congatec
the rhythm of embedded computing

Whitepaper

What's new at COM Express Revision 2.0

COM Express®

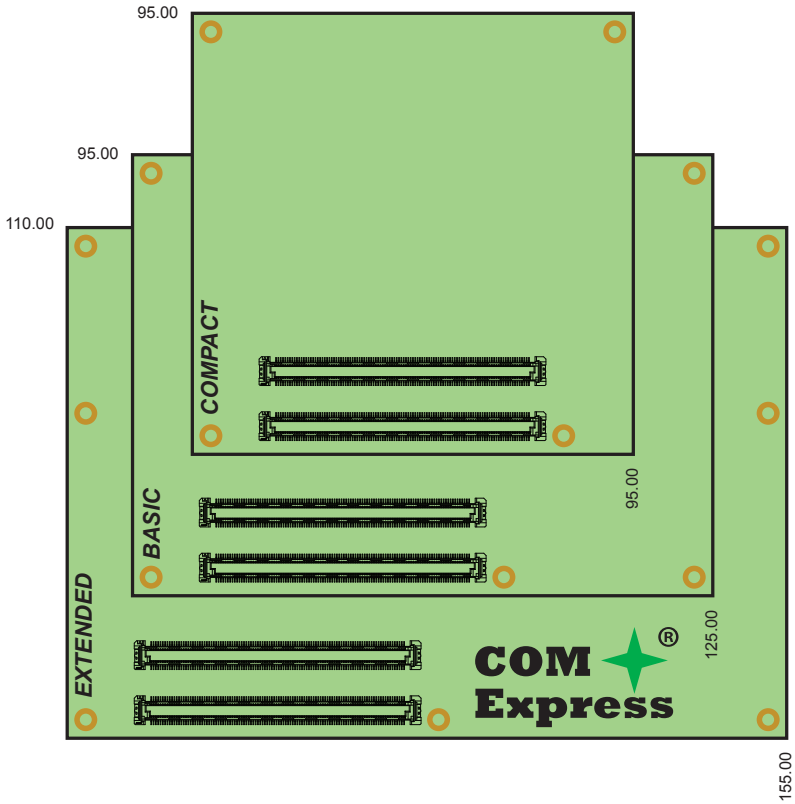
Since its beginning in 2005, the COM Express Specification success story continues to build. Its main target was, and still is, to define the mandatory requirements of COM Express modules and carrier boards as far as it is necessary to ensure interoperability between the products of different vendors. Nevertheless, with continuous technical progress, there is also the need for adjustments of the common interface – that being the COM Express connector.

More than 5 years after the initial release of the COM Express Specification, the Revision 2.0 prepares the COM Express standard for the future.

What changes with Revision 2.0?

Compact Form Factor

Rev 1.0 defined two form factors for COM Express modules: Basic (125 mm x 95 mm) and Extended Size (155 mm x 110 mm). Whereas the rarely used extended form factor is especially suited for high power consuming modules, e.g. server technology, the more commonly used basic form factor is based on less power consuming mobile and embedded technology. Shortly after the official release of Rev. 1.0, multiple vendors, including congatec, created space-saving 95 x 95 mm modules that were widely known as Compact modules. The official incorporation of this additional form factor size into Rev. 2.0 of the COM Express standard can be considered as a tribute to the popularity of this size definition. The small size of the Compact modules allows for an easier integration when it comes to low power application with space limitations.



Size comparison: Extended - Basic - Compact

conga-TCA: COM Express Compact module based on the dual core Intel® Atom™ D2550 / N2600 / N2800 processor

New Interfaces and Major Changes of Connector Pinouts

TV Out is no longer part of the latest revision of the COM Express standard. Since all modern displays and TVs accept digital high bandwidth signals, e.g. HDMI, there is no longer a need for analog video transmission via the outdated TV Out.

Although the support for PCIe Gen. 2 implies no change to the pinout of the COM Express module, nevertheless it affects the layout of the carrier board. PCIe Gen. 2 provides twice the speed of PCIe Gen. 1, which is achieved by doubling the frequency. To ensure sufficient signal quality at the receiver, designers have to take care of higher losses in the PCB, increased crosstalk etc. Furthermore, the differential PCIe clock signal and the PCIe clock buffer must be able to provide the increased jitter requirements of PCIe Gen. 2.

A popular benefit of the Computer-on-Module concept is that the firmware of a system can be stored on the module or on the carrier board. With Rev. 1.0 the LPC interface was the only way for COM Express modules to directly load the firmware from an off-module storage device. Rev 2.0 now introduces SPI (Serial Peripheral Interface) as primary interface for off-module firmware storage. Booting from a firmware hub attached to the LPC bus is still possible but is not preferable for new designs due to the advantages of SPI. SPI flashes are more cost efficient, less space consuming and offer more storage space than LPC flashes. To be able to select the desired startup firmware, a 2nd BIOS disable pin has been introduced. Combined with the existing BIOS_DISABLE# pin, they form a 2-bit value. The 2nd BIOS disable pin, as well as the SPI interface, reside on previously reserved pins so that backwards compatibility is maintained.

Minor Updates

Some changes made by the transition from Rev. 1.0 to Rev. 2.0 are more or less due to the evolution of interfaces.

With Rev. 2.0, it's possible to optionally use the existing GPIO pins as a SDIO interface. Beside the typical mass storage SD and SDHC cards, the SDIO interface is also capable of handling I/O cards such as WLAN, Bluetooth and GPS, based on the same size as a SD Card.

USB port 7 (last port) can now be used as USB client port, so that, if supported by the module, the whole COM Express system can act as a USB device.

Another update is the official support of HD Audio. Due to the lack of AC'97 support on modern embedded platforms, HD Audio was already used with Rev. 1.0 compliant modules, for example the conga-BM67, although it is not part of the Rev. 1.0 COM Express Specification. With the introduction of Rev. 2.0, the former AC'97 pins of the COM Express connector can carry now either HD Audio or AC'97 signals, depending on the module vendor. Although both interfaces, AC'97 and HD Audio use the same pins, they are not compatible due to different protocols.

In order to allocate pins for additional signals and future extensions, ten 12V pins were reclaimed. This doesn't limit COM designers because the new maximum possible power consumption of 68 W for single connector modules and 137 W for dual connector modules is still more than enough.

Additionally, the I²C bus receives two small updates: It now has the ability to support multiple I²C masters and its main power rail was moved from non-standby to standby power. This transition has become necessary because of the optional support of a carrier EEPROM that stores information about carrier board capabilities (e.g. amount of PCIe slots and lane configurations). The respective module may be able to read this information before powering up and pre-configure itself to fit best to the carrier board's abilities.

congatec's conga-BM67 COM.0R1.0 Type 2 module, offering three DDIs

Other than the COM Express module specification the COM Express Embedded EEPROM specification (EeeP) is available free of charge from the PICMG web page (http://www.picmg.org/pdf/PICMG_EeeP_R1_0.pdf).

This EeeP addresses the following issues:

- Device revision identification
- Standardized cross vendor cross platform I2C EEPROM data storage and retrieval (including product, marketing and branding information)
- Generic approach to data storage
- Vendor specific data storage in a multi-vendor environment
- Consolidation of data currently stored in multiple discrete devices, into 1 device (e.g. PICMG EEPROM, OEM specific EEPROM, Display Device EEPROM)
- Maximum code reuse
- Improve EEPROM access characteristics and increase EEPROM device selection flexibility

In addition to the existing pinouts of Type 1 through 5, Rev 2.0 of the COM Express specification adds two new pinout definitions called Type 6 and Type 10.

New Single Connector Pinout Type 10

The Type 10 pinout is a refresh of Type 1 and uses a single 220 pin connector. Type 10 COMs take advantage of one modern display connection, which can either be used as TMDS (HDMI/DVI), DisplayPort or SDVO and have had the number of LVDS channels halved so only one LVDS channel is available now. An additional Type 10 pin (formerly a 12 V pin) on the A-B connector allows the carrier board to distinguish between Rev 1.0 Type 1, Rev. 2.0 Type 1 and Type 10 modules.

Up to now, the Type 2 pinout is the most commonly available COM Express pinout. The root of its success may be the variety of interfaces, such as PCI, PCIe, IDE, SATA and USB 2.0, which also correspond best with most of the current x86 platforms. The rarely used Types 3 to 5 are specialized for single industries that require more Ethernet connections or more PCIe lanes.

conga-TS77 COM.0R2.0 Type 6 module based on the third generation of Intel Core i7 processors

New Connector Pinout Type 6

The newly defined Type 6 builds on the same success factors as Type 2 but also takes into consideration future interfaces. The A-B connector has nearly the same pinout as Type 2 Rev. 2.0. Only some reserved pins are used for UART, FAN (PWM), Lid and Sleep signals. The UART pins (2x SER_Tx/Rx) were added for debugging purposes (e.g. console redirection) due to their simplicity. Additionally, a new pin has been defined to indicate physical presence to an optional TPM chip located on the module. The fact that these pins are used on Rev 1.0 systems for supplying the module with power requires that module and carrier board designers spend some additional time to ensure that these interfaces can withstand a connection to a 12 V rail. This provides the ability to connect a Rev. 1.0 module to a Rev 2.0 carrier board, or vice versa.

In contrast to the previously mentioned small changes on the A-B connector, the C-D connector has been completely redefined. It gets rid of parallel legacy interfaces such as PCI and IDE and provides support for current and future interfaces.

These changes can be separated into 3 main categories:

- Up to four USB 3.0 Interfaces
- Up to three Digital Display Interfaces
- Up to 2 additional PCIe 2.0 lanes

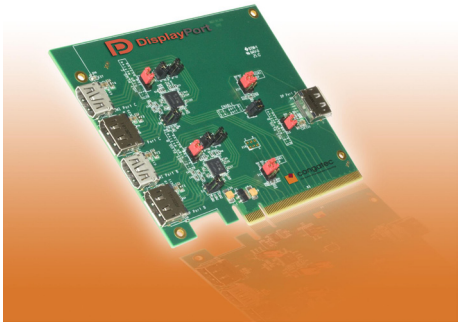
Digital Display Interfaces (DDI):

Digital Display Interface is a sum of differential pairs that carry display data. The new Type 6 pinout allows the usage of up to 3 independent DDIs. The first DDI channel is capable of supporting SDVO, Display Port and TMDS. TMDS can be used as HDMI or DVI, depending on the I/O connector. The 2nd and 3rd DDI channel only support TMDS and DisplayPort. As a result of this general definition, the decision about the proper interface for an application is up to the carrier board designer. When using a DDI channel as DisplayPort, it can easily be connected from the COM Express connector straight through to the I/O connector on the carrier board. Whereas a TMDS output requires an additional level shifter on the carrier board because of the different signal levels.

DDI 1			DDI 2		DDI 3	
TMDS	Display Port	SDVO	TMDS	Display Port	TMDS	Display Port

DDI channel capabilities

Some vendors, including congatec, recognized the potential of these Digital Display Interfaces and offer them together with the latest Type 2 Rev. 1.0 compliant modules but to do so there must be a trade-off, which means giving up the PCIe Graphics (PEG) port. Type 6 modules like the conga-TM77 support PEG Port and DDI allowing for maximum connectivity.



conga-ADD2DP for quick DDI evaluation

Image 2: congatec's conga-BM67 COM.0R1.0 Type 2 module, offering three DDIs

Image 3: conga-ADD2DP for quick DDI evaluation

Image 4: conga-TM67 COM.0R2.0 Type 6 module based on the second generation of Intel Core i7 processors

USB 3.0 – SuperSpeed:

Although the official release of the USB 3.0 specification was at the end of 2008, its wide adoption is just beginning. Unlike the transition from USB 1.1 to USB 2.0, the introduction of USB 3.0 (5 GBit/s) additionally requires changes to the hardware:

Two differential pairs, SuperSpeed-TX and SuperSpeed-RX carry the USB 3.0 complaint signals in addition to the already existing USB 2.0 signal pair Data+ and Data-. A separate GND pin between the SuperSpeed pairs allows for a high level of signal integrity.

In addition to the higher transfer rates, USB 3.0 allows drawing up to 900 mA (USB 2.0: 500 mA) from the 5V rail. This addresses the start-up problems of some bus-powered devices, like external hard disks.

In addition to eight USB 2.0 pairs, Type 6 modules offer up to four USB 3.0 SuperSpeed-RX and -TX pairs. It must be mentioned that this does not mean that with Type 6 overall there are 12 USB ports made available. The point is that the first four out of the eight USB 2.0 ports can be upgraded to be USB 3.0 compliant. The maximum amount of USB port is limited to 8 interfaces from the module. Additional ports can be generated using dedicated chips on the carrier board.

Embedded Application Programming Interface (EAPI)

With the introduction of the revision 2.0 of the COM Express specification a software interface (available free of charge at http://www.picmg.org/pdf/COM_EAPI_R1_0.pdf) was created. The EAPI specifies functions for industrial applications which do not feature a common programming interface. The use of special features such as watchdog timer did require vendor depending software programming in the past. This limited the free exchangeability of modules between different module vendors. This freedom is enabled with the release of the EAPI.

EAPI describes a common API to unify the software control for:

- System information
- Watchdog timer
- I2C Bus
- Flat Panel brightness control
- User storage area

GPIO

The EAPI definition is not limited to COM Express. It's open to be used for other embedded form factors too. It's already implemented for other module form factors such as Qseven, ETX and XTX and can also support 3.5" or mini-ITX boards

Specification

The COM Express specification was created by many COM Express module vendors within a technical subcommittee of the PICMG. It can be purchased at the PICMG web page http://picmg.org/v2internal/specorderformsec.htm at the price of 95$ or 45$ for members. Refer to the internal name "COM.0" to find the COM Express specification.

Design Guide

In order to ease the design of a custom carrier board some major COM Express module vendors created a technical subcommittee at the PICMG to join force for a common Carrier Board Design Guide. This is a very technical and valuable 160 page document. It provides information for designing a custom system Carrier Board for COM Express Modules. It includes reference schematics for the external circuitry required to implement the various COM Express peripheral functions. It also explains how to extend the supported buses and how to add additional peripherals and expansion slots to a COM Express based system. This design guide is still based on the COM Express Rev 1.0 specification but it's still extremely helpful to speed up the design of a custom carrier board. This valuable document is available as a free download at: http://www.picmg.org/pdf/PICMG_COMDG_100b.pdf

Outlook

The technology development moves on. And COM Express is following. A new release of the specification – just a minor release to Rev. 2.1 – is expected to be released by the PICMG within the first half of 2012. This release will face the announcement that the graphics interfaces VGA and LVDS will disappear within the next years. And an even smaller form factor than the Compact will also be announced.

All the changes since Rev 1.0 also need to be added to the Carrier Board Design guide. The technical subcommittee is just about to be formed. If this new to be formed team of specialists is performing well then we can expect an updated document within 2012.

Conclusion

The new Type 6 and Type 10 pinouts directly address the market needs for maximized support of displays. Type 6 goes even one step further and offers support for up to four USB 3.0 channels and two additional PCIe lanes, so that a PCIe x8 configuration is possible on the carrier board. In contrast, pinouts Type 1 through 5 receive only small updates so that they are backwards compatibility to the Rev. 1.0 devices will be largely retained. The official adoption of the Compact form factor is a logical decision given its market-wide implementation.

Overall, it's the correct time for this update and this helps make COM Express future proof.

Author

- Dipl.-Ing. (FH) Christian Eder, Electronics Engineer
- 1990 product manager industrial systems, Kontron
- 1999 product manager Compact PCI systems, Force Computers
- 2000 marketing manager Jumptec (introduced ETX)
- 2002 director marcom EMEA, Kontron
- 2005 marketing manager, congatec
  PICMG Editor COM Express Carrier Design Guide 1.0
  PICMG Editor COM Express Rev. 2.0