Technical Specifications: Structured Cabling System (With Shielded Cat 5 Cables)

1. General Requirements for a Structured Cabling System

1. Ease of Expansion:
The cabling system shall offer an infrastructure which avoids the need to install new cables or to reroute existing cables in the case of relocations or expansions (staff or equipment).

2. Ease of Installation and Maintainance
The cabling system must be easy to install, manage and maintain and shall enable visually (e.g. Colour Coding at the outlet, coloured strain relief to distinguish between minimum 4 different Applications. (Voice, Data, Building Services ....)

3. Upgradability
The structured Cabling System shall offer a long term communication infrastructure which supports future growth requirements and the increasing need for higher bandwidth.

2. Cabling System Requirements

2.1 Structured Cabling System
A structured cabling system consists out of the following subsystems:

A) Work area cabling system
B) Horizontal Cabling System
C) Building (Vertical) Backbone Cabling Subsystem
D) LAN room / Network Centre Subsystem

A) Work Area Cabling
The Work Area cabling connects the Telecommunication Outlet (TO) to the terminal equipment. It consists of work area cables, adapters and / or other transmission electronics.

I.) Work Area Cables (Line Cords)
- All work area cables must consists of a Screened and Foiled Category 5 Patch Cable (S-FTP, 4 Pairs, stranded conductors, conductor size AWG 26) and are connected on both sides to a shielded RJ 45 plug.
- All RJ 45 plugs must be factory assembled and comply to IEC 603.7 / Class A.
- All assembled cables must be 100% short-circuit and continuity tested.
- All Patch cables must comply to Cat 5 Cable Specification (ISO/IEC 11801 / Annex C). The maximum total length of all used flexible cables in one horizontal link shall not exceed 10m. (option: see 3.2)
- The RJ45 plugs shall have a removable, colour coded strain relief sleeve which allows the enduser to distinguish between a minimum of 4 different communication services. Each line cord shall have the option of retrofittable mechanical keying in order to prevent damage caused by incorrectly connected active equipment.

B) Horizontal Cabling Subsystem
The horizontal cabling subsystem extends from the Floor Distributor (FD) to the Telecommunication Outlet (TO). The Subsystem includes the Telecommunication Outlet (TO), the Horizontal Cable and the Floor Distributor (Patch Panel) including the Patch Panel.
I.) Telecommunication Outlet (TO)

- All outlets used for terminating Category 5 FTP / S-FTP cables shall be shielded Category 5 RJ45 type.
- All RJ45 outlets shall meet the transmission characteristics as defined in ISO/IEC 11801.
- Emission Tests shall have been performed and Test results shall be available.
- The RJ45 outlet shall enable a quick and tool-less termination (IDC) of the horizontal cables.
- The RJ45 outlet shall accommodate a large surface cable shield connection.
- The RJ45 outlet shall enable a sufficient cable strain relief mechanism.
- A label on each outlet shall show the termination map according to EIA/TIA 568A and B.
- Each outlet shall have a retrofittable keying system which prevents visually (colour coding) and avoids mechanically, an incorrect connection to active equipment.
- The outlet shall have a labelling window with exchangeable labelling strips.
- Each outlet shall be available in single or dual version.
- Dust Covers for the RJ45 Outlets to prevent contact contamination shall be available.
- The face plates shall be angled for optimum protection of the line cords such that when mounted the lane cords do not extend at a horizontal.
- Each outlet shall allow installation in various environments such as: Wall mounting (flush or surface), Duct mounting (conduits, raceways, raised floors), The face plates shall be modular type to enable interchangeability between optical fibre couplers and RJ45 ports. The Shielded IBM / ACS RJ 45 outlet is recommended.

II.) Horizontal Cable

- All horizontal cables must be Shielded Twisted Pair Cables (FTP or S-FTP).
- All Cables must comply to the international Category 5 cable standards (ISO / IEC 11801) which are listed in Clause 3.1.
- The maximum length of the horizontal cables shall not exceed 90m. (option: see 3.2) All Category 5 Pair cables shall be installed in star topology from the Floor Distributor to the RJ45 outlet.
- The horizontal Cables shall be connected to an RJ45 at both ends. Each cable run shall be continuous without any joints or splices.
- All Category 5 FTP or S-FTP cables must be terminated on both ends. During installation of cables around bends and junctions, the Contractor shall ensure that the minimum bend radius for the Category 5 FTP or S-FTP cables is not violated. For critical environments Fire retardant / halogen-free Cables (LSFROH) according to IEC 332-3C, EN50167) shall be available.

III.) Patch Panels

The patch panel shall be designed for 19” racks with the option of direct wall mounting. The panels shall be modular to enable the intergration of category 5 RJ45 modular jacks or optical fibre connecting Hardware.
The connecting modules of the patch panels shall be preferably available as modular, swivel units to allow access from the front. The minimum connection density for RJ45 patch panels shall be as follows: - 19” 1U: 15 ports, - 19” 2U: 30 ports, - 19” 3U: 48 ports
The minimum connection density for Optical Fibre (ST/SC/E2000, Fibredesk) patch panels shall be as follows: 19” 3U: 72 ports (duplex)
- The RJ45 patch panel shall consist of connection modules which comply to the international Category 5 standards for connectors such as ISO/IEC 11801. The electrical performance must fulfill the requirements as mentioned under part I. (telecommunication outlets) of this specification.
- Each patch panel shall have a labelling window with exchangeable labelling strips.
- The RJ45 jacks shall enable a quick termination technique (IDC) of the horizontal cables without using punch-down-tools.
- The RJ45 outlet shall enable a large surface cable shield termination.
- A label attached to the RJ45 moduls shall show a termination map according to EIA/TIA 568A/B. The shielded RJ45 ports must be connectable to an earthing kit which ensures simple and efficient bonding to the communication earth.
- Each port must have the option of separate or common grounding as required. The earth potential of the shielded cabling system must be insulated from the communication cabinet (4kV) and its PE (power-earth) potentials. The earthing kit ensures a low impedance connection (min. 4mm²) to the communication earth which is connected to the central building earthing point.

Optical fibre cable patch panels (termination units) shall be available as breakout or pigtail version.

IV.) Patch Cables / Jumper Cables

- All Patch cables must consists of a Category 5 Patch Cable (4 pairs, stranded conductor, conductor size: 24AWG or 26AWG) and are connected on both sides to an RJ 45 plug.
- All RJ 45 plugs must be factory assembled and comply to IEC 603.7 / Class B.
- All assembled cables must be 100% short-circuit and continuity tested and marked with a quality stamp.
- All Patch cables must comply to Cat 5 Cable Specification (ISO/IEC 11801) which are listed in Clause 3.1.
- The maximum length for patch cables shall not exceed 5m.
- All RJ45 plugs shall have a removable, colour coded strain relieve sleeve to enable the identification between different communication services.

C) Building (Vertical) Backbone Cabling Subsystem

The Building Backbone Cabling Subsystem extends from the Building Distributor (BD) to the Floor Distributor (FD). The Subsystem includes the Building Backbone cables, the mechanical termination of the building backbone cables and the cross-connect at the building distributor (BD).

I.) Floor Distributor (FD) and Building Distributor (BD)

- Both distributors shall be 19” Racks with the option of direct wall mounting.
- The Distributors shall allow installation of RJ45 Patch Panels (see Clause 2.1, B / III.)
- The Patch Panel shall cater to both voice, data, image and video applications.
- The 19” racks shall allow 50% Space for active equipment or other use.
- IBM /ACS Patch Panels are recommended.

II.) Backbone Cables

There are two options for the backbone cables:
a) Backbone with Copper Cables

The backbone with copper cables consists of Category 5 Cables (4 pairs, solid conductor, 24AWG). To achieve optional category 5 transmission performance it is recommended that only 4 Pair Cables be used. All Cables shall achieve category 5 performance documented in ISO/IEC 11801, Clause 3.1.

b) Backbone with Fibre Optic Cables

- All fiber optic cables shall consist of bundles of 62.5/125 mm multi-mode optical fibers with suitable coating for protection. Each run of cable between two termination points shall be continuous. All fibers must be terminated on both ends. During installation of cables around bends and junctions, the Contractor shall ensure that the minimum bend radius for fiber optic cables is not violated.
- Each fiber in the fiber optic cable shall be buffered with colour-coded PVC for easy identification. The Contractor shall provide all the necessary equipment for the installation of fiber optic cables, such as splices.

D) LAN Room / Network Centre Subsystem

The Lan Room and Network Centre Subsystem includes all the Racks needed to fit the modular Patch Panels and Networking Equipment. The Cabinets / Racks shall meet the following requirements:

- The Racks shall be able to accommodate 19" wide network equipment and patchpanels.
- The Rack shall be used for all Category 5 Voice/Data, Category 3 Voice and Fibre Optic Cable termination.
- The Rack shall have at least twelve (12) 240V, 13A power distribution outlets.
- The Racks shall have metallic bar straps for grounding purpose.
- The height of the rack shall be at least 42 RU (standard rack units).
- The number of Racks in one Room shall be sufficient to meet all cabling requirements.
- In each Rack shall be 50% available space for network equipment.

Interface Voice and Category 5 Cabling:

For Incoming Phone Lines and for the PABX distributor a "VS Standard" module shall be used.

- The Voice module shall offer double jumpering for each outgoing Pair.
- The Voice module shall offer overvoltage protection from the rear of the module.
- The Voice module shall also offer the option for overcurrent protection.
- Additional Protection such as voltage clamping must be provided as an option.
- As an "Interface" between Voice and Category 5 Cabling a Patching System with high density such as "SRV" from R&M shall be used.

3. Technical Requirements for Passive Components

3.1 Category 5 Cable and Connector Specifications

A) Cable Specification:

The horizontal cables (solid conductor) shall meet or exceed the Category 5 performance requirements for Cables as outlined in ISO/IEC DIS 11801. For flexible Category 5 Cables (work area cables and patch cables) which have a stranded conductor, 50% higher Attenuation is allowed.
### Main Limits for Category 5 Cables: (Flexible and horizontal Cables)

<table>
<thead>
<tr>
<th>Frequency [MHz]</th>
<th>Next (min) * Horizontal and Flexible Cables [dB]</th>
<th>Attenuation (max.) Horizontal Cables [dB]</th>
<th>Attenuation (max.) Flexible Cables [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>62</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>4.0</td>
<td>53</td>
<td>4.3</td>
<td>5.2</td>
</tr>
<tr>
<td>8.0</td>
<td>48</td>
<td>5.9</td>
<td>7.1</td>
</tr>
<tr>
<td>10.0</td>
<td>47</td>
<td>6.6</td>
<td>7.9</td>
</tr>
<tr>
<td>16.0</td>
<td>44</td>
<td>8.2</td>
<td>9.8</td>
</tr>
<tr>
<td>20.0</td>
<td>42</td>
<td>9.2</td>
<td>11</td>
</tr>
<tr>
<td>31.25</td>
<td>39</td>
<td>11.8</td>
<td>14.1</td>
</tr>
<tr>
<td>62.5</td>
<td>35</td>
<td>17.1</td>
<td>20.5</td>
</tr>
<tr>
<td>100.0</td>
<td>32</td>
<td>22.0</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Where Next*: Next (f) = NEXT (0.772) - 15 log (F/0.772)

Further all Category 5 Cables must comply to the following limits:
- DC loop resistance < 19.2/100m.
- Nominal Velocity Propagation. NVP > 65c
- Characteristic Impedance between 85W and 115W (1-100MHz).

### B) Connector Specification

All Category 5 Connectors have to comply to the limits in ISO/IEC 11801 / 9.2.4.

### 3.2 Requirements for a Transmission Link:

This section defines the transmission requirements for a Class D Link which is based on section 7 of ISO/IEC 11801.

These are the limits which must be programmed in a Category 5 Field Tester.

### Limits for Class D Link:

<table>
<thead>
<tr>
<th>Frequency [MHz]</th>
<th>Next (Min) [dB]</th>
<th>Attenuation (Max) [dB]</th>
<th>ACR (Min) [dB]</th>
<th>Characteristic Impedance [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>54</td>
<td>2.5</td>
<td>-</td>
<td>85-115</td>
</tr>
<tr>
<td>4.0</td>
<td>45</td>
<td>4.8</td>
<td>40</td>
<td>85-115</td>
</tr>
<tr>
<td>10.0</td>
<td>39</td>
<td>7.5</td>
<td>35</td>
<td>85-115</td>
</tr>
<tr>
<td>16.0</td>
<td>36</td>
<td>9.4</td>
<td>30</td>
<td>85-115</td>
</tr>
<tr>
<td>20.0</td>
<td>35</td>
<td>10.5</td>
<td>28</td>
<td>85-115</td>
</tr>
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<td>31.25</td>
<td>32</td>
<td>13.1</td>
<td>23</td>
<td>85-115</td>
</tr>
<tr>
<td>62.5</td>
<td>27</td>
<td>18.4</td>
<td>13</td>
<td>85-115</td>
</tr>
<tr>
<td>100.0</td>
<td>24</td>
<td>23.2</td>
<td>4</td>
<td>85-115</td>
</tr>
</tbody>
</table>

Further have all Class D Links to comply to the following limits:
- Max Length = 100m
- DC loop resistance < 40W

### 3.2 Option: Exceeding the length of work area cables
Note: With the growing use of “Soft Cabling” whereby longer work area cables are used in work stations, the maximum length of 10m for flexible cables is under review. Because Patch cables (stranded conductor) have higher attenuation values than horizontal cables (solid conductor), the fixed cable length of 90m for horizontal cables must be reduced by this extra amount to maintain equivalent overall attenuation figures. Table 2 shows the required fixed cable reduction for various patch cable increases. This information is given as a guide only. At present work area cable increases are in contravention of ISO/IEC 11801.

<table>
<thead>
<tr>
<th>Case</th>
<th>Flexible Cables (stranded conductor)</th>
<th>Horizontal Cables (solid conductor)</th>
<th>Maximum Length Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10m</td>
<td>90m</td>
<td>100m</td>
</tr>
<tr>
<td>1</td>
<td>15m</td>
<td>82m</td>
<td>97m</td>
</tr>
<tr>
<td>2</td>
<td>20m</td>
<td>75m</td>
<td>95m</td>
</tr>
</tbody>
</table>

3.3 Fibre Optic Cable and Connector Specifications:

Multimode optical fiber is used for the backbone subsystem, as well as providing data connections for selected end-users. The fiber optic cables used shall meet or exceed the performance requirements described in ISO/IEC DIS 11801.

The following multi-mode optical fiber characteristics shall be met:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Core</td>
<td>62.5 ± 3 micron</td>
</tr>
<tr>
<td>Cladding Diameter</td>
<td>125 ± 2 micron</td>
</tr>
<tr>
<td>Attenuation</td>
<td>Max. 3.75 dB/km (850 nm)</td>
</tr>
<tr>
<td></td>
<td>Max. 1.5 dB/km (1300nm)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Min. 160 MHz-km (850 nm)</td>
</tr>
<tr>
<td></td>
<td>Min. 500 MHz-km (1300 nm)</td>
</tr>
<tr>
<td>Core Non-Circularity*</td>
<td>Less than 6%</td>
</tr>
<tr>
<td>Cladding Non-Circularity*</td>
<td>Less than 2%</td>
</tr>
<tr>
<td>Concentricity Error*</td>
<td>Less than 6%</td>
</tr>
<tr>
<td>Primary Coating Material*</td>
<td>UV curable acrylate</td>
</tr>
<tr>
<td>Primary Coating Diameter*</td>
<td>Nom. 250 micron</td>
</tr>
</tbody>
</table>

Where * denotes Not Mandatory

Additional requirements for the fiber optic patch cables and station cables requirements are:

(a) The cables shall be duplex.
(b) Patch and station cables used for patching or connecting of electronic equipment shall meet or exceed the performance requirements described in ISO/IEC DIS 11801.
(c) The cables shall be factory terminated and tested.

For SC fiber optic connectors used to terminate the multi-mode optical fibers: The connectors shall be IEC 874-13 duplex SC fiber optic connectors. All SC fiber optic connectors must be from the same manufacturer as the through connecting adapter.

3.2 Standards and Quality Assurance
The following standards may be used during the design, implementation and end testing of the structured cabling system.


**ANSI/ EIA/TIA 568A/B**: Commercial Building Telecommunications Wiring Standards.

**ANSI/ EIA/TIA 607**: Grounding and Bonding Requirements for Telecommunications in Commercial Buildings

**TSB 67**: Standard for Category 5 Field Testing

4. Acceptance Tests

4.1 General Requirements

a) Requirements for Field Tester
b) Test Setup

4.2 Link Testing with Field Testers

a) Field Tester
All Tests shall be performed with a Category 5 Field Tester / Level II (see TSB 67). Recommended is the Lantek Pro XL 100mhz Tester or Fluke DSP-100 LAN Cable Meter with DSP-SR Smart Remote.

b) Test Setup
It is recommended to test the “Basic Link” as described in TSB 67. Starting from the workstation side of the horizontal link, the following segments are included:
- The test equipment patch cord which is mated to the Cable Tester Remote.
- The horizontal cable from the work area outlet to outlet on the patch panel side.
- The test equipment patch cord which is mated to the Cable Tester Master.

c) Tests
The following Tests shall be performed and reported: (Autotest). The Test limit shall be the Class D Link Limits.
- Wire Map
- NEXT (Both sides)
- Attenuation
- ACR (Both side)
- Characteristic Impedance
d) Test Documentation

The Test Results should include the following minimum information to assist the administration of the cabling system.

- Unique identification of the Link (equal to the Label on the outlet)
- Link configuration tested
- Date / Time of Test
- Name of testing organisation / test person
- Type of tester, model, software version, and serial number
- Standard referenced for test limit

The test documentation shall preferably be available on a spread sheet such as Excel.

e) Control Tests / Customer Acceptance

After final test and documentation the responsible parties shall do a random control check of a number of test results. Each measured control test shall be compared with the documented test results. Only Link Length and Attenuation shall be compared. If there are more than 10% accuracy variations to the documented test results the responsible person who has done the first test and the documentation has to find an explanation. If there is no simple explanation of the mistakes all (100%) the outlets must be retested.