IGC-APPROVALS FOR GNSS FLIGHT RECORDERS
followed by
HISTORY OF IGC-APPROVAL ACTIVITIES

Document dated 15 November 2018

Contents

FAI & IGC Web References:

FAI Links to approval documents: www.fai.org/page/igc-documents , then look for "Flight Recorders"

IGC-approved Flight Recorders: as above, then select "IGC-approved Flight Recorders - Approval Documents", then look for "IGC-approval Documents for all IGC-approved Flight Recorders", "IGC Shell Program", "Technical Specification", as required

GFAC web site for FR documents: www.ukiws.demon.co.uk/GFAC

TABLE OF IGC-APPROVED FLIGHT RECORDERS
63 MAIN TYPES
(72 including different models within Types)

The table lists types of IGC-approved Flight Recorder in alphabetical order of Manufacturer.
Production and modification status should be confirmed with the manufacturer. See the notes after the table.

s/n	Manufacturer (alphabetical order)	Type of Recorder	In Production	IGC-approval Levels 1-3 (see note 2 below)	Engine recording System, (see note 1 below)	Date of latest approval document Click to download
1	Aircotec	XC Profi (Gliders)	Yes	1 (All Flights)	Aircotec ENL	30 May 2006
2	Cambridge	CAI 10	No	3 (Badges up to Diamonds)	Cambridge ENL 1	1 October 2012
3	Cambridge	CAI 20	No	3 (Badges up to Diamonds)	Cambridge ENL 1	1 October 2012
4	Cambridge	CAI 25	No	3 (Badges up to Diamonds)	Cambridge ENL 1	1 October 2012
5	Cambridge	CAI 302	No	1 (All Flights)	Cambridge ENL 2	12 April 2007
6	Cambridge	CAI 302A (without display)	No	1 (All Flights)	Cambridge ENL 2	12 April 2007
7	ClearNav Instruments (was Nielsen Kellerman)	ClearNav-IGC Version 1	No	1 (All Flights)	ClearNav ENL	4 November 2017
8	ClearNav Instruments	CNv-IGC	Yes	1 (All Flights)	ClearNav ENL	4 November 2017
9	ClearNav Instruments	ClearNav II	Yes	1 (All Flights)	ClearNav ENL	4 November 2017
10	DSX	T-Advisor (with DSX Traffic Alert function)	Yes	1 (All Flights)	Not fitted	12 April 2008
11	DSX	Tracer (T-advisor without Traffic Alert function)	Yes	1 (All Flights)	Not fitted	12 April 2008
12	DSX	SaFly (with satellite-based tracking system)	Yes	3 (Badges up to Diamonds)	Not fitted	15 Sept 2011
13	EDIATec	ECW100F (Flarm firmware)	Yes	3 (Badges up to Diamonds)	Triadis ENL	14 February 2013
14	EW	microRecorder	Yes	1 (All Flights)	EW ENL	20 Nov 2008
15	FLARM	Flarm-IGC	Yes	3 (Badges up to Diamonds)	Triadis ENL	14 February 2013
16	FLARM	PowerFlarm-IGC	Yes	3 (Badges up to Diamonds)	Triadis ENL	28 February 2013
17	Garrecht	Volkslogger VL1.0	No	1 (All Flights)	Garrecht ENL	20 January 2008
18	IMI	Erixx V1.0	Yes	1 (All Flights)	Not fitted	7 June 2008
19	Logstream	FR1	Yes	1 (All Flights)	Logstream ENL	22 November 2015
20	LXNAV	FlarmMouse (Flarm firmware)	Yes	3 (Badges up to Diamonds)	LXNAV ENL	31 July 2013
21	LXNAV	Nano	Yes	1 (All Flights)	LXNAV ENL	30 April 2014
22	LXNAV	Nano 3 (with screen)	Yes	1 (All Flights)	LXNAV ENL	30 April 2014
23	LXNAV	Nano 4	Yes	1 (All Flights)	LXNAV ENL & internal MOP sensor	12 February 2017
24	LXNAV	LX8000, and LX8000F with extra Flarm function	Yes	1 (All Flights)	LXNAV ENL & optional external MOP sensor	5 October 2015
25	LXNAV	LX8080, and LX8080F with extra Flarm function	Yes	1 (All Flights)	LXNAV ENL & optional external MOP sensor	5 October 2015

26	LXNAV	LX9000, and LX9000F with extra Flarm function	Yes	1 (All Flights)	LXNAV ENL & optional external MOP sensor	5 October 2015
27	LXNAV	LX9000HAFR HAFR=High Altitude Flight Recorder for altitude claims over 15,000 m	Yes	1 (All Flights)	LXNAV ENL	3 August 2016
28	LXNAV	LX9050, and LX9050F with extra Flarm function	Yes	1 (All Flights)	LXNAV ENL & optional external MOP sensor	5 October 2015
29	LXNAV	LX9070, and LX9070F with extra Flarm function	Yes	1 (All Flights)	LXNAV ENL & optional external MOP sensor	5 October 2015
30	LXNAV	PowerMouse-IGC with Flarm firmware	Yes	3 (Badges up to Diamonds)	LXNAV ENL	14 February 2018
31	LXNAV	S-10	Yes	1 (All Flights)	LXNAV ENL	25 April 2016
32	LXNAV	S-100	Yes	1 (All Flights)	LXNAV ENL	25 April 2016
33	LX Navigation	DX50	No	3 (Badges up to Diamonds)	Not fitted	1 October 2013
34	LX Navigation	Flarm Eagle & Flarm Eagle Mobile	Yes	3 (Badges up to Diamonds)	LXN ENL	15 November 2018
35	LX Navigation	LX20 with RSA (Hardware V3 & later)	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
36	LX Navigation	LX20-2000	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
37	LX Navigation	LX21	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
38	LX Navigation	LX5000IGC	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
39	LX Navigation	LX7000	No	1 (All Flights)	LXN ENL	22 January 2012
40	LX Navigation	LX7007, and 7007F with extra Flarm function	Yes	1 (All Flights)	LXN ENL	22 January 2012
41	LX Navigation	LX Colibri V1/4 with Firmware up to V7	No	3 (Badges up to Diamonds)	LXN ENL	5 November 2012
42	LX Navigation	LX Colibri V1/4 with Firmware V8 and later	Yes	2 (All Badges & Distance Diplomas)	LXN ENL	1 October 2013
43	LX Navigation	LX Colibri II	Yes	1 (All Flights)	LXN ENL	1 October 2012
44	LX Navigation	LX Colibri X	Yes	1 (All Flights)	LXN ENL	31 August 2018
45	LX Navigation	LX Eos and Eos 80	Yes	1 (All Flights)	LXN ENL & optional external MOP sensor	10 November 2018
46	LX Navigation	LX Era 57 and Era 80	Yes	1 (All Flights)	LXN ENL & optional external MOP sensor	10 November 2018
47	LX Navigation	LX 10000	Yes	1 (All Flights)	LXN ENL & optional external MOP sensor	10 November 2018
48	LX Navigation	LX MOP IGC	Yes	1 (All Flights)	LXN ENL & internal high frequency MOP sensor	16 November 2016
49	LX Navigation	LX Mini Box Flarm-IGC with Flarm firmware	Yes	3 (Badges up to Diamonds)	LXN ENL	31 January 2014
50	LX Navigation	LX Red Box Flarm-IGC with Flarm firmware	Yes	3 (Badges up to Diamonds)	LXN ENL	6 November 2018
51	Naviter	Oudie-IGC	Yes	1 (All Flights)	LXNAV ENL	20 March 2014
52	New Technologies	NTE Easy	Yes	1 (All Flights)	NTE ENL	10 January 2007
53	New Technologies	NTE Easy Matchbox	Yes	1 (All Flights)	NTE ENL	8 August 2005
54	Peschges	VP8	No	2 (All Badges & Distance Diplomas)	Cable to microswitch	1 October 2004
55	PressFinish	GCA-IGC	Yes	1 (All Flights)	PFE ENL	10 April 2015
56	Scheffel	Themi	Yes	2 (All Badges & Distance Diplomas)	Not fitted	5 May 2003
57	Streamline Digital Instruments (SDI)	PosiGraph V1.0	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
58	Streamline Digital Instruments (SDI)	PosiGraph V2	No	3 (Badges up to Diamonds)	LXN ENL	1 October 2013
59	Triadis	Altair RU1	Yes	1 (All Flights)	Triadis ENL	5 May 2013
60	Triadis	Triadis RU2	Yes	2 (All Badges & Distance Diplomas)	Triadis ENL	5 May 2013
61	Triadis	Triadis RU3	Yes	1 (All Flights)	Triadis ENL	5 May 2013
62	Zander	GP940	No	3 (Badges up to Diamonds)	Zander Vibration system	1 October 2013
63	Zander/SDI	GP941	Yes	1 (All Flights)	Zander ENL	10 June 2007
s/n	**FR Manufacturer**	**FR Type**	**Production**	**Approval Level**	**Engine Recording**	**Document Date**

Notes to the table: **Next page**

1. **Engine Recording**. Details on engine recording are in each IGC-approval document, together with figures recorded during GFAC tests.

1.1 IGC ENL System. The Environmental Noise Level (ENL) system is inside the recorder and records acoustic noise, adding three ENL numbers from 000 to 999 to each fix in the IGC file. This system is most sensitive between 100 and 200 Hz and is to detect running of engines such as two-strokes that produce significant noise at the recorder in the cockpit, or for other engines where the recorder is mounted close to the source of engine noise rather than at the front of the cockpit. The ENL system does not require wiring outside the recorder or any other actions by the pilot.

1.2 Low-ENL installations and the extra MOP sensor. Where a recorder and engine installation produces low ENL values that make it difficult to differentiate between some aspects of soaring and when the engine is producing a small amount of forward thrust, there are 2 alternatives: (1) Position the recorder close to the engine, propeller or jet pipe so that high ENL figures are always produced when any forward thrust is produced, or (2) Use a type of recorder that has a separate sensor under the MOP (Means of Propulsion) code so that high MOP is recorded whenever any forward thrust is generated. Some systems have the MOP sensor on a cable connected to the FR that can be placed close to the engine, some have a high-frequency MOP sensor designed for jet engines inside the FR itself. In these cases, three MOP numbers are recorded in the IGC file in addition to ENL, see Annex B to the Sporting Code, para 1.4.2.4.

2. **Flarm Traffic Alert System**. In some of the above recorders, the Flarm (Flight Alarm) traffic alert system is fitted in addition to the main systems of the recorder and is described above as "with extra Flarm function". In other recorders, the named manufacturer makes the case, connectors and other facilites, but the primary firmware is a Flarm module, after-flight validation of IGC files being by the Flarm program IGC-FLA.dll. Such recorders are listed as "with Flarm firmware".

3. **Levels of Approval**. There are three levels of IGC-approval for different types of flight. These are allocated by GFAC at the time of initial IGC-approval, and revised if testing shows different results. They depend on the recorder characteristics, particularly compliance with the IGC FR Specification and security systems (resistance to hacking or data corruption in IGC files). See para 4 for competitions and para 5 on "Grandfather Rights". The definitive rules are in para 1.1.4 of Annex B to the Sporting Code for Gliding.

3.1 Level 1 - All Flights. This applies to Recorders that comply with all of the provisions of the IGC Technical Specification at the time that the approval is first given, and sustain that standard with time.

3.2 Level 2 - All IGC Badges & Distance Diplomas. This applies to types of Recorders that do not fulfil the Specification in a few areas at the time of approval, but it has been decided that they may be given an approval that excludes World Record flights. This level of approval includes all IGC Badges and IGC Distance Diplomas. For competition flights, see para 4 below.

3.3 Level 3 - Diamonds. This is for FAI Silver, Gold and Diamond badge flights only. It is used for types of Recorders that have significant differences from the Specification at the time of approval but it is decided that a limited approval can be given rather than no approval at all. For competition flights, see para 3 below.

4. **Competition Flights**. Annex A to the Sporting Code specifies the use of IGC-approved Recorders in World Championships and other competitions that use Annex A rules. It does not specify the approval level, so all approval levels may be used in Annex A competitions, subject to any local rules. In competitions where Annex A is not used, other rules and procedures may be made by the National AirSport Control (NAC) authority or the competition organizer, but if FR levels differ from those in para 2 above, such competition flights will not be eligible for the appropriate IGC badges, diplomas and records.

4.1 On-Line Competitions (OLCs). An OLC is a "de-centralised competition" in which participants file IGC flight data by email under the rules of the particular OLC organiser. OLCs are not official IGC competitions and their rules may, or may not, conform to IGC criteria such as the Sporting Code for Gliding (SC3) and its Annexes. In an OLC, pilots fly from different sites, unlike a Centralised Competition flown at one site with a common task on each day.

5. **Grandfather Rights and IGC-approval Levels**. The term "Grandfather Rights" describes a system similar to that used in the Regulation of Commercial Air Transport where already-approved clearances are continued after rules and procedures are changed, so that aircraft and equipment in Service does not have to be constantly modified or even grounded while modifications take place. In the case of IGC recorders, approval levels and other provisions are continued even though the Technical Specification is changed (generally, requirements being increased over time). For details, see Annex B of the Sporting Code (SC3B) para 1.1.5.2 or search for "Grandfather Rights". However, where the technical standard of a particular type of Recorder falls well below the current Specification, particularly on security aspects such as low resistance to hacking or production of incorrect IGC files, the IGC-approval level of that type of Recorder may be lowered in accordance with procedures given in Appendix A to SC3B.

IGC-APPROVED FLIGHT RECORDERS - 20 MANUFACTURERS

s/n	Name of Manufacturer (alphabetical order)	Country	Manufacturer's web page	IGC Codes for the Firmware Manufacturer	
				3 letters	1 letter (for short version of IGC file name)
1	Aircotec Flight Instruments	Austria	www.aircotec.at	ACT	I
2	Cambridge Aero Instruments	USA	www.cambridge-aero.com	CAM	C
2	ClearNav Instruments (Nielsen Kellerman for Version 1 FR)	USA	www.clearnav.net	CNI (was NKL)	K
4	DSX Data Swan	Switzerland	www.d-s-x.net	DSX	D
5	EDIATec (uses Flarm Firmware)	Switzerland	www.ediatec.ch	FLA	G
6	EW Avionics	UK	www.ewavionics.com	EWA	E
7	Flarm Technology GmbH	Switzerland	www.flarm.com	FLA	G
8	Garrecht Avionik GmbH	Germany	www.garrecht.com	GCS	A
9	IMI Gliding Equipment	Czech Republic	www.imi-gliding.com	IMI	M
10	Logstream SP z.o.o.	Poland	www.logstream.eu	LGS	Only IGC 3-letter code used
11	LXNAV d.o.o.	Slovenia	www.lxnav.com	LXV	V
12	LX Navigation	Slovenia	www.lxnavigation.com	LXN	L
13	Naviter d.o.o.	Slovenia	www.naviter.com	NAV	Only IGC 3-letter code used
14	New Technologies s.r.l.	Italy	www.ntsrl.it	NTE	N
15	Peschges Variometer GmbH	Germany	www.peschges-variometer.de	PES	P
16	PressFinish Electronics GmbH	Germany	www.pressfinish.de	PFE	Only IGC 3-letter code used
17	Scheffel Automation	Germany	www.themi.de	SCH	H
18	Streamline Digital Instruments (SDI)	Germany	www.sdi-variometer.de	SDI	S
19	Triadis Engineering GmbH	Switzerland	www.triadis.ch	TRI	T
20	Zander Segelflugrechner	Germany	www.zander-variometer.de	ZAN	Z

Note: In previous years other companies such as Filser and Print Technik manufactured GNSS Flight Recorders that were approved at the time, but due to changes in requirements these early FRs are no longer IGC-approved. A chronological record is in Part 2 which gives dates and other details about IGC-approval changes.

PART 2 - DATES OF ISSUE OF IGC-APPROVAL DOCUMENTS

The following IGC-approval documents and updates have been issued on behalf of IGC by the IGC GNSS Flight Recorder Approval Committee (GFAC). This list is in reverse date order, the most recent approvals coming first. To preserve a complete record of Approval activity, the list goes back to the first IGC-approval in January 1996.

15 November 2018 - LX Navigation - addition of Flarm Eagle and Flarm Eagle Mobile
10 November 2018 - LX Navigation - addition of LX 10000, a variant of the LXN Era 80
6 November 2018 - LX Navigation Red Box Flarm - update to references to IGC file header record
31 August 2018 - LX Navigation Colibri X, initial approval
15 April 2018 - LX Navigation - adding Eos 80 and Era 57 and Era 80 models to original Eos approval
14 February 2018 - LXNAV PowerMouse-IGC with Flarm firmware, initial approval

4 November 2017 - ClearNav FRs (3), update with new Company address
12 February 2017 – LXNAV Nano 4, initial approval

16 November 2016 – LX Navigation LX MOP IGC recorder, initial approval
3 August 2016 – LXNAV LX9000HAFR, initial approval. HAFR=High Altitude Flight Recorder, for altitude claims above 15,000 metres
25 April 2016 – LXNAV S-10 and S-100, initial approval

10 December 2015 - LX Navigation Eos, addition of external MOP sensor box for rear-mounted jet and electric engines
22 November 2015 – Logstream FR-1, initial approval
5 October 2015 - LXNAV LX8000 and 9000 series, addition of electric current sensor for gliders with rear-mounted electric engines
10 April 2015 – PressFinish GCA-IGC, initial approval
10 March 2015 – ClearNav Instruments, ClearNav II, initial approval

26 November 2014 – LX Navigation LX Eos, initial approval
30 June 2014 – LXNAV 9050 and 9050F, initial approval
30 April 2014 – LXNAV Nano 3, initial approval
10 April 2014 – ClearNav CNv-IGC, initial approval
20 March 2014 – Naviter Oudie-IGC, initial approval. Also introduction of shorter format in main document.
31 January 2014 – LX Navigation Mini Box Flarm, addition of battery-powered portable version

10 October 2013 – LXNAV LX9000 series, addition of LX9070
1 October 2013 – Changes of Approval level for the LX Navigation DX50, LX20, LX21, LX5000; SDI Posigraph; Zander 940
31 August 2013 – Notice of IGC-approval level changes to take place on 1 October 2013
31 July 2013 – LXNAV FlarmMouse with Flarm-IGC firmware, initial approval.
5 May 2013 – Triadis Recorder Unit 2, initial approval.
5 May 2013 - Also update to LXNAV FRs with the external MOP box for rear-mounted jet and electric engines
31 March 2013 – Triadis Recorder Unit 3 (RU3), initial approval
28 February 2013 – Flarm, Flight Recorder aspects of powerFlarm-IGC, initial approval
14 February 2013 – Update to FLARM-IGC recorder and others using it as the main recorder module.
`These are the Ediatec ECW100F, and the LX Navigation Mini-Box Flarm and Red Box Flarm

5 October 2012 - LX Navigaton Colibri approval updated with Hardware and Firmware versions for Models 1 & 4.
1 October 2012 - Changes as a result of the 2011 ANDS/GFAC Security paper, approved by the Bureau & 2012 IGC Plenary:
Reductions in IGC-approval levels: Cambridge 10, 20, 25, Filser/LXN DX50, Filser/LXN LX20 (with RSA192), Filser/LXN LX21, Filser/LXN LX5000 IGC, LXN Colibri 1, SDI/LXN Posigraph, Zander GP940.
Withdrawal of IGC-approval due to low security: EW FR A-D with separate GPS receiver (no viable security), Filser/LXN LX20 batch 1 without RSA (also hacked), Print Technik GR 1000/1000A (keys revealed).
10 August 2012 – Notice of the changes to take place on 1 October 2012 (see above)
29 May 2012 – Security update to EDIATEC ECW100F, LX Navigation Mini Box and Red Box Flarm
15 May 2012 - Flarm-IGC security warning
31 January 2012 - LXNAV LX8000 and 8000F, addition of MOP box for jet-engined motor gliders
22 January 2012 – LX Navigation LX7007FC, initial approval
10 January 2012 – LXNAV LX9000, addition of MOP box for jet-engined motor gliders

20 November 2011 – LX Navigation Colibri II, initial approval
31 October 2011 – LXNAV LX8080F, addition of MOP box for jet-engined motor gliders
31 August 2011 – DSX SaFly, initial approval issued
20 April 2011 – ClearNav-IGC, name change from Nielsen Kellerman
14 March 2011 – LXNAV LX8080F, initial approval issued

31 August 2010 – LXNAV Nano, initial approval issued
30 June 2010 – LX Navigation Mini Box Flarm and Red Box Flarm, addition of ENL system
14 June 2010 – LXNAV LX9000, initial approval issued
25 April 2010 – EWA Models A-D approval. Garmin GPS60 added, also the list of stand-alone GPS receivers permitted for use with the EW series are now in a separate, smaller document as Annex C to the main IGC-approval.
28 February 2010 – Zander GP940 approval changed to allow airborne engine run rather than only a ground run.

25 May 2009 – Nielsen Kellerman ClearNav-IGC, Version 1 of IGC-approval document issued
14 February 2009 – Triadis Altair V1.0, Version 1 of IGC-approval document issued

20 November 2008 – EW microRecorder – update to allow for low ENL readings in quiet flight
31 August 2008 – LXN Mini Box Flarm-IGC, Version 1 of IGC-approval document issued, to "Diamonds" level.
31 August 2008 – LXN Red Box Flarm-IGC, Version 1 of IGC-approval document issued, to "Diamonds" level.
14 June 2008 – EDIATec ECW100F, Version 1 of IGC-approval document issued, to "Diamonds" level.
7 June 2008 – IMI Erixx V1.0, Version 1 of IGC-approval document issued
25 April 2008 – LXN LX8000 and LX8000F, Version 1 of IGC-approval document issued
12 April 2008 – DSX 7100 T-Advisor series and DSX 8000 Tracer series, Version 1 of IGC-approval document issued

10 March 2008 – Flarm-IGC V1.0, Version 1 of IGC-approval document issued, to "Diamonds" level.
20 February 2008 – LXN (ex Filser) DX50, LX20, LX21, LX5000IGC update and change of name from Filser to LXN
20 January 2008 – Garrecht Volkslogger, update of wording

30 April 2007 – Cambridge 10, 20 & 25 updated
12 April 2007 – Cambridge 302 series updated
31 March 2007 – LXN Colibri 4F with Flarm, Version 1 of IGC-approval document issued
10 January 2007 – NT Easy, Version 1 of IGC-approval document issued

20 November 2006 – EW microRecorder, addition of EW engine noise recording system
20 August 2006 - Zander/SDI GP941, amendment with Firmware 2.11 on time recording
10 June 2006 - EW microRecorder, Version 1 of IGC-approval document issued
30 May 2006 - Aircotec XC Profi (Gliders), Version 1 of IGC-approval document issued
17 March 2006 - LXN 7007F with uBLOX board and internal FLARM module
24 February 2006 - LXN Colibri model 4 with uBLOX GPS receiver board

8 August 2005 - New Technologies (NTE) Easy Matchbox, Version 1 of IGC-approval document
20 July 2005 - LX Navigation LX7000 series, Version 2 with addition of LX7007
20 June 2005 - LX Navigation Colibri, addition of Colibri Version 4.
10 April 2005 - EW Models A-D, update of manufacturer details
10 April 2005 - Cambridge 10, 20 & 25, update of manufacturer details and notice of change of IGC-approval level.

1 October 2004 - PrintTechnik GR1000 and GR1000A Issue 3
1 October 2004 - Filser LX20 Issue 5
1 October 2004 - Peschges VP8 Edition 2A
20 September 2004 - Zander 940 Issue 2
12 September 2004 - Cambridge 10, 20 & 25, Issue 5
28 March 2004 - Cambridge 10, 20 & 25, Issue 4A
28 March 2004 - Filser LX20 Issue 5A
28 March 2004 - Peschges VP8 Edition 2
28 March 2004 - Prink Technik GR1000 Issue 2
1 February 2004 - LX Navigation LX20, "all badges" level for early standard without micro & RSA
1 January 2004 - Cambridge (Martinsville) 10/20/25 and 302 series withdrawn (company out of business)

25 November 2003 - Cambridge (Horn Lake) 10/20/25 and 302 series with Horn Lake address
25 November 2003 - Cambridge (Martinsville) 10/20/25 and 302 series with new manufacturer codes
25 August 2003 - Cambridge (Martinsville) 302 series, addition of simpler 302A model.
20 May 2003 - Cambridge (Martinsville) 10, 20 and 25, update to approval document
5 May 2003 - Scheffel Themi increased from Diamonds to "all badges" level
14 March 2003 - LX Navigation LX7000, new type of recorder, Version 1 of IGC-approval document issued
14 February 2003 - SDI Posigraph, introduction of Model 2
12 February 2003 - Zander/SDI GP941, introduction of A model with GPS15 board.
13 January 2003 - Cambridge (Martinsville) 302 series, introduction of ENL system

31 October 2002 - Scheffel Themi, Version 1 of IGC-approval document issued, to "Diamonds" level.
20 October 2002 - LX5000IGC, addition of 2002 model LX5000IGC-2 with higher resolution screen and extra button.

10 December 2001, updated approval documents issued for the following 5 types:
Filser DX50, Filser LX20, Filser LX5000IGC, LX Navigation Colibri, SDI PosiGraph
30 October 2001 - Cambridge 302, Version 1 of IGC-approval document issued
30 October 2001 - Zander/SDI GP941, Version 1 of IGC-approval document issued
25 May 2001 - Specification amendment 4 adds the IGC Shell Program and FR Manufacturers DLL files, designed by GFAC member Marc Ramsey

15 May 2000 - Filser LX5000IGC series, addition of LX5000IGC-2 and update of earlier approvals.
21 Mar 2000 - Filser LX20, Version 3 including the LX20-2000 and updated wording
10 Mar 2000 - Amendment 3 to EWFR approval to add 2 new Garmin GPS units

19 Nov 99 - Amendment 2 to EWFR approval to add 5 new Garmin GPS units.
21 Jun 99 - Cambridge Issue 3 Including Pilot Event (PEV) Function and the Palm-Nav Display.
10 May 99 - Garrecht Volkslogger Model Vl1.0, Issue 2 including Motor Glider ENL Function
8 Mar 99 - Streamline Digital Instruments (SDI, Germany) PosiGraph Model 1.0, Version 1 of IGC-approval
29 Jan 99 - Amendment 1 to EWFR approval to add new Model D with improved memory.

16 Nov 98 - Filser DX50, Amendment 1 to allow for three tube static pressure system.
26 Oct 98 - LX Navigation Colibri 1.0, Issue 2 with ENL recording
31 Aug 98 - LX Navigation Colibri 1.0 Version 1 of IGC-approval document issued
24 Aug 98 - Issue 2 of EWFR approval to add model C, add additional Garmin GPS units, update the wording.
30 Jun 98 - Filser LX5000IGC, Version 1 of IGC-approval document issued
19 May 98 - Filser DX50, Version 1 of IGC-approval document issued
24 Apr 98 - Filser LX21, Version 1 of IGC-approval document issued
3 Apr 98 - Garrecht Volkslogger VL1.0, Version 1 of IGC-approval document issued

20 Jul 97 - Cambridge 10, 20, 25; Version 2 Approval, adding a 12 channel RX, variable time fixing, updated wording.
13 May 97 - Amendment to EWFR A/B approval to add Garmin 12XL to list of approved stand-alone GPS units.
19 Apr 97 - EW "EWFR A & B" for badges up to and including Diamonds, when connected by cable to one of a list of approved GPS units
25 Mar 97 - Filser LX20 Version 2 Approval, with the addition of motor glider engine recording
20 Mar 97 - Print Technik GR1000, Version 1 of IGC-approval document issued

10 Nov 96 - Zander GP940, Version 1 of IGC-approval document issued
12 Aug 96 - Filser LX20, Version 1 of IGC-approval document issued
31 May 96 - Peschges VP8, Version 1 of IGC-approval document issued
16 Jan 96 - Cambridge Models 10, 20 and 25, Version 1 of IGC-approval document issued

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PART 3 - HISTORY OF GNSS AND ITS USE IN IGC

Contents: *Definitions and descriptions –*
GNSS, General Principles of GNSS operation.GPS/NAVSTAR, Beidou 2, Galileo, GLONASS

1987-1991	*Early IGC Discussions*
1992	*first commercial GPS recorder*
1993	*Electronic Barographs with GPS input*
1993	*World Gliding Championships in Borlange, Sweden*
1994	*GPS Recorder for Omarama Worlds.*
1993-94	*Development of the IGC flight data standard*
1995	*January - New Zealand World Gliding Championships*
1995	*March - IGC GFA Committee formed*
1995-96	*Testing, issue of first IGC-approvals*
1996 - now	*Annual Reports on GNSS Recording*
2012	*GFAC receives FAI Group Diploma*

GNSS = Global Navigation Satellite System, the generic term for the specific systems described below.

Principle of operation – US GPS. This para describes the US NAVSTAR/GPS system. Other satellite navigation systems use similar principles although details such as frequencies and orbits will differ. A GPS receiver on the ground records the very small time-differences between transmissions at about 1500 MHz from the array of GPS satellites that are in view above the horizon at any one time. The satellites are in an orbit 55 degrees oblique to the equator at an altitude of about 20,200 km. 24 satellites are normally active at any one time with some in-orbit reserves (their transmission state is controlled from the ground). Each satellite has an atomic clock accurate to better than a nanosecond and its accuracy is monitored from the ground and updated as necessary. Due to earth shielding, a maximum of up to 12 transmitting satellites can be in view to a receiver at any one time. The exact number depends on where the receiver is placed on or near the earth's surface. Terrain shielding reduces the number of satellites in view, as do receivers at latitudes over the 55 degree GPS satellite orbit. Because a GPS receiver is constantly updated with data on the satellite orbits, it knows the exact position in space from which a satellite transmits a signal. When the signal is received, the time-difference from when it was transmitted is a measure of the distance between the satellite and the receiver. The time-differences from several satellites provide lines-of-position which are used by the receiver's computer to calculate the Most Probable Position (MPP). In receivers with 12 or more channels operating on the ground in mid-latitudes, between 6 and 8 satellite position lines are typical for an individual fix. With sensitive receivers, good antenna layouts and a clear horizon, 12 satellites have been observed to be locked on as far north as 51 degrees. A brief description of some GNSS systems follows, followed by a history of GNSS recording in IGC.

GPS/NAVSTAR. In 1973, the US Department of Defense (DoD) decided to develop the NAVSTAR system (NAVigation System for Timing And Ranging), commonly referred to as GPS (Global Positioning System). From 1978, Block 1 GPS satellites were launched and the system first came on line in January 1980. It was initially for military use with receivers that had special codes to access the data. Later, civil GPS receivers were produced for general use but these were subject to a deliberate reduction in accuracy by the GPS controlling authority. The authority was originally the US Department of Defense (DoD) and later the US Department of Transportation (DoT) was added. The accuracy reduction was so that the military receivers would always have more accurate data and also that civilian receivers were less likely to be used for undesirable purposes such as disruption or terrorism. The accuracy-reduction system was called "Selective Availability" (SA) and used a random short-term variation (wobble) of the timebase. Average error in lat/long for civilian receivers in these early days was measured by GFAC at about 50 metres for single fixes, reducing to about 40 metres as improved 12-channel receivers came on the market. Errors were recorded from a moving vehicle using several accurately-surveyed points on the ground at about 51N 001W and the overall average with SA was 44 m. When the SA system was withdrawn on 1 May 2000, GFAC accuracy results improved substantially, showing an average error at the end of 2000 of about 13m. Since then, average errors have improved to between 11 and 12m. The is due to improved processing within receiver boards, and the increased number of satellites whose data can be processed for each fix. The GPS system is updated as new satellites are put in orbit and old ones taken off-line.

Accuracy enhancement systems. Enhancements to basic system accuracy are provided by regional Satellite-Based Augmentation Systems (SBAS). These increase accuracy by monitoring errors at ground stations in the area concerned and making corrections available to compatible receivers. Such systems in service include WAAS (North America) and EGNOS (Europe). Other SBAS systems include BeiDou 1 (China), GAGAN (India) and MSAS (Japan). A Ground-Based Augmentation System (GBAS) has been developed in Australia.

BeiDou 2 (original name "Compass"). This is the GNSS of the Peoples Republic of China (PRC) and in 2017, 23 satellites were in orbit. BeiDou2 is planned to have 35 satellites, 30 in elliptical orbit and 5 geostationary.
See: http://en.wikipedia.org/wiki/Beidou_navigation_system

Galileo. The European Galileo project was launched in May 2002 under EU Council Regulation EC 876/2002. There are to be 30 satellites at an altitude of about 22,200 km, in three groups at an orbital plane of 56 degrees. Galileo will under civil control and is intended to be interoperable with the Russian GLONASS and US GPS systems. In 2016, twelve satellites had been launched, giving an Initial Operational Capability (IOC).
See: http://en.wikipedia.org/wiki/Galileo_(satellite_navigation)
and http://ec.europa.eu/enterprise/policies/satnav/galileo/index_en.htm

GLONASS. The Russian GNSS system, the initials standing for GLObal'naya NAvigatsionnaya Sputnikovaya Sistema (GLObal NAvigation Satellite System). The first satellite was launched in October 1982 and a full Constellation completed in 1995. Since then, agreements have been made that bring the technical standards of the US GPS system and GLONASS to a similar level so that receivers can more easily process both systems. In 2017, 27 satellites were in orbit of which 24 are operational at any one time. See www.glonass-ianc.rsa.ru and http://en.wikipedia.org/wiki/GLONASS

USE OF GNSS IN GLIDING

1987-1991 - Early Discussions and Development. In 1987, discussions were held by the IGC Championships sub-committee on the potential use of GPS flight recorders for validation of flights and for display of position.

In 1991, Dr David Ellis of Cambridge Aero Instruments of Vermont, USA, presented a paper on GPS recording to the OSTIV Conference in Uvalde, USA, the site of the World Gliding Championships. This paper was based on GPS flight recordings made in April 1991 using equipment loaned to Cambridge by a development engineer at Trimble Navigation. Flights were made from Palo Alto airport in California with a Cessna 172 and demonstrated the feasibility of GPS recordings.

Also at Uvalde in 1991 were Alf Ingesson-Thoor and John Roake, the Directors of the future World Championships in 1993 at Borlange, Sweden, and in 1995 at Omarama, New Zealand. Bernald Smith (USA), then a Vice-President of IGC, heard Ellis' presentation and became an advocate of GPS recording. John and Alf then had meetings with Dave Ellis with a view to using GPS recording in future World Championships. At Uvalde, Bernald was responsible for photo evaluation and in a presentation described the work of his 15-person team, and said that if GPS recording could succeed, such a large team would not be required. Also, Bernald Smith and John Roake were particularly concerned with the problems of photo evaluation from wave flights at altitudes such as 20,000ft at the future 1995 WGC in New Zealand. Following the Uvalde OSTIV conference, Cambridge Aero Instruments produced a recording system consisting of a Garmin GPS-10 engine and a HP-95 pocket calculator. This was flown by John Good (USA) in a gliding competition at Matamata, New Zealand, in February 1992.

1992 - first commercial GPS recorder on the gliding market. A GPS recorder was developed by avionics supplier RD Aviation Ltd., of Oxford, UK. This was to a specification by its Managing Director Dickie Feakes, a UK glider pilot since the mid 1950s. This "RD Logger" was connected by cable to a stand-alone GPS receiver such as one of the Garmin range and was a simple memory module with no pressure altitude sensor or built-in security. The format of its data output was an ASCII file with the suffix "dat", short for data. The software compiler of this so-called "dot.dat" format was Vince May, the founder and owner of the UK company Skyforce, with inputs from Phil Jeffrey of the BGA Competitions Committee. The DAT format was later developed into the IGC data format that we use today. In 1992 the recorder was sold and badged by RD Aviation and in 1993 by Skyforce as the "Skyforce Logger".

1993 – Electronic Barographs with GPS input. Two companies that had been producing electronic barographs, in 1993 developed versions with larger memory that could connect to a Garmin GPS receiver unit and record GPS fixes as well as pressure altitude. These companies were EW Avionics (UK, MD Wayne Richards) and Borgelt Instruments (Australia, MD Mike Borgelt).

1993 – Borlange World Gliding Championships. Trials supervised by Bernald Smith on behalf of IGC were made during the World Championships in Borlange, Sweden, using prototypes supplied free of charge to IGC from Dr Ellis' Cambridge Aero Instruments company in Vermont, USA. For the next Worlds in New Zealand, Director John Roake sent specifications to a number of manufacturers for GPS recorders to be used for scoring the Championships. The equipment was to be rented to pilots, not sold to the organizers, and was to be tested first in the next New Zealand Nationals and the "Kiwiglide" pre-world competition. Cambridge made a bid along these lines with a rental price of US$200 per recorder, which was accepted.

1994 - GPS Recorder for Omarama World Gliding Championships. In 1994, IGC approved the use of the Cambridge design of recorder as the primary system for scoring the World Championships in 1995. This was after the tests mentioned above of 15 pre-production Cambridge Model 10 recorders in the 1994 New Zealand Nationals and 30 in the later pre-worlds ("KiwiGlide"). This IGC decision for the first time gave priority to GPS recording over photographic evidence. This recorder design, which became the Cambridge Model 10, included pressure altitude recording, physical and electronic security, and had the GPS receiver and memory units in one sealed case. This was different to the earlier Borgelt, EW and RD/Skyforce designs that were connected by cable to a separate GPS receiver such as by Garmin. IGC was particularly sensitive to security issues after a case of cheating on photographic evidence at Borlange had resulted in a pilot being sent home. The Cambridge system used a microswitch to show whether the case had been opened and an electronic checksum system was able to check whether the output data file was un-altered and valid to IGC data standards. Cambridge was to deliver the recorders for hire at Omarama in January 1995 to all championships pilots. These were stand-alone units with a large internal battery so that no changes to glider avionics or wiring would be required other than the need for the GPS antenna to be in a good position to receive signals.

1993-94 - Development of the IGC flight data standard. The IGC ASCII data format was developed during 1993 and 1994 from the BGA "dot.dat" format by a group of experts led by Bob Fletcher in the USA (then General Manager of Cambridge Aero

Instruments) and Hans Trautenberg in Europe. The initial version of this data format was finalised by October 1994, used in the New Zealand world championships in January 1995, and was included in the new Annex B to the Sporting Code that was approved by IGC in March 1995. The original IGC file suffix was "GPS" but this was considered by the IGC GFA Committee to be too general and was changed to "IGC" later in 1995.

1995 - January - New Zealand World Gliding Championships. In January 1995 the World Gliding Championships were held at Omarama in New Zealand with John Roake as Director. Cambridge supplied all competitors with early versions of what would become their model 10 recorder, for which the software writer was John Good. This was the first time GPS recording had been used for scoring purposes in a World Championship. The Chairman of the IGC GNSS Committee, Bernald Smith, independently checked the GPS recorder results on behalf of IGC with a view to their future use for other flights to IGC/FAI criteria.

1995 - January-March - Development of IGC procedures on GNSS recording. IGC officials at the New Zealand championships assessed the GPS recording in the championships as a success, and asked other IGC committees and technical experts to draft a definitive set of rules for more general use of GPS recorders in world gliding. The next IGC Plenary was only 6 weeks away on 17 and 18 March 1995 so this was a difficult task. The option of delaying until the next IGC Plenary was not really practical as this would have resulted in a delay of a further 12 months during which criticism would build up from those who wished to develop and use the new technology. Ian Strachan, then Sporting Code editor working for Tor Johannessen, had the task of making an initial draft and co-ordinating suggested changes. Fortunately he had some GPS knowledge, having previously tested some GPS recorders and been the author of an article on GPS recording in the UK magazine "Sailplane and Gliding". Bernald Smith, then Chairman of the IGC GNSS Committee, also took part in this process and drafted chapter 1 of the new IGC document. Intensive effort followed including the circulation of several drafts of IGC rules and procedures. A meeting was held on 15 March 1995 in Paris between IGC people including Bernald Smith and Ian Strachan, and potential recorder manufacturers. These activities resulted in a draft for a new Annex B to the Sporting Code for Gliding, in time to be approved by the IGC Plenary on 18 March 1995.

1995 - March - start of the IGC GFA Committee. The IGC GNSS Flight Recorder Approval Committee (GFAC) was formed on 18 March 1995 at the same time that IGC approved the issue of the first edition of Annex B to the Sporting Code for Gliding. The first members of GFAC were Angel Casado (Spain), Arnie Hartley (Australia), Ian Strachan (UK), Kilian Grefen (Germany) and Mike Strang (USA). Shortly after, Ian Strachan was elected by the others as Chairman. The new Annex B to the Sporting Code gave GFAC the authority to test and evaluate GNSS Flight Recorders on behalf of IGC and to draw up and issue documents giving IGC-approval for the use of such recorders for validating flights to IGC standards of evidence.

1995-96 - Testing and issue of first IGC-approvals. The first types of recorder were submitted to GFAC for testing later in 1995 were the Cambridge Models 10, 20 and 25 and the first IGC-approval documents were issued in January 1996. The Model 10 was the commercial version of those that were used in the Omarama Worlds in January 1995. Models 20 and 25 were developed during 1995 and were smaller units that needed external power rather than having the large internal battery of the Model 10. As well as built-in security, these could all store pre-flight declarations and a list of turn points. In addition, a separate screen could be connected by cable to display position, range to selected points, and other data.

After the IGC-approval of the Cambridge 10, 20 and 25, other testing and approvals in 1996 were for, in chronological order, the Peschges VP8, Filser LX20 and Zander GP940. For later GFAC activity, see the table in Part 2 above.

Motor Glider Engine Recording. During 1995, Cambridge developed the Environmental Noise Level (ENL) system in which a microphone inside the FR detects acoustic noise and ENL numbers between 000 and 999 are added to each fix in the IGC file. This is so that the use of engine in motor gliders can be recorded without needing wires outside the recorder case. This system was fitted to the three types of Cambridge FRs that were approved in January 1996. Other FR manufacturer's systems for recording use of engine used wires connected to microswitches on the engine doors or pylon, or a sensor to record vibrations when the recorder is connected to part of the glider structure that vibrates when the engine is run. However, there were problems with wire- and vibration-based systems and an ENL system inside the FR soon became the IGC standard. Later, to allow for quiet electric engines, and jet engines with a high noise frequency, provision for an additional external MOP (Means-of-Propulsion) sensor that could be placed close to the engine, was added to the FR Technical Specification.

1997 to the Present Day - Technical Specification for IGC-approved GNSS FRs. After GFAC had gained experience of early types of FRs, in October 1997 the first edition of an IGC Technical Specification was issued so that characteristics of future FRs, their security, and the structure of their IGC files would be to a similar standard. The Specification is updated regularly and a Second Edition was issued in 2010, to which regular updates are made.

1996 to the Present Day - Reports. The GFAC Chairman makes a presentation to the annual IGC Plenary meeting and a written report is published in the Plenary agenda. These reports, when combined with IGC-approval documents listed in Part 2 above, give an account of the work that has been carried out by GFAC on behalf of IGC.

Other FAI Air Sports. After the initial IGC system was seen to be working well and had been publicised at FAI Conferences, several other FAI Air Sports started to use the IGC Flight Recorder system for their competitions and records.

2012. In 2012 the IGC GFA Committee was awarded one of the FAI Group Diplomas for their work on behalf of Sport Aviation.

Current FR Numbers, Names, Characteristics. Listed in the table at the beginning of this document.
