IIDC2, A New Beginning for Industrial Digital Video Camera Technology

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The true sign of successful specifications are revisions driven by the industry leaders in concert with the open source community. Ethernet, SCSI and JTAG specifications are decades old, in wide use today and have been updated multiple times for ease of use and enhanced benefits.

Another example is found in the recent development of an industry standard known as the Instrumentation and Industrial Digital Camera 2 specification (IIDC2), which is a major revamping of the industry standard IIDC 1.3* and Digital Camera (DCAM) specifications.

Digital video camera functionality generally has been bi-model, as consumer digital camcorders generate compressed audio/video streams and follow the Audio Video Control (AV/C IEC-6188* specifications). In contrast, instrumentation and industrial digital video cameras generate uncompressed video streams (no audio) and follow the DCAM and IIDC 1.3* specifications. The DCAM and IIDC 1.3* specifications include extensive camera controls, for example, brightness, frame rate, shutter speed and white balance, all of which are not included in the AV/C specifications.

Uncompressed Video Key for Real Time Applications

Digital video cameras for instrumentation and industrial applications are unique because of their focus on uncompressed video, raw frame rate and high resolution.
The ability to operate with uncompressed video is critical for real time applications like security systems and automotive back-up cameras where latency cannot be tolerated. Latency is introduced by the video compression routines used in video camcorders, webcams and cell phone cameras. For safety critical applications, which are the most stringent, a maximum latency of 5 milliseconds can be tolerated. Security and machine vision systems require a high frame rate, typically greater than 60 frames/sec, to maintain surveillance and position. IIDC cameras offer standard frames rates from 60 fps to 1.875 fps. Point Grey, Basler and Sony have used the extended IIDC registers to reach 100 fps routinely and as high as 200 fps in one application. High resolution is most valuable in security and surveillance applications and IIDC cameras are available today ranging from 2448 by 2048 down to 640 by 480 with color depth ranging from 8 bits to 24 bits per pixel.

A Little History……

The first digital video camera specification was developed by the 1394 Trade Association in 1996 as IIDC 1.04, and it was updated to IIDC 1.32 in 2008. The transport mechanism chosen for the early IIDC specifications was IEEE 1394 (FireWire) because of its high speed (400mb/sec), high bus power distribution and guaranteed delivery of video data. IIDC 1.3* cameras found wide acceptance in machine vision and computer vision applications in addition to webcams, including the hugely successful Apple iSight camera family.

The popularity of IIDC 1.3* digital video cameras grew over time because of the daisy chain (simplified cabling) and the ability to have simple, bus powered video cameras because of the high bus power (45 watt) distribution capabilities of IEEE-1394 over competing serial bus technologies, USB (2.5 watt) & Ethernet (0 watts). IIDC 1.32 became the basis for many digital video camera open source (Linux) community projects for example: libdc1394; unicap and coriander, because IEEE-1394 was an early, open standard with the appropriate technical capabilities. The "right" technical capabilities for the Linux community included the low CPU overhead benefits of IEEE-1394 that derive from the self-managed hardware features built into every IEEE-1394 device: non-CPU driven device enumeration, bus arbitration and bandwidth allocation.

The original DCAM and IIDC specifications were difficult to design products with as well, because of their fragmented and non-contiguous control and status register (CSR) organization. Basically, the IIDC 1.* series of specifications used a flat, linear register map where function additions were simply "tacked" on to the end of the linear list. The table below has been extracted from the IIDC

1.32 specification and it shows the INQ (capabilities), function enabling and status of a single feature scattered about the register map.

4.8 Register map

Offset	Register
000h	<Camera initialize register> INITIALIZE
100h 180h	<Inquiry register for video format> V_FORMAT_INQ <Inquiry register for video mode> V_MODE_INQ_x
200h	<Inquiry register for video frame rate> V_RATE_INQ_y_x
300h 360h	V_RATE_INQ_y_x continued <Reserved>
400h 480h	<Inquiry register for feature presence> BASIC_FUNC_INQ FEATURE_HI_INQ FEATURE_LO_INQ OPT_FUNCTION_INQ <Optional Function CSR offset>
500h	<Inquiry register for feature elements> xxxxxxxxxx_INQ
600h 640h 680h 6C0h	<Status and control register for camera> CAM_STA_CTRL <Feature control error status register> <Storage Media CSR> (Only for Format_6) <Stored Image CSR> (Only for Format_6)
700h	<Inquiry register for Absolute value CSR offset address>
800h	<Status and control register for feature> xxxxxxxxxxxx

In addition, the original DCAM and IIDC specifications were targeted solely for the IEEE-1394 transport medium.

Updating IIDC

In 2009, the Japan Industrial Imaging Association (JIIA) and the 1394 TA initiated a development effort to update the IIDC 1.32 specification to a more "modern" standard which in contrast groups all elements of a feature into a contiguous register space that can be implemented in products with

less effort (cost). The IIDC2 standard was created to simplify the design of industrial video cameras and to make it easier for personal computers to detect the individual features of a particular digital video camera when connected to a PC.

The IIDC2 specification is not backward compatible with the IIDC 1.32 specification.

In contrast, the IIDC2 specification has been established with a clear separation between camera control, status, function capabilities and transport media capabilities. Digital video camera controls have been purposely isolated from the high-speed data transport mechanisms in order to allow alternative transport media to be utilized in the future.

The IIDC2 specification requires functions and capabilities to be organized in a standard structure organized in category blocks with fixed offsets in a common register format linked in a list, similar to the Open Host Controller Interface (OHCI) formats proven successful by the USB, SATA and 1394 specifications. In addition, IIDC2 includes additional instructions, stream and stream transport, to streamline data transport. The table below has been extracted from the IIDC2 specification and it shows a linked list of general purpose, identical in structure, category blocks that describe the capabilities, functions and status of an IIDC2 camera.

Offset	Name	Description	
+0x000	Keyword	0x4949 4443 ("IIDC")	
+0x004	Version	[31..24]	reserved
		[23..16]	Major version number
		[15..8]	Minor version number
		[7..0]	Sub-minor version number
+0x008	NumberOfCategoryBlocks	[31..16]	reserved
		[15..0]	Number of CategoryBlocks (=N)
+0x00C	-	reserved	
+0x010	OffsetForXmlManifestTable	Quadlet offset for XML manifest table	
+0x014–0x01C	-	reserved	
+0x020	OffsetForCategoryBlock0	Quadlet offset for CategoryBlock0	
+0x024	OffsetForCategoryBlock1	Quadlet offset for CategoryBlock1	
+0x028	OffsetForCategoryBlock2	Quadlet offset for CategoryBlock2	
+0x02C	OffsetForCategoryBlock3	Quadlet offset for CategoryBlock3	
+0x030	OffsetForCategoryBlock4	Quadlet offset for CategoryBlock4	
+0x034	OffsetForCategoryBlock5	Quadlet offset for CategoryBlock5	
+0x038	OffsetForCategoryBlock6	Quadlet offset for CategoryBlock6	
+0x03C	OffsetForCategoryBlock7	Quadlet offset for CategoryBlock7	
+0x040	OffsetForCategoryBlock8	Quadlet offset for CategoryBlock8	
+0x044	OffsetForCategoryBlock9	Quadlet offset for CategoryBlock9	
+0x048	OffsetForCategoryBlock10	Quadlet offset for CategoryBlock10	
+0x04C–+0x098	-	reserved	
+0x09C	OffsetForCategoryBlock31	Quadlet offset for CategoryBlock31	
+0x0A0	OffsetForCategoryBlock32	Quadlet offset for CategoryBlock32 (ExpandedCategoryBlock)	
+0x0A4	OffsetForCategoryBlock33	Quadlet offset for CategoryBlock33	
...	...	...	
+(0x004*N +0x01C)	OffsetForCategoryBlock(N-1)	Quadlet offset for CategoryBlock(N-1)	

Table 1 –IIDC2Entry

IIDC2 defines 31 basic category blocks that can be used to implement IIDC2 camera functions. Examples of basic control blocks include device control and controls for the transport layer, image format, acquisition, luminance, and digital I/O.

Ratification of the IIDC2 specification by the JIIA and 1394 Trade Association came in March 2012, following the first IIDC2 prototype demonstrations at the November 2011 Vision Show in Stuttgart, Germany. Additional demonstrations of IIDC2 products took place at the 2012 Korean Vision Show this past April.

IIDC2 products will first use the IEEE-1394 transport mechanism at 800MB/sec for data transport and power distribution. Future implementations of IIDC2 digital video cameras may make use of Ethernet or USB transport mechanisms.