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TECHNICAL REPORT

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Fibre optic interconnecting devices and passive components – Summarising results of round robin on connector end face scratch recognition and verification by automated microscopes

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FOREWORD

IEC TR 63367 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
86B/4492/DTR	86B/4521/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

It is known that contamination and scratches on connector end face can result in degradation of optical performance as described in IEC TR 62627-05. It is important to inspect and clean, when necessary, each connector before mating with another connector to ensure they are fit for function. The visual inspection methods and criteria for fibre optic connectors and fibre-stub transceivers are defined in IEC 61300-3-35. Three different methods can be used for visual inspection: direct view optical microscopy (method A), video microscopy (method B) and automated analysis microscopy (method C). All methods are susceptible to system variability: methods A and B are operator dependent; method C is operator independent but relies on software analysis for measurement results. The uncertainty inherent to imaging equipment, processing methods, and detection software can lead to measurement variability among different brands and even the same types of microscopy. For all methods, the fibre microscopes can be certified for use in either low- and high-resolution applications with a purpose-built certification artefact.

There is industry concern about the veracity of the results of the visual inspection of the same part using different automated inspection equipment and software for method C. The IEC SC 86B task force group on scratch recognition was organized to investigate automated inspection system variability and provide recommendations to improve repeatability and reproducibility of the inspection. The task force group specifically limited its investigation to inspection using method C.

The task force group consisted of the following members (in alphabetical order): Arden, CommScope, Corning, Data Pixel, Exfo, Fibre QA, Fluke Corporation, Sumix, University College of London, and decided to perform this investigation by means of a round robin. The round robin involved inspection systems from multiple vendors in a blind study to determine the baseline performance of the systems with regard to automated scratch detection relative to IEC criteria of pre-selected samples.

This report summarizes the results (data collection and analysis) of end face scratch recognition and verification round robin performed by the following task force contributors (5 fibre inspection system manufactures). The following sequence in which the contributors are listed does not represent the order in which the data is presented in the results section. One contributor provided results from four unique inspection systems, each having their own participant ID (eight ID's in total):

- Data-Pixel;
- Exfo;
- FiberQA;
- Fluke Corporation;
- Sumix.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – SUMMARISING RESULTS OF ROUND ROBIN ON CONNECTOR END FACE SCRATCH RECOGNITION AND VERIFICATION BY AUTOMATED MICROSCOPES

1 Scope

This document summarises the results of a round robin on connector end face scratch recognition and verification by automated microscopes. The prime objectives of the study were:

- determine the amount of variability (repeatability and reproducibility) when different state-of-the-art inspection systems are assessed against IEC 61300-3-35:2015;
- evaluate any system-to-system variation in the quantity of reported scratches;
- provide recommendations to improve the repeatability and reproducibility of fibre optic inspection systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

4 Round robin procedure

The round robin workflow consisted of the following steps.

a) Specimen preparation (see Clause 5): Multimode and single-mode single-fibre and multi-fibre test specimens were produced. An image of each end face was captured by high resolution microscope, attenuation and return loss were measured for each fibre, and end-face geometry was determined to verify that the specimens met the IEC interface requirements.

b) Circulation initiation: Measurement procedure and results template (see Annex A) were developed and approved by the group. The order of participants for specimen circulation was agreed.

c) Measurements: Specimens were circulated among round robin participants. Every participant performed measurements and collected image data according to the agreed procedure.

d) Analysis of results: The results were gathered from all participants. Data analysis was performed, and the synthesis report was composed.

5 Specimen preparation

5.1 General

The round-robin test specimens were fabricated to consider various interface configurations and conditions. Specimens were arranged into both cylindrical ferrule single fibre (1,25 mm zirconia material) and rectangular ferrule multi-fibre types (12-fibre MT with polyphenylene sulphide [PPS] material). Both multimode (50 µm core diameter) and single-mode specimens were produced.

5.2 Multimode specimens

The multimode specimens were further organised into categories that had pristine fibre end-face surface quality, and ones with low-level, light scratches (produced with a 1 µm diamond film) which still meet functional performance criteria. Furthermore, specimens were created with 1 to 3 heavy scratches (produced with a 5 µm diamond suspension), as well as a control without detectable heavy scratches. A summary describing all of the multimode variants is provided in Table 1. A total of twelve multimode single-fibre specimens and twelve multi-fibre specimens (with three specimens per group) were produced. Images for each of the specimens are given in Figure 1 for the single-fibre and Figure 2 for the multi-fibre groups. All images were taken with an end face inspection system utilizing blue-light illumination, an objective having an NA of 0,40 and a magnification of 400 x (see Figure 1 to Figure 4).

Table 1 – Multimode test specimen categorisation

Group identification	Ferrule type	Ferrule material	Light scratches	Heavy scratches
A MM	1,25 mm	Zirconia	No	No
B MM	1,25 mm	Zirconia	No	Yes
C MM	1,25 mm	Zirconia	Yes	No
D MM	1,25 mm	Zirconia	Yes	Yes
E MM	MT (PPS)	PPS	No	No
F MM	MT (PPS)	PPS	No	Yes
G MM	MT (PPS)	PPS	Yes	No
H MM	MT (PPS)	PPS	Yes	Yes

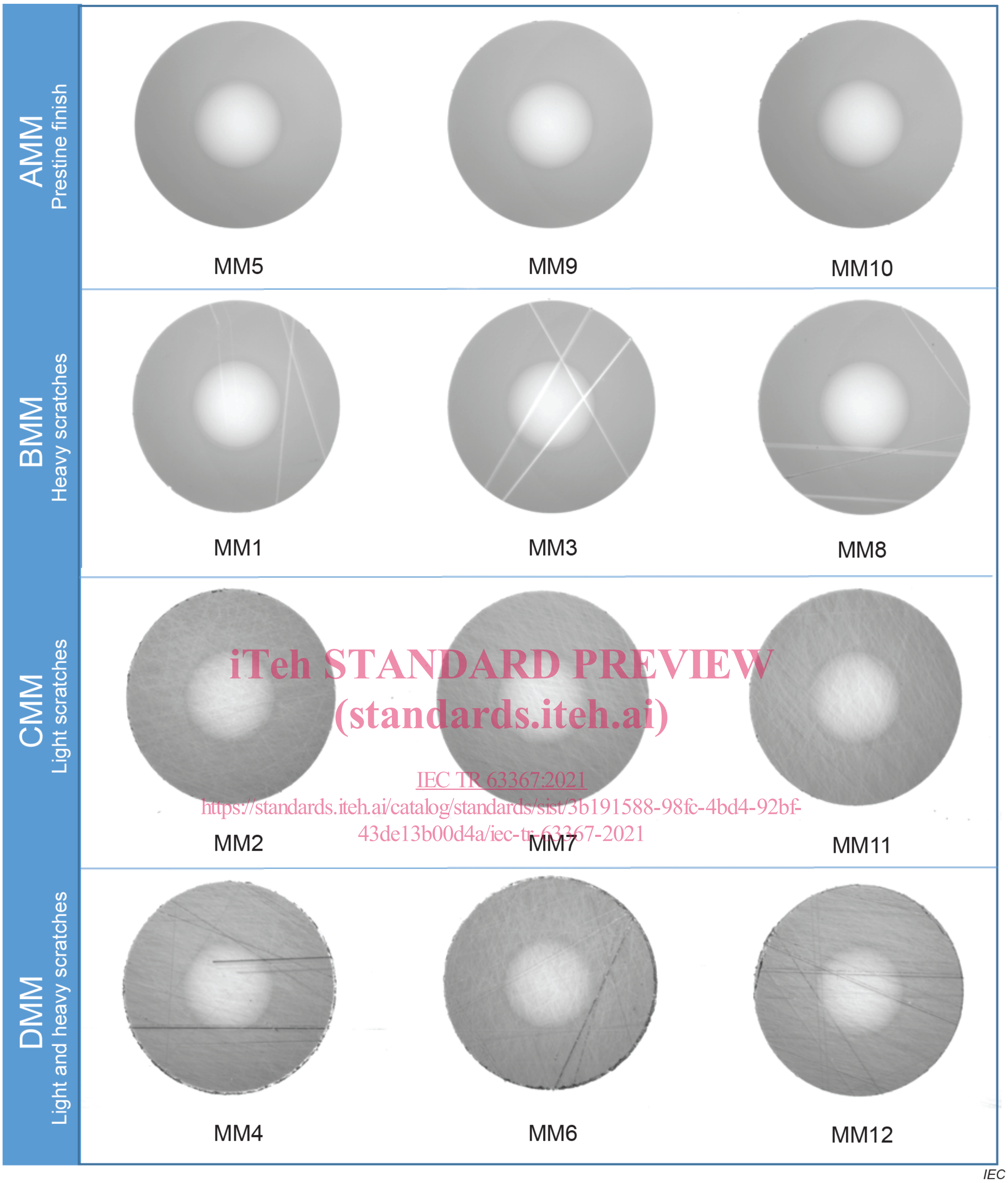

Figure 1 – Multimode single-fibre test specimen grouping

Following visual inspection, the optical performance of each specimen was qualified at 850 nm wavelength and the end-face geometry was determined. The attenuation and return loss were measured per IEC 61300-3-4, insertion method (B), and IEC 61300-3-6, method 1: OCWR, respectively. The results for the single-fibre specimens is reported in Annex B (Table B.1 and Figure B.1 to Figure B.2). End face geometry of the single-fibre specimens was estimated using IEC 61300-3-47 and summarized in Annex B (Table B.2).

The multi-fibre specimens had specific fibres of each ferrule identified for the study. However, attenuation, return loss, and geometry measurements were made across all fibres of the interconnection. A key to identify the fibre specimen inspected during the round robin is provided in Annex B (Figure B.3). Attenuation and return loss values are given in Annex B (Table B.3 to Table B.4 and Figure B.4 to Figure B.5), with the round robin fibre inspection interfaces highlighted. The end-face geometry of the multi-fibre interfaces was determined using IEC 61300-3-30. The relevant geometric parameters, fibre heights, and core dip results are summarised in Annex B (Table B.5 to Table B.7).

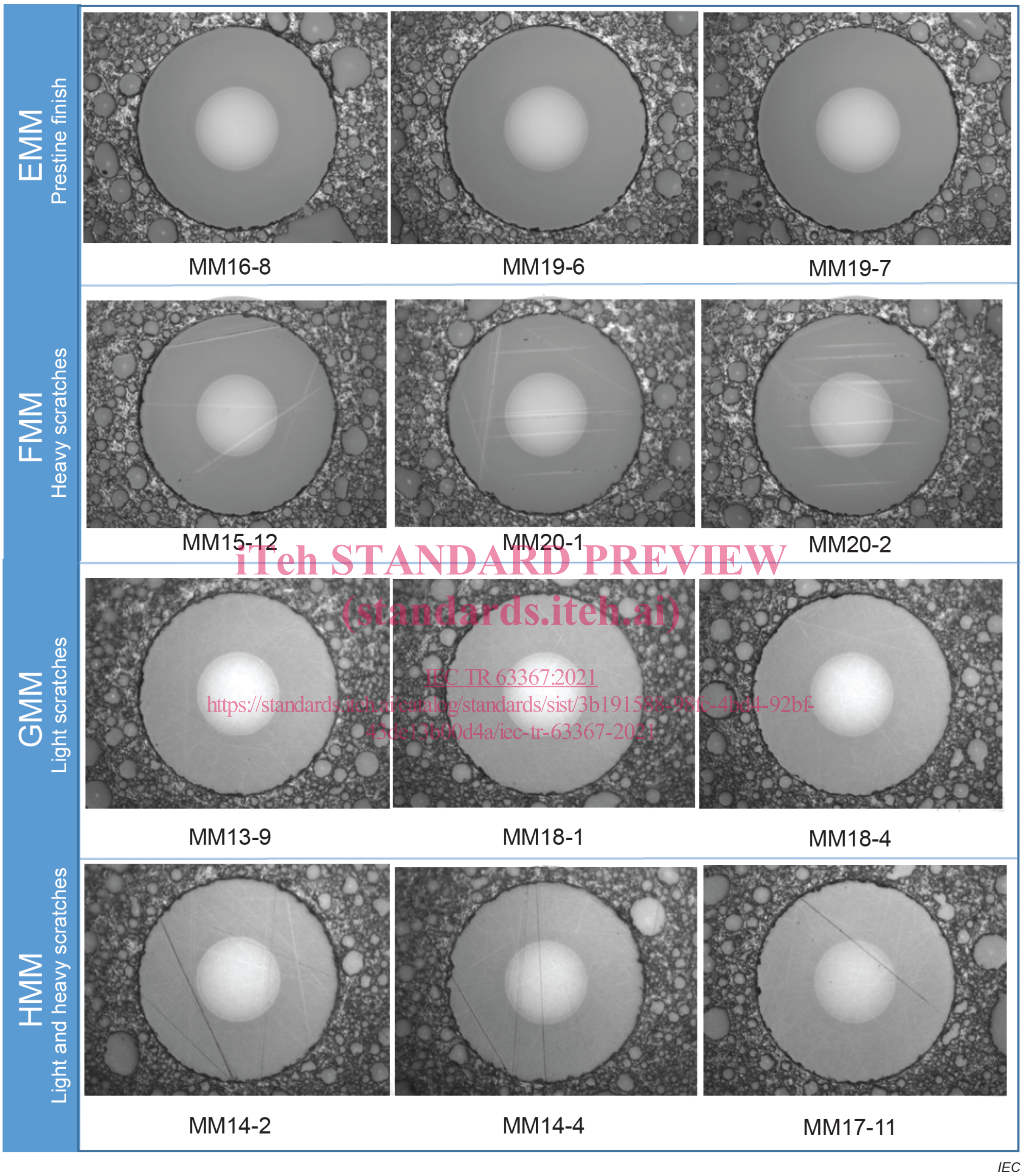

Figure 2 – Multimode multi-fibre test specimen grouping

5.3 Single-mode specimens

The single-mode end faces were binned into categories, which either had 1 to 3 scratches that pass through the fibre core or pass through zone A (without intersecting the core). These scratches were approximately 1 µm width. In addition, a single-mode specimen group without any observable scratches was produced. A summary describing all of the single-mode variants is provided in Table 2. A total of nine single-mode, single-fibre specimens were produced and nine multi-fibre interfaces (with three specimens per group). Images for each of the specimens are given in Figure 3 for single-fibre and Figure 4 for the multi-fibre groups.