AVIONICS TECHNOLOGY REVIEW

Collision Avoidance Systems

BY JAMES WYNBRANDT

The history of electronic collision avoidance systems has been driven by both technology and tragedy. The modern Air Traffic Control system was developed in response to the 1956 mid-air collision of a TWA Super Constellation and a United Airlines DC-7 over the Grand Canyon, an accident that claimed 128 lives. The year before, Dr. J.S. Morell of Bendix had published "The Physics of Collisions," a seminal paper that included the algorithm for closure rates of approaching aircraft. His monograph laid the foundation for the development of Airborne Collision Avoidance Systems (ACAS).

Early on, researchers determined that merely informing a crew that a danger of collision existed was insufficient warning. Pilots needed to know the relative bearing of conflicting traffic in order to both see and avoid the other aircraft.

In subsequent years engineers designed several systems, including Honeywell's AVOIDS (AVionic Observation of Intruder Danger System); McDonnell Douglas's EROS (Eliminate Range Zero System) and RCA's SECANT (Separation and Control of Aircraft using Nonsynchronous Techniques) systems. All exhibited several common problems. First, aircraft had to be outfitted with the same manufacturer's system in order for the equipment to function, reducing the potential utility of any single system. Second, the systems were plagued by false alarms. Additionally, the systems could cause electronic interference with other avionics; and finally, these systems communicated directly with each other, not with ATC's ground-based equipment, and the FAA wanted a solution that would involve controllers.

The imperative of controller involvement led to a new design, called a Beacon Collision Avoidance System (BCAS). BCAS used the ATC's secondary surveillance radar. But this system proved unreliable in areas of high traffic density, where the large volume of signals created a condition called "synchronous garble."

Meanwhile, the FAA became directly involved in the development and evaluation of ACAS in 1971. Public attention on the need for a dependable collision avoidance solution was refocused by another collision, this one involving a Cessna 172 and a Pacific Southwest Airlines (PSA) B-727 over San Diego in 1978.

In the late 1970s the concept of a passive system based on monitoring transponder replies from nearby aircraft to ground-based interrogators was developed. But such systems only worked in areas where there was secondary surveillance radar coverage, whose interrogations elicited the transponder replies a passive system relied on to identify potential traffic conflicts.

In 1981, the FAA launched its Traffic Alert/Collision Avoidance Systems (TCAS) program. A modified BCAS design, TCAS relied on new antenna design and interrogation techniques to provide improved warning of potential traffic conflicts, as well as recommen

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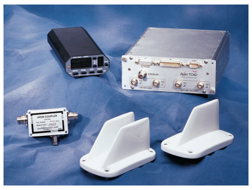
MANUFACTURER	MODEL
Monroy Aerospace www.monroyaero.com	ATD-300 Traffic-Watch
Ryan International www.ryaninternational.com	9900B TCAD
	9900BX Traffic Advisory System
L-3 Communications www.l-3com.com	Skywatch
	Skywatch HP
	TCAS791
Honeywell www.honeywell.com	Bendix/King KTA 870
	Bendix/King KMH 980

	PRODUCT PHOTO	DESCRIPTION	DISPLAY/OPTIONS	PRICE
		Passive proprietary system. Visual traffic alert annunciates target range and relative/MSL altitudes. Aural traffic alerts. Displays multiple targets in sequence. 5 nm range. Determines range by Xponder signal magnitude. Portable and installed configurations.	LED dot matrix display	*Approximately $795*
		Passive proprietary system. Aural alert of traffic conflict and bearing. General bearing of conflicting traffic displayed visually Works in enroute and approach radar environments or in range of transponders interrogated by out-of-range ATC radar. 6 nm range.	LED/ Interfaces with major MFDs and EFIS	*Approximately $7,990 w/o digital display; $9,300 w/ digital display.*
		TAS. Tracks up to 50 targets, displays up to 9. Audible traffic alert includes bearing, distance and vertical position. Adjustable shield size up to 20 nm.	LED/ Interfaces with major MFDs and EFIS	*Approximately $20,600; $21,600 w/ alphanumeric display; $28,600 w/ multi-hazard display*
		TAS. Tracks up to 30 targets. Provides aural and visual alerts. Selectable 2 and 6 nm range. Displays up to eight conflicting targets. TCAS-like symbology. Dual sensitivity levels. “Look up/Look down” altitude display modes simplify conflict identification.	Dedicated CRT display; interfaces with selected MFDs and Stormscope.	*Approximately $29,000 w/WX1000 display; $24,600 w/o display; $27,700 w/ TCAS antenna.*
		TAS/TCAS I. Provides aural and visual alerts. Tracks up to 35 aircraft within active surveillance range of up to 35 nm. TCAS-like symbology. Dual sensitivity levels. “Look up/Look down” altitude display modes. With TCAS I antenna, Skywatch can be installed as TCAS.	Interfaces with most MFDS and Stormscope.	*Approximately $29,000 w/WX1000 display; $24,600 w/o display; $27,700 w/ TCAS antenna.*
		TCAS I. Selectable 5-, 10-, and 20-nm range, and 35-nm surveillance range. Tracks up to 35 aircraft. “Look up/Look down” altitude display modes.	Dedicated CRT/ MFD; EFIS; IVSI	*Approximately $70,300 w/CRT; $69,800 compatible with interfaced display*
		TAS. Provides aural and visual alerts. Tracks up to 60 targets and displays up to 30 targets. Eight display ranges of 2 to 40 miles. Can be integrated with the IHAS 5000 hazard avoidance system.	KMD 550/850 MFD	*Approximately $21,900*
		TCAS I combined with EGPWS. Does not include installation kit.	Dual color, flat-panel LCD/ KMD 550/850, EFIS, Wx radar	*Approximately $37,100*

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dations for evasive action. Ultimately the program evolved to develop three different levels of TCAS: TCAS I, II and III.

TCAS I interrogates Mode C transponders just as ground-based ATC radar does. The equipment displays a Traffic Advisory (TA) indicating the approximate bearing and relative altitude of the conflicting traffic within a selected range. Color coded dots on the cockpit display indicate the level of potential conflict of the tracked aircraft.

TCAS II adds to the capabilities of TCAS I by providing Resolution Advisories (RA), or recommended evasive action, either a climb or descent. (TCAS II does not support lateral RAs.)

TCAS III, currently under development, adds the capability of providing lateral RAs, made possible by its improved antenna design which reduces bearing error. And TCAS III enables an aircraft to receive the position and velocity vector of aircraft equipped with a Mode-S transponder, delivering greater accuracy in identifying conflicting traffic and in providing RAs.

TCAS implementation was accelerated by the 1986 mid-air collision of a Piper Archer and an Aeromexico DC-9 over the Los Angeles suburb of Cerritos. In the wake of the accident, all commercial air carriers operating in the US with 10-30 seats and all those with more than 30 seats were to be equipped with TCAS I and TCAS II respectively by 1994. Additionally, the 30-mile "ring" around Class B airspace was established, restricting the area to aircraft equipped with altitude-encoding (Mode C) transponders.

TCAS II and III installations can cost well into the six figures, and thus are found almost exclusively in commercial airliners. TCAS I installations typically cost almost $30,000 and up, making them out of reach (and probably overkill anyway) for many GA pilots. However, lower cost forms of electronic avoidance are available for installation in GA aircraft. These include proprietary systems like Ryan International's TCAD (Traffic and Collision Alert Device) as well as Traffic Advisory Systems (TAS). TAS are active interrogating units whose performance meets standards stipulated in TSO C147, but fall below that stipulated for TCAS units, most typically in their attenuated range. TAS products are manufactured by L-3 Communications and Honeywell as well as Ryan. For separation assistance at a real entry-level price, Monroy Aerospace offers the Traffic Watch ATD-300. ❑