5V, the DDC interface on the VGA connector must also be sourced with 5V. This can be accomplished by placing a 100kΩ pull-up resistors between the 5V power plane and each DDC interface line. Level shifters for the DDC interface signals are required between the COM Express Module signal side and the signals on the standard VGA connector on the Carrier Board.
Additional Schottky diodes must be placed between 5V and the pull-up resistors of the DDC signals to avoid backward current leakage during Suspend operation of the Module.

2.12.2.4. ESD Protection/EMI

All VGA signals need ESD protection and EMI filters.

2.12.3. VGA Trace Length Guidelines

Figure 22: Topology for VGA

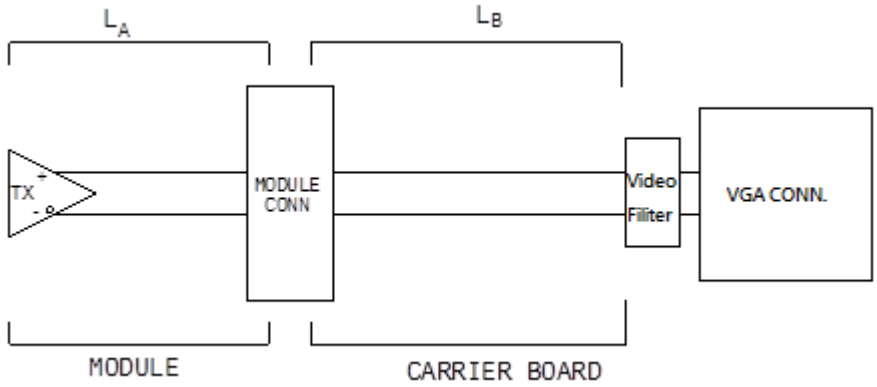


Table 33: VGA Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	VGA	
Single End	50Ω ±10%	
Nominal Trace Space within CRT DAC Signal Group	Min. 15mils	
Spacing to Other Signal Group	Min. 20mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	15.1”	
Length matching	1. Match the trace lengths within R, G, B to ±200 mils. 2. Match the trace lengths of CRT SYNC signals with CRT DAC signals to ±1000 mils	
Reference Plane	GND referencing preferred. Min 20-mil trace edge-to-major plane edge spacing.	

Notes:

1. Video filter must be near VGA CONN.

2.13. Digital Audio Interfaces

The COM Express Specification allocates seven pins on the A-B connector to support digital AC'97 and HD interfaces to audio Codecs on the Carrier Board. The pins are available on all Module types. High-definition (HD) audio uses the same digital-signal interface as AC '97 audio. Codecs for AC '97 and HD Audio are different and not compatible. Current Module chipsets support HD Audio only.

2.13.1. Audio Codec Signal Descriptions

Table 34: Audio Codec Signal Descriptions

Signal	Pin#	Description	I/O	Note
AC/HDA_RST#	A30	CODEC Reset. Carrier Board: AC97 - Connect 0 Ω in series to CODEC pin 11 RESET# HDA - Connect 0 Ω in series to CODEC pin 11 RESET# N/C if not used	O 3.3V Suspend CMOS	
AC/HDA_SYNC	A29	Serial Sample Rate Synchronization. Carrier Board: AC97 - Connect 0 Ω in series to CODEC pin 10 SYNC HDA - Connect 0 Ω in series to CODEC pin 10 SYNC N/C if not used	O 3.3V CMOS	
AC/HDA_BITCLK	A32	24 MHz Serial Bit Clock for HDA CODEC. Carrier Board: AC97 - Connect 33-47 Ω in series to CODEC pin 6 BIT_CLK HDA - Module has integrated series resistor. Connect 0 Ω in series to CODEC pin 6 BIT_CLK N/C if not used	O 3.3V CMOS	
AC/HDA_SDOUT	A33	Audio Serial Data Output Stream. Carrier Board: AC97 - Connect 33-47 Ω in series to CODEC pin 5 SDATA_OUT HDA - Connect 33-47 Ω in series and PD 10KΩ(NL) to CODEC pin 5 SDATA_OUT N/C if not used	O 3.3V CMOS	
AC/HDA_SDIN0 AC/HDA_SDIN1 AC/HDA_SDIN2	B30 B29 B28	Audio Serial Data Input Stream from CODEC[0:2]. Carrier Board: AC97 - Connect 33-47 Ω in series to CODEC pin 8 SDATA_IN HDA - Connect 33-47 Ω in series and PD 10KΩ(NL) to CODEC pin 8 SDATA_IN N/C if not used	I 3.3V Suspend CMOS	

The codec on a COM Express Carrier Board is usually connected as the primary codec with the codec ID 00 using the data input line 'AC/HDA_SDIN0'. Up to two additional codecs with ID 01 and ID 10 can be connected to the COM Express Module by using the other designated signals 'AC/HDA_SDIN1' and 'AC/HDA_SDIN2'.

Connect the primary audio codec to the serial data input signal 'AC/HDA_SDIN0' and ensure that the corresponding bit clock input signal 'AC/HDA_BITCLK' is connected to the AC'97/HDA interface of the COM Express Module.

Clocking over the signal 'AC/HDA_BITCLK' is derived from a 24.576 MHz crystal or crystal oscillator provided by the primary codec in AC97 implementations. The crystal is not required in HDA implementations. This clock also drives the second and the third audio codec if more than one codec is used in the application. For crystal or crystal oscillator requirements, refer to the datasheet of the primary codec.

2.13.2. Audio Routing Guidelines

The implementation of proper component placement and routing techniques will help to ensure that the maximum performance available from the codec is achieved. Routing techniques that should be observed include properly isolating the codec, associated audio circuitry, analog power supplies and analog ground planes from the rest of the Carrier Board. This includes split planes and the proper routing of signals not associated with the audio section.

The following is a list of basic recommendations:
Traces must be routed with a target impedance of 50Ω with an allowed tolerance of ±15%.
Ground return paths for the analog signals must be given special consideration.
Digital signals routed in the vicinity of the analog audio signals must not cross the power plane split lines.
Locate the analog and digital signals as far as possible from each other.
Partition the Carrier Board with all analog components grouped together in one area and all digital components in another.
Keep digital signal traces, especially the clock, as far as possible from the analog input and voltage reference pins.
Provide separate analog and digital ground planes with the digital components over the digital ground plane, and the analog components, including the analog power regulators, over the analog ground plane. The split between the planes must be a minimum of 0.05 inch wide.
Route analog power and signal traces over the analog ground plane.
Route digital power and signal traces over the digital ground plane.
Position the bypassing and decoupling capacitors close to the IC pins with wide traces to reduce impedance.
Place the crystal or oscillator (depending on the codec used) as close as possible to the codec. (HDA implementations generally do not require a crystal at the codec)
Do not completely isolate the analog/audio ground plane from the rest of the Carrier Board ground plane. Provide a single point (0.25 inch to 0.5 inch wide) where the analog/isolated ground plane connects to the main ground plane. The split between the planes must be a minimum of 0.05 inch wide.
Any signals entering or leaving the analog area must cross the ground split in the area where the analog ground is attached to the main Carrier Board ground. That is, no signal should cross the split/gap between the ground planes, because this would cause a ground loop, which in turn would greatly increase EMI emissions and degrade the analog and digital signal quality.

2.13.3. Audio Trace Length Guidelines

Figure 23: Topology for Audio

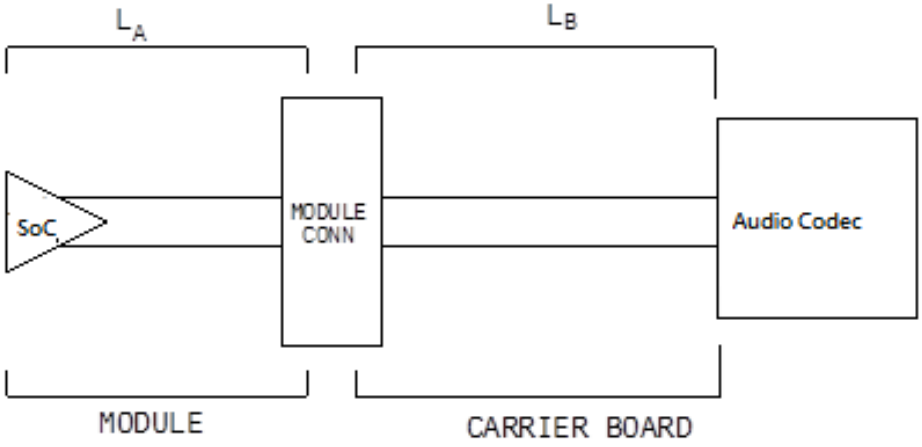


Table 35: Audio Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	Audio	
Single End	50Ω ±15%	
Nominal Trace Space within Audio Signal Group	Min. 15mils	
Spacing to Other Signal Group	Min. 20mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	14.5”	
Length matching	Data to Clock must be matched within 500mils	
Reference Plane	GND referencing preferred. Min 20-mil trace edge-to-major plane edge spacing.	

Notes:

2.14. LPC Bus – Low Pin Count Interface

Since COM Express is designed to be a legacy free standard for embedded Modules, it does not support legacy functionality on the Module, such as PS/2 keyboard/mouse, serial ports, and parallel ports. Instead, it provides an LPC interface that can be used to add peripheral devices to the Carrier Board design. COM Express also provides interface pins necessary for (optional) Carrier Board resident PS keyboard controllers.

The Low Pin Count Interface was defined by the Intel® Corporation to facilitate the industry's transition toward legacy free systems. It allows the integration of low-bandwidth legacy I/O components within the system, which are typically provided by a Super I/O controller. Furthermore, it can be used to interface Firmware Hubs, Trusted Platform Module (TPM) devices, general-purpose inputs and outputs, and Embedded Controller solutions. Data transfer on the LPC bus is implemented over a 4 bit serialized data interface, which uses a 24MHz LPC bus clock. It is straightforward to develop PLDs or FPGAs that interface to the LPC bus.

For more information about LPC bus, refer to the 'IntelR Low Pin Count Interface Specification Revision 1.1'.

2.14.1. LPC Signal Definition

Table 36: LPC Interface Signal Definition

Signal	Pin#	Description	I/O	Note
LPC_SERIRQ	A50	LPC serialized IRQ. Carrier Board: Connect to LPC - SERIRQ N/C if not use	I/O 3.3V CMOS	
LPC_FRAME#	B3	LPC frame indicates start of a new cycle or termination of a broken cycle. Carrier Board: LPC - LFRAME# FWH - Pin 23 LFRAME# N/C if not used	O 3.3V CMOS	

Signal	Pin#	Description	I/O	Note
LPC_AD0 LPC_AD1 LPC_AD2 LPC_AD3	B4 B5 B6 B7	LPC multiplexed command, address and data. Carrier Board: Connect to LPC - LAD0 , LAD1, LAD2, LAD3 FWH - Pin 13 LAD0, Pin 14 LAD1, Pin 15 LAD2, Pin 17 LAD3 N/C if not used	I/O 3.3V CMOS	
LPC_DRQ0# LPC_DRQ1#	B8 B9	LPC encoded DMA/Bus master request. Carrier Board: Connect to LPC - LDRQ0#, LDRQ1# N/C if not used	I 3.3V CMOS	Not all Modules support LPC DMA. Contact your vendor for information.
LPC_CLK	B10	LPC clock output 24MHz. Carrier Board: Connect to LPC - LCLK FWH - Pin 31 LCLK N/C if not used	O 3.3V CMOS	

Note

Implementing external LPC devices on the COM Express Carrier Board always requires customization of the COM Express Module's BIOS in order to support basic initialization for those LPC devices. Otherwise the functionality of the LPC devices will not be supported by a Plug&Play or ACPI capable system.

2.14.2. LPC Routing Guidelines

2.14.2.1 General Signals

LPC signals are similar to PCI signals and may be treated similarly. Route the LPC bus as 50 Ω, single-ended signals. The bus may be referenced to ground (preferred), or to a well-bypassed power plane or a combination of the two. Point-to-point (daisy-chain) routing is preferred, although stubs up to 1.5 inches may be acceptable. Length-matching among LPC_AD[3:0], LPC_FRAME# are needed

2.14.2.2 Bus Clock Routing

Route the LPC clock as a single-ended, 50 Ω trace with generous clearance to other traces and to itself. A continuous ground-plane reference is recommended. Routing the clock on a single ground referenced internal layer is preferred to reduce EMI.

The LPC clock implementation should follow the routing guidelines for the PCI clock defined in the COM Express specification and the 'PCI Local Bus Specification Revision 2.3'.

2.14.3. LPC Trace Length Guidelines

Figure 24: Topology for LPC

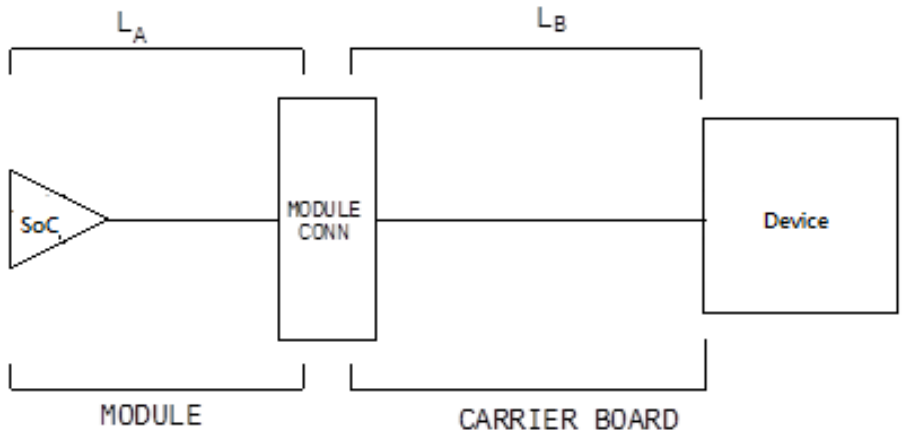


Table 37: LPC Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	LPC	
Single End	50Ω ±15%	
Nominal Trace Space within LPC Signal Group	Min. 15mils	
Spacing to Other Signal Group	Min. 15mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	12”	
Length matching between single ended signals	Max. 200mils	
Length matching between clock signals	Max. 200mils	
Reference Plane	GND referencing preferred.	
Via Usage	Try to minimize number of vias	

Notes:

2.15. SPI – Serial Peripheral Interface Bus

The SPI interface is defined in this specification to service as an off-module option for BIOS storage. The SPI interface replaces the LPC Firmware Hub interface, which is now considered a legacy interface for firmware storage (LPC does continue to be used for SuperIO connectivity).

Many current chipsets only specify SPI for BIOS/Firmware storage usage, so the COM.0 specification is limited to that connectivity use-case to enable maximum compatibility across Modules and silicon platforms. Additional features, such as SPI-based Trusted Platform Module support might be added to a given carrier design, but compatibility is not guaranteed across Modules.

2.15.1. SPI Signal Definition

Table 38: SPI Interface Signal Definition

Signal	Pin#	Description	I/O	Note
SPI_CS#	B97	Chip select for Carrier Board SPI – may be sourced from chipset SPI0 or SPI1 Carrier Board: Connect to SPI flash pin 1 Chip Select N/C if not used	O CMOS – 3.3V Suspend	
SPI_MISO	A92	Data in to Module from Carrier SPI Carrier Board: Connect 15~33Ω in series to SPI flash pin 2 Serial Output N/C if not used	I CMOS – 3.3V Suspend	
SPI_MOSI	A95	Data out from Module to Carrier SPI Carrier Board: Connect 33~47 Ω in series to SPI flash pin 5 Serial Input N/C if not used	O CMOS – 3.3V Suspend	
SPI_CLK	A94	Clock from Module to Carrier SPI Carrier Board: Connect 33~47 Ω in series to SPI flash pin 6 Clock N/C if not used	O CMOS – 3.3V Suspend	

Signal	Pin#	Description	I/O	Note
SPI_POWER	A91	Power supply for Carrier Board SPI – sourced from Module – nominally 3.3V. The Module shall provide a minimum of 100mA on SPI_POWER. Carriers shall use less than 100mA of SPI_POWER. SPI_POWER shall only be used to power SPI devices on the Carrier. Carrier Board: Connect to SPI flash pin 8 VDD N/C if not used	O – 3.3V Suspend	
BIOS_DIS0#	A34	Selection strap to determine the BIOS boot device. The Carrier should only float these or pull them low, please refer to for strapping options of BIOS disable signals. Carrier Board: 1 - N/C 0 - PD 1K to GND BIOS options are shown in Table "Effect of the BIOS disable signals"	I CMOS	
BIOS_DIS1#	B88	Selection strap to determine the BIOS boot device. The Carrier should only float these or pull them low, please refer to Table 39: Effect of the BIOS disable signals on page 119 below for strapping options of BIOS disable signals. Carrier Board: 1 - N/C 0 - PD 1K to GND BIOS options are shown in Table "Effect of the BIOS disable signals"	I CMOS	

The signals with the “SPI_” prefix names are used to connect directly to the regarding SPI device. SPI_CS# is the chip select signal and is usually sourced from the Module's chipset SPI0 or SPI1 signal. SPI_MISO and SPI_MOSI are the input and output signals and SPI_CLK offers the clock from the Module to the carrier's device. The SPI_POWER pin can be used to power the SPI devices and it should use less than 100mA in total. The signal is helpful to simplify the SPI schematic, because the Module's SPI power domain can be either in power state S0 or in S5.

BIOS_DIS[0:1]# signals are used to determine the boot device according to Table 39: Effect of the BIOS disable signals below. BIOS_DIS0# (formerly known as BIOS_DISABLE# in COM.0 R1.0) is used to

disable the on-module BIOS device and enable the LPC firmware hub. For SPI BIOS flash device usage the signal BIOS_DIS1# should be activated to disable the on-module BIOS device and enable the BIOS flash chip on the carrier.

Table 39: Effect of the BIOS disable signals

BIOS_DIS1#	BIOS_DIS0#	Chipset SPI CS1# Destination	Chipset SPI CS0# Destination	Carrier SPI_CS#	SPI Descriptor	BIOS Entry	Ref Line
1	1	Module	Module	High	Module	SPI0/SPI1	0
1	0	Module	Module	High	Module	Carrier FWH	1
0	1	Module	Carrier	SPI0	Carrier	SPI0/SPI1	2
0	0	Carrier	Module	SPI1	Module	SPI0/SPI1	3

2.15.2. SPI Routing Guidelines

NA

2.15.3. SPI Trace Length Guidelines

Figure 25: Topology for SPI

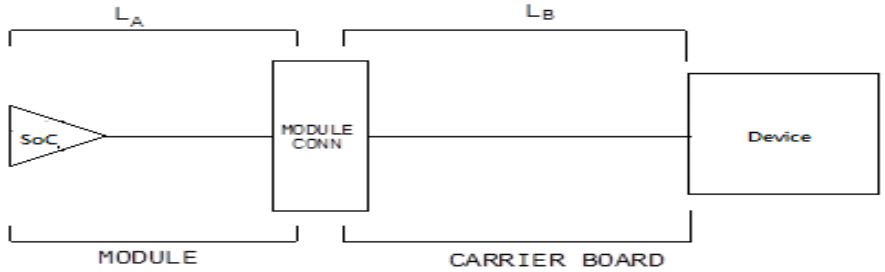


Table 40: SPI Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	SPI	
Single End	50Ω ±15%	
Nominal Trace Space within SPI Signal Group	Min. 10mils	
Spacing to Other Signal Group	Min. 15mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	6.5”	
DATA to CLK Maximum Pin to Pin Length Mismatch	Max. 500mils	
Via Usage	Try to minimize number of vias	

Notes:

2.16. General Purpose I2C Bus Interface

The I2C (Inter-Integrated Circuit) bus is a two-wire serial bus originally defined by Philips. The bus is used for low-speed (up to 400kbps) communication between system ICs. The bus is often used to access small serial EEPROM memories and to set up IC registers. The COM Express Specification defines several I2C interfaces that are brought to the Module connector for use on the Carrier. Some of these interfaces are for very specific functions (VGA, LVDS, and DDIX), one interface is the SMBus used primarily for management and one other interface is a general purpose I2C interface. Since COM.0 Rev. 2.0 this interface should support multi-master operation. This capability will allow a Carrier to read an optional Module EEPROM before powering up the Module.

Revision 1.0 of the specification placed the I2C interface on the non-standby power domain. With this connection, the I2C interface can only be used when the Module is powered on. Since the I2C interface is used to connect to an optional Carrier EEPROM and since it is desirable to allow a Module based board controller access to the optional Carrier EEPROM before the Module is powered on, revision 2.0 of this specification changes the power domain of the I2C interface to standby-power allowing access during power down and suspend states. There is a possible leakage issue that can arise when using a R2.0 Module with a R1.0 Carrier that supports I2C devices. The R1.0 Carrier will power any I2C devices from the non-standby power rail. A R2.0 Module will pull-up the I2C clock and data lines to the standby-rail through a 2.2K resistor. The difference in the power domains on the Module and Carrier can provide a leakage path from the standby power rail to the non-standby power rail.

Vendor interoperability is given via EAPI – Embedded Application Programming Interface, which allows and easier interoperability of COM Express Modules.

2.16.1. Signal Definitions

The general purpose I2C Interface is powered from 3.3V suspend rail. The I2C_DAT is an open collector line with a pull-up resistor located on the Module. The I2C_CK has a pull-up resistor located on the Module. The Carrier should not contain pull-up resistors on the I2C_DAT and I2C_CK signals. Carrier based devices should be powered from 3.3V suspend voltage. The use of main power line for a Carrier I2C device will require a bus isolator to prevent leakage to other I2C devices on 3.3V power.

At this time, there is no allocation of I2C addresses between the Module and Carrier. Carrier designers will need to consult with Module providers for address ranges that can be used on the Carrier.

Table 41: General Purpose I2C Interface Signal Descriptions

Signal	Pin#	Description	I/O	Pwr Rail	Note
I2C_CK	B33	General Purpose I2C Clock output Carrier Board: 3.3VSB I2C device - Connect to SCL of I2C device. 3.3V I2C device - Connect 3.3V isolation circuit controlled by COME pin B24 PWR_OK to SCL of I2C device. 5VSB I2C device - Connect 5VSB Level Shifter to SCL of I2C device. 5V I2C device – Connect an 5V isolation circuit controlled by COME pin B24 PWR_OK to SCL of I2C device. N/C if not used	I/O OD CMOS	3.3V Suspend	
I2C_DAT	B34	General Purpose I2C data I/O line. Carrier Board: 3.3VSB I2C device - Connect to SDA of I2C device. 3.3V I2C device - Connect 3.3V isolation circuit controlled by COME pin B24 PWR_OK to SDA of I2C device 5VSB I2C device - Connect 5VSB Level Shifter to SDA of I2C device 5V I2C device - Connect an 5V isolation circuit controlled by COME pin B24 PWR_OK to SDA of I2C device N/C if not used	I/O OD CMOS	3.3V Suspend	

2.16.2. I2C Routing Guidelines

NA

2.16.3. I2C Trace Length Guidelines

Figure 26: Topology for I2C

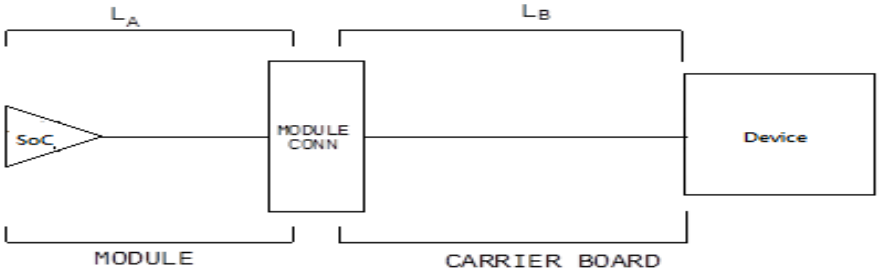


Table 42: I2C Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	I2C	
Single End	50Ω ±15%	
Nominal Trace Space within SPI Signal Group	Min. 10mils	
Spacing to Other Signal Group	Min. 15mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	NA	
Length Mismatch	+/- 500 mils	
Via Usage	Try to minimize number of vias	

Notes:

2.16.4. Connectivity Considerations

The maximum amount of capacitance allowed on the Carrier General Purpose I2C bus lines (I2C_DAT, I2C_CK) is specified by Advantech's Module. The Carrier designer is responsible for ensuring that the maximum amount of capacitance is not exceeded and the rise/fall times of the signals meet the I2C bus specification. As a general guideline, an IC input has 8pF of capacitance, and a PCB trace has 3.8pF per inch of trace length.

2.17. System Management Bus (SMBus)

The SMBus is primarily used as an interface to manage peripherals such as serial presence detect (SPD) on RAM, thermal sensors, PCI/PCIe devices, smart battery, etc. The devices that can connect to the SMBus can be located on the Module and Carrier. Designers need to take note of several implementation issues to ensure reliable SMBus interface operation. The SMBus is similar to I2C. I2C devices have the potential to lock up the data line while sending information and require a power cycle to clear the fault condition. SMBus devices contain a timeout to monitor for and correct this condition. Designers are urged to use SMBus devices when possible over standard I2C devices. COM Express Modules are required to power SMBus devices from Early Power in order to have control during system states S0-S5. The devices on the Carrier Board using the SMBus are normally powered by the 3.3V main power. To avoid current leakage between the main power of the Carrier Board and the Suspend power of the Module, the SMBus on the Carrier Board must be separated by a bus switch from the SMBus of the Module. However, if the Carrier Board also uses Suspend powered SMBus devices that are designed to operate during system states S3-S5, then these devices must be connected to the Suspend powered side of the SMBus, i. e. between the COM Express Module and the bus switch. Since the SMBus is used by the Module and Carrier, care must be taken to ensure that Carrier based devices do not overlap the address space of Module based devices. Typical Module located SMBus devices and their addresses include memory SPD (serial presence detect 1010 000x, 1010 001x), programmable clock synthesizes (1101 001x), clock buffers (1101 110x), thermal sensors (1001 000x), and management controllers (vendor defined address). Contact Advantech for information on the SMBus addresses used.

2.17.1. SMB Signal Definitions

Table 43: SMB Signal Definitions

Signal	Pin#	Description	I/O	Pwr Rail	Note
SMB_CK	B13	System Management Bus bidirectional clock line Carrier Board: 3.3VSB SMBus device - Connect to SMBCLK of SMBus device. 3.3V SMBus device - Connect 3.3V isolation circuit controlled by COME pin B24 PWR_OK to SMBCLK of SMBus device. 5VSB SMBus device - Connect 5V Level Shifter to SMBCLK of SMBus device. 5V SMBus device - Connect 5V isolation circuit controlled by COME pin B24 PWR_OK to SMBCLK of SMBus device N/C if not used.	I/O OD CMOS	3.3V Suspend rail	
SMB_DAT	B14	System Management bidirectional data line. Carrier Board: 3.3VSB SMBus device - Connect to SMBDAT of SMBus device. 3.3V SMBus device - Connect 3.3V isolation circuit controlled by COME pin B24 PWR_OK to SMBDAT of SMBus device. 5VSB SMBus device - Connect 5V Level Shifter to SMBDAT of SMBus device. 5V SMBus device - Connect 5V isolation circuit controlled by COME pin B24 PWR_OK to SMBDAT of SMBus device N/C if not used.	I/O OD CMOS	3.3V Suspend rail	
SMB_ALERT#	B15	System Management Bus Alert Carrier Board: Connect to SMBALERT# of SMBus device. N/C if not used.	I CMOS	3.3V Suspend Rail	

Note:

2.17.2. SMB Routing Guidelines

The SMBus should be connected to all or none of the PCIe/PCI devices and slots. A general recommendation is to not connect these devices to the SMBus.

The maximum load of SMBus lines is limited to 3 external devices. Please contact Advantech if more devices are required.

Do not connect Non-Suspend powered devices to the SMBus unless a bus switch is used to prevent back feeding of voltage from the Suspend rail to other supplies.

Contact Advantech for a list of SMBus addresses used on the Module. Do not use the same address for Carrier located devices.

2.17.3. SMB Trace Length Guidelines

Figure 27: Topology for SMB

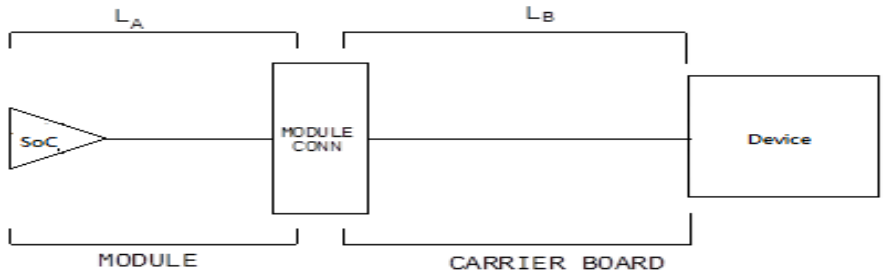


Table 44: SMB Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	SMB	
Single End	50Ω ±15%	
Nominal Trace Space within SPI Signal Group	Min. 10mils	
Spacing to Other Signal Group	Min. 15mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	13”	
Length Mismatch	+/- 500 mils	
Via Usage	Try to minimize number of vias	

Notes:

2.18. General Purpose Serial Interface

Advantech provides two serial ports on Type 10 and Type 6 COM Express Modules.

2.18.1. Serial interface Signal Definitions

Table 45: Serial interface Signal Definitions

Signal	Pin#	Description	I/O	Note
SER0_TX	A98	Transmit Line for Serial Port 0 Carrier Board: connect to Device - TXD COM DB-9 port - TxIN of Serial Transceiver and TxOUT to DB-9 pin 3 TXD N/C if not used.	O CMOS	
SER0_RX	A99	Receive Line for Serial Port 0 Carrier Board: Connect to Device - RXD COM DB-9 port - TxOUT of Serial Transceiver and TxIN to DB-9 pin 2 RXD N/C if not used	I CMOS	
SER1_TX	A101	Transmit Line for Serial Port 1 Carrier Board: connect to Device - TXD COM DB-9 port - TxIN of Serial Transceiver and TxOUT to DB-9 pin 3 TXD N/C if not used.	O CMOS	
SER1_RX	A102	Receive Line for Serial Port 1 Carrier Board: Connect to Device - RXD COM DB-9 port - TxOUT of Serial Transceiver and TxIN to DB-9 pin 2 RXD N/C if not used	I CMOS	

Note:

2.18.2. Serial interface Routing Guidelines

NA

2.18.3. Serial interface Trace Length Guidelines

Figure 28: Topology for Serial interface

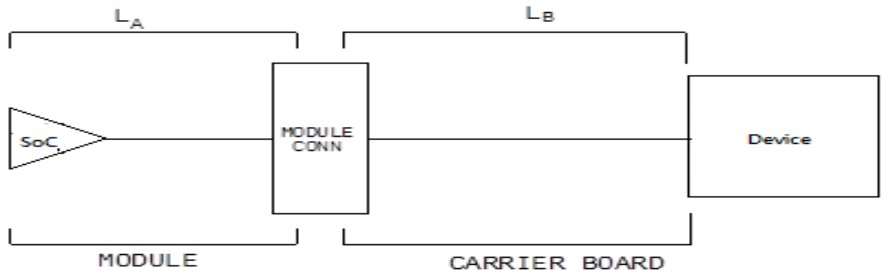


Table 46: Serial interface Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	Serial interface	
Single End	50Ω ±15%	
Nominal Trace Space within SPI Signal Group	Min. 10mils	
Spacing to Other Signal Group	Min. 15mils	
LA	Please see the SOM-5898 Layout Checklist	
LB	Carrier Board Length	
Max length of LA+LB	NA	
Length Mismatch	NA	
Via Usage	Try to minimize number of vias	

Notes:

2.19. CAN Interface *SOM-5898 is not support CAN Interface.

CAN bus is a vehicle bus standard designed to allow controllers and devices to communicate with each other without a host computer. CAN bus is a message-based protocol, designed specifically for automotive applications but now also used in other areas such as industrial automation and medical equipment.

Development of CAN bus started originally in 1983. The protocol was officially released in 1986 at the Society of Automotive Engineers (SAE) congress in Detroit, Michigan. The first CAN controller chips, produced by Intel and Philips, came on the market in 1987. In 1991 the CAN 2.0 specification was published.

Since 2008 CAN bus has been mandatory in any US vehicle in the OBD-II car diagnostic port. It is also used extensively in industrial automation.

2.19.1. CAN interface Signal Definitions

Table 47: CAN interface Signal Definitions

Signal	Pin#	Description	I/O	Note
CAN_TX	A101	Transmit Line for CAN Carrier Board: Check your CAN transceiver application notes.	O CMOS	1
CAN_RX	A102	Receive Line for CAN Carrier Board: Check your CAN transceiver application notes.	I CMOS	1

Note:

1. SOM-5898 is not support CAN Interface.

2.19.2. CAN interface Routing Guidelines

It should be routed as a differential pair signal with 120 Ohm differential impedance. The end points of CAN bus should be terminated with 120 Ohms or with 60 Ohms from the CAN_H line and 60 Ohms from the CAN_L line to the CAN Bus reference voltage. Check your CAN transceiver application notes for further details on termination.

2.19.3. CAN interface Trace Length Guidelines

Figure 29: Topology for CAN interface

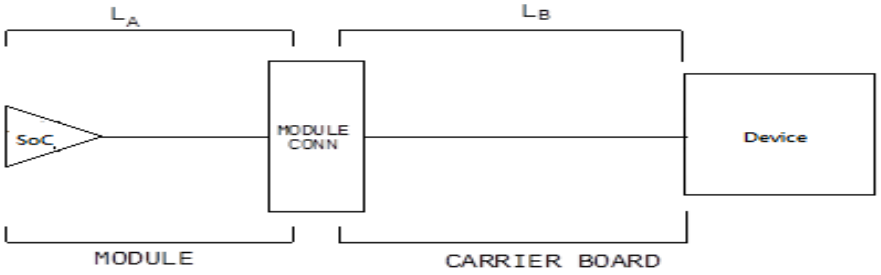


Table 48: CAN interface Trace Length Guidelines

Parameter	Main Route Guidelines	Notes
Signal Group	CAN interface	1
Single End	NA	
Nominal Trace Space within SPI Signal Group	Min. 10mils	
Spacing to Other Signal Group	Min. 15mils	
LA	SOM-5898 is not support CAN Interface	
LB	Carrier Board Length	
Max length of LA+LB	NA	
Length Mismatch	NA	
Via Usage	Try to minimize number of vias	

Notes:

1. SOM-5898 is not support CAN Interface

2.20. Miscellaneous Signals

2.20.1. Miscellaneous Signals

Table 49: Miscellaneous Signal Definitions

Signal	Pin#	Description	I/O	Note
TYPE0# TYPE1# TYPE2#	C54 C57 D57	The Type pins indicate the COM Express pin-out type of the Module. To indicate the Module's pin-out type, the pins are either not connected or strapped to ground on the Module. The Carrier Board has to implement additional logic, which prevents the system to switch power on, if a Module with an incompatible pin-out type is detected.	O 5V PDS	Only Available on T2-T6
TYPE10#	A97	Indicates to the Carrier Board that a Type 10 Module is installed. Indicates to the Carrier Board, that a Rev 1.0/2.0 Module is installed. TYPE10# NC Pin-out R2.0 PD Pin-out Type 10 pull down to ground with 47k 12V Pin-out R1.0		
SPKR	B32	Output used to control an external FET or a logic gate to drive an external PC speaker. Carrier Board: Connect to Speaker circuit. N/C if not used	O 3.3V CMOS	
BIOS_DISABLE0#	A34	Selection straps to determine the BIOS boot device. The Carrier should only float these or pull them low.	I 3.3V CMOS	See Section 2.15 'SPI – Serial Peripheral Interface Bus'
BIOS_DISABLE1#	B88	Selection straps to determine the BIOS boot device. The Carrier should only float these or pull them low.	I 3.3V CMOS	See Section 2.15 'SPI – Serial Peripheral Interface Bus'

Signal	Pin#	Description	I/O	Note
WDT	B27	Output indicating that a watchdog time-out event has occurred. Carrier Board: Connect to Watchdog trigger input. N/C if not used	O 3.3V CMOS	
KBD_RST#	A86	Input signal of the Module used by an external keyboard controller to force a system reset.	I 3.3V CMOS	Type 6 is not supported.
KBD_A20GATE	A87	Input signal of the Module used by an external keyboard controller to control the CPU A20 gate line. The A20 gate restricts the memory access to the bottom megabyte of the system. Pulled high on the Module.	I 3.3V CMOS	Type 6 is not supported.
LID#	A103	LID switch. Low active signal used by the ACPI operating system for a LID switch. Carrier Board: R1.0/R2.x Module both - Connect protection scheme referred to Figure 5-11 of COM.0 R2.0 or Figure 5-13 of COM.0 R2.1 Spec to LID button. R2.x Module only - Connect to LID button. N/C if not used.	I 3.3V CMOS OD	
SLEEP#	B103	Sleep button. Low active signal used by the ACPI operating system to bring the system to sleep state or to wake it up again. Carrier Board: R1.0/R2.x Module both - Connect protection scheme referred to Figure 5-11 of COM.0 R2.0 or Figure 5-13 of COM.0 R2.1 Spec to Sleep button. R2.x Module only - Connect to Sleep button. N/C if not used	I 3.3V CMOS OD	

Signal	Pin#	Description	I/O	Note
FAN_PWMOUT	B101	Fan speed control. Uses the Pulse Width Modulation (PWM) technique to control the fan's RPM. Carrier Board: R1.0/R2.x Module both - Connect protection scheme referred to Figure 5-11 of COM.0 R2.0 or Figure 5-13 of COM.0 R2.1 Spec to FAN connector pin 2 PWMOUT via Smart FAN circuit R2.x Module only - PD 4.7KΩ to GND and connects to FAN connector pin 2 PWMOUT via Smart FAN circuit N/C if not used	O 3.3V CMOS OD	
FAN_TACHIN	B102	Fan tachometer input for a fan with a two pulse output. Carrier Board: R1.0/R2.x Module both - Connect protection scheme referred to Figure 5-11 of COM.0 R2.0 or Figure 5-13 of COM.0 R2.1 Spec to FAN connector pin 3 TACHIN via Smart FAN circuit R2.x Module only - Connect to FAN connector pin 3 TACHIN via Smart FAN circuit N/C if not used	I 3.3V CMOS OD	
TPM_PP	A96	Trusted Platform Module (TPM) Physical Presence pin. Active high. TPM chip has an internal pull down. This signal is used to indicate Physical Presence to the TPM. Carrier Board: Physical Absence - N/C Physical Presence - PU 1KΩ to 3.3V N/C if not used	I 3.3V CMOS	
GPO0 GPO1 GPO2 GPO3	A93 B54 B57 B63	General Purpose Outputs for system specific usage. Carrier Board: Connect to GPO[3..0] N/C if not used	O 3.3V CMOS	
GPI0 GPI1 GPI2 GPI3	A54 A63 A67 A85	General Purpose Input for system specific usage. The signals are pulled up by the Module. Carrier Board: Connect to GPI[3..0] N/C if not used	I 3.3V CMOS	
VCC_RTC	A47	Real-time clock circuit power input. Nominally +3.0V		

Note:

2.20.2. Power Management Signals

Table 50: Power Management Signal Definitions

Signal	Pin#	Description	I/O	Note
PWRBTN#	B12	Power button low active signal used to wake up the system from S5 state (soft off). This signal is triggered on the falling edge. Module has integrated PU resistor 10K ohm to 3.3V suspend power and has an internal 50 ms de-bounce on the input. Carrier Board: ATX - Connect to Power Button or SIO Power Button output pin (Active low) AT - N/C N/C if not used	I 3.3V Suspend CMOS	
SYS_RESET#	B49	Reset button input. Active low request for Module to reset and reboot. May be falling edge sensitive. For situations when SYS_RESET# is not able to reestablish control of the system, PWR_OK or a power cycle may be used. Carrier Board: Connect to Reset button N/C if not used	I 3.3V Suspend CMOS	
CB_RESET#	B50	Reset output signal from Module to Carrier Board. This signal may be driven low by the Module to reset external components located on the Carrier Board. Carrier Board: Connect to reset pin of devices except PCI slots or devices. N/C if not used.	O 3.3V Suspend CMOS	
PWR_OK	B24	Power OK status signal generated by the ATX power supply to notify the Module that the DC operating voltages are within the ranges required for proper operation. Carrier Board: Connect to power good pin of main power supply ATX - PW-OK pin 8 of ATX power connector connects 3.3V level shifter to COME PWR_OK. AT - PG pin P8.1 of AT power connector connects 3.3V level shifter to COME PWR_OK. Other - PWROK of 12V power generator circuit connects 3.3V level shifter to COME PWR_OK. N/C is not allowed, if the system is ATX mode. N/C if not used.	I 3.3V CMOS	

Signal	Pin#	Description	I/O	Note
SUS_STAT#	B18	Suspend status signal to indicate that the system will be entering a low power state soon. It can be used by other peripherals on the Carrier Board as an indication that they should go into power-down mode. Carrier Board: Connect to LPCPD# of LPC device. N/C if not used.	O 3.3V Suspend CMOS	
SUS_S3#	A15	S3 Sleep control signal indicating that the system resides in S3 state (Suspend to RAM). This signal can be used to control the ATX power supply via the *'PS_ON#'* signal. Carrier Board: Connect to SLP_S3# (Suspend To RAM) of LPC device or SIO. N/C if not used.	O 3.3V Suspend CMOS	
SUS_S4#	A18	S4 Sleep control signal indicating that the system resides in S4 state (Suspend to Disk). Carrier Board: Connect to SLP_S4# (Suspend To Disk) of LPC device or SIO. N/C if not used.	O 3.3V Suspend CMOS	
SUS_S5#	A24	S5 Sleep Control signal indicating that the system resides in S5 State (Soft Off). Carrier Board: Connect to SLP_S5# (Soft Off) of LPC device or SIO. N/C if not used.	O 3.3V Suspend CMOS	
WAKE1#	B67	General purpose wake-up signal. Carrier Board: Connect to PME# of SIO N/C if not use	I 3.3V Suspend CMOS	
BATLOW#	A27	Battery low input. This signal may be driven low by external circuitry to signal that the system battery is low. It also can be used to signal some other external power management event. Carrier Board: Connect to BATLOW# of Smart Battery. N/C if not used.	I 3.3V Suspend CMOS	

Note:

2.20.3. Thermal Interface

Table 51: Thermal Management Signal Definitions

Signal	Pin#	Description	I/O	Note
THRM#	B35	Thermal Alarm active low signal generated by the external hardware to indicate an over temperature situation. This signal can be used to initiate thermal throttling. Carrier Board: Connect to THRM# output of Hardware Monitor. N/C if not used.	I 3.3V CMOS	
THRMTRIP#	A35	Thermal Trip indicates an overheating condition of the processor. If *'THRMTRIP#'* goes active the system immediately transitions to the S5 State (Soft Off). Carrier Board: Connect to THERMTRIP# input of devices. N/C if not used.	O 3.3V CMOS	

Note:

2.20.4. Miscellaneous Signals Routing Guidelines

NA

2.20.5. Miscellaneous Signals Trace Length Guidelines

NA

3. Power

3.1. General Power requirements

COM Express calls for the Module to be powered by a single 12V power rail, with a +/-5% tolerance. The Mini format Modules are specified in COM.0 Rev. 2.1 to support a power input range of 4.75V to 20.0V. Advantech offer a wide range input even on Compact and Basic Modules. COM Express Modules may consume significant amounts of power – 25 to 50W is common, and higher levels are allowed by the standard. Close attention must be paid by the Carrier Board designer to ensure adequate power delivery. Details are given in the sections below.

If Suspend functions such as Suspend-to-RAM, Suspend-to-disk, wake on power button press, wake on USB activity, etc. are to be supported, then a 5V Suspend power source must also be provided to the Module. If Suspend functions are not used, the Module VCC_5V_SBY pins should be left open. On some Modules, there may be a slight power efficiency advantage to connecting the Module VCC_5V_SBY rail to VCC_5V rather than leaving the Module pin open.

Please contact Advantech for further details. Carrier Boards typically require other power rails such as 5V, 3.3V, 3.3V Suspend, etc. These may be derived on the Carrier Board from the 12V and 5V Suspend rails.

3.2. VCC5_SBY Routing

The +5V Suspend power rail, if used, should be sized to handle 2A. Most, but not all, Modules will use considerably less than 2A for this power rail. Modules with multiple Ethernet channels and wake-on-LAN capability will use more current. The COM Express Specification allows up to 2A on this rail. Advantech recommends design 2A for VCC5_SBY.

3.3. ATX and AT Power Sequencing Diagrams

A sequence diagram for an ATX style boot from a soft-off state (S5), initiated by a power button press, is shown in Figure 30 below.

A sequence diagram for an AT style boot from the mechanical off state (G3) is shown in Figure 31 below .

In both cases, the VCC_12V, VCC_5V and VCC_3V3 power lines should rise together in a monotonic ramp with a positive slope only, and their rise time should be limited. Please refer to the ATX specification for more details.

Figure 30: ATX Style Power Up Boot – Controlled by Power Button

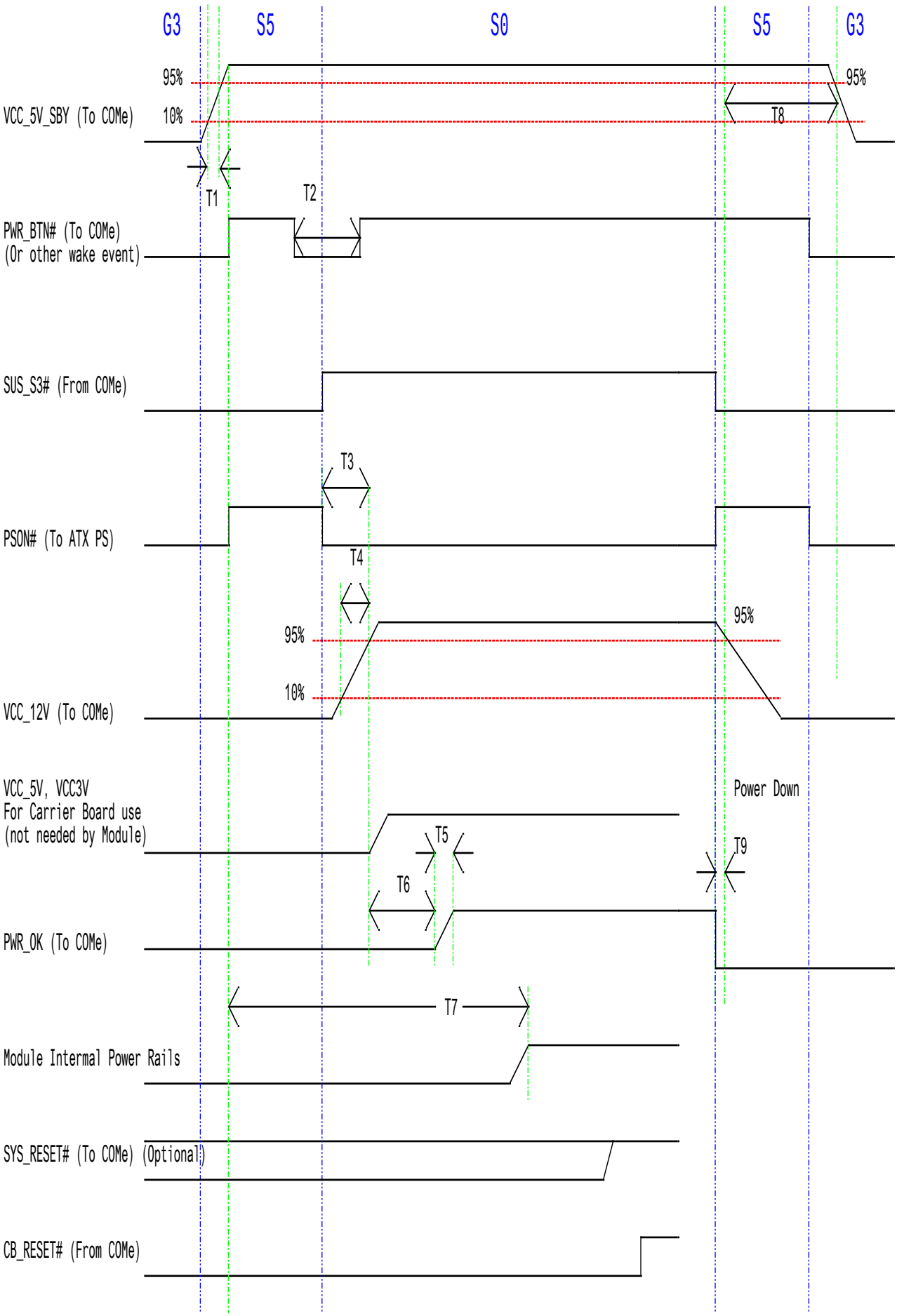

G3
S5
S0
S5
G3
95%
10%
95%
T8
VCC_5V_SBY (To COMe)
T1
T2
PWR_BTN# (To COMe)
(Or other wake event)
SUS_S3# (From COMe)
T3
PSON# (To ATX PS)
T4
95%
95%
10%
VCC_12V (To COMe)
VCC_5V, VCC3V
For Carrier Board use
(not needed by Module)
Power Down
T5
T9
T6
PWR_OK (To COMe)
T7
Module Internal Power Rails
SYS_RESET# (To COMe) (Optional)
CB_RESET# (From COMe)

Figure 31: AT Style Power Up Boot

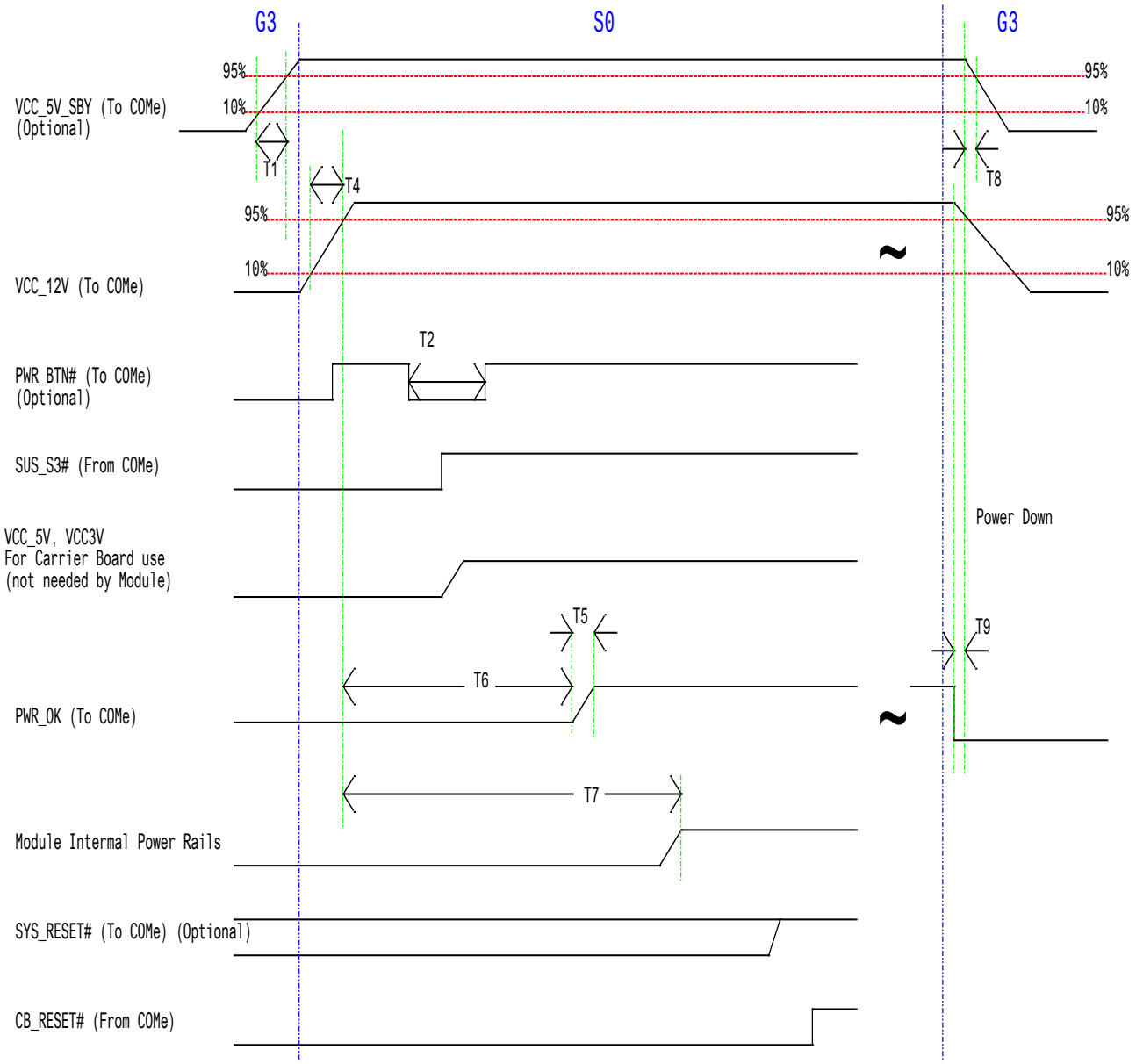


Table 52: Power Management Timings

Sym	Description	Min	Max
T1	VCC_5V_SBY rise time from 10% to 95%	0.1ms	20ms
T2	Power Button	50ms	
T3	The power-on time is defined as the time from when PS_ON# is pulled low to when the VCC_12V, VCC_5V and VCC_3V output 95%.		500ms
T4	VCC_12V rise time from 10% to 95%	0.1ms	20ms
T5	PWR_OK rise time		10ms
T6	VCC_12V rise 95% to PWROK rise	0ms	
T7	See Note 1	1ms	
T8	VCC_12V fall 95% to VCC_5V_SBY fall 95%	0ms	
T9	PWR_OK fall to VCC_12V fall 95%.	1ms	

Note:

1. There is a period of time (T6 in Figure 30 and Figure 31 above) during which the Carrier Board circuits have power but the COM Express Module main internal power rails are not up. This is because almost all COM Express internal rails are derived from the external VCC_12V and there is a non-zero start-up time for the Module internal power supplies.

   Carrier Board circuits should not drive any COM Express lines during the T6 interval except for those identified in the COM Express Specification as being powered from a Suspend power rail. Almost all such signals are active low. Such signals, if used, should be driven low by open drain Carrier Board circuits to assert them. Pull-ups, if present, should be high value (10K to 100K) and tied to VCC_5V_SBY.

   The line PWR_OK may be used during the T6 interval to hold off a COM Express Module boot. Sometimes this is done, for example, to allow a Carrier Board device such as an FPGA to be configured before the Module boots.

   The deployment of Carrier Board pull-ups on COM Express signals should be kept to a minimum in order to avoid back-driving the COM Express signal pins during this interval.
   Carrier Board pull-ups on COM Express signal pins are generally not necessary – most signals are pulled up if necessary on the Module.

3.4. Input Power - Rise Time

The input voltages to the COM Express Module VCC_12V, wide input (Mini) and VCC_5V_SBY if used shall rise from ≤10% of nominal to within the regulation ranges within 0.1 ms to 20 ms (0.1 ms ≤ T1/T4 ≤ 20 ms). There must be a smooth and continuous ramp of each DC output voltage from 10% to 95% of its final set point within the regulation band. The smooth turn-on requires that, during the 10% to 95% portion of the rise time, the slope of the turn-on waveform must be positive and have a value of between 0 V/ms and [Vout, nominal / 0.1] V/ms. Also, for any 5ms segment of the 10% to 95% rise time waveform, a straight line drawn between the end points of the waveform segment must have a slope ≥ [Vout, nominal / 20] V/ms.

3.5. Design Considerations for Carrier Boards containing FPGAs/CPLDs

Very often, the Carrier Board will contain custom FPGA or other programmable devices which require the loading of program code before they are usable. The Carrier Board designer needs to take the necessary precautions to ensure that his Carrier Board logic is up and running before the Module starts. Conflicts can occur if the Module is powered on and allowed to run before devices on the Carrier Board are fully programmed and initialized. A typical example is an FPGA which includes a PCIe device. Such devices must be initialized and ready before the chipset on the Module performs link training and before the BIOS code performs enumeration of PCI devices. The Module should therefore be prevented from starting before Carrier Board devices are ready.

One method to achieve this is to delay assertion of the PWR_OK# signal to the Module until the Carrier Board initialization process has completed. Note that during the phase when the Carrier Board is powered and the Module is not powered there is potential for back drive voltages from the carrier to the Module.

Another possibility is to use the SYS_RESET# signal to delay Module start-up. However, depending on the Module implementation and the chipset used, SYS_RESET# may only be a falling edge triggered signal and not a low active signal as was originally intended. In that case, asserting SYS_RESET# may not hold the Module in the reset state. Also, PCIe link training will occur regardless of the reset signal state for some chipsets.

Please refer to the COM.0 R2.1 specification (Power and System Management section) for more details and check the Module provider’s documentation for their implementations of these signals.

4. Electrical Characteristics

4.1. Absolute Maximum Ratings

Table 53: Absolute Maximum Ratings

SOM-5898		MIN	MAX	UNIT
Power	VIN	8.5 (5-5%)	20 (19+5%)	V
	VSB	4.75 (5-5%)	5.25 (5+5%)	V
	RTC Battery	2.4	3.3	V

4.2. DC Characteristics

Table 54: Input Power Consumption of 8.5V / 12V / 20V

Intel(R) Core(TM) i7-7820EQ CPU @3.00GHz, Adavantech 8G 1R*8 DDR4 2400SO*2pcs					
Power Plane	Maximum Power Consumption				
Symbol	S0		S3	S5	G3
+VIN (+12V)	TAT turbo CPU80%+GPU100%	52.137W	0.403W	0.232W	
	Idle	6.77W			
+VIN (+8.5V)	TAT turbo CPU80%+GPU100%	50.696W			
	Idle	6.374W			
+VIN (+20V)	TAT turbo CPU80%+GPU100%	54.761W			
	Idle	7.027W			
+V5SB_CB	0.035W		0.403W	0.232W	
RTC Battery				1.51uA	4.64uA

Note:S0 power consumption is Intel TAT tools setting CPU-All 100% Turbo On.

4.3. Inrush Current

Table 55: Inrush Current

Power Plane	Maximum	
Symbol	G3 to S5	S5 to S0
+V5SB_CB	680.42mA	
+VIN (+12V)		7.9514A
+VIN (+8.5V)		10.2495A
+VIN (+20V)		5.1212A