ECEN 5803

Mastering Embedded Systems Architecture

Be Boulder.

University of Colorado Boulder

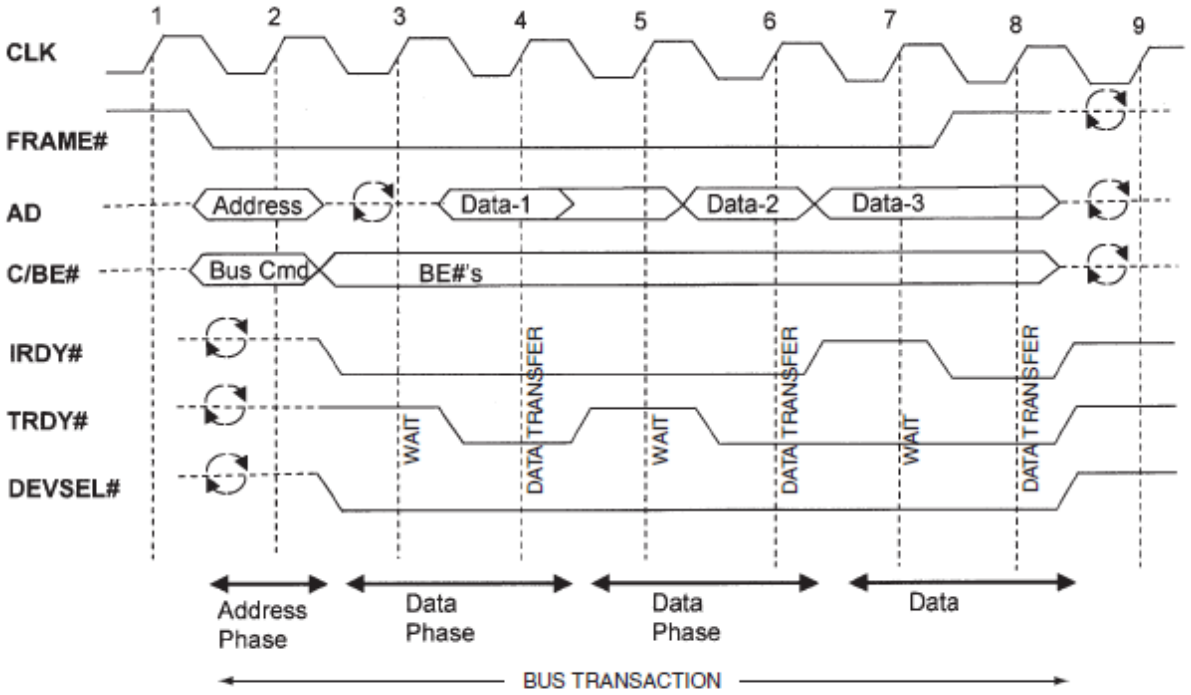
Backplane Buses

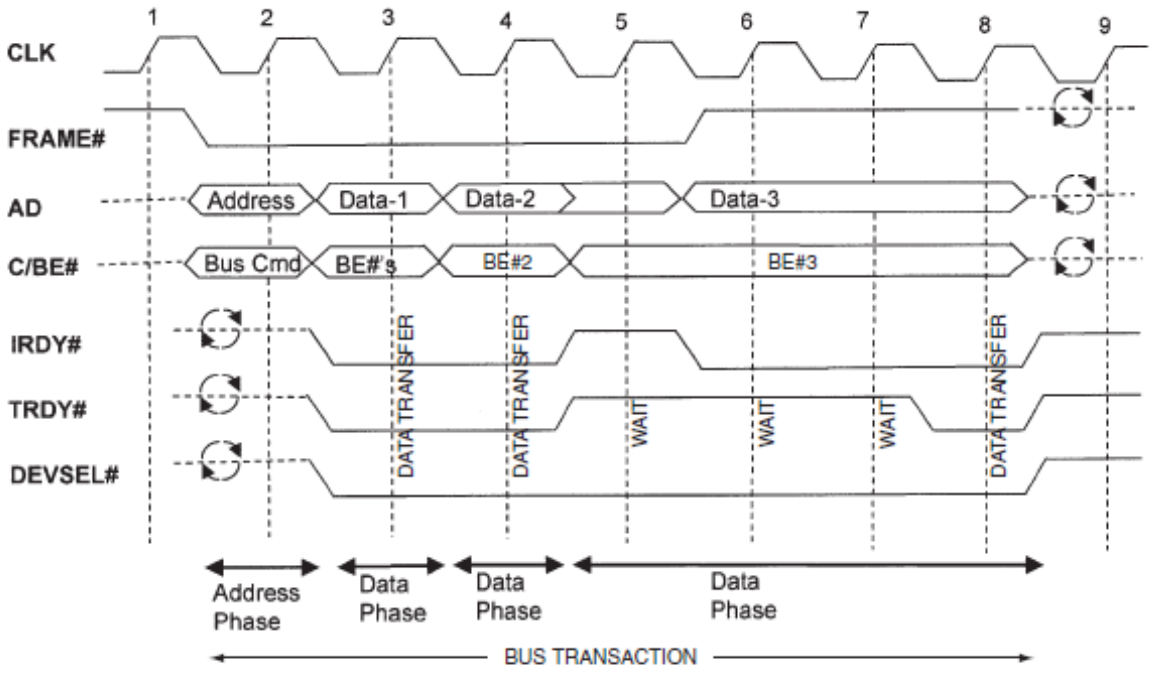
Bus	Description
ISA	The first PC expansion card bus; 16 bits at 8 MHz
PCI	The next PC expansion card bus; 32 then 64 bits at 33 then 66 MHz
PC104	ISA bus for industrial or ruggedized use, 3.55” x 3.75” stackable bus
PC104+, PCI104	PC104 with PCI bus added, or just PCI bus
EPIC	Embedded Platform for Industrial Computing – 4.5” x 6.5”platform for PC104 stack
CPCI	Compact PCI; Used for Telecom racks and networking switches in the 90’s, 6U or 3U form factor
PCIe	The latest PC expansion bus; Serial differential lanes
VME	Motorola parallel bus for large rugged card cage. Military and Avionics use, 320 MB/s BW
VPX	VME with additional SERDES backplane signals – increases BW to 30 GB/s
ATCA	Advance Telecom. Computing Architecture. Supplanted CPCI. Spawned MicroTCA
PICMG	PCI Industrial Computer Manufacturers Group (PICMG) is a consortium of over 227 companies

PCI Bus Arbitration

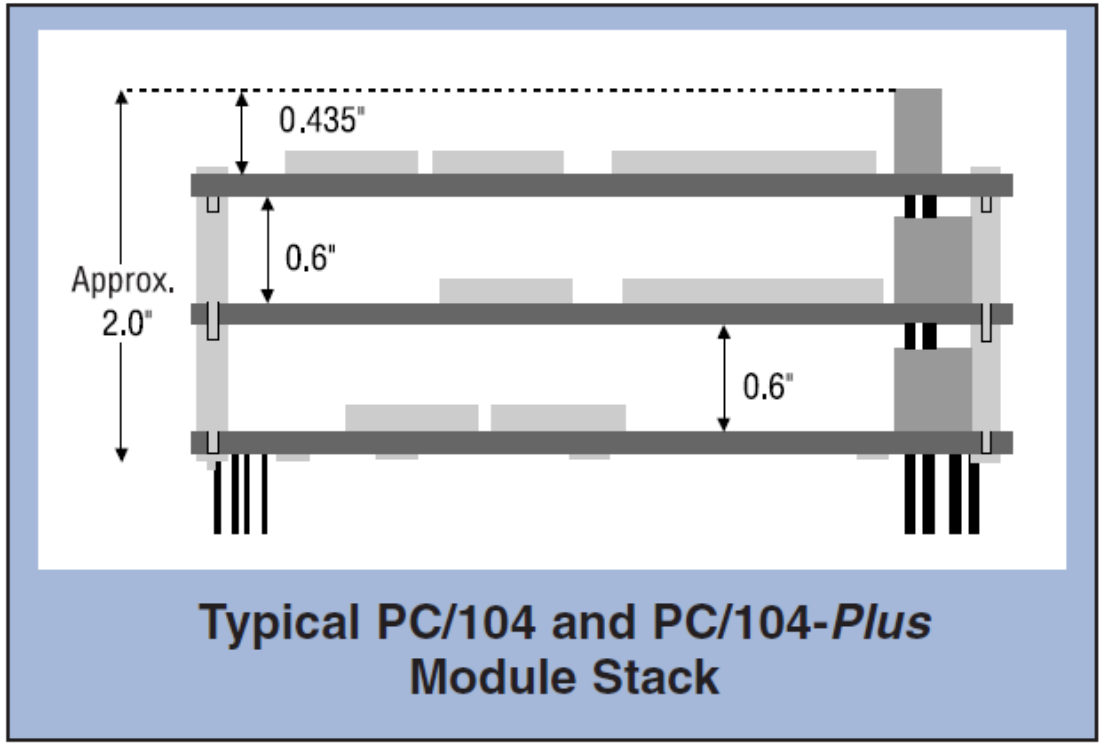
In general, a PCI transaction is made up of five steps:
1. An initiator makes a bus request by asserting a REQ# signal to the central arbitrator.
2. The central arbitrator does a bus grant to the initiator by asserting GNT# signal.
3. The address phase which begins when the initiator activates the FRAME# signal, and then sets the C/BE[3:0]# signals to define the type of data transfer (memory or I/O read or write). The initiator then transmits the address via the AD[31:0] signals at the next clock edge.
4. After the transmission of the address, the next clock edge starts the one or more data phases (the transmission of data). Data is also transferred via the AD[31:0] signals. The C/BE[3:0], along with IRDY# and #TRDY signals, indicate if transmitted data is valid.
5. Either the initiator or target can terminate a bus transfer through the deassertion of the #FRAME signal at the last data phase transmission. The STOP# signal also acts to terminate all bus transactions.

PCI Bus Arbitration

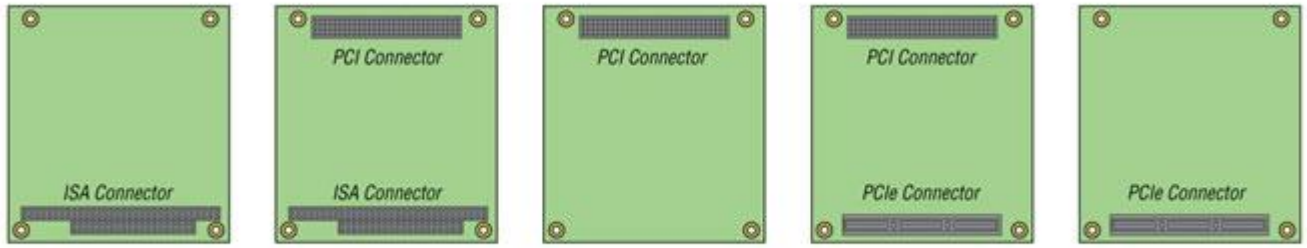




PC104 Connector Backplane



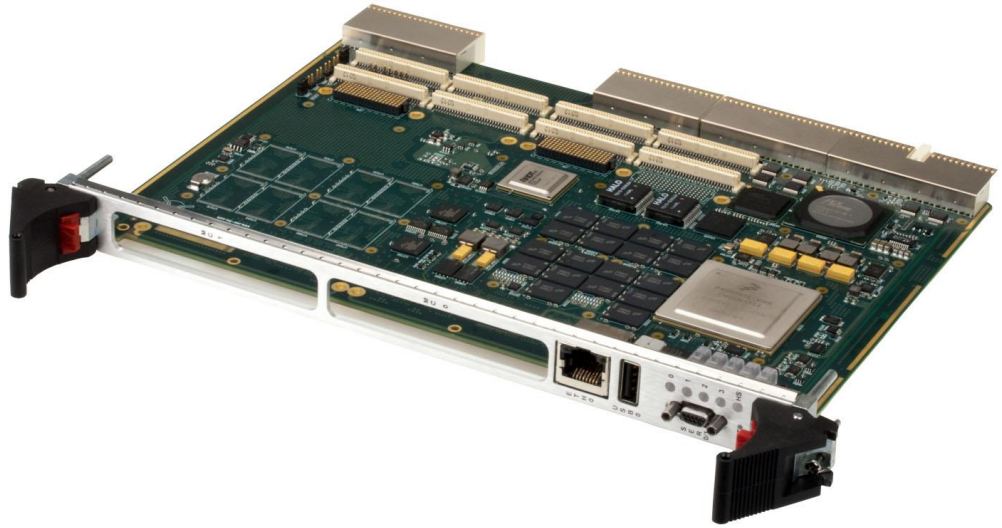
Typical PC/104 and PC/104-*Plus* Module Stack



PC/104 | PC/104-*Plus* | PCI-104 | PCI/104-Express | PCIe/104

VPX Chassis

CPCI Chassis



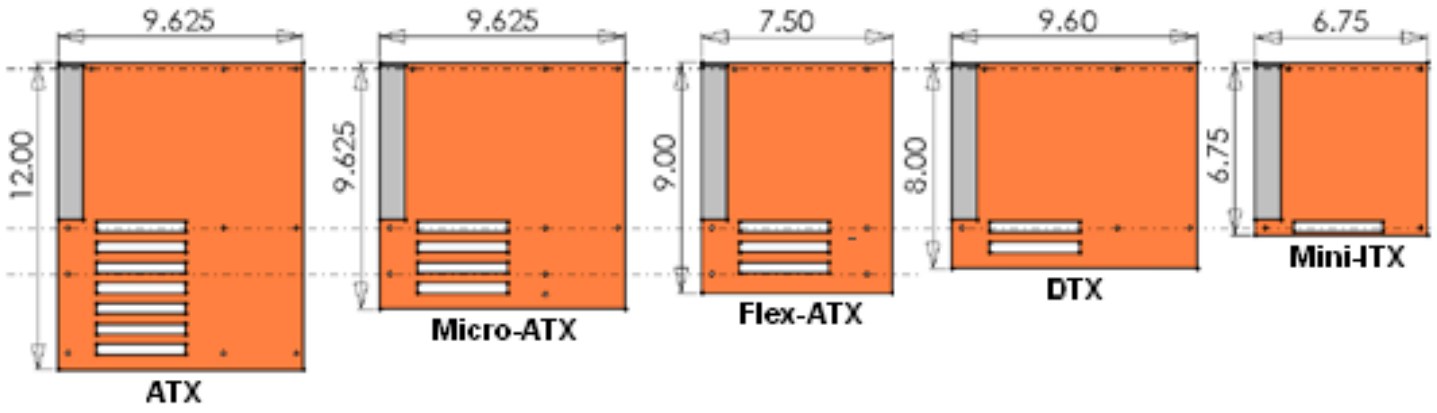
Storage (Peripheral) Buses

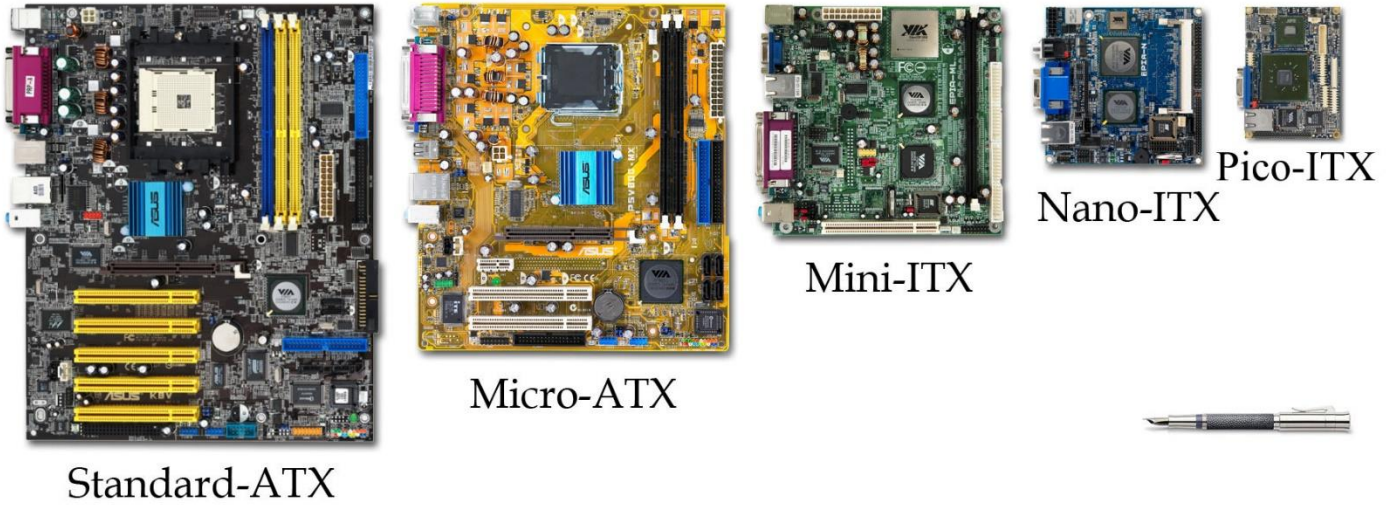
Bus	Description
IDE	Old PC hard drive bus system
SCSI	Fast, wide, or fast and wide, long in the tooth
SATA	Current bus interface for RAID systems
PCMCIA	Old; for hard drives and modems in laptops
Compact Flash	Camera Mass Storage
SD Card, micro SD	Dominant small form factor Mass storage interface

Storage buses are not I/O buses or System buses. I2C is not a system bus or I/O bus. I2C can be big-banged; No system bus is this slow.

Motherboard Options

Board	Description
ATX	305 mm x 244 mm
MicroATX	244 mm x 244 mm
EBX	203 mm x 146 mm
ITX	215 mm x 191 mm
Mini-ITX	170 mm x 170 mm
nanoITX	120 mm x 120 mm
Flex-ATX	229 mm x 191 mm
DTX	244 mm x 200 mm
Pico-ITX	100 mm x 72 mm





Computer on Module (COM)

COMs are complete embedded computers built on a single circuit board.

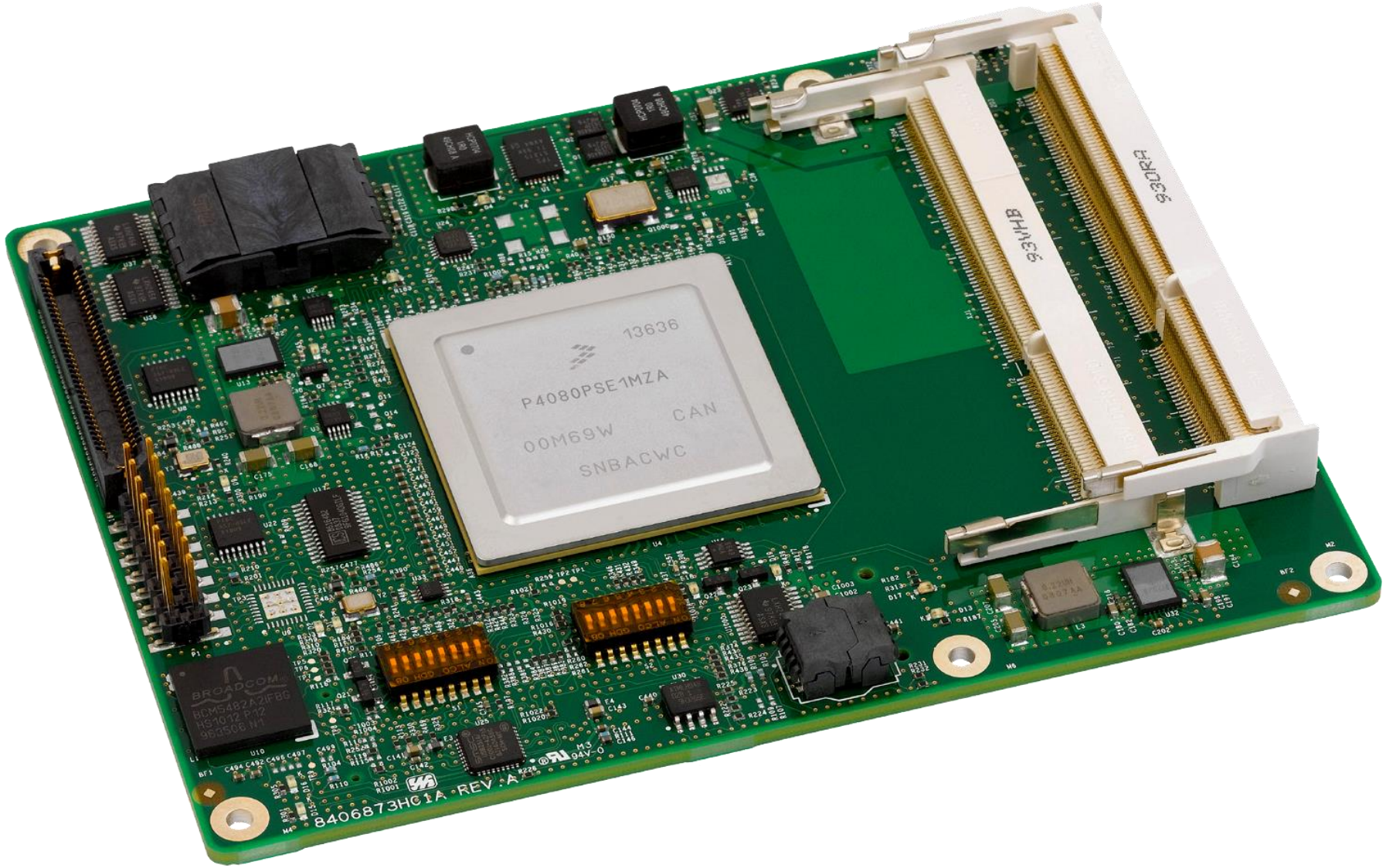
- COM lies between a full-up computer and a microcontroller.
- Unlike a single-board computer, COM usually lacks the standard connectors for peripherals
- The module usually needs to be mounted on a carrier board (or "baseboard")

Benefits to using COM products

- increasing speed to market,
- reduction to risk,
- cost savings,
- choice of a variety of CPUs,
- requirements and time for customer design,
- ability to conduct both hardware and software development at once.

Computer on Module (COM)

Features
•Freescale QorIQ P4040 or P4080 processors
•Four or eight Power Architecture cores running at 1.5 GHz
•Supports two channels of 2GB DDR3-1333 ECC SO-UDIMM (4GB max.)
•95 mm x 125 mm COM Express Basic footprint
•12 configurable SERDES lanes available for maximum flexibility



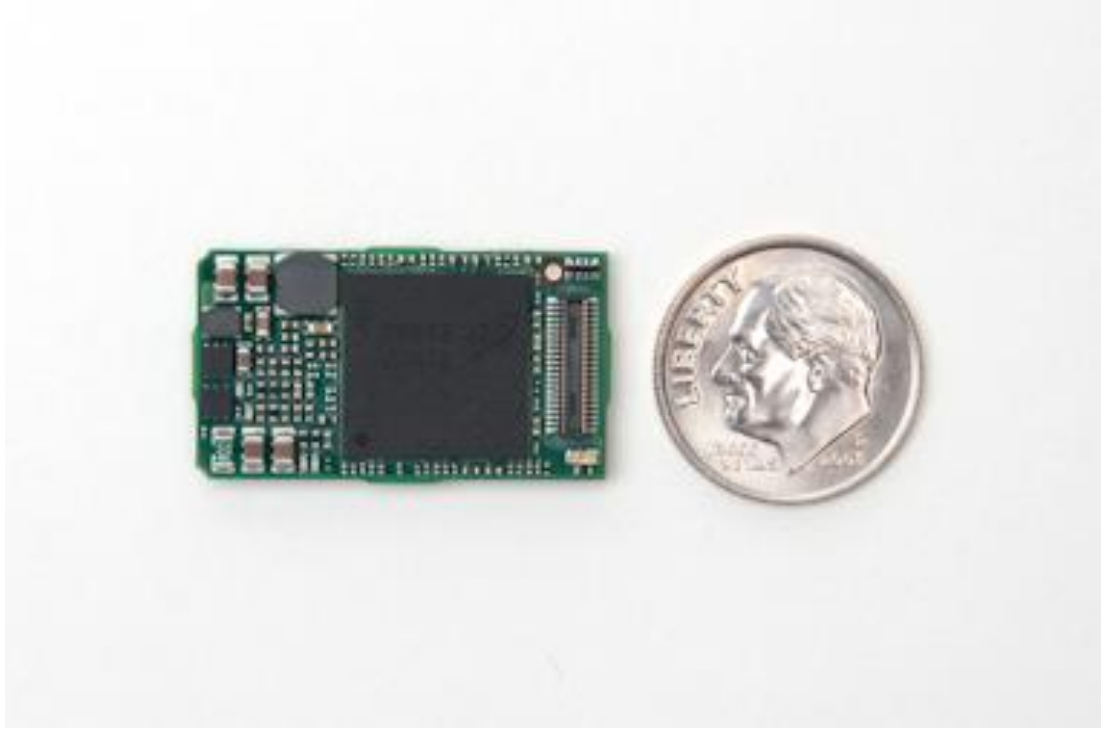
Computer on Module (COM)

Board	Description
COM - Express Basic	95 x 125 mm
COM - Express Compact	95 x 95 mm
ETX/XTX	95 x 114 mm
COM - Ultra	84 x 55 mm
PMC	149 x 74 mm
prPMC	149 x 74 mm
AMC	181.5 x 73.5 mm
PC-Mip	90.5 x 47.5 mm
XMC	144 x 74 mm
FMC	76.5 x 69 mm
Q7	70 x 70 mm

System on Module (SOM)

Texas Instruments
DM3730 / AM3703 Torpedo™ SOM

The DM3730 Torpedo SOM occupies less than one square inch, but boasts PC-like speeds up to 1 GHz with long battery life. Partnered with such high performance is a startlingly low power consumption of less than 5 mW when in suspend state. - See more at: http://www.logicpd.com/products/system-on-modules/texas-instruments-dm3730-am3703-torpedo-som/#sthash.WE1G2K1x.dpuf



- Android Board Support Package (BSP)
- Linux BSP
- Windows Embedded CE BSP

System on Module (SOM)

Toradex
Colibri T30 SOM

The Colibri T30 is a SODIMM-sized computer module based on the NVIDIA® Tegra™ 3 embedded System-on-Chip (SoC). The ARM Cortex-A9 quad core CPU peaks at 1.4 GHz. The module delivers very high CPU and graphic performance with minimum power consumption. - See more at: https://www.toradex.com/computer-on-modules/colibri-arm-family/nvidia-tegra-3

- Android Board Support Package (BSP)
- Linux BSP
- Windows 10 IoT BSP
- Windows Embedded Compact 7 and 2013 BSP

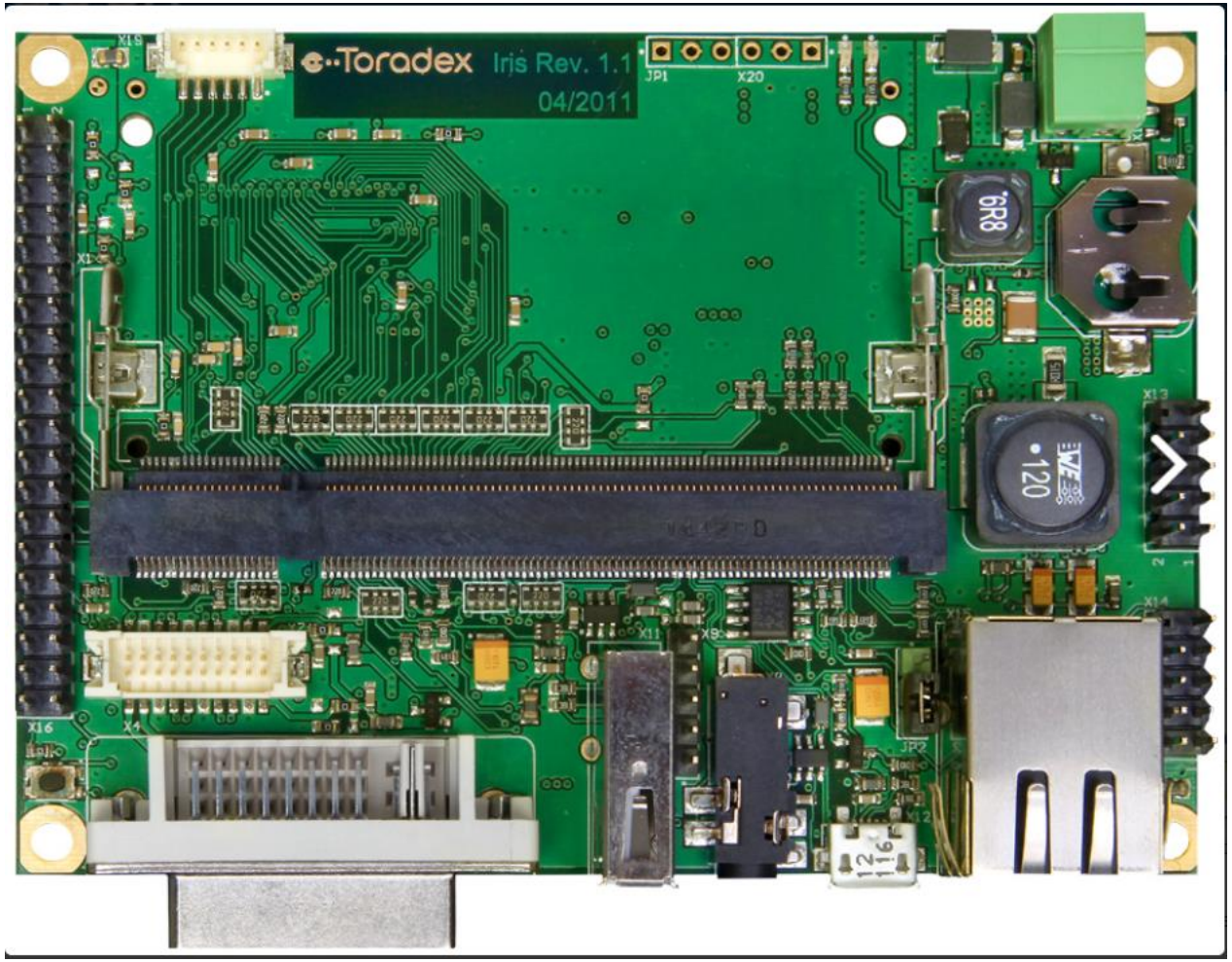
67.6 x 36.7 x 6.2 mm
2.66” x 1.44” x 0.244”
1 GB DDR3L, 4GB eMMC

http://www.logicpd.com/products/system-on-modules/texas-instruments-)3-torpedo-som/#sthash.WE1G2K1x.dpuf

System on Module (SOM) Carrier Board

Toradex
Iris Carrier Board

The Iris carrier board is compatible with the Colibri Arm family of modules. This low cost Arm development board, Iris, packs a large number of Colibri features into a very optimised small form factor which has been designed to be cost effective in small to medium volume applications. The Iris Carrier Board is designed to be used with the Colibri T20 and T30 (based on NVIDIA® Tegra™ 2/Tegra™ 3 SoCs.
Communication interfaces include USB 2.0 host and client, and 100 Mbit Fast Ethernet. Support for common industrial interfaces including I2C, SPI, RS232, CAN and GPIO makes the Iris carrier board perfectly suited for industrial and embedded applications.
Supported multimedia interfaces include DVI, LVDS, VGA, TFT LCD, Analogue Audio and Resistive Touch.



100 x 72 mm

http://www.logicpd.com/products/system-on-modules/texas-instruments-)3-torpedo-som/#sthash.WE1G2K1x.dpuf

System on Module (SOM)

Manufacturer	Part Number	Processor	Cores	Length(mm)	Width(mm)
LogicPD	DM3730 / AM3703 Torpedo SOM	TI DM3730	A8	27	15
Phytec	phyCORE-OMAP4460/OMAP4430	TI OMAP4460	A9 x2	51	41
Phytec	phyCORE Vybrid	Freescale VF5xx, VF6xx	A5, M4	51	41
Phytec	phyCORE®-AM335x	TI AM3359	A8	50	44
LogicPD	DM3730 / AM3703 SOM-LV	TI DM3730	A8	76.2	31
Boundary Devices	Nitrogen6x-SOM	Freescale I.MX6 Quad	A9 x4	63.5	57.15
Kontron	ULP-COM-sAT30	nVidia Tegra 3	A9 x4	82	50
Kontron	ULP-COM-sAMX6i	Freescale I.MX6 Quad	A9 x4	82	50
Phytec	phyFLEX®-i.MX6	Freescale I.MX6 Quad	A9 x4	70	60
Novtech	NOVSOMTM i.MX6Q/D Module	Freescale I.MX6 Quad	A9 x4	72.009	59.182
Eurotech	CPU-301-16	Freescale I.MX6 Quad	A9 x4	85	67