Sudan University of Science and Technology

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DESIGN OF POWER BUDGET AND RISE TIME CALCULATOR FOR OPTICAL FIBER LINK

A thesis submitted in partial fulfillment of the requirements for the degree of M.Sc. in communication engineering

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الآيــةُ

{ وَاضْــرِبْ لَهُــمْ مَثَلًا أَصْــحَابَ الْقَرْيَــةِ إِذْ جَاءَهَــا الْمُرْسَلُونَ* إِذْ أَرْسَلْنَا إِلَيْهِـمُ اثْنَيْـنِ فَكَـذَّبُوهُمَا فَعَزَّزْنَـا بِثَالِثٍ فَقَالُوا إِنَّـا إِلَيْكُـمْ مُرْسَـلُونَ* قَـالُوا مَـا أَنْتُـمْ إِلَّا بَشَرٌ مِثْلُنَا وَمَـا أَنْـزَلَ الرَّحْمَـنُ مِـنْ شَـيْءٍ إِنْ أَنْتُـمْ إِلَّا تَكْذِبُونَ * قَالُوا رَبُّنَـا يَعْلَـمُ إِنَّـا إِلَيْكُـمْ لَمُرْسَـلُون* وَمَـا عَلَيْنَا إِلَّا الْبَلَاغُ الْمُبِينُ }

سورة يس 13 – 17

Dedication

To my mother
To my father
To my family
To my friends
To my neighbors
To the teachers in Sinnar university
To the teachers in Sudan university
To the engineers in National Electricity Corporation

Acknowledgement

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Abstract

The power and rise time budgets are two important approaches in designing fiber optic links. The power budget approach must take into the consideration the power levels across the link. In the rise time approach, the system designer must take into account the temporal response of the system components. In this research a fiber optic link calculator was designed using visual basic 6.0. The calculator was designed to be user friendly and to fulfill all requirements of both approaches. An executable file was made to run the calculator in all computers under all windows operating system that have DLL libraries which comes with the visual basic.

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ميزانية القدرة والارتفاع الزمنى هما طريقتان مهمتـان فى تصميم ربط الألياف الضوئية . طريقـة ميزانيـة القـدرة تأخذ فى الاعتبـار مسـتويات القـدرة خلال الربـط . أمـا فـى طريقة الارتفاع الزمنـى فمصـمم النظـام لابـد أن يأخـذ فـى الحسـبان الاسـتجابة الزمنيـة لمكونـات النظـام . فـى هـذا البحـث قـد صـممت الـة حاسـبة ربـط الأليـاف الضـوئية باسـتخدام لغـة البيسـك المـرئى الاصـدار السـادس . قـد برمجت واجهة صديقة للالة الحاسبة لتلبى متطلبات كل مـن طريقـتى ميزانيـة القـدرة والارتفـاع الزمنـى. وعمـل للالـة الحاسبة ملف تنفيذى ليتـم الاسـتفادة منهـا فـي الحواسـيب تحت بئيات نظـام التشـغيل ونـدوز المختلفـة والـتى لابـد ان تمتلك مكتبات ال DLL التى تأتى مع البيسك المرئى .

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List of Abbreviations and Symbols

LASER Light Amplification by the Stimulated Emission of radiation
SNR Signal to Noise Ratio
SM Single Mode fiber
MM MultiMode fiber
SI Step Index fiber
GRIN Graded Index fiber
LAN Local Area Network
FWHP Full Wave at Half Power
BER Bit Error Rate
LED Light Emitting Diode
APD Avalanche Photodiode
RZ Return to Zero code format
NRZ Non Return to Zero
NA Numerical Aperture
BW.L The bandwidth-length product for modal dispersion in MHz.Km
τ_{Tx} Transmitter's rise time
τ_{Rx} Receiver' rise time
dB Decibel
dBm Decibel relative to 1 miliwatt
m meter
v velocity
s second
f frequency
h Planck's constant
θ_a Acceptance Angle
α index profile parameter
$\propto_{dB}$ attenuation of the fiber per unit length
$D(\lambda)$ chromatic dispersion parameter
M_a safety margin

C_L The connection loss

S_L The splices loss

F_L The fiber loss

P_i The mean input optical power launched into the fiber

P_o is the mean incident optical power required at the receiver

B_T Maximum bit rate in Mbps

B the bandwidth in MHz

L The installation length in Km

λ The operating wave length in nm

$\Delta\lambda$ The spectral width in nm

$D(\lambda)$ The chromatic dispersion parameter in ns/nm.Km

τ_{ele} The rise time of the light wave equipment in ns

The total rise time in ns τ_{sys}

The fiber rise time in ns according to the equipments and bit rate or bandwidth $\tau_{fiber-B}$

τ_{modal} The rise time in ns caused by modal dispersion

τ_{chrom} The chromatic rise time in ns

$\tau_{fiber-dis}$ The fiber rise time in ns according to the dispersion

GN OF POWER BUDGET