



Designation: G115 – 24

Standard Guide for Measuring and Reporting Friction Coefficients¹

This standard is issued under the fixed designation G115; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers information to assist in the selection of a method for measuring the frictional properties of materials. Requirements for minimum data and a format for presenting these data are suggested. The use of the suggested reporting form will increase the long-term usefulness of the test results within a given laboratory and will facilitate the exchange of test results between laboratories. It is hoped that the use of a uniform reporting format will provide the basis for the preparation of handbooks and computerized databases.

1.2 This guide applies to most solid materials and to most friction measuring techniques and test equipment.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- C808** Guide for Reporting Friction and Wear Test Results of Manufactured Carbon and Graphite Bearing and Seal Materials
- C1028** Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the

Horizontal Dynamometer Pull-Meter Method (Withdrawn 2014)³

D1894 Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheet (Withdrawn 2023)³

D2047 Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine

D2394 Test Methods for Simulated Service Testing of Wood and Wood-Based Finish Flooring

D2534 Test Method for Coefficient of Kinetic Friction for Wax Coatings

D2714 Test Method for Calibration and Operation of the Falex Block-on-Ring Friction and Wear Testing Machine

D3108/D3108M Test Method for Coefficient of Friction, Yarn to Solid Material

D3412/D3412M Test Method for Coefficient of Friction, Yarn to Yarn

D3702 Test Method for Wear Rate and Coefficient of Friction of Materials in Self-Lubricated Rubbing Contact Using a Thrust Washer Testing Machine

D4103 Practice for Preparation of Substrate Surfaces for Coefficient of Friction Testing

D4917 Test Method for Coefficient of Static and Kinetic Friction of Uncoated Writing and Printing Paper by Use of the Horizontal Plane Method (Withdrawn 2010)³

D4918 Test Method for Coefficient of Static Friction of Uncoated Writing and Printing Paper by Use of the Inclined Plane Method (Withdrawn 2010)³

D5183 Test Method for Determination of the Coefficient of Friction of Lubricants Using the Four-Ball Wear Test Machine

D6078 Test Method for Evaluating Lubricity of Diesel Fuels by the Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE) (Withdrawn 2021)³

D6079 Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)

D6425 Test Method for Measuring Friction and Wear Properties of Extreme Pressure (EP) Lubricating Oils Using SRV Test Machine

¹ This guide is under the jurisdiction of ASTM Committee G02 on Wear and Erosion and is the direct responsibility of Subcommittee G02.50 on Friction.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

- E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
- E303 Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
- E670 Test Method for Testing Side Force Friction on Paved Surfaces Using the Mu-Meter
- E1911 Test Method for Measuring Surface Frictional Properties Using the Dynamic Friction Tester
- E2100 Practice for Calculating the International Runway Friction Index (Withdrawn 2019)³
- E2101 Test Method for Measuring the Frictional Properties of Winter-Contaminated Pavement Surfaces Using an Averaging-Type Spot Measuring Decelerometer
- F609 Test Method for Using a Horizontal Pull Slipmeter (HPS) (Withdrawn 2022)³
- F695 Practice for Ranking of Test Data Obtained for Measurement of Slip Resistance of Footwear Sole, Heel, and Related Materials (Withdrawn 2018)³
- F732 Test Method for Wear Testing of Polymeric Materials Used in Total Joint Prostheses
- G40 Terminology Relating to Wear and Erosion
- G77 Test Method for Ranking Resistance of Materials to Sliding Wear Using Block-on-Ring Wear Test
- G99 Test Method for Wear and Friction Testing with a Pin-on-Disk or Ball-on-Disk Apparatus
- G133 Test Method for Linearly Reciprocating Ball-on-Flat Sliding Wear
- G137 Test Method for Ranking Resistance of Plastic Materials to Sliding Wear Using a Block-On-Ring Configuration
- G143 Test Method for Measurement of Web/Roller Friction Characteristics
- G163 Guide for Digital Data Acquisition in Wear and Friction Measurements (Withdrawn 2016)³
- G164 Test Method for Determination of Surface Lubrication on Flexible Webs
- G176 Test Method for Ranking Resistance of Plastics to Sliding Wear Using Block-on-Ring Wear Test—Cumulative Wear Method
- G181 Test Method for Conducting Friction Tests of Piston Ring and Cylinder Liner Materials Under Lubricated Conditions
- G182 Test Method for Determination of the Breakaway Friction Characteristics of Rolling Element Bearings
- G194 Test Method for Measuring Rolling Friction Characteristics of a Spherical Shape on a Flat Horizontal Plane
- G203 Guide for Determining Friction Energy Dissipation in Reciprocating Tribosystems
- G204 Test Method for Damage to Contacting Solid Surfaces under Fretting Conditions
- G219 Guide for Determination of Static Coefficient of Friction of Test Couples Using an Inclined Plane Testing Device

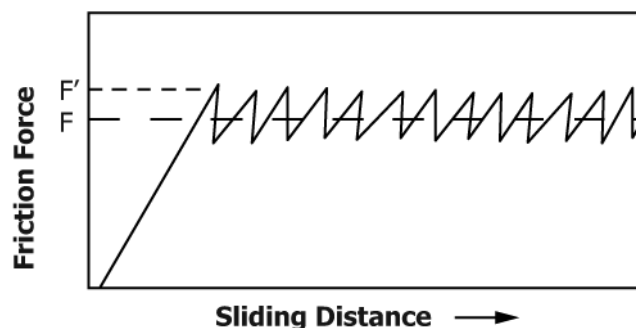


FIG. 1 Idealized Friction Force versus Distance Relationship for a System that Exhibits Stick-Slip Behavior (Long dashes indicate mean friction (kinetic) force (F) and short dashes indicate maximum (static) friction force (F').)

3. Terminology

3.1 For definitions relating to friction as a characteristic of a tribosystem, refer to Terminology G40.

3.2 Definitions:

3.2.1 *stick-slip, n*—relaxation oscillation usually associated with a decrease in the coefficient of friction as the relative velocity increases.

3.2.1.1 *Discussion*—The usual manifestation is a cycling decrease and subsequent increase in the friction force as sliding proceeds (Fig. 1).

4. Summary of Guide

4.1 A number of ASTM International standard test methods and guides (referred to here as simply “test methods” for brevity) that consider friction are tabulated here (Table 1) so that users can review available likely test methods and determine which may be most applicable for a particular application. Any of the listed tests or another accepted test may be used. Due to the ongoing nature of standards development, it should be noted that while this table cannot be exhaustive, its content has been selected to balance breadth, detail, and utility. Similarly, users are encouraged to review the most recent version of any test method cited as they may have been revised since this guide was published. Some test methods that have been “withdrawn” have been included for reference.

4.2 General friction testing precautions are cited and a prescribed method of recording friction data is recommended. This guide is intended to promote the use of this standard reporting system and standard friction test methods.

4.3 The use of one of the test methods cited in this guide will give assurance of a testing procedure that has been agreed-to for a particular application. In addition, it is important to keep in mind that friction is a system property. For example, the coefficient of friction of polystyrene against mild steel measured on a sled test (Test Method D1894) will probably be different than the coefficient of the same couple measured on a block-on-ring tester (Test Method G176) *since the coefficient of friction is a system property.*

TABLE 1 Selected ASTM Guides and Test Methods that Consider Friction

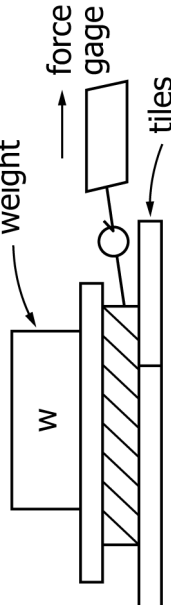
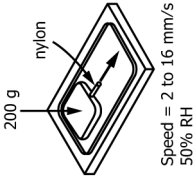
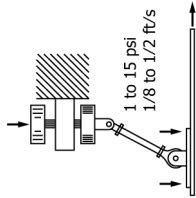
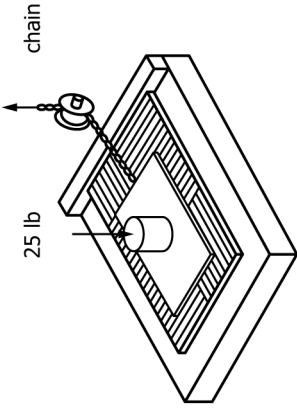
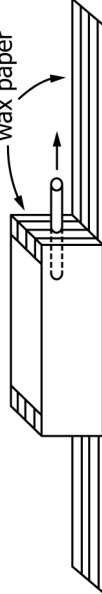
Standard/Committee	Title	Measured Parameters	Test Configuration
C808/D02.F0 on Manufactured Carbon and Graphite Products	Guide for Reporting Friction and Wear Test Results of Manufactured Carbon and Graphite Bearing and Seal Materials	Carbon versus other materials (μ_s and μ_k)	any
C1028/C21 on Ceramic Whitewares and Related Products (Withdrawn 2014)	Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method	Static COF wet and dry	
D1894/D20 on Plastics (Withdrawn 2023)	Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheet	Plastic film versus stiff or other solids (μ_s and μ_k)	
D2047/D21 on Polishes	Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine	Walking materials versus shoe heels and soles (μ_s and μ_k)	
D2394/D07 on Wood	Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring	Wood and wood base flooring versus sole leather (μ_s and μ_k)	
D2534/D02 on Petroleum Products and Lubricants	Test Method for Coefficient of Kinetic Friction for Wax Coatings	Kinetic coefficient of friction	

TABLE 1 Continued

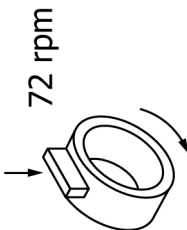
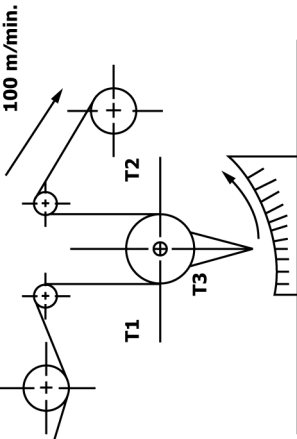
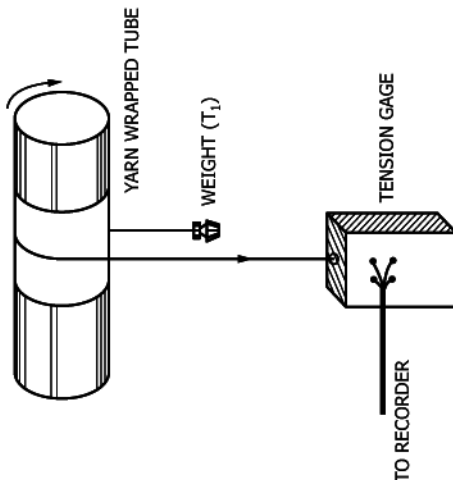
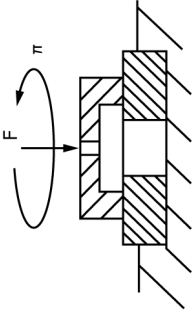
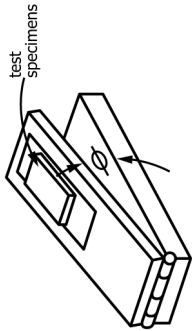
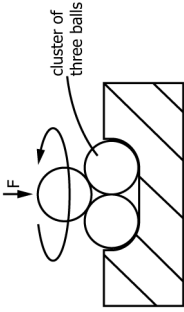
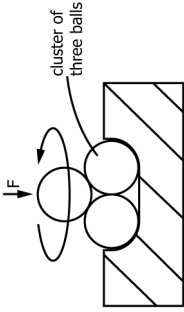
Standard/Committee	Title	Measured Parameters	Test Configuration
D2714/D02 on Petroleum Products and Lubricants	Test Method for Calibration and Operation of the Falex Block-on-Ring Friction and Wear Testing Machine	Steel ring versus steel block (lubricated with standard oil) (μ_k)	
D3108/D3108M/D13 on Textiles	Test Method for Coefficient of Friction, Yarn to Solid Material	Textile yarn versus solids (μ_k)	 $\mu = (\ln T_2 - \ln T_1) / \phi$
D3412/D3412M/D13 on Textiles	Test Method for Coefficient of Friction, Yarn to Yarn	Continuous filament and spun yarns self-mated (μ_s and μ_k)	

TABLE 1 Continued

Standard/Committee	Title	Measured Parameters	Test Configuration
D3702/D02 on Petroleum Products and Lubricants	Test Method for Wear Rate and Coefficient of Friction of Materials in Self-Lubricated Rubbing Contact Using a Thrust Washer Testing Machine	Kinetic COF	
D4103/D21 on Polishes	Practice for Preparation of Substrate Surfaces for Coefficient of Friction Testing	Vinyl and wood tiles (preparation)	any
D4917/D06 on Paper and Paper Products (Withdrawn 2010)	Test Method for Coefficient of Static and Kinetic Friction of Uncoated Writing and Printing Paper by Use of the Horizontal Plane Method	μ_s and μ_k	
D4918/D06 on Paper and Paper Products (Withdrawn 2010)	Test Method for Coefficient of Static Friction of Uncoated Writing and Printing Paper by Use of the Inclined Plane Method	Static COF	
D5183/D02 on Petroleum Products and Lubricants	Test Method for Determination of the Coefficient of Friction of Lubricants Using the Four-Ball Wear Test Machine	Coefficient of force for each increment of 10 kgf	
D6078/D02 on Petroleum Products and Lubricants (Withdrawn 2021)	Standard Test Method for Evaluating Lubricity of Diesel Fuels by the Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE) (withdrawn in 2021, but may still be used)	Tangential friction force (friction coefficient) Minimum applied load required to produce a friction coefficient greater than 0.175	