REVIEWER'S OPINION OF FINAL THESIS

I. IDENTIFICATION DATA

Thesis name:	**Transmission of Millimeter Waves over Fiber-Optic Infrastructure**
Author's name:	**Bc. Přemysl Michal Vidner**
Type of thesis:	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Electromagnetic Field
Thesis reviewer:	Ing. Jan Látal, Ph.D.
Reviewer's department:	VSB-Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science, Department of Telecommunications, 17. listopadu 15, 708 33 Ostrava-Poruba

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

Evaluation of thesis difficulty of assignment.

Task of this thesis belongs to the more difficult in my opinion. Student must combine knowledge of several fields as well as perform simulations and real measurements related with thesis task. He also must make effort for analysis of millimeter wave transmission possibilities in 5G mobile systems over optical infrastructure (Radio over Fiber, RoF) and free space optical link (free space optics, FSO).

Satisfaction of assignment **fulfilled**

Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.

I have read out carefully given thesis, therefore I can affirm that all assigned task points are fulfilled. In thesis practical part was student dealing with problems connected with millimeter wave transmission in 5G mobile systems over RoF, FSO with aim to test different modulation formats. QAM and QPSK modulation were chosen as these will be used for PDSCH in future 5G networks. This part also includes proper behavior analysis of these modulation formats from the point of view of transmitted frequency band. In simulation part, performed in Optiwave Optisystem software, were studied modulation techniques focusing on suppression of optical carrier.

Method of conception **correct**

Assess that student has chosen correct approach or solution methods.

Student has chosen correct procedures for all individual practical parts as well as for simulation models. This is also evident in overall thesis processing. I have nothing to reproach for this given point. I very much appreciate the fact that the student presents a partial conclusion after each part of his thesis.

Technical level **B - very good.**

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

Professional level of thesis is good. Student is using correctly technical terms connected with given topic and therefore sufficiently prove that he is able to use scientific sources.

Unfortunately, I have to reproach student for a large number of abbreviations that are not included in the list of abbreviations, but are present in the thesis (for example UHF, PTFE, WR42, SMF-28, DRFoF, SDoF, IFoF, SG, E/O, O/E, SA, MUX/DEMUX, BS) or a combination of a description of abbreviations in the thesis (once is explained abbreviated in brackets and then in brackets is an abbreviation and in front of it is its explanation / definition). There are some minor typos in the work, see equation 2.1, but those do not significantly reduce the level of thesis itself.

Formal and language level, scope of thesis **A - excellent.**

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.

Thesis language level is good, with respect that is written by non-native English language user. I did not find any principal mistakes or unclear expressions. The quality of used figures could be better, because student adopt figures with different qualities from used sources. Therefore, sometimes figures quality is on the edge of readability.

Selection of sources, citation correctness **A - excellent.**

Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.

Student correctly used technical literature (mainly scientific articles from IEEE, OSA, etc.) in thesis and used sources are up to date. Author thoughts and original results are sufficiently distinguished from used sources except figures. Student used different citation standards for used sources within the thesis. This should be unified.

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.

The thesis consists of a general overview of the solved problem in the introduction part. In the practical part, the student presents the results obtained from simulations and measurements and then subsequently evaluates appropriately the results. Within the practical part, the student has made many measurements of the properties of modulation techniques, the influence of frequency band vs. EVM and boundary (threshold) values, which are the basis for more sophisticated measurements in future work or possibly in follow-up doctoral thesis. I will allow to myself to say that much of the work done is directly linked to the LTC18008 project named "Transmission of Millimeter Waves over Fiber and Free-space Optical Infrastructures" solved by the thesis supervisor and his team. This is very positive, as the student has been given the opportunity to develop his thesis with relation to scientific knowledge.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

I evaluate handed thesis with classification grade **A - excellent.**

The thesis is sufficiently elaborated and the student demonstrated ability of independent engineering work. Student Vidner worked out a very interesting diploma thesis, which **I recommend for defense** and at the same time, I present possible questions for discussion:

1.) Have you considered the possibility of using software-defined radio (SDR) for your experiments?
2.) Was the possibility of using the Sweep Iteration in Optisystem simulations considered?
3.) During the transmission of the signal through the FSO system, no simulated atmospheric effect was affecting the optical beam, why is that so? Do you think that there would be any fundamental changes of the optical beam if a phenomenon such as rain or temperature turbulence will be simulated?
4.) From what was the RF link length of 3.6 m deduced in real measurements? Is there some direct connection with the utilization of the used components?
5.) On page 23, you are saying, "Then it was coupled to a 1 km SMF-28 fiber path and amplified by a Keopsys KPS-BT2-C-10-LN-SA EDFA (15 dB gain)." but on the block diagram you define 5 km SMF-28. What was the actual length of the optical path made by SMF-28? Does the choice of optical path length have any effect on the transmitted signal?

6.) Please explain more clearly the usage of the variable attenuator in real RoF experiments. How it was set, what was the insertion loss of VOA itself, etc.
7.) What type of dispersion of the variable "D" is discussed in the case of the formula 2.1?
8.) In Fig. 3.9 you specify the length of the FSO link to 2 m and in Fig. 3.20 you define the losses of 4 dB at the same distance. Can be then draw that the loss of FSO link is the same in all other experiments?

Date: **3.6.2019** Signature: