AIEE
No. 66
July 1957

IEEE STANDARDS
ARCHIVES
DO NOT REMOVE

Proposed Guide

for

DETERMINATION OF SHORT-CIRCUIT CHARACTERISTICS OF DIRECT-CURRENT MACHINERY

(Published for trial use)

AIEE No. 66

Published by
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West Thirty-ninth Street, New York 18, N. Y.

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on February 25,2026 at 22:07:45 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 66-1957

ACKNOWLEDGEMENT

The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge, and have conducted experimental work on which many of the AIEE Guides are based.

The work of preparing this Guide was carried out by a Working Group of the Direct-Current Machinery Subcommittee of the AIEE Rotating Machinery Committee. The personnel of this Working Group was:

A. T. McClinton, *Chairman*

O. C. Coho
W. R. Crites
J. S. Ewing
L. Greer
C. B. Hathaway
L. H. Hirsch
R. Lamborn
J. P. O'Connor
D. S. Pearson
J. H. Schneider
C. Weilbaecher

CONTENTS

Purpose 3

1.0 Scope 3

2.0 Calculations From Design Parameters 3

2.1 Equations for Transient Armature Current 3

2.2 Equations for Transient Field Current 3

3.0 Calculations from Nameplate Data 3

3.1 Effective Armature-Circuit Resistance 3

3.2 Initial Rate of Rise of Armature Current 4

4.0 Effect of Flashover 5

5.0 Nomenclature 8

6.0 Bibliography 8

Documents
Document Sharing Hub

Authorized licensed use limited to: Tsinghua University. Downloaded on February 25,2026 at 22:07:45 UTC from IEEE Xplore. Restrictions apply.

Full document details: IEEE 66-1957

Proposed Guide For

Determination of Short-Circuit Characteristics of Direct-Current Machinery

Purpose

The purpose of this Guide is to:

(a) Review the factors that affect the short-circuit characteristics of direct-current machinery.

(b) Recommend equations for calculating the transient armature and field current from design parameters.

(c) Recommend methods for approximating the rate of rise and peak value of armature current from nameplate data.

(d) Discuss the causes of flashover and its effect on short-circuit current and effective armature-circuit resistance.

1.0 Scope

1.0.1 This Guide presents general recommendations for determining, by approximate methods from nameplate data and by more exact methods from design data, the short-circuit characteristics of direct-current motors and generators. Both methods are applicable to General Purpose, General Industrial Mill Motors, and Special Purpose direct-current machines. This includes constant-speed and adjustable-speed motors and machines with and without compound windings, and with and without compensating windings.

1.0.2 This Guide is intended to help those concerned with the transient characteristics of direct-current machines and direct-current systems and the effects of these transients on their operation. The calculated values of rate of rise and peak armature current will facilitate the proper selection of system components which will safely withstand the mechanical and thermal stresses during fault. When only nameplate data is available, the approximate methods presented will yield results sufficiently accurate for estimates. Values computed by this method will be high, in general, thus on the safe side. Additional data from machine design sheets, or tests, will permit use of the more exact methods of computation with the view of minimizing the size of components and circuit protective equipment.

1.0.3 For an exact and rigorous analysis it should be emphasized that the variability and non-linearity of the parameters involved in short-circuit calculations present a difficult, if not insuperable task. For these reasons, the equations recommended for the more exact method involve simplifying assumptions and errors within the limits of approximately −5 to +10 percent in peak armature current. The approximate method utilizing only nameplate data will have a range of accuracy from −20 to +30 percent. These accuracies refer to conditions where no flashover exists.

2.0 Calculations from Design Parameters

2.1 Equations for Transient Armature Current

It is recommended that the methods of computation presented in references 6, 9, 20 and 21 be used to determine the peak and transient value of armature current from design data.

2.2 Equations for Transient Field Current

It is recommended that the method of computation presented in references 6, 9, 20 and 21 be used to determine the peak and transient value of field current from design data.

3.0 Calculations from Nameplate Data

3.0.1 In the preliminary design of direct-current power systems, generally only the voltage and power rating of the machines are known. Even with this minimum data some knowledge of system design requirements may be provided by an estimate of peak armature current and peak fault current under assumed conditions. The approach is as follows: A simple schematic representation consisting of a voltage source and a resistance can be made for each direct-current machine. The voltage source represents the generated voltage of the machine at the initial speed, which is assumed constant up to the time of peak short-circuit current. The resistance is an effective internal resistance which represents all factors tending to limit the flow of current from the generator, or motor, which operates as a generator under fault condition. These factors are: armature circuit ohmic resistance, brush contact drop, reactance voltage, and flux reduction and distortion.

3.0.2 A similar simple schematic representation can also be employed to obtain an approximation of the initial rate of rise of armature current. The circuit consists of a voltage source, and an inductance where the voltage is the generated voltage prior to short circuit and the inductance is an equivalent armature circuit inductance for the machine.

3.0.3 These two equivalent circuits, which will be discussed more fully in the sections to follow, cannot be combined in an attempt to obtain the overall transient response to short circuit. Each is applicable only for its specific purpose. When more than one machine is connected to a system reasonable accuracy can be expected on system calculations for total fault current if the time to reach peak current is essentially equal for all machines on the system.

3.1 Effective Armature Circuit Resistance

3.1.1 The transient armature current of a direct-current machine on short circuit rises rapidly to a peak value and then decays slowly to a sustained value (zero magnitude if the machine is self-excited). The decay to the sustained value is dependent on the

Documents
Document Sharing Hub
Authorized licensed use limited to: Tsinghua University. Downloaded on February 25,2026 at 22:07:45 UTC from IEEE Xplore. Restrictions apply.
Full document details: IEEE 66-1957