



Designation: F3232/F3232M – 19a

# Standard Specification for Flight Controls in Small Aircraft<sup>1</sup>

This standard is issued under the fixed designation F3232/F3232M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification covers international standards for the flight control aspects of airworthiness and design for “small” aircraft.

1.2 The applicant for a design approval must seek the individual guidance of their respective CAA body concerning the use of this specification as part of a certification plan. For information on which CAA regulatory bodies have accepted this specification (in whole or in part) as a means of compliance to their Small Aircraft Airworthiness regulations (hereinafter referred to as “the Rules”), refer to ASTM F44 webpage ([www.ASTM.org/COMMITTEE/F44.htm](http://www.ASTM.org/COMMITTEE/F44.htm)) which includes CAA website links.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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 Following is a list of external standards referenced throughout this specification; the earliest revision acceptable for use is indicated. In all cases later document revisions are acceptable if shown to be equivalent to the listed revision, or if

otherwise formally accepted by the governing civil aviation authority; earlier revisions are not acceptable.

### 2.2 ASTM Standards:<sup>2</sup>

F3060 Terminology for Aircraft

F3061/F3061M Specification for Systems and Equipment in Small Aircraft

F3082/F3082M Specification for Weights and Centers of Gravity of Aircraft

F3116/F3116M Specification for Design Loads and Conditions

F3117/F3117M Specification for Crew Interface in Aircraft  
F3173/F3173M Specification for Aircraft Handling Characteristics

F3180/F3180M Specification for Low-Speed Flight Characteristics of Aircraft

F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft

### 2.3 Other Standards:

FAA-S-ACS Private Pilot - Airplane Airman Certification Standards<sup>3</sup>

RTCA/DO-335 Guidance for Installation of Automatic Flight Guidance and Control Systems (AFGCS) for Part 23 Airplanes<sup>4</sup>

## 3. Terminology

3.1 Terminology specific to this specification is provided below. For general terminology, refer to Terminology F3060.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *aircraft type code, n*—an Aircraft Type Code (ATC) is defined by considering both the technical considerations regarding the design of the aircraft and the aeroplane certification level established based upon risk-based criteria; the method of defining an ATC applicable to this specification is defined in Specification F3061/F3061M.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.50 on Systems and Equipment.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, <http://www.faa.gov>.

<sup>4</sup> Available from RTCA, Inc., 1150 18th St., NW, Suite 910, Washington, DC 20036, <http://www.rtca.org>.

3.2.2 *continued safe flight and landing, n*—continued safe flight and landing as applicable to this specification is defined in Specification **F3061/F3061M**.

3.2.3 *single failure, n*—a single failure as applicable to this specification is defined in Practice **F3230**.

#### 4. Manual Flight Controls

NOTE 1—Table 1 provides correlation between various Aircraft Type Codes and the individual requirements contained within this section; refer to 3.2.1. For each subsection, an indicator can be found under each ATC character field; three indicators are used:

An empty cell ( ) in all applicable ATC character field columns indicates that an aircraft must meet the requirements of that subsection.

A white circle (○) in multiple columns indicates that the requirements of that subsection are not applicable to an aircraft *only* if all such ATC character fields are applicable.

A mark-out (×) in any of the applicable ATC character field columns indicates that the requirements of that subsection are not applicable to an aircraft if that ATC character field is applicable.

Examples—An aircraft with an ATC of 1SRLLDLN is being considered. Since all applicable columns are empty for 4.1.2, that subsection is applicable to the aircraft. However, since the “S” number-of-engines column for 4.4.7 contains an ×, then that subsection is not applicable.

##### 4.1 Control Surface Installation:

4.1.1 Movable surfaces must be installed so that there is no interference between any surfaces, their bracing, or adjacent fixed structure, when one surface is held in its most critical clearance positions and the others are operated through their full movement.

4.1.2 If an adjustable stabilizer is used, it must have stops that will limit its range of travel to that allowing safe flight and landing.

4.1.3 Control surface hinges, except ball and roller bearing hinges, must have a factor of safety of not less than 6.67 with respect to the ultimate bearings strength of the softest material used as a bearing.

4.1.3.1 For ball or roller bearing hinges, the approved rating of the bearing may not be exceeded.

4.1.4 Control system joints (in push-pull systems) that are subject to angular motion, except those in ball and roller bearing systems, must have a special factor of safety of not less than 3.33 with respect to ultimate bearing strength of the softest material used as a bearing.

4.1.4.1 The factor specified in 4.1.4 may be reduced to 2.0 for joints in cable control systems.

4.1.4.2 For ball or roller bearings, the approved rating of the bearing may not be exceeded.

##### 4.2 Operation and Arrangement:

4.2.1 Each control must operate easily, smoothly, and positively enough to allow proper performance of its functions.

4.2.2 Controls must be arranged and identified to provide for convenience in operation and so as to not cause confusion and subsequent inadvertent operation; refer to Specification **F3117/F3117M**.

##### 4.3 Control System Stops:

4.3.1 Each control system must have stops that positively limit the range of motion of each movable aerodynamic surface controlled by the system.

4.3.2 Each stop must be located so that wear, slackness, or takeup adjustments will not adversely affect the control characteristics of the aircraft because of a change in the range of surface travel.

4.3.3 Each stop must be able to withstand any loads corresponding to the design conditions for the control system.

##### 4.4 Trim Systems:

4.4.1 Proper precautions must be taken to prevent inadvertent, improper, or abrupt trim tab operation.

4.4.2 There must be means near the trim control to indicate to the pilot the direction of trim control movement relative to aircraft motion.

4.4.3 There must be means to indicate to the pilot the position of the trim device with respect to both the range of adjustment and, in the case of lateral and directional trim, the neutral position.

4.4.4 The means provided to satisfy the requirements of 4.4.2 and 4.4.3 must be visible to the pilot and must be located and designed so as to not cause confusion.

4.4.5 The pitch trim indicator must be clearly marked with a position or range within which it has been demonstrated that take-off is safe for all center of gravity positions and each flap position approved for takeoff.

4.4.6 Trimming devices must be designed so that, when any one connecting or transmitting element in the primary flight control system fails, adequate control for safe flight and landing is available with the longitudinal trimming devices.

4.4.7 Trimming devices must be designed so that, when any one connecting or transmitting element in the primary flight control system fails, adequate control for safe flight and landing is available with the longitudinal and directional trimming devices.

4.4.8 Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics. Irreversible tab systems must have adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the aircraft structure.

##### 4.5 Control System Locks:

4.5.1 If there is a device to lock the control system on the ground or water, there must be a means to give unmistakable warning to the pilot when lock is engaged, or to automatically disengage the device when the pilot operates the primary flight controls in a normal manner.

4.5.2 If there is a device to lock the control system on the ground or water, the device must be installed to limit the operation of the aircraft so that, when the device is engaged, the pilot receives unmistakable warning at the start of the takeoff.

4.5.3 If there is a device to lock the control system on the ground or water, the device must have a means to preclude the possibility of it becoming inadvertently engaged in flight.

##### 4.6 Limit Load Static Tests:

4.6.1 Compliance with established limit load requirements must be shown by limit load tests in which the direction of the test loads produces the most severe loading in the control system.

**TABLE 1 ATC Compliance Matrix, Section 4**

Section	Aeroplane Certification Level				Number of Engines		Type of Engine(s)		Stall Speed			Cruise Speed		Meteorological Conditions			Altitude		Maneuvers	
	1	2	3	4	S	M	R	T	L	M	H	L	H	D	N	I	L	H	N	A
4																				
4.1																				
4.1.1																				
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4.13.3						x														
4.13.4	o										o									

4.6.1.1 In meeting the requirements of 4.6.1, each fitting, pulley, and bracket used in attaching the system to the main structure must be included.

4.6.2 Compliance must be shown by analysis or by individual load tests with the special factor requirements for control system joints subject to angular motion.

#### 4.7 *Operation Tests:*

4.7.1 It must be shown by operation tests that, when the controls are operated from the pilot compartment with the system loaded as prescribed in 4.7.2 and 4.7.3, the system is free from jamming, excessive friction, excessive deflection, or any combination thereof.

4.7.2 For the entire system, the prescribed test loads are those corresponding to the limit airloads on the appropriate surface, or the limit pilot forces in Specification F3116/F3116M, whichever are less.

4.7.3 For secondary controls, the prescribed test loads must be not less than those corresponding to the maximum pilot effort established under Specification F3116/F3116M.

#### 4.8 *Control System Details:*

4.8.1 Each detail of each control system must be designed and installed to prevent jamming, chafing, and interference from cargo, passengers, loose objects, or the freezing of moisture.

4.8.2 There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

4.8.3 There must be means to prevent the slapping of cables or tubes against other parts.

4.8.4 Each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimize the possibility of incorrect assembly that could result in malfunction or reverse operation of the control system.

4.9 *Spring Devices*—The reliability of any spring device used in the control system must be established by tests simulating service conditions unless failure of the spring will not cause flutter or unsafe light characteristics.

#### 4.10 *Cable Systems:*

4.10.1 Each cable, cable fitting, turnbuckle, splice, and pulley used must meet specifications that are acceptable to the governing civil aviation authority.

4.10.2 No cable smaller than 3.2 mm [0.125 in.] diameter may be used in primary control systems.

4.10.2.1 Tab control cables are not part of the primary control system and may be less than 3.2 mm [0.125 in.] diameter in aircraft that are safely controllable with the tabs in the most adverse positions.

4.10.3 Each cable system must be designed so that there will be no hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations.

4.10.4 There must be means for visual inspection at each fairlead, pulley, terminal, and turnbuckle.

4.10.5 Each kind and size of pulley must correspond to the cable with which it is used.

4.10.6 Each pulley must have closely fitted guards to prevent the cables from being misplaced or fouled, even when slack.

4.10.7 Each pulley must lie in the plane passing through the cable so that the cable does not rub against the pulley flange.

4.10.8 Fairleads must be installed so that they do not cause a change in cable direction of more than 3°.

4.10.9 Clevis pins subject to load or motion and retained only by cotter pins may not be used in the control system.

4.10.10 Turnbuckles must be attached to parts having angular motion in a manner that will positively prevent binding throughout the range of travel.

#### 4.11 *Wing Flap Controls:*

4.11.1 Each wing flap control must be designed so that, when the flap has been placed in any position upon which compliance with the performance requirements of the rules of governing civil aviation authority is based, the flap will not move from that position unless the control is adjusted or is moved by the automatic operation of a flap load limiting device.

4.11.2 The rate of movement of the flaps in response to the operation of the pilot's control or automatic device must give satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and attitude; refer to Specification F3082/F3082M.

4.11.3 If compliance with Specification F3082/F3082M necessitates wing flap retraction to positions that are not fully retracted, the wing flap control lever settings corresponding to those positions must be positively located such that a definite change of direction of movement of the lever is necessary to select settings beyond those settings.

#### 4.12 *Wing Flap Position Information:*

4.12.1 There must be a means to provide wing flap position information for flap installations with only the retracted and fully extended positions, unless: a direct operating mechanism provides a sense of "feel" and position (such as when a mechanical linkage is employed); or, the flap position is readily determined without seriously detracting from other piloting duties under any flight condition, day or night.

4.12.2 There must be a means to provide wing flap position information for flap installations with intermediate flap positions if any flap position other than retracted or fully extended is used to show compliance with the performance requirements of the rules of the governing civil aviation authority, and the flap installation does not provide a sense of "feel" and position (such as when a mechanical linkage is employed).

#### 4.13 *Flap Interconnection:*

4.13.1 The main wing flaps and related movable surfaces as a system must: be synchronized by a mechanical interconnection between the movable flap surfaces that is independent of the flap drive system; or, be designed so that the occurrence of any failure of the flap system that would result in an unsafe flight characteristic of the aircraft is extremely improbable (refer to Practice F3230).

4.13.2 As an alternative to 4.13.1, the aircraft may be shown to have safe flight characteristics with any combination of extreme positions of individual movable surfaces (mechanically interconnected surfaces are to be considered as a single surface).

4.13.3 Except as provided in 4.13.4, if compliance with 4.13.1 or 4.13.2 is met through the use of an interconnection it must be designed to account for the unsymmetrical loads resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at takeoff power.