

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION TYPE CERTIFICATE DATA SHEET E00088EN	TCDS NUMBER E00088EN REVISION: ORIGINAL ISSUE DATE: 23 MAY 2016 CFM INTERNATIONAL, S.A. MODEL: LEAP-1B28 LEAP-1B28B2
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Engines of model described herein conforming with this data sheet (which is part of Type Certificate Number E00088EN) and other approved data on file with the Federal Aviation Administration, meet the minimum standards for use in certificated aircraft in accordance with pertinent aircraft data sheets and applicable portions of the Federal Aviation Regulations, provided they are installed, operated, and maintained as prescribed by the approved manufacturer's manuals and other approved instructions.

TYPE CERTIFICATE (TC) HOLDER: **CFM International, S.A.**
2 Boulevard du Général Martial Valin
75724 Paris Cedex 15
France

MODEL	LEAP-1B28	LEAP-1B28B2
TYPE	High bypass turbofan engine, with: coaxial front fan/booster driven by a multi-stage low pressure turbine; a multi-stage compressor; two-stage high pressure turbine; twin annular pre swirl combustors; and a full authority digital engine control (FADEC).	
RATINGS	<i>See Note 1.</i>	
Static Thrust at Sea Level lb (daN)		
• Takeoff (5 min.)	29,317 (13,041)	--
• Maximum continuous	28,690 (12,762)	--
Flat Rating Ambient Temperature at Sea Level °F (°C)		
• Takeoff	86 (30)	--
• Maximum continuous	77 (25)	--
COMPONENTS	Part Number	
<i>Full Authority Digital Control (FADEC)</i>		
• <i>Electronic control unit</i>	2474M64	--
• <i>PSS</i>	2474M65	--
• <i>Software</i>	2628M86, 2628M87, 2628M88, 2697M83	--
• <i>Identification plug</i>	2531M61P26	2531M61P28
FUEL	<ul style="list-style-type: none"> Approved fuel conforming to GE Specification D50TF2, Classes A, C, D, and E. Primary fuel is D50TF2 Class-A (Jet A) with other fuels listed being acceptable alternates. No fuel control adjustment is required when changing from primary to alternate fuels. Use of aviation gasoline and D50TF2 Class-B, Wide-Cut Distillate (Jet B or JP-4) is not authorized. Refer to the latest revision of CFM Service Bulletin LEAP-1B S/B 73-0001 for a list of fuels specifically approved for LEAP-1B engine. 	
OIL	<ul style="list-style-type: none"> Synthetic type conforming to GE Specification D50TF1, Type I and Type II. Refer to the latest revision of CFM Service Bulletin LEAP-1B S/B 79-0001 for a list of oil specifically approved for the LEAP-1B engine. 	

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LEGEND: "- -" INDICATES "SAME AS PRECEDING MODEL"
"--" NOT APPLICABLE
NOTE: SIGNIFICANT CHANGES ARE BLACK-LINED IN THE LEFT MARGIN.

MODEL	LEAP-1B28	LEAP-1B28B2
PHYSICAL CHARACTERISTICS		
PRINCIPLE DIMENSIONS	in (mm)	
Length Fwd. fan case flange to TRF aft flange	123.9 (3147)	--
Width Maximum Envelope	95.31 (2421)	--
Height Maximum Envelope	88.82 (2256)	--
WEIGHT Not to Exceed	The engine weight is defined as the weight of the basic engine, including basic engine accessories lb (kg)	
	6128 (2780)	--
CENTER OF GRAVITY LOCATION		
Engine Only, Nominal Weight	in (mm)	
Station (axial) HPC case fwd flange = 200 in (5080 mm)	211.8 (5380.0)	--
Waterline	98.2 (2494)	--
Buttline	98.2 (2494)	--

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**CERTIFICATION
BASIS**

1. 14 CFR Part 33, effective February 1, 1965, with Amendments 33-1 through 33-33 thereto.
2. 14 CFR Part 34, Amendment 5A, effective October 23, 2013.
3. Emissions: ICAO Annex 16, Vol.II, Amendment 7(CAEP/8) latest change
4. Equivalent Level of Safety (ELOS) Findings:
 - LEAP1B-2014-TC-01-P-1 to 14 CFR 33.27(c): High Pressure Shaft Loss-of-Load
 - LEAP1B-2014-TC-01-P-2 to 14 CFR 33.77: Foreign object Ingestion – Ice
 - LEAP1B-2014-TC-01-P-3 to 14 CFR 33.83: Vibration Test
5. Special Conditions:
 - Fan Blade Special Condition No. 33-017-SC
6. Exemptions: None

MODEL	APPLICATION DATE	TC ISSUED/ AMENDED
LEAP-1B28	09 May 2013	04 May 2016
LEAP-1B28B2	09 May 2013	04 May 2016

PRODUCTION BASIS

Production Certification No. FR.21G.0007 dated December 17th, 2009 for engines produced in France by Snecma under license from CFM International, S.A.

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NOTES

NOTE 1.**ENGINE RATING**

Engine rating is based on calibrated stand performance under the following conditions:

Takeoff thrust is nominally independent of ambient temperature (flat rated) up to ambient temperature of: Std + 15°C (30°C, 86°F), except as noted above.

Maximum continuous thrust is nominally independent of ambient temperature (flat rated) up to ambient temperature of Std. + 10°C (25°C, 77°F).

Assumptions:

1. Sea level static, standard day: 101.325 kPa Pressure (14.696 psia); 15°C temperature (59°F)
2. Zero customer bleed or customer horsepower extraction
3. Ideal inlet, 100% ram recovery
4. Production aircraft flight cowling
5. Production instrumentation
6. Fuel lower heating value of 18,400 BTU/lb

Thrust Setting Parameter

Power setting, power checks and control of engine thrust output in all operations is to be based on CFM International engine charts referring to fan speed. Fan speed sensors are included in the engine assembly for this purpose.

NOTE 2.**TEMPERATURE LIMITS**

<u>Indicated Turbine Exhaust Gas Temperature</u>	
Takeoff, 5 min	1038°C (1900°F)
Maximum Continuous	1013°C (1855°F)
Max Transient (30 sec.)	1048°C (1918°F)
Ground Starts	753°C (1387°F)
Inflight Starts	883°C (1621°F)
<u>Fuel Pump Inlet Temperature</u>	
Maximum	54.5°C (130°F)
Minimum (Cold Start)	-43°C (-45°F)
Or the relevant fuel freezing point, whichever is higher.	
<u>Oil Temperature</u>	
Maximum	
• Continuous operation	140°C (284°F)
• Transient (15 minutes)	155°C (311°F)
Minimum (Cold Start)	-19°C (-2°F)

NOTE 3.**FUEL AND OIL PRESSURE LIMITS**

Fuel Pressure Limits At The Engine Pump Inlet	
• Aircraft Boost Pump Operative	The minimum pressure at the engine fuel pump inlet with aircraft boost pumps operative is true vapor pressure plus 5 psia (34.5 kPa). The maximum vapor to liquid ratio at the engine fuel pump inlet with aircraft boost pumps operative is zero.
• Aircraft Boost Pump Inoperative	The engine fuel system operation is restricted with the aircraft boost pumps inoperative as outlined in the LEAP-1B Installation Manual.
Oil Pressure Limits	
• The minimum pressure limit at idle is 17.4 psid (120.0 kPa) and varies up to 29 psid (200.0 kPa) at redline.	
• The maximum pressure is limited during cold starts by a 420.5 psid (2900 kPa differential) pressure-relief valve.	

NOTE 4.**ACCESSORY DRIVE CHARACTERISTICS**

Electrical (IDG)*		
Rotation Direction ⁺		CCW
Speed ratio to core ^{**}		0.418
Pad Rating	HP (kW)	168 (125)
Shear Torque	in.lb (N.m)	9408 (1063)
Maximum overhung moment (wet)	in.lb (N.m)	956 (108)
Hydraulic Pump*		
Rotation Direction ⁺		CCW
Speed ratio to core ^{**}		0.191
Pad Rating	in.lb (N.m)	1407 (159)
Shear Torque	in.lb (N.m)	3602 (407)
Maximum overhung moment (wet)	in.lb (N.m)	166 (18.8)
* - <i>Airframer Supplied Hardware</i>		
+ - <i>CW = CLOCKWISE (looking at the Pad)</i>		
** - <i>100% core speed = 17,167 RPM</i>		

NOTE 5.**ENGINE MODEL CHARACTERISTICS**

The model shown on this TCDS has the following general characteristics	
LEAP-1B28	737MAX 8 Configuration
LEAP-1B28B2	Same as LEAP-1B28 with additional takeoff thrust at high altitude conditions.

NOTE 6.**NOT APPLICABLE****NOTE 7.****COMPATIBLE SYSTEM ASSEMBLIES**

Thrust Reverser

The LEAP-1B engine is approved for use with the Boeing thrust reverser system P/N 315A6295

NOTE 8.**NOT APPLICABLE****NOTE 9.****NOT APPLICABLE****NOTE 10.****NOT APPLICABLE****NOTE 11.****SPECIAL REQUIREMENTS**

ETOPS

LEAP-1B engine model is not eligible for Extended Twin Engine Operations (ETOPS) operation at this time.

Time Limited Dispatch Criteria

Criteria pertaining to the dispatch and maintenance requirements for the engine control systems are specified in the airworthiness limitation section of the LEAP-1B Engine Shop Manual (LEAP-1B-05-17-00), which defines the various configurations and maximum operating intervals.

A control system reliability monitoring program has been established with LEAP, as a contingency of the dispatch criteria approval, to ensure that overall engine control system and specific component failure rates do not exceed the maximum values permitted by the reliability analysis.

Induction System Icing

Demonstration of compliance to 14 CFR Part 33.68, Induction System Icing, is installation specific to the Boeing B737 MAX model aircraft for the LEAP-1B28 and -1B28B2 engine models. Installation of these engine models on different airplane models or types will require a separate evaluation and finding of compliance to 14 CFR Part 33.68.

NOTE 12.**NOT APPLICABLE**

NOTE 13.**SPECIAL OPERATING PROCEDURES****Negative G Operation**

During negative g operation only, it is permissible to operate below minimum oil pressure (17.4 psid) for a maximum of 10 seconds. See LEAP-1B Specific Operating Instruction Manual, GEK 113769

Minimum Flight Idle

The minimum permissible idle in flight is a non-adjustable limit, preset into the EEC Control schedule. Flight idle is engaged based on thrust lever position and operating conditions as specified in the LEAP-1B Specific Operating Instructions Manual, GEK 113769

Takeoff Time Limit

The normal 5 minute takeoff rating may be extended to 10 minutes for engine out contingency, as specified in the LEAP-1B Specific Operating Instructions Manual, GEK 113769

Icing Operation

For operation in icing conditions; requirements, limitations, and notes are specified in the LEAP-1B Specific Operating Instructions Manual, GEK 113769

NOTE 14.**NOT APPLICABLE****NOTE 15.****APPLICABLE INSTALLATION, MAINTENANCE AND OVERHAUL MANUALS**

Instructions for Continued Airworthiness (ICA) for the LEAP-1B engine are incomplete. Aircraft with these engines installed will be eligible for airworthiness certification when the ICA are completed and accepted by the FAA Engine Certification Office, ANE-140.

ICA: Installation Manuals, Specific Operating Instructions, Engine Shop Manuals, Service Bulletins, Overhaul and Maintenance Manuals, Repair Manuals, Vendor Manuals, and Design Changes which contain a statement that the document is EASA approved or approved under authority of DOA No. EASA.21J.086 are accepted by the FAA and considered FAA approved. Repair data and related instructions are considered FAA approved or accepted as applicable. These approvals pertain to the type design only.

NOTE 16.**IMPORT REQUIREMENTS**

The type certificate holder, CFM International, S.A., is a company established and jointly owned by Snecma of France and the General Electric Company for the certification, sale, and support of CFM56 & LEAP series engines. The LEAP-1B engine series is a product line designed to power the Boeing 737MAX 7, 8 and 9 aircraft. With respect to the benefits of type certification for production, General Electric and Snecma function as licensees of CFM International, S.A.

All LEAP-1B engines will be assigned serial numbers sequentially, with the three-digit prefix "602-" regardless of engine final assembly location. The location of final assembly can be inferred from the engine manufacturer, which will be identified on the engine nameplate, along with the date of production. Engines produced in the United States by GE are identical to and fully interchangeable with engines produced in France by Snecma.

Modules, assemblies, or parts produced in France are eligible for use in engines produced to this type certificate provided an airworthiness approval certificate (EASA Form 1 – Authorized Release Certificate or JAA Form 1) issued by Snecma under authority of European Aviation Safety Agency (EASA) Production Certificate No. FR.21G.0007 is attached to the item or invoice covering shipment of items (Ref. 14 CFR § 21.502).

NOTE 17.**CRITICAL ENGINE PARTS**

Life limits established for critical engine parts are published in the ALS section of Chapter 05 of the LEAP-1B Engine Shop Manual, ESM.21.

NOTE 18.**NOT APPLICABLE****NOTE 19.****MAXIMUM PERMISSIBLE ENGINE ROTOR SPEEDS**

SPOOL	RPM	%
Low pressure rotor (N1)	4,586	104.3
High pressure rotor (N2)	20,171	117.5

NOTE 20. NOT APPLICABLE

NOTE 21. MAXIMUM PERMISSIBLE BLEED AIR EXTRACTION

LOCATION	TEMPERATURE CORRECTED FAN SPEED	FLOW LIMIT
HPC Stage 4	All speeds above minimum idle.	10% of primary airflow*
HPC Stage10	All speeds above minimum idle.	15% of primary airflow*
Bypass Duct	All speeds above minimum idle.	1% of primary airflow

* - Absolute maximum. Refer to the LEAP-1B Installation Manual, for detailed bleed schedules.

NOTE 22. NOT APPLICABLE

NOTE 23. EXHAUST EMISSIONS AND FUEL VENTING

The following emissions standards promulgated in 14 CFR Part 34, Amendment 5A, effective October 23, 2013, and 40 CFR Part 87, effective October 31, 2012, have been complied with for the LEAP-1B28 and LEAP-1B28B2.

Fuel Venting Emission Standards: 14 CFR 34.10(a) and 34.11 ; in addition, 40 CFR 87.10(a) and 87.11.

Smoke Number (SN) Emission Standards: 14 CFR 34.21 (e)(2); in addition, 40 CFR 87.23(c)(1).

Carbon Monoxide (CO) Emission Standards: 14 CFR 34.21(d)(1)(ii); in addition, 40 CFR 87.23(c)(1).

Hydrocarbons (HC) Emission Standards: 14 CFR 34.21(d)(1)(i); in addition, 40 CFR 87.23(c)(1).

Oxides of Nitrogen (NOx) Emission Standards: 14 CFR 34.23(b)(1); in addition, 40 CFR 87.23(c)(3).

In addition to the FAA's finding of compliance based on the certification requirements defined in this TCDS, the engine manufacturer has declared that the ICAO emissions standards identified in Annex 16, Volume II, Third Edition, Part III, Chapter 2, Section 2.2.2 for SN, Section 2.3.2 for CO and HC, Section 2.3.2.e.3 for NOx (also known as CAEP/8), and Part II Chapter 2 for fuel venting have also been demonstrated.

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