Period of Time:
July 2010

SW-Version:
TC 3.1.0.215463

Device class:
The room system C90 is a Full HD capable modular video conference system. The codec (dimensions: w/h/d 441/93/30, weight: 5.1kg) can be installed in a 19 inch rack and, by its large number of connections, enables a flexible use in different scenarios, from group system up to auditorium integration.

Scope of delivery:
The integration package is delivered with codec, PrecisionHD 1080p camera, two microphones and a remote control. The steel base plates for the assembly in a rack are also included in the scope of delivery. Furthermore, all necessary cables for the basic operation, a graphical documentation for the initial installation and a CD with manuals, data sheets and numerous helpful overviews for administrators as well as users are provided.

Bandwidth
The device enables video conferences per H.323 and SIP with up to 6 Mbps in point-to-point connections and with up to 10 Mbps in multipoint conferences via the optional multisite function.
From a connection bandwidth of 768kbps on, HD 720p30 can be transferred, from 1472kbps on, 1080p30 can be transferred.
All necessary connections for carrying out a video conference exist at the device, there are numerous possibilities of connections available in order to be able to display different scenarios. All connections are standardized AV interfaces, Tandberg goes without proprietary plug connections.

Next to the delivered PrecisionHD 1080p camera, which is connected via HDMI, 12 more video inputs can be used (all in all 4x HDMI, 4x HD-SDI, 2x DVI-I, 2x YPbPr, 1x S video). 5 output media can be operated at the device via different connections (2x HDMI, 2x DVI-I, 1x Composite Video). Furthermore, the Codec provides 14 different audio inputs (8x XLR - each with separate Echo-Canceller, 4x Cinch, 2x HDMI) and 8 audio outputs (2x XLR, 4x Cinch, 2x HDMI).

The installation of the device is carried out quickly and without problems due to the well designed graphical overview, but also because of the good labeling of the interfaces at the back side of the codec. The connections necessary for the basic operation are colored (cp. figure, click to enlarge), which facilitates the assembly. The configuration also turns out to be uncomplicated, since the menu navigation is structured logically and self-explanatory. Tandberg developed a new firmware for the systems of the C series (C20, C40, C60, C90 and EX90), which provides a convincing operational concept and stands out by an intuitive surface.

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**TEST**

**Operation**

The system is primarily controlled by a remote control which conforms to the MXP series and was extended by context sensitive function keys (see figure on the right side, click to enlarge). Depending on the menu item or state of connection, different options are displayed at the lower edge of the monitor while using the remote control, which can be activated by the according keys (for instance, switching to Far End Camera Control is possible during a present connection).

The design and arrangement of the menus differs from Tandberg systems of other series essentially in optics, which is no disadvantage for the operability. The well structured arrangement of the menu items and their distinct labeling as well as the intuitive menu navigation enable a quick and precise control of the system. Even primary users will get along quickly due to the clear structures.
Furthermore, the device can be controlled via the integrated web interface, at which only basic configuration functions can be carried out (adjustments, call setup and call end). More detailed diagnosis or monitor functions (e.g. observation of a current connection with outlook image, camera control, microphone control etc.) do not exist. This can only be achieved by using a Management System (e.g. Tandberg Management Suite).

**Audio/Video**

The system Tandberg C90 is designed as high efficiency codec, which becomes noticeable also in the connection parameters and corresponding evaluations of quality.

The audio codecs negotiated were AAC-LD or G.722 in all connections, in connections with Polycom CMA also G.722.1. The quality of those connections can always be rated "very good". Only Exception was the system Mirial Softphone (for MacOS as well as for Windows), which used for audio codec solely G.711 in the connection tests and can therefore only be rated "fair" when it comes to quality.

In all tests, H.264 was used as video codec, only exception here was the Sony PCS-G70, which sent H.263 with 4CIF (704x576 pixel) with good image quality. The video image sent by C90 could be rated with the best mark "very good" in all other test connections, the video image of the remote system with "good" up to "very good", except for Mirial Softphone as remote system (MacOS as well as Windows). Here, only a "bad" video was received under a negotiated Full HD resolution 1080p (1920x1080 pixel) and 13-15 frames per second.

Full HD resolutions 1080p with 25-30 frames per second in very good quality were achieved with according Tandberg devices of the new generation, such as TANDBERG EX90, TANDBERG C20 or Tandberg Codian MCU, in all other connections, mainly HD resolution 720p (1280x720) with 25-30 frames was negotiated. Older SD systems did also send with lower resolution. The Tandberg 990 MXP device sent the aspect ratio 448p (576x448 pixel), Polycom CMA only sent VGA (640x480) and Polycom PVX only sent QVGA (320x240 pixel).

**H.239**

The majority of the sent and received slide presentations could qualitatively be rated "very good". Font was always readable from 8 pixel on, colors were displayed without errors and disrupting signals were compensated. After a slide switch, this was immediately visible also at the remote side, re-sharpen effects were insignificantly small. In connection with older systems (Tandberg 6000 MXP, 990 MXP, Polycom CMA), the video codec H.263 with XGA resolution (1024x768) and a frame rate of 3-7 images was negotiated. With current HD devices (Tandberg EX90 / C20, Polycom HDX8004, LifeSize Room, Mirial Softphone), H.264 with XGA resolution was used. In the tests with Tandberg EX90, LifeSize Room and Mirial Softphone (Windows), the presentation could also be transferred in higher resolutions of 720p30 (LifeSize Room), SXGA@30 (Tandberg EX90) and 1080p (Mirial Softphone) in very good quality, by according adjustment of the laptop.

In connection with other systems, different problems occurred during the tests, mostly in one transfer direction. Sony PCS-G70 as well as XG80 could display presentation material sent by Tandberg C90 only in fair quality, since on the one hand, the resolution of 352x288 pixel was too low (with PCS-G70) and on the other hand, disrupting signals could not be compensated (XG80). Presentations sent by Mirial Softphone (Windows) were received in Full HD resolution 1080p, however, only in satisfying quality due to the switch times that were too long. Presentations sent to the system Tandberg Movi 4 Beta could only be rated "bad", because a switch time of more than 30 seconds for slide changes is unacceptable. Presentations received by Polycom PVX aborted reproducible or were afflicted with massive errors, which is why those, too, could only be rated "bad" in quality.

HD and SD video material transferred via H.239 and sent by the C90 could be received as video in all connection tests at the remote systems, with HD remote systems partly even with very high frame rates: H.239 video in SXGA resolution (1280x1024) was transmitted to Tandberg EX90 with 30 pictures per second, to Mirial Softphone (Mac OS and Windows) with 720p respectively XGA resolution with 30 pictures per second, to LifeSize Room also in 720p with 30 pictures per second.

In some cases, H.239 video material received by C90 had to be rated as not practicable due to a too low frame rate (Mirial Softphone for Mac OS and for Windows, LifeSize Room, Sony PCS-G70, Tandberg MXP 990) or incorrect transmission (Polycom PVX, Tandberg Movi 4 Beta).

Detailed test results are available in the [compatibility matrix](#).

Positively mentioned must be the fact that under an active H.239 channel, the layout was adapted automatically according to the resolution of the slides (widescreen or standard) to guarantee an optimized utilization of the monitor area.
Remote control
The camera remote control worked in all tests under existence of the preconditions, except for Sony PCS-XG80.

MCU
The cooperation with the Codian MCU of the DFNVideoConference service worked without problems for video with H.264 and 720p resolution in sending and receiving direction as well as for audio with AAC-LD. The transmission of H.239 was carried out in H.263pp with XGA resolution.
In connection to the Full HD Codian MCU 4520 SW version 4.1(1.45), the Tandberg C90 was connected with H.264@1280x720@30 in sending direction and with H.264@1920x1088@25 in receiving direction.

Gatekeepers
The cooperation with the gatekeepers GNU-GK 2.0.7 and CISCO MCM worked without restrictions.

Test patterns
The tests of the test patterns for resolution capacity and color fidelity demonstrated that the PrecisionHD 1080p shows no color changes in the scope of the sober natural colors and that records the color values authentically. The visual resolution accords to the abilities of current HD cameras. The image quality is very good. Color, sharpness and contrast are excellent and the control of the camera (Pan/Tilt/Zoom) also works quickly and noiseless. The autofocus could convince as well.

Miscellaneous
The device Tandberg C90 could not built up an SIP connection to the DFN-MCU with the syntax "conference-ID@mcu.vc.dfn.de". Also URI dialing according to H.323 Annex O (e.g. via "mcu.vc.dfn.de##conference-ID") did not work, independent of whether the system was registered at a gatekeeper or not.
The connection encoding with AES according to H.235 always worked in all connections, except for Mirial Softphone(encoding functions for H.323 are not implemented here).
According to the data sheet, the device supports Firewall-Traversal according to H.460.18 and H.460.19.
For the codec Tandberg C90, three additional options which require an extra charge are available: the Natural Presenter Package (NPP) enables the transmission of PC graphics (H.239 "Dual Stream"), the 1+3 Multisite Option (HD-MS) enables multipoint conferences to be carried out with up to 4 participants (in resolutions 1080p30/720p60 with integrated transcoding) as well as the Premium Resolution Option (1080p30 / 720p60 / UXGA) for Full HD resolutions.
The codec itself is used also in Tandberg´s Telepresence solutions T1 (1x C90 + 1x 65'' monitor) and T3 (3x C90 + 3x 65'' monitor).

CONCLUSION
The system C90 is a high performance video conference system which can flexibly be used in various scenarios. Not only does it impress by a large number of existing standard connections at the codec, but also by the high quality of the transferred media. Video conference connections in Full HD resolution with 30 pictures per second and parallel transmission of a second source (e.g. laptop, document camera, whiteboard etc.) with the same resolution and frame rate in brilliant quality are possible without further ado. For this reason, the device stands at the upper end of the current scope of quality and performance, but therefore also at the upper end of its price class.

Documentation
Manufacturer: Tandberg
Distributor: MVC
<table>
<thead>
<tr>
<th>Supported standards</th>
<th>H.323, SIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio encoding</td>
<td>G.711, G.722, G.722.1, MPEG4 AAC-LD (plus Stereo)</td>
</tr>
<tr>
<td>Video compression</td>
<td>H.261, H.263, H.263++, H.264</td>
</tr>
</tbody>
</table>
| Bandwidth           | 6 Mbps (P-to-P)  
                    | 10 Mbps (Multisite) |