



DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Small/Micro Identification Friend or Foe (IFF) Transponder Survey

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ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense information analysis center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

DSIAC serves as the national clearinghouse for worldwide scientific and technical information for weapon systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. We collect, analyze, synthesize, and disseminate related technical information and data for each of these focus areas.

A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit www.DSIAC.org.

ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) worked with Georgia Tech Research Institute and various transponder manufacturers to survey and catalog small and micro-sized identification friend or foe (IFF) transponders that could be candidates for use in small (i.e., Group 1) unmanned aerial vehicles. The smallest of these transponders weighs only a few ounces and occupies only a few cubic inches of volume. DSIAC generated a response document that catalogs over 20 IFF transponders.

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1.0 TI Request

1.1 INQUIRY

What small/micro identification friend or foe (IFF) transponders could be used in small (i.e., Group 1) unmanned aerial vehicles (UAVs)?

1.2 DESCRIPTION

Group 1, Class 1 UAV systems require IFF systems with capabilities similar to those of IFF systems used in larger UAV and fixed-/rotary-wing U.S. Navy platforms.

The inquirer requested information on existing companies, Department of Defense (DoD)/National Laboratories, North Atlantic Treaty Organization (NATO), industry, and academia organizations working in the technically challenging area of UAV IFF systems. The inquirer was particularly interested in organizations working on small, form-factor interrogation Mode 5 and crypto-capable IFF system technologies at a relatively high Technology Readiness Level.

2.0 TI Response

The Defense Systems Information Analysis Center (DSIAC) staff and subject matter experts from SURVICE Engineering and Georgia Tech Research Institute (GTRI) surveyed open sources (e.g., websites, fact sheets, etc.) and contacted multiple DoD, industry, and academia organizations to gather information on IFF systems with relatively small form factors, weighing 5 lbs or less.

Where available, information on modes supported, cryptographic encoding compatibility, and existing certifications was documented. DSIAC staff compiled a table of 22 IFF systems weighing 0.04–6 lbs, with volumes of 0.7–154 cubic inches (shown later in Table 2).^{*} Table 1 provides information on transponder modes, and Table 2 includes details on the 22 IFF transponders documented by DSIAC. Table 2 can be requested in a Microsoft Excel format that includes additional information not available in this report.

Eleven of the IFF systems documented in Table 2 are Mode 5 and crypto capable, weigh 0.3–6.0 lbs, and have volumes of 2–154 cubic inches. In most cases, a crypto applique (CA) was required to provide encryption capabilities. With the CA added, the 11 systems range in weight from 1–7 lbs and have volumes of 3–169 cubic inches. The smallest system, the R Cubed Engineering Micro Trx, does not require a CA, weighs only 1.0 lb, and has a volume of 2.1 cubic inches [1–4].

^{*} Information on the BAE AN/APX-123(V) Common Transponder (i.e., the common IFF transponder used in fighter aircraft), which weighs 12.0 lbs and has a volume of 242 cubic inches, is provided for comparison in Table 2 [5].

Table 1: Aviation Transponder Interrogation Modes

Military Mode	Civilian Mode	Description
1	—	Provides a two-digit, 5-bit mission code (cockpit selectable).
2	—	Provides a four-digit octal unit code (set on ground for fighters; can be changed in flight by transport aircraft).
3	A	Provides a four-digit octal identification code for the aircraft. It is set in the cockpit but assigned by the air traffic controller. Mode 3/A is often combined with Mode C to provide altitude information as well.
	C	Provides the aircraft's pressure altitude and is usually combined with Mode 3/A to provide a combination of a four-digit octal code and altitude as Mode 3 A/C, often referred to as Mode A and C.
4	—	Provides a three-pulse reply; delay is based on the encrypted challenge.
5	—	Provides a cryptographically secured version of Mode S and Automatic Dependent Surveillance-Broadcast (ADS-B) [†] global positioning system (GPS) position.
S		Provides multiple information formats to a selective interrogation. Each aircraft is assigned a fixed, 24-bit address.

[†]ADS-B: Aircraft self-report their GPS location in a networked environment.

- Automatic: Properly equipped aircraft automatically report their position without the need for a radar interrogation.
- Dependent: ADS-B depends on aircraft having an approved Wide Area Augmentation System (WAAS) GPS on board and an ADS-B out transmitter.
- Surveillance: Surveillance technology that allows Air Traffic Control (ATC) to monitor airplane movement.
- Broadcast: Aircraft broadcast their position information to airplanes and ATC.

Table 2: Small to Micro IFF Transponder Survey [1–22]

IFF Manufacturer & Name		Modes Available [‡]						Characteristics											Existing Certifications					Other					
Company	Nomenclature	1	2	3A	3C	4	5	S/ADS-B In/Out	Peak Power Out [§] (W)	Weight (lbs)	Length (inch)	Width (inch)	Height (inch)	Volume (cu. inch)	Crypto Capable	Requires Crypto Applique (CA)	Crypto Applique Weight ^{**} (lbs)	Crypto Applique Volume (cu. inch)	Total Weight (lbs)	Total Volume (inch ³)	AIMS	ETSO ^{**}	FAA ^{**}	NSA ^{§§}	STANAG ^{***}	Currently Integrated on	Unit Cost (USD)	Notes	
AIR Avionics [6]	VT-01 ultra-compact	—	—	—	—	—	—	Yes	220	1.30	6.69	2.42	2.42	39.18	No	Not CA Compat.	—	—	1.30	39.18	—	Yes	—	—	—	—	—	\$1,950	ADS-B/Mode-S only. No Mode 4/5 capability.
BAE Systems [5]	AN/APX-123	Yes	Yes	Yes	Yes	Yes	Yes	Yes	500	12.00	5.38	5.38	8.38	241.96	Yes	No	—	—	12.00	241.96	Yes	—	Yes	Yes	—	Manned aircraft	\$35,000	Current manned aircraft transponder.	
BAE Systems [7]	AN/DPX-7 (with GPS)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	500	6.00	5.38	5.38	4.00	115.56	Yes	Yes	1.00	14.90	7.00	130.46	Yes	—	Yes	Yes	—	New smaller unit	—	Current, smaller-sized unit for UAS and small aircraft; Raytheon KIV-77 Crypto Applique ^{***}	
Intelligent Automation [8]	Micro Trx	Yes	Yes	Yes	Yes	Yes	Yes	Yes	250	1.00	1.62	3.28	0.63	3.35	Yes	No	—	—	1.00	3.35	—	—	—	—	—	SBIR II	—	Embedded crypto; Small Business Innovation Research (SBIR) N142-102, Phase I & II [2, 3].	
Leonardo [9]	M428	Yes	Yes	Yes	Yes	Yes	Yes	Yes	500	5.50	4.88	3.31	7.87	127.12	Yes	Yes	1.10	21.20	6.60	148.32	Yes	—	—	—	Yes	Manned aircraft	—	Current manned aircraft transponder; Leonardo SIT2010 Crypto Applique. ^{***}	
Micro Systems Inc. [10]	MD500L	Yes	Yes	Yes	Yes	—	—	—	500	4.00	5.00	5.13	2.52	64.64	No	Not CA Compat.	—	—	4.00	64.64	—	—	Yes	—	—	—	—	—	No Mode 4/5 capability.
Naval Air Warfare Center Aircraft Division 4.11.2 [11]	Organic transponder	Yes	Yes	Yes	Yes	Yes	Yes	Yes	157	2.00	3.50	4.25	2.70	40.16	Yes	Yes	0.00	0.00	2.00	40.16	—	—	—	Yes	—	Prototype	\$12,000	Integrated with KIV-77.	
R Cubed Engineering [1–4]	Micro Trx	Yes	Yes	Yes	Yes	Yes	Yes	Yes	500	1.00	3.50	2.00	0.30	2.10	Yes	No	—	—	1.00	2.10	—	—	—	—	—	SBIR II	—	Embedded crypto; SBIR N142-102, Phase I & II, [2, 3]; also see SBIR Phase I, A3.02, [4].	
Raytheon (Korean Air) [12]	Mini XP Mark IIA Trx	Yes	Yes	Yes	Yes	Yes	Yes	Yes	150	5.00	—	—	—	100.00	Yes	Yes	1.00	14.90	6.00	114.90	—	—	—	Yes	—	Korean Air Lines UAS	—	Requires KIV-77 CA. ^{***}	
Sagotech [13]	MX12A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	316	0.33	3.30	2.40	0.91	7.21	Yes	Yes	1.00	14.90	1.33	22.11	Yes	—	Yes	—	—	Certified units were to be shipped late 2018	—	SBIR N142-02, Phase I [3], noncertified MXS and MXS-G Mode S/ADS-B variants now available. Certified MXS and MXS-G units were to be shipped mid-2018. Certified MX12 units were to be shipped late 2018.	
Sagotech [13]	MX12A-G (with GPS)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	316	0.51	3.30	2.40	0.91	7.21	Yes	Yes	1.00	14.90	1.51	22.11	Yes	—	Yes	—	—	Certified units were to be shipped late 2018	\$16,675	SBIR N142-02, Phase I [3], noncertified MXS and MXS-G Mode S/ADS-B variants now available. Certified MXS and MXS-G units were to be shipped mid-2018. Certified MX12 units were to be shipped late 2018.	
Sagotech [13]	MXS	—	—	Yes	Yes	—	—	Yes	316	0.33	3.30	2.40	0.91	7.21	No	Not CA Compat.	—	—	0.33	7.21	—	—	Yes	—	—	Certified units were to be shipped mid-2018	\$6,100	SBIR N142-02, Phase I [3], noncertified MXS and MXS-G Mode S/ADS-B variants now available. Certified MXS and MXS-G units were to be shipped mid-2018. Certified MX12 units were to be shipped late 2018.	
Sagotech [13]	MXS-G (with GPS)	—	—	Yes	Yes	—	—	Yes	316	0.51	3.30	2.40	0.91	7.21	No	Not CA Compat.	—	—	0.51	7.21	—	—	Yes	—	—	Certified units were to be shipped mid-2018	\$6,665	SBIR N142-02, Phase I [3], noncertified MXS and MXS-G Mode S/ADS-B variants now available. Certified MXS and MXS-G units were to be shipped mid-2018. Certified MX12 units were to be shipped late 2018.	
Sagotech [14]	XPC-TR	—	—	Yes	Yes	—	—	—	250	0.22	3.50	1.80	0.70	4.41	No	Not CA Compat.	—	—	0.22	4.41	Yes	—	No	—	—	—	—	—	Also see parent company Unmanned Systems Technology (UST) [15].
Sagotech [14]	XPC-TR-50	—	—	Yes	Yes	—	—	—	250	0.22	3.50	1.80	0.70	4.41	No	Not CA Compat.	—	—	0.22	4.41	—	—	No	—	—	ScanEagle; RQ-21A	\$4,350	Also see parent company UST [15].	
Sagotech [14]	XPG-TR (with GPS)	—	—	Yes	Yes	—	—	Yes	250	0.32	4.00	1.80	1.00	7.20	No	Not CA Compat.	—	—	0.32	7.20	—	—	No	—	—	Aerial Targets	\$5,200	Also see parent company UST [15].	

[‡] All IFF systems transmit interrogation at 1030 MHz and receive response at 1090 MHz.

[§] Air Traffic Control Radar Beacon System, IFF, Mark XII/XIIA, Systems (AIMS) power out UAS requirements are 150 W peak power out with a single, omnidirectional antenna.

^{**} General Dynamics KIV-78 CA weighs 24 oz, has a volume of 33.56 cubic inches, and has the following dimensions: 3.4 inches × 4.7 inches × 2.4 inches. General Dynamics MICA CA weighs 19 oz, has a volume of 14.8 cubic inches, and has the following dimensions: 3.0 inches × 4.5 inches × 1.1 inches.

^{**} European Technical Standard Order (ETSO).

^{**} Federal Aviation Administration (FAA).

^{§§} National Security Agency (NSA).

^{***} Standardization Agreement (STANAG).

^{***} Leonardo SIT2010 CA has a volume of 21.2 cubic inches and weighs 17.6 oz.

^{***} Raytheon KIV-71 CA has a volume of 12.9 cubic inches, weighs 16 oz, and has the following dimensions: 3.5 inches × 4.25 inches × 1 inch.

IFF Manufacturer & Name		Modes Available ⁺					Characteristics										Existing Certifications					Other								
Company	Nomenclature	1	2	3A	3C	4	5	S/ADS-B In/Out	Peak Power Out [§] (W)	Weight (lbs)	Length (inch)	Width (inch)	Height (inch)	Volume (cu. inch)	Crypto Capable	Requires Crypto Applique (CA)	Crypto Applique Weight ^{**} (lbs)	Crypto Applique Volume (cu. inch)	Total Weight (lbs)	Total Volume (inch ³)	AIMS	ETSO ^{**}	FAA ^{**}	NSA ^{§§}	STANAG ^{***}	Currently Integrated on	Unit Cost (USD)	Notes		
Sagetech [14]	XPS-TR	—	—	Yes	Yes	—	—	Yes	250	0.22	3.50	1.80	0.70	4.41	No	Not CA Compat.	—	—	0.22	4.41	—	—	No	—	—	—	\$5,264	Also see parent company UST [15].		
Seamatica Aerospace [16]	Micro-IFF Trx	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—	—	—	—	—	—	Yes	Yes	—	—	—	—	—	—	—	—	—	—	—	—	Appears to be the same as the R Cubed Engineering version; website literature notes that development is a joint partnership among SMA, R Cubed Engineering, and Kratos Lancaster.	
Telephonics [17]	Small lightweight Trx (SLT)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	500	4.00	5.00	4.60	5.20	119.60	Yes	Yes	1.00	14.90	5.00	134.50	Yes	Yes	Yes	—	Yes	—	—	—	Requires KIV-77 Crypto Applique. ⁺⁺⁺	
Thales [18]	TSC 1430	Yes	Yes	Yes	Yes	Yes	Yes	Yes	150	3.50	2.40	7.24	8.88	154.30	Yes	Yes	1.00	14.90	4.50	169.20	—	—	—	—	Yes	—	—	Aircraft, UAS	Current aircraft and UAS transponder; Raytheon KIV-77 Crypto Applique. ⁺⁺⁺	
Trig Avionics [19]	TT26 (with GPS)	—	—	Yes	Yes	—	—	Yes	250	1.04	6.02	2.83	2.44	41.57	No	Not CA Compat	—	—	1.04	41.57	—	Yes	—	—	—	—	—	—	Manned aircraft	No Mode 4/5 capability. GPS/Alt incorporated.
uAvionix [20]	ECHOESX 11-15207	—	—	Yes	Yes	—	—	Yes	250	0.17	1.77	2.76	0.67	3.27	No	Not CA Compat	—	—	0.17	3.27	—	—	Yes	—	—	—	\$1,675	—	No Mode 4/5 capability.	
uAvionix [21]	PING-2020	—	—	Yes	Yes	—	—	Yes	30	0.04	0.98	1.54	0.47	0.71	No	Not CA Compat	—	—	0.04	0.71	—	—	Yes	—	—	—	—	—	No Mode 4/5 capability.	

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