

Tandberg C40

Manufacturer: Tandberg

Model: C40

Software Version: TC 3.1.0

Optional Features and Premium Resolution Option Modifications: (720p 60fps, 1080p 30fps, UXGA)

Natural Presenter Package (NPP)

Multisite (MCU)

Dual Monitor

Date of Test: 14th – 18th June 2010

A: INTRODUCTION

The Tandberg C40 is a High Definition (HD) videoconferencing system with a basic picture resolution of 1280 x 720 pixels at 30 fps (frames per second). The Premium Resolution option extends this to 1980 x 1080 pixels at 30fps or 1280 x 720 pixels at 60 fps. Compatibility with other H.323 CODECS is achieved across a range of resolutions from CIF (352x288 pixels) up to 1920 x 1080 depending on the capability of the remote CODEC and the connection bandwidth.

The Tandberg C40 offers four options:

Options	Features
Dual Display	Second monitor support
Natural Presenter Package (NPP)	H.239 dual video stream

MultiSite	Internal 4 site w576p 30fps MCU
Premium Resolution Option	Support for 1080p 30fps, 720p 60fps and UXGA resolutions

The equipment submitted for evaluation had version 3.1.0 software installed and included the above four options.

Feature Summary:

- A high definition videoconferencing system which supports several resolutions up to 1920 x 1080 pixels at 30 fps and 1280 x 720 pixels at 60 fps.
- A 1U rack-mountable CODEC, operating at connection speeds up to 6 Mbit/s over H.323 and SIP.
- H.261, H.263, H.263+, and H.264 video coding.
- Premium Resolution option provides a wide range of resolutions including HD w1080p (1920x1080), HD w720p (1280x720) and w448p (768x448).
- G.711, G.722, G.722.1, G.728 and MPEG4 AAC-LD audio coding.
- Separate pan and tilt HD camera with 1920 x 1080 native resolution @ 60 frames per second.
- Analogue stereo input for connection of DVD/VCR or PC.
- Analogue stereo output.
- Digital audio output (SPDIF).
- Digital audio carried on HDMI input and output connections.
- Supports AES encryption.
- Far end camera control.
- H.239 second video channel up to WXGAp resolution @ 30 frames per second in point to point and MultiSite calls.
- Four site MultiSite (local + 3 remote sites)
- A comprehensive range of resolutions supported by the analogue VGA and digital PC inputs (full details are included in the Hardware Description)
- Extended Display Identification Data (EDID) is supported
- LDAP global directory support

B: SETUP PROCEDURE

Setting up the C40 system was straightforward. The CODEC unit may be rack mounted in an under monitor cabinet or positioned adjacent to the monitor. The HD camera may be positioned either on top or below a picture monitor. A microphone and an infrared remote control complete the basic package.

The connections for basic operation were clearly illustrated on the installation reference card and in the documentation available on the web and involved:

- Mounting the camera adjacent to the monitor
- Connecting the separate HDMI-HDMI video and DSUB-RJ45 control cables between the camera and the CODEC

- Connecting the CODEC to the monitor/s with the supplied HDMI-HDMI and DVI-HDMI cables
- Cabling the microphone to the CODEC.
- Establishing an Ethernet IP network connection through the single RJ45-RJ45 cable.
- Connecting power to the unit.

System set up was conveniently configured through the “on-screen” menus via the hand held remote control. IP address, IP Gateway, Subnet mask and Gatekeeper address were all entered through these menus.

Approximate set-up time: 20 minutes

Documentation quality: The supplied installation card and web sourced Administrators guide were both concise and easy to follow.

C: Hardware Description

General

This IP only CODEC with a single auto switching 10/100/1000 Mbit Ethernet connection delivered an image resolution up to 1080p at a maximum bandwidth of 6 Mbit/s. The equipment submitted for evaluation had Version 3.1.0 software installed with all available options i.e. Dual Display, Premium Resolution, Natural Presenter Package and internal MCU. A rack mount kit is supplied with the system. The CODEC is nearly silent in operation as no cooling fan is fitted but as a consequence the case becomes very hot as it is acting as a heat sink. To enable good heat dissipation adequate air flow around the unit would be necessary.

The CODEC offers single or dual monitor mode of operation including two high definition outputs that support up to w1080p widescreen. The main HDMI output connection carries audio signals but alternatively there are separate analogue and digital audio outputs available.

On some manufacturers’ display monitors the CODEC HDMI main monitor output exhibits a degree of “over-scan” and excludes some of the image, including the system menu. Version 3 software provides an adjustment which scales the main CODEC output slightly to overcome this problem. Over-scan corrections of “High, Medium or None” are available. The medium setting resolved the issues experienced with Dell 2709Wb monitors highlighted in earlier evaluations of the C60 and C20 CODEC’s.

The C40 system supports thirteen video resolutions including:

- The basic CIF format resolution of 352x288 pixels
- w288p at 512x288
- Optimal Resolution w448p at 768x448
- High Definition (HD) w720p 1280x720 30 fps
- High Definition (HD) w720p 1280x720 60 fps*
- High Definition (HD) w1080p 1920x1080 30 fps*

* Requires the Premium Resolution option

The image resolution is also dependent on the call connection bandwidth:

Connection Bandwidth	Resolution
128 Kbit/s	w288p
384 Kbit/s	w288p
768 Kbit/s	w448p
1 Mbit/s	w720p 30 fps
2 Mbit/s	w720p 30 fps
4 Mbit/s	w720p 60 fps
6 Mbit/s	w720p 60 fps

At higher bandwidths the system administrator has the option to select the thresholds for 1080p 30 fps or 720p 60 fps. We chose the 720p 60 fps setting during the tests due to its better motion rendition.

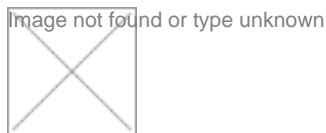
The resolutions above are negotiated when the CODEC input is optimised for “motion”, when the input is optimised for “sharpness” the negotiated resolution is 1920x1080 irrespective of connection bandwidth.

The TC3.0 (and above) software introduced “Optimal Definition Profiles” that refines the choice of bandwidth. This allows the administrator to match the bandwidth to the video resolutions in three steps; “Normal,” “Medium” and “High.” The “Normal” profile is the default setting for a typical office scene. The “Medium” profile requires more attention to the lighting. The “High” profile is intended for dedicated video conferencing rooms where the lighting has been optimised to produce excellent video images. The table below shows how the image resolution is dependent on the call connection bandwidth and the “Optimal Definition Profile.”

30 fps	w288p30	w488p30	w576p30	w720p30	w1080p30
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NORMAL	256 kbit/s	512 kbit/s	768 kbit/s	1152 kbit/s	2560 kbit/s
MEDIUM	128 kbit/s	384 kbit/s	512 kbit/s	768 kbit/s	1929 kbit/s
HIGH	128 kbit/s	265 kbit/s	512 kbit/s	768 kbit/s	1472 kbit/s
60 fps	w288p60	w488p60	w576p60	w720p60	
NORMAL	512 kbit/s	1152 kbit/s	1472 kbit/s	2240 kbit/s	
MEDIUM	384 kbit/s	768 kbit/s	1152 kbit/s	1472 kbit/s	
HIGH	256 kbit/s	512 kbit/s	768 kbit/s	1152 kbit/s	

In addition to the traditional Picture in Picture (PIP) display format, the CODEC also supports Picture outside Picture (POP). This allows both near and far end images to be displayed simultaneously on a single picture monitor.



Full screen of the far end image with near image Picture in Picture (PIP)



Large far image, small near image Picture outside Picture (POP)

POP is particularly useful when a single large screen display device such as a plasma/LCD panel or video/data protector is used.

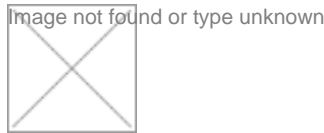
In single image mode the “layout-button” on the remote control can select these displays:

- Full screen of the far end image with near image PIP
- Large far image, small near image POP

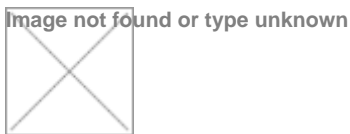
Positioning the POP images vertically rather than side by side enables both images to be displayed wide screen while retaining the image aspect ratio.

During H.239 conferences in single display mode the remote control layout button selects various combinations of screen layout:

- Full screen of the presentation image with near image PIP
- Large presentation image, small near and far images
- Medium presentation and far images, small near image
- Large far image, small near and presentation images



Large presentation image, small near and far images



Medium presentation and far images, small near image



Large far image, small near and presentation images

In Dual monitor mode without presentation material the monitors display:

	Layout 1	Layout 2
Main monitor	Far image	Far image with near image PIP
Second monitor	Near image	Blank

When H.239 presentation material is either transmitted or received the layout button determines how the presentation image is displayed on the second monitor.

Several main monitor screen layout are possible:

- Full screen of the far image
- Full screen of the far image with near image PIP
- Large far image, small near image

Image not found or type unknown



Large far image, small near image

The precision 1080p High Definition (HD) camera features pan, tilt and zoom, functions. When ceiling mounted, (upside down) the camera image automatically switches to the correct orientation. The camera unit includes a Kensington lock slot for increased security. When multiple cameras are in use, for convenience the control signal cables may be daisy-chained between cameras, but as the CODEC is only capable of powering the first camera all the other cameras will require external power supplies. The lens offers a wide horizontal viewing angle of 72 degrees and includes a lens hood to prevent 'flare'. The camera has a native resolution of 1920 x 1080 pixels at 60 frames per second. Five metre long HDMI-HDMI camera video and control cables are supplied. Remote camera control is supported.

The camera was silent in operation, but the auto focus sometimes became disorientated and locked in an out of focus position. The camera then had to be moved to enable the auto focus to re-engage, this was particularly evident at low light levels and when the lens was zoomed in.

The C40 CODEC has four video inputs: 2 HDMI, 1 DVI and 1-Y/C but only three of these are available for user selection as neither the DVI nor Y/C inputs are available simultaneously. If four inputs are a necessity then it is possible to reconfigure CODEC image source 3 by using the Administrator settings via the remote control. This is not a trivial task and could exceed the skills of many users. Alternatively if a room control system is available this may be used to automatically reconfigure image source 3 within the CODEC to match the source selected by the user on the touch panel, a much simpler solution.

The DVI input may be manually set to the following signal formats:

- Analogue component Y Pb Pr
- Analogue RGB
- Digital

Alternatively the CODEC will auto detect the type of signal.

High Definition Content Protection (HDCP) is not supported on either the HDMI or DVI inputs

A PC may be directly connected to the CODEC via the DVI interface, the following resolutions and frame rates are supported:

Using the RGB VGA PC input

1920 x 1080 @ 60 Hz	(1080p)
1280 x 720 @ 60 Hz	(720p)
1600 x 1200 @ 60 Hz	(UXGA)

1280 x 1024 @ 60, 75 Hz	(SXGA)
1280 x 960 @ 60 Hz	
1024 x 768 @ 60, 70, 75, 85 Hz	(XGA)
1920 x 1200 @ 50 Hz	(WUXGA)
1680 x 1050 @ 60 Hz	(WSXGA+)
1440 x 900 @ 60 Hz	(WXGA+)
1280 x 800 @ 60 Hz	(WXGA)
1280 x 768 @ 60 Hz	(WXGA)

Using the Digital PC input

1920 x 1080 @ 60, 59.94 Hz	(1080p60)
1920 x 1080 @ 50 Hz	(1080p50)
1920 x 1080 @ 30, 29.97 Hz	(1080p30)
1920 x 1080 @ 25 Hz	(1080p25)
1920 x 1080 @ 24, 23.97 Hz	(1080p24)
1280 x 720 @ 60, 59.94 Hz	(720p60)
1280 x 720 @ 50 Hz	(720p50)
720 x 480 @ 60, 59.94 Hz	(480p60)
640 x 480 @ 60 Hz	(480p60)
1600 x 1200 @ 50, 60 Hz	(UXGA)
1280 x 1024 @ 60, 75 Hz	(SXGA)
1024 x 768 @ 60, 70, 75, 85 Hz	(XGA)
800 x 600 @ 56, 60, 72, 75, 85 Hz	(SVGA)
1920 x 1200 @ 50, 60 Hz	(WUXGA)
1680 x 1050 @ 60 Hz	(WSXGA+)
1440 X 900 @ 60 Hz	(WXGA+)
1280 x 768 @ 60 Hz	(WXGA)

Although both 50 and 60 frames per second signals are supported on the Digital PC input only 30 frames per second is transmitted.

Using the Analog (YPbPr) input:

- 1920 x 1080 @ 60 Hz (1080p60)
- 1920 x 1080 @ 50 Hz (1080p50)
- 1920 x 1080 @ 30 Hz (1080p30)
- 1920 x 1080 @ 25 Hz (1080p25)
- 1280 x 720 @ 60 Hz (720p60)
- 1280 x 720 @ 50 Hz (720p50)
- 1280 x 720 @ 30 Hz (720p30)
- 720 x 576 @ 50 Hz (576p50)
- 720 x 480 @ 60 Hz (w480p60)

Extended Display Identification Data (EDID) is also supported on the DVI CODEC input when it is set to Digital.

H.239 dual video coding provides a second unidirectional video channel during H.323 calls, but without a second audio channel. The bandwidth is shared between the presentation channel and the main video, the bandwidth allocation between channels is user configurable. Thus presentation material from a camera and material from a PC or VCR could be transmitted simultaneously and displayed on two monitors at the remote site. In calls between C40 systems it was possible to transmit two simultaneous high resolution full frame rate images, the main channel at 1280x720 60fps and the presentation channel at 1280x720 30fps.

Depending on the type of material being transmitted the user may choose to prioritise either motion or resolution. If “motion” is chosen to preserve the integrity of moving sequences then as the call bandwidth is reduced, to maintain reasonable rendition of movement (i.e. a high frame rate) the resolution is reduced accordingly. The table illustrates this:

Main Channel Only		Main plus Presentation		Main plus Presentation		
Call Bandwidth	Main set to Motion	Main set to Sharpness	Main set to Motion	Presentation set to Motion	Main set to Motion	Presentation set to Sharpness

6Mbit/s	1280x720	1920x1080	1280x720	1280x720	1280x720	1280x720
4Mbit/s	1280x720	1920x1080	1280x720	1280x720	1280x720	1280x720
2Mbit/s	1280x720	1920x1080	1024x576	1024x576	1024x576	1280x720
1Mbit/s	1280x720	1920x1080	768x448	768x448	768x448	1280x720
768 kbit/s	768x448	1920x1080	512x288	512x288	512x288	1280x720
384 kbit/s	512x288	1920x1080	512x288	512x288	512x288	1280x720
128 kbit/s	512x288	1920x1080	176x144	176x144	176x144	1280x720

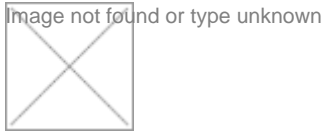
Several audio formats are provided by the C40 CODEC. Tandberg has implemented the ITU standard MPEG-4 AAC-LD, giving 20 KHz analogue audio with low latency/delay and either 64Kb/s or 128Kb/s bandwidth.

Industry standard XLR and RCA connectors allow for straightforward integration with microphones, VCRs/DVDs and PC audio. Each XLR audio input includes a dedicated echo canceller to optimise the systems audio performance. Analogue stereo audio is available via two RCA-Phono connectors. Digital stereo may also be obtained from the SPDIF output connector by using additional optional audio equipment and stereo speakers. The CODEC's main audio output (RCA connector) may be switched between analogue mono, analogue stereo left and the SPDIF digital signal while digital stereo audio is also available on the main HDMI output.

Encryption is available at all connection speeds through Advanced Encryption Standard (AES) with a 128 bit session key.

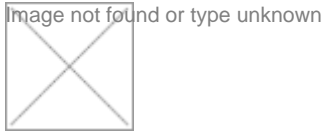
D: SYSTEM OPERATION

The system may be operated locally either from a remote control or via a room control system. The on-screen menus are logical and easy to follow. The system may also be remotely configured via a password protected web browser from a network connected PC, however this web connection provides very limited dial control and no web snapshot images are available for system monitoring.



Web Interface Screen Shots

A separate downloadable Audio Console web application is also available to assist in advanced configuration of the C40 audio.



Audio Console

An H.239 connection is initiated and terminated through the remote control via the “on-screen” graphical interface. The main camera normally occupies the main video channel while the second (or presentation) channel can be any selected source. Alternatively any source may also be selected for transmission via the main video channel. At the remote site the two images may either be viewed on two separate monitors or using picture outside picture POP displayed on a single large screen.

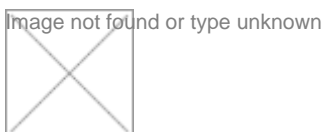
The C40 remote control includes a single “Presentation Source” button:

- Pressing this button for a short period selects the “favourite” (user defined) presentation source and opens the H.239 channel.
- Pressing the button again for a short period reselects the main camera
- Pressing and holding down for a longer period displays a sub-menu, the appropriate source selection is then enabled through the cursor keys and ? menu button.



Tandberg Remote Control

Five context sensitive soft keys are located at the top of the remote control. The function of these keys is indicated by on-screen menus which appear when the soft key functions are available. The text within these on-screen soft keys was fairly small and required a largish image for legibility so care is required in selection of screen size.



Soft Key Menus

The system takes a significant period to boot up from cold (nearly two minutes), during this time there is no on-screen indication that the system is booting up and the user may think that the system is inoperative. When not in a call the system automatically goes into sleep mode after a selectable period of time, it can also be put into standby mode via the remote control. An incoming call or movement of the remote control (picking it up), will return the system to active mode.

The system information menu displayed call status data including connection speed, compression protocols and packet loss.

Optional MCU

An optional four site MCU supports up to three remote sites and the host C40 MCU CODEC. The maximum combined conference bandwidth of 10 Mbit/s will provide resolutions of up to w576p at 30 frames per second.

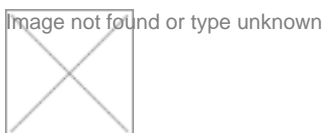
Controlling an MCU conference is a simple procedure:

1. Select the "Connect" button during a call.
2. Enter the number of the additional site into the call menu or select the site from the directory or the recent call list.
3. Press the "OK" button.
4. The additional site will then be connected to the conference.

Individual connections or all connections may be disconnected using the graphic interface.

The three remote sites only receive a continuous presence split screen display but the local MCU CODEC offers several layout options. In single display mode with no presentation material transmitted or received these are:

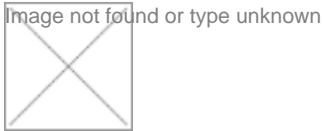
- Remote sites equal size with local PIP
- Large voice switched current speaker image with small images of other sites
- Voice switched full screen image of current speaker with local PIP



Remote sites equal size with local PIP



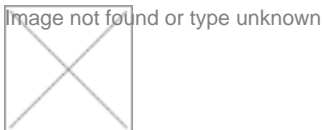
Large voice-switched current speaker image with small images of other sites



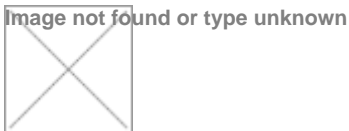
Voice-switched full screen image of current speaker with local PIP

When presentation material is transmitted or received the available layouts include:

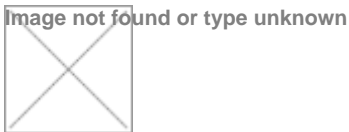
- Full Screen presentation with local PIP
- Large presentation image with small images of other sites
- Large voice switched current speaker image with small images of other sites and the presentation



Full Screen presentation with local PIP



Large presentation image with small images of remote sites



Large voice switched current speaker image with small images of remote sites and presentation

System Operation Problems Encountered

In the absence of a Tandberg supplied cable or adapter for the DVI input to connect an analogue Y Pb Pr signal we attempted to use a standard component to DVI cable. Unfortunately this was not successful using auto signal selection or forcing the input to analogue component.

We were unable to successfully connect a 1920 x 1080 @ 60 fps (1080p 60) signal input to the CODEC.

E: VIDEO TESTS SUMMARY

The C40 CODEC's were capable of producing excellent pictures. At 720p resolution and 60 frames per second the HD camera signals were impressive. Full motion high resolution video material played from a PC and transmitted via the main channel was also very good. At 1080p 30 frames per second however the image movement appeared to stutter slightly on motion. The ability of the system at high bandwidths to transmit two video images simultaneously at high resolution with full frame rate was first class. The high definition camera coped well with difficult lighting conditions and the inclusion of a lens hood certainly improved the images when compared to earlier

versions. The camera was silent in operation, but the auto focus sometimes became confused and locked out of focus. The camera then had to be moved to enable the auto focus to re-engage, this was particularly evident at low light levels and when the lens was zoomed in.

F: AUDIO TESTS SUMMARY

Setup The echo canceller is fully automatic in operation. The quality of echo cancellation and doubletalk from the system was very good.

	Lecture Theatre	Room
Audio levels adequate? (Yes/no)	Not tested	Yes
Audio quality acceptable? (Yes/no)	Not tested	Yes
Echo cancellation acceptable? (Yes/no)	Not tested	Yes
Quality of double talk	Not tested	Very Good

G: DATA TESTS

The Tandberg C40 does not support T.120 in-band data communications between CODECs . A PC may be directly connected to the CODEC via the DVI-I interface.

H: CONNECTIVITY

H.323

There were no problems connecting between the Tandberg C40 units at Edinburgh and Newcastle over IP.

Time to Connect with encryption On

H.323

All speeds 4 seconds

During an H.323 call the network connection was removed and reconnected after a specific time.

5 Seconds	Picture froze – picture goes to black - successful reconnection, call does not terminate
15 Seconds	Picture froze – picture goes to black - successful reconnection, call does not terminate
30 Seconds	Picture froze – picture goes to black - successful reconnection, call does not terminate
55 Seconds	Picture froze – picture goes to black - call terminates

Connectivity with Other Machines (models listed with comments)

H.323

Successful connections were made in each direction with the following CODECs, where the system supported H.239 presentation material was also shared.

CODEC	Call Bandwidth	Resolution Transmitted by the C40	Resolution Received by the C40
Polycom® VS4000	2 Mbit/s	CIF	CIF
Tandberg 6000 Classic (B version hardware)	2 Mbit/s	CIF	CIF
Polycom® VSX8000	2 Mbit/s	CIF	CIF
Polycom® PVX	2 Mbit/s	w228p	QVGA

Note: We were unable to transmit H.239 from a Polycom PVX to the C40.			
Tandberg 990 MXP Connectivity with JANET Videoconferencing Switching Service (JVCSS)	2 Mbit/s	w720p	w448p
H.323 Tandberg Edge 95	2 Mbit/s	w720p	w720p
The Tandberg C40 connected successfully to the JVCSS MGC MCU negotiating H.263 Video, CIF resolution and G.722 audio with video and audio in both directions.			
Tandberg 6000 MXP The received audio level was measured as peaking to -4dBm.	4 Mbit/s	w720p	w720p
The Tandberg C40 connected successfully to the JVCSS Codian MCU negotiating H.264 Video, 720p resolution and AAC-LD audio with video and audio in both directions. However the incoming video to the C40 was at times very blocky.	4 Mbit/s	1024 x 576	1024 x 576
The received audio level was measured as peaking to -2dBm.	6 Mbit/s	w720p	w720p
Procedure for making a call			
Lifesize Room 200	6 Mbit/s	w720p	w720p
<ol style="list-style-type: none"> 1. Press Connect button on the remote control 2. Input IP address 3. Press the Connect button 			

Or use the local contacts directory available from the user interface Phone Book or the Recent Calls lists.

Appendix 1 Detailed Physical Information

Dimensions: (w x h x d) 44 x 4.4 x 28 cm

Video Inputs	Signal Type	Connector
Main camera	Digital	HDMI
Second camera	Digital	HDMI
Auxiliary input		
PC	Analogue RGB	DVI
	Analogue Y Pb Pr	
Auxiliary input	Digital	

VCR/DVD

Composite/YC

2 x BNC

Auxiliary input

* The DVI and Composite-Y/C inputs are not available simultaneously.

The DVI input may be manually set to the following signal formats:

- Analogue Component Y Pb Pr
- Analogue RGB
- Digital

Alternatively the CODEC will auto detect between them.

The HDMI and DVI inputs do not support High Definition Content Protection (HDCP)

During the evaluation we were unable to successfully input analogue component Y Pb Pr into the CODEC via the DVI input.

Video Outputs	Signal Type	Connector
Main monitor	Digital	HDMI*
Second monitor**	Digital	DVI

Note: *The Main Monitor HDMI output includes embedded stereo audio.

** The second monitor output requires the Dual Display Option.

Audio Inputs	Level	Connector
Microphone/Line 1	Microphone or Line	XLR
Microphone/Line 2	Microphone or Line	XLR

Mono Auxiliary input or VCR/DVD/PC stereo left	Line	RCA Phono
Mono Auxiliary input or VCR/DVD stereo right	Line	RCA Phono
HDMI 2	Digital	HDMI

Echo cancellation is only available on the microphone/line XLR-inputs. These inputs may be set to either line or microphone level.

Audio Outputs	Level	Connector
Main output	Digital	HDMI
Main output left		
Main output mono	Line/Digital	RCA Phono
Digital SPDIF		
Main output right		
Main output mono	Line	RCA Phono

Data

1. 1 off LAN 10/100 Mbits/s Ethernet connection (RJ45)
2. 2 off RS232 data connection (9 pin D type)
3. 1 off USB connector

Cables Supplied

As the systems supplied for evaluation were demonstration units we are unable to confirm which cables would be supplied with a purchased system.

Mobility

The Tandberg C40 is designed to be installed in a rack but is also portable, lightweight and can be moved easily. To establish a connection, each new location will need the

local IP address to be re-entered into the configuration menu or its DHCP registration amended.

Appendix 2 Detailed Video Tests

The C40 CODEC does not permit selection of the video or audio protocols, so we were only able to carry out detailed tests at the H.264 video coding. Similarly the audio protocol AAC-LD was automatically negotiated to 64K at call speed 384Kbit/s and to 128K at call speeds above 384Kbit/s

Objective Video Tests: Signal measurements

1. 75% EBU bars
2. Grey scale

Subjective Video Impairments Tested:

Lip synchronisation	LS
Block distortion (tiling)	BLK
Blurring (reduced edge sharpness and spatial detail)	BLR
Colour errors	CLR
Jerkiness (distortion of smooth motion)	JRK
Object persistence (lagging images from previous frames as faded or outline images)	OP
Scene cut response (i.e. time to build up the new image)	SCR

Scale of impairments:

Imperceptible	1
Perceptible	2

Slightly annoying	3
Annoying	4
Very annoying	5

Test DVD:

<u>Signals recorded</u>	<u>Time on tape</u>
1. EBU colour bars	1min 30secs
2. Grey scale	1.40 - 2.40
3. Blue field	2.50 - 3.50
4. Medium close up female face, still	4.00 - 5.00
5. Medium close up female face, talking	5.10 - 6.10
6. Close up face, nodding	6.20 - 7.20
7. Close up face, shaking head side to side	7.30 - 8.30
8. Zoom out slowly to wide angle three people	8.40 - 9.40
9. Zoom in quickly to close up of centre person	9.50 - 10.50
10. Turntable speeds: 1,2,3 and 4	11.00 - 15.30
11. Football sequence	15.40 - 16.40
12. Zoom in and out of "A to Z" map	16.50 - 17.50
13. Text legibility, font sizes 20 to 12 pt	20.30 - 20.50
14. Cut tests, scenes various with camera movements	21.00 - 22.00
15. Man teaching at whiteboard	22.10 - 23.23

(Insert 75% EBU bars at local site, measure at remote site)

Test 1c (H264): Colour bar test

Any waveform aberrations? None

Subjective

<u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	1	1	1	1	1
CLR	1	1	1	1	1

Test 2c (H.264): Grey scale

Any waveform aberrations? None

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	1	1	1	1	1
CLR	1	1	1	1	1

Test 3c (H.264): Blue screen

Any waveform aberrations? None

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
CLR	1	1	1	1	1

Test 4c (H.264): Medium close up female (still)

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1

BLR	2	2	2	1	1
CLR	1	1	1	1	1

Test 5c (H.264): Medium close up female (talking)

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
LS	1	1	1	1	1
BLK	2	1	1	1	1
BLR	2	2	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 6c (H.264): Close up head (nodding)

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	2	1	1	1	1
BLR	2	2	1	1	1
CLR	1	1	1	1	1

JRK	1	1	1	1	1
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Test 7c (H.264): Close up head (shaking side to side)

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	3	2	1	1	1
BLR	3	2	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 8c (H.264): Medium close up, slow zoom out to three shot

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	2	2	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 9c (H.264): Three shot, quick zoom in to medium close up centre person

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	2	2	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 10c (H.264): Turntable speed 1

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	1	1	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 10f (H.264): Turntable speed 2

Subjective

Impairments H.323

384 kbit/s

768 kbit/s

2 Mbit/s

4 Mbit/s

6 Mbit/s

BLK	1	1	1	1	1
BLR	1	1	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 10i (H.264): Turntable speed 3

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	2	2	2	2	2
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 10I (H.264): Turntable speed 4

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
BLK	1	1	1	1	1
BLR	3	3	3	3	3

CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 11c (H.264): Football sequence

<u>Subjective</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
<u>Impairments H.323</u>					
BLK	4	3	2	2	1
BLR	4	3	2	2	2
CLR	2	2	2	2	2
JRK	1	1	1	1	1

Test 12c (H.264): Zoom in and zoom out of 'A to Z' map

<u>Subjective</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
<u>Impairments H.323</u>					
BLK	4	2	2	1	1
BLR	4	2	2	2	2
CLR	1	1	1	1	1
JRK	1	1	1	1	2

Test 13c (H.264): Text legibility (% of screen height) at viewing distance approx.

5x screen diagonal

<u>Legibility H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
20 pt (3.5%)	Yes	Yes	Yes	Yes	Yes
16 pt (3%)	Yes	Yes	Yes	Yes	Yes
14 pt (2.5%)	No	Yes	Yes	Yes	Yes
12 pt (2.3%)	No	No	No	No	No

Test 14c (H.264): Video with several vision cuts

<u>Subjective</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
<u>Impairments H.323</u>					
BLK	3	3	2	1	1
BLR	3	3	2	1	1
CLR	1	1	1	1	1
OP	1	1	1	1	1
SCR	3	3	2	2	2
JRK	1	1	1	1	1

Test 15c (H.264): Man teaching with flip chart

<u>Subjective</u> <u>Impairments H.323</u>	<u>384 kbit/s</u>	<u>768 kbit/s</u>	<u>2 Mbit/s</u>	<u>4 Mbit/s</u>	<u>6 Mbit/s</u>
LS	1	1	1	1	1
BLK	2	2	1	1	1
BLR	2	1	1	1	1
CLR	1	1	1	1	1
JRK	1	1	1	1	1

Test 16: Playback from a domestic VHS videotape player

Is picture stable?

Yes

Appendix 3 Detailed Audio Tests

Audio protocols are automatic so we were only able to carry out detailed tests on G.722.1 and AAC-LD audio coding.

Test 1: Frequency response (-3 dB)

(Insert -6 dB signal at local site, measure at remote site)

G.722.1 AAC-LD, 64 and 128K

7.00 KHz

20.0 KHz

Test 2: Headroom (measured on AAC-LD signal coding)

Insert increasing amplitude 1 KHz tone at local site, monitor for overload distortion at remote site

Overload occurs at: +18dBm

Test 3: Audio level

(Insert -6dBm 1KHz tone at local site, monitor received level at remote site.)

As the audio output level is affected by the volume control this test was not carried out.

Test 4: Echo Cancellation

Setup The echo canceller is fully automatic in operation. The quality of echo cancellation and doubletalk from the system was very good.

	Lecture Theatre	Room
Audio levels adequate? (Yes/no)	Not tested	Yes
Audio quality acceptable? (Yes/no)	Not tested	Yes
Echo cancellation acceptable? (Yes/no)	Not tested	Yes
Quality of double talk	Not tested	Very Good

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