

**DEVELOPMENT OF A SOFTWARE PACKAGE FOR  
CALCULATING CURRENT RATING OF MEDIUM  
VOLTAGE POWER CABLES**

**A Thesis presented to  
the department of Electrical Engineering  
University of Moratuwa, Sri Lanka**

**In partial fulfillment of the requirement for the degree  
Master of Engineering**

**BY**

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## **ABSTRACT**

CableAmp, a Windows based software has been developed to calculate the cable ampacity of medium voltage power cables laid in free air or directly buried in the ground. The highly graphical user interface allows easy usage. The user inputs the required data of the cable design as well as the cable installation method. CableAmp then calculates the continuous current rating (at 100% load factor) of the power cables laid in free air or directly buried in the ground. It is applicable to extruded solid insulation, rated from 6 kV to 33 kV. An increased peak current rating, called the cyclic current rating, can also be obtained from the software package for a specified load profile. The calculation procedure is in accordance with International Standard IEC 287.

The report presents the theory for the software, and also validates the results obtained by the software by comparison with manufacturers current ratings for standard cables.

## DECLARATIONS

I certify that this thesis has not been previously prepared in whole or part to any University or Institution for a higher degree.

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## LIST OF SYMBOLS

A	Cross sectional area of the armour	(mm <sup>2</sup> )
C	Capacitance per core per unit length	(F/m)
D	Mean diameter of the sheath/screen	(mm)
Da'	External diameter of the armour	(mm)
D <sub>e</sub> *	External diameter of cable	(m)
D <sub>i</sub>	External diameter of insulation	(mm)
Doc	The diameter of imaginary coaxial cylinder which just touches the crest of a corrugated sheath	(mm)
Dit	The diameter of imaginary coaxial cylinder which just touches the inside surface of troughs of a corrugated sheath	(mm)
D <sub>s</sub>	External Diameter of sheath	(mm)
F	Coefficient defined in 5.1.7.1	
H	Intensity of solar radiation	(W/m <sup>2</sup> )
I <sub>cont</sub>	Continuous current in one conductor	(A)
I <sub>cyclic</sub>	Cyclic current in one conductor	(A)
L	Distance from the surface of the ground to the cable axis	(mm)
N	Number of conductors in the cable	
P, Q	Coefficient defined in 5.1.5	
R	a.c. resistance of conductor at maximum operating temperature	(Ω/m)
R'	d.c. resistance of conductor at maximum operating temperature	(Ω/m)
R <sub>a</sub>	a.c. resistance of armour at maximum armour temperature	(Ω/m)
R <sub>i</sub>	d.c. resistance of conductor at 20 <sup>o</sup> c	(Ω/m)
R <sub>s</sub>	The resistance of sheath or screen per unit length of cable at its maximum operating temperature	(Ω/m)
T <sub>1</sub>	Thermal resistance between the conductor and sheath	(K.m/W)
T <sub>2</sub>	Thermal resistance between sheath and the armour	(K.m/W)
T <sub>3</sub>	Thermal resistance of the outer serving	(K.m/W)
T <sub>4</sub>	Thermal resistance of the surrounding medium	(K.m/W)
U <sub>0</sub>	Voltage between conductor and screen or sheath	(kV)
W	Total joule losses per cable at maximum operating temperature	(W/m)
Wd	Dielectric Loss per unit length per phase	(W/m)
X	The reactance and resistance per unit length of the sheath or screen per unit length of cable	(Ω/m)
X <sub>11</sub>	Mutual reactance per unit length of cable between sheath of an outer cable and the conductors of the other two	(Ω/m)
c	Distance between the axis of one conductor and the axis of the cable	(mm)
d	Mean diameter of sheath or screen	(mm)
d <sub>a</sub>	Mean diameter of the armour	(mm)
d <sub>i</sub>	External diameter of insulation	(mm)
d <sub>e</sub>	External diameter of conductor (Including screen if any)	(mm)
f	System frequency	(Hz)
h	Heat dissipation coefficient	
k <sub>p</sub>	Factor used in calculating x <sub>p</sub> (proximity effect)	
k <sub>s</sub>	Factor used in calculating x <sub>s</sub> (skin effect)	
r <sub>f</sub>	Radius of the circle circumscribing the two sector shaped conductors	(mm)
s	Distance between conductor axes	(mm)



t	Thickness of insulation between conductors	(mm)
t <sub>1</sub>	Thickness of insulation between conductor and sheath	(mm)
t <sub>2</sub>	Thickness of bedding	(mm)
t <sub>3</sub>	Thickness of the outer serving	(mm)
t <sub>s</sub>	Thickness of sheath	(mm)
y <sub>s</sub>	Skin effect factor	
y <sub>p</sub>	Proximity effect factor	
λ <sub>1</sub>	Sheath loss factor	
λ <sub>2</sub>	Armour loss factor	
θ	Maximum operating temperature	(°C)
Δθ	Temperature difference	(K)
Δθ <sub>s</sub>	Excess of cable surface temperature above ambient temperature	(K)
θ(∞)	Conductor steady state temperature rise above ambient	(K)
σ	Absorption coefficient of solar radiation for the cable surface (This value is taken as 10 <sup>3</sup> for most latitudes)	
δ	Equivalent thickness of armour (A/(Πd <sub>Λ</sub> ))	(mm)
δ <sub>1</sub>	Soil thermal diffusivity (taken as 0.5*10 <sup>-6</sup> m <sup>2</sup> /s )	
ω	Angular frequency of the system (2Πf)	
ε	The relative permittivity of insulation	
α <sub>20</sub>	Constant mass temperature coefficient at 20 <sup>0</sup> c per Kelvin	(1/K)
μ	Relative permittivity of the steel tape (Usually taken as 300)	
ρ <sub>s</sub>	Electrical resistivity of sheath material at operating temperature	(Ωm)
ρ <sub>11</sub>	Thermal resistivity of insulation	(K.m/W)
ρ <sub>12</sub>	Thermal resistivity of bedding material	(K.m/W)
ρ <sub>13</sub>	Thermal resistivity of outer serving material	(K.m/W)
ρ <sub>14</sub>	Thermal resistivity of soil	(K.m/W)

