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TCAS II
PILOT'S GUIDE

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SECTION I

GENERAL

SCOPE

This document deals with the Traffic Collision and Avoidance System II (TCAS II) provided by Rockwell Collins (TTR-4x00 / TSS-4100) and installed as a basic kits on AW189 helicopter. The document provides information on the use and operation of such system.

APPLICABILITY

This document is applicable to the AW189 Helicopter installing the following TCAS II systems:

- TTR-4x00 (CORE AVIONICS S/W PH3, PH4, PH5, PH6 and PH7);
- TSS-4100 (CORE AVIONICS S/W PH6 and PH7).

RELATED DOCUMENTS

Ref.	Doc. Num.	Title
1	189G0290X002	AW189 Rotorcraft Flight Manual
2	189G4600X011	AW189 FMS Pilot's Manual
3	8G3450F00111	KIT TTR-4100 (TCAS II)
4	8G3450P02911	KIT TSS-4100 (XPDR & TCAS II Integrated)
5	189G4620U001	AW189 Solid State Electrical Plants Management System Maintenance User Manual
6	523-0780448	TCAS-4x00 Traffic Alert and Collision Avoidance System Installation Manual
7	523-0809018	TSS-4100 Integrated TCAS, Transponder, and ADS-B Traffic Surveillance System Installation manual

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SECTION II

SYSTEM DESCRIPTION

The TCAS II system (TTR-4x00 / TSS-4100), supplied by Rockwell Collins, is an airborne traffic and collision avoidance advisory system that operates without the support from the Air Traffic Control (ATC) ground stations and aids the flight crew by detecting the presence of nearby aircraft (Traffic Advisory) and providing a warning (Resolution Advisory) when the proximity of that aircraft is determined to be a safety threat. The TCAS interrogates the transponders of the surrounding aircrafts in the vicinity and uses the replies from those transponders to compute their flight path. The data received from this interrogation are track, range, altitude (when it is included in the reply message) and the bearing. From these data, the TCAS calculate a time to reach the Closest Point of Approach (CPA) with the intruder and by dividing the range by the closure rate. This time value (TAU) is the main parameter for issuing alerts. If the transponder replies, from nearby aircraft, includes their altitude, TCAS also computes the time to reach co-altitude. Through these calculations, the TCAS system evaluates the potential threat.

The TCAS determines the relative position of surrounding aircraft by using its directional antennas for bearing information and by measuring the time from interrogation to reply to compute the distance. The altitude information is supplied by the radio altimeter unit.

The maximum surveillance range of TCAS is about 14nm with display of detected intruder aircraft up to 12nm. The TCAS-4000 system can track up to 60 aircraft simultaneously and display up to 30 aircraft.

The TCAS receiver/transmitter interrogates the transponders of neighbouring aircraft and uses the replies to locate and track those aircraft. These replies include altitude information. Bearing and distance information is derived using the directional antennas and timing information based on transponder replies to specific interrogations.

The bearing, distance, and altitude of each aircraft are used to calculate the track. This data is used to evaluate any potential conflict. The system provides no resolution advisories at altitudes below 1000ft.

Descriptions of the three types of advisories that can be issued are listed below:

– Traffic advisory (TA). A TA is primarily informative in nature, informing the crew of nearby traffic that is not presently seen as a threat but can become a threat if conditions change adversely. A TA advisory is intended to assist the pilot in the visual search for the intruder aircraft and to prepare the pilot for a potential RA.

– Resolution Advisory (RA) to recommend manoeuvres that will either increase or maintain the existing vertical separation from an intruder aircraft. When the intruder aircraft is also fitted with the TCASII unit, both TCAS coordinate their RAs through the Mode S data link to ensure that complementary resolution senses are selected.
  - Preventive Resolution Advisory (PRA), A PRA advises the crew to avoid certain deviations from the present vertical flight path. This means that the TCAS has determined that the situation is being resolved with the existing conditions. The crew, however, must not make certain changes from the current vehicle speed.
  - Corrective Resolution Advisory (CRA). A CRA advises the crew to take some action (i.e. to climb or descend) in order to resolve the developing threat.

Obviously the vertical maneuvering resolution advisories given by TCAS are calculated and given against the intruder aircraft that report altitude data in their transponder messages while, for non-altitude reporting (NAR) aircraft, traffic advisories are given only.

The AW189 TCAS II system architecture with TTR-4x00 is depicted in Figure 2-1 In this configuration, the AW189 TCAS II system consists of the TTR-4000 (or TTR-4100) TCAS Transmitter-Receiver p/n 822-1294-432 (or p/n 822-3075-001), installed inside the left nose avionic bay and two TRE-920 TCAS II Directional Antennas p/n 622-8973-001, installed on the top and bottom fuselage.

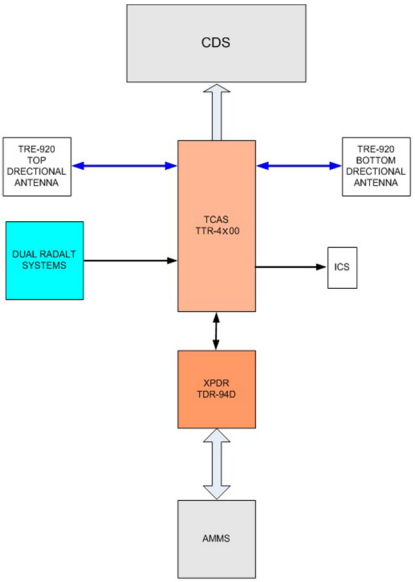

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Figure 2-1 AW189 TCAS II System Architecture (with TTR-4x00)

The AW189 TCAS II system architecture with TSS-4100 is depicted in Figure 2-2 In this configuration, the AW189 TCAS II system consists of the TSS-4100 Transmitter-Receiver p/n 822-2132-001, installed inside the left nose avionic bay and two TSA-4100 Directional Antennas p/n 866-0016-001, installed on the top and bottom fuselage.

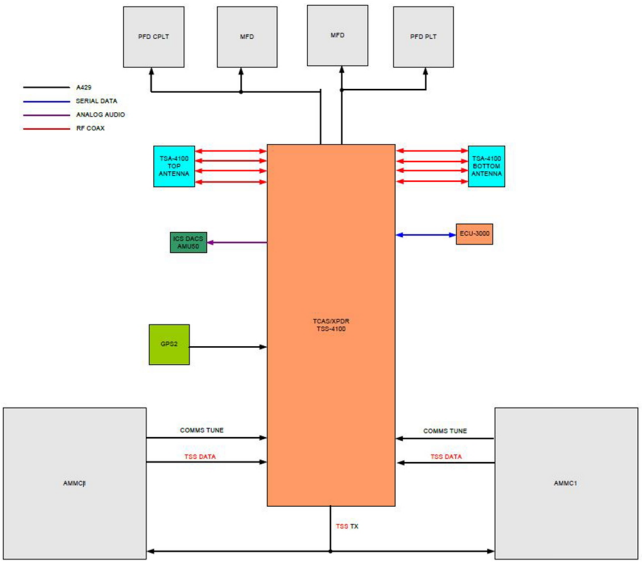

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Figure 2-2 AW189 TCAS II System Architecture (with TSS-4100)

Other main systems involved in the TCAS II architecture are:

- One TDR-94D Mode S diversity transponders with relative antennas and control (only if theTTR-4x00 is installed);
- One ECU-3000 external memory used to hold all of the aircraft and unit configuration data necessary for the TSS-4100 to operate properly (only if the TSS-4100 is installed);
- The AMMS/MCDUs for primary TCAS II controls;
- The CDS system used for secondary TCAS II tuning;
- PFDs and MFDs used to display the Traffic and Resolution advisories;
- ICS to provide the TCAS aural warnings;
- Dual RADALT systems as radio altitude source;

The TCAS Receiver/Transmitter performs airspace surveillance, intruder tracking, its own aircraft altitude tracking, threat detection, RA manoeuvre determination and selection, and generation of advisories.

The TCAS Processor uses pressure altitude, radar altitude, helicopter attitude information and discrete aircraft status inputs from its own aircraft to control the collision avoidance logic parameters that determine the protection volume around the TCAS aircraft.

The altitude information is provided from dual Radio altimeters system. The video information is supplied by the TCAS computer to the CDS.

The CAS logic also performs the function to output TCAS TA and RA aural annunciations. The Aural audio signals, provided by the TCAS processor, are connected to the ICS of the pilot's and co-pilot audio panels (in order to permit the warning messages to be heard to cockpit operators only). The AMMS provides the controls for XPDR/TCAS.

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SECTION III

METHOD OF OPERATION

GENERAL

The operation of the TCAS II can be summarized by the following functions:

- Surveillance
- Collision Avoidance Tracking
- Threat Detection
- Threat Resolution
- Communication and coordination.

SURVEILLANCE

Target Surveillance

TCAS listen for the spontaneous transmissions, or squatters, that are generated once per second by the Mode S transponder. Among other information, the squitter contains the unique Mode S address of the sending aircraft. Following the receipt and decoding of a squitter message, TCAS sends a Mode S interrogation to the Mode S address contained in the squitter. The Mode S transponder replies to this interrogation and the reply information is used by TCAS to determine the range, bearing, and altitude of the Mode S aircraft. To minimize interference with other aircraft and ATC on the 1030/1090 MHz channels, the rate at which a Mode S aircraft is interrogated by TCAS is dependent on the range and closure rate between the two aircraft. As the target aircraft approaches the area where a TA may be required, the interrogation rate increases. TCAS uses a modified Mode C interrogation known as the Mode C Only All Call to interrogate nearby Mode A/C transponders. The nominal interrogation rate for these transponders is once per second. Because TCAS does not use Mode A interrogations, the Mode A transponder codes of nearby aircraft are not known to TCAS.Mode S squitter transmission are typically detected up to about 30 nm. The maximum tracking range of the TCAS is 14nm around with display of detected intruders up to 12nm. The TCAS can track as many as 60 aircraft and displays up to 30 of them. The area to be visualized on the CDS is set by the pilot.

Because TCAS surveillance operates on the same frequencies as that used by the ground based ATC radars, there is a requirement imposed on TCAS that it not interfere with the functions of the ATC radars. Several design features have been developed and implemented to allow TCAS to provide reliable surveillance without degrading the performance of the ATC radars.

Garble Rejection

TCAS surveillance of Mode C targets is complicated by problems of synchronous and non-synchronous garbling (replies from different intruder overlap), as well as reflections of signals from the ground (multipath). Various techniques have been incorporated into TCAS to cope with this condition. The whisper shout (WS) technique takes advantage of differences between the receiver sensitivity of transponders and the transponder antenna gains of target aircraft. Another technique used to reduce synchronous garble is the use directional transmissions to further reduce the number of potential overlapping replies. Non synchronous garble is caused by the receipt of undesired transponder replies that were generated in response to interrogations from ground sensors or other TCAS interrogations. These so-called fruit replies are transitory so they are typically identified and discarded by correlation algorithms in the surveillance logic.

COLLISION AVOIDANCE TRACKING

The TCAS receiver/transmitter interrogates the transponders of neighbouring aircraft and uses the replies to locate and track those aircraft; the TCAS receiver/transmitter receives ATCRBS and Mode S transponder replies from the top antenna and/or the bottom antenna. The bottom antenna is installed to detect aircraft that may be shadowed from the top antenna by the airframe. These replies include altitude information. Bearing and distance information is derived using the directional antennas and timing information based on transponder replies to specific interrogations. The bearing, distance, and altitude of each aircraft are used to calculate the track. This data is used to evaluate any potential conflict.

When the altitude is lower than 1700ft AGL, the TCAS approximates the elevation of the ground ASL. This is determined by subtracting the radar altitude from the pressure altitude. The TCAS considers any aircraft within 360ft of this ground altitude to be on the ground and displays no track for such aircraft.

THREAT DETECTION

The type of advisory appropriate for a given threatening situation is a function of the aircraft altitude. These altitude ranges can be seen as sensitively levels. Thus, the system provides no resolution advisories at altitudes below 1000 feet. Descriptions of the three types of advisories that can be issued are listed below:

- Traffic advisory (TA). A TA is primarily informative in nature, informing the crew of nearby traffic that is not presently seen as a threat but can become a threat if conditions change adversely.
- Preventive Resolution Advisory (PRA). A PRA advises the crew to avoid certain deviations from the present vertical flight path. This means that the TCAS has determined that the situation is being resolved with the existing conditions. The crew, however, must not make certain changes from the current vehicle speed.
- Corrective Resolution Advisory (CRA). A CRA advises the crew to take some action in order to resolve the developing threat.

THREAT RESOLUTION

The key to understanding the TCAS threat evaluation and resolution is in recognizing that it is based on a projected CPA (closest point of approach). This CPA is at the centre of a volume of airspace cylindrical in shape with a radius that is determined by either of two thresholds. TAU, which is a time threshold, or a horizontal distance threshold, whichever occurs first. Both TAU and the horizontal threshold increase with altitude. The vertical depth of this cylindrically-shaped volume is determined by certain separation ranges that also increase with altitude.

The TCAS in both aircraft interrogates the other airplane's transponder and acquires heading, altitude, and vertical and horizontal speed information. The vertical speed is determined by the rate of change in altitude while the horizontal speed is determined by the rate of change of distance and bearing. Using this information and similar information concerning its own flight parameters, it is able to calculate a closure rate and a projected CPA. In this scenario, the airplanes are in danger of colliding at CPA. At 45 seconds before CPA or at the horizontal threshold, whichever occurs first, TCAS alerts both crews to the presence of the other airplane by means of traffic advisory. It is expected this advisory will cause the crew to attempt to acquire visual contact with the other aircraft and mentally prepare for a TCAS commanded manoeuvre. With this advisory, the TCAS expects the crew to assume a vertical speed of 1500 fpm. In order to satisfy the corrective advisory situation at this altitude, TCAS expects a minimum separation of 400 feet.

When an intruder is declared a threat, a two-step process is used to select the appropriate RA for the encounter geometry. The first step in the process is to select the RA sense, i.e., upward or downward. Based on the range and altitude tracks of the intruder, the CAS logic models the intruders' flight path from its present position to CPA. The CAS logic then models upward and downward sense RAs for own aircraft to determine which sense provides the most vertical separation at CPA. In encounters where either of the senses results in the TCAS aircraft crossing through the intruders altitude, TCAS is designed to select the non-altitude crossing sense if the non-crossing sense provides the desired vertical separation. If non-crossing sense doesn't provide the required vertical separation an altitude crossing RA will be issued.

The second step in selecting an RA is to choose the strength of the advisory. TCAS is designed to select the RA strength that is the least disruptive to the existing flight path. After the initial RA is selected, the CAS logic continuously monitors the vertical separation that will be provided at CPA and if necessary, the initial RA will be modified.

In a TCAS/TCAS encounter, each aircraft transmits interrogations to the other via the Mode S link to ensure the selection of complementary RAs by the two aircraft. The coordination interrogations use the same 1030/1090 MHz channels used for surveillance interrogations and replies and are transmitted once per second by each aircraft for the duration of the RA. Coordination interrogations contain information about an aircraft's intended RA sense to resolve the encounter with the other TCAS-equipped intruder. When an aircraft selects an upward sense RA, it will transmit a coordination interrogation to the other aircraft that restricts that aircraft's RA selection to those in the downward sense. The strength of the downward sense RA would be determined by the threat aircraft based on the encounter geometry and the RA Selection logic. The basic rule for sense selection in a TCAS/TCAS encounter is that each TCAS must check to see if it has received an intent message from the other aircraft before selecting an RA sense. If an intent message has been received, TCAS selects the opposite sense from that selected by the other aircraft and communicated via the coordination interrogation. If TCAS has not received an intent message, the sense is selected based on the encounter geometry in the same manner as would be done if the intruder were not TCAS equipped.

COMMUNICATION AND COORDINATION

In the case where both aircraft involved in an advisory situation are TCAS equipped, the TCAS communicates with the other aircraft to coordinate evasive strategies. This coordination may occur before an advisory is issued and is calculated for optimum safe separation using the least disruptive manoeuvre possible.

	ADVISORY	RADIO ALTITUDE		PRESSURE ALTITUDE				
		UP TO 1,000	1,000 TO 2,350	UP TO 5,000	5,000 TO 10,000	10,000 TO 20,000	20,000 TO 42,000	ABOVE 42,000
Advisory Time to CPA (TAU)	Traffic	20 sec	25 sec	30 sec	40 sec	45 sec	48 sec	48 sec
	Resolution	—	15 sec	20 sec	25 sec	30 sec	35 sec	35 sec
Horizontal Threshold	Protected Volume	—	0.20 nmi	0.35 nmi	0.55 nmi	0.80 nmi	1.10 nmi	1.10 nmi
Vertical Separation Thresholds at CPA	Traffic	850 ft	850 ft	850 ft	850 ft	850 ft	850 ft	1,200 ft
	Preventive Resolution Threshold	—	600 ft	600 ft	600 ft	600 ft	700 ft	800 ft
	Corrective Resolution Threshold	—	300 ft	300 ft	350 ft	400 ft	600 ft	700 ft

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Figure 3-1 TCAS II Advisory Parameters

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SECTION IV

CONTROLS, FUNCTIONALITIES AND VISUALIZATIONS

The control features are provided by mean of the pilot and co-pilot MCDUs and MFDs. The TCAS II information is displayed on the PFDs and MFDs.

MCDU CONTROLS

On MCDUs the TCAS II controls are integrated in the XPDR/TCAS Radio Tuning page accessible via the TUNE functional key (See Figure 4-1). When the LSK-6 key is pressed in the TUNE page, the XPDR/TCAS detail page is displayed (See Figure 4-2). When the LSK-5 key is pressed in the TUNE page, the XPDR/TCAS MODE page is displayed (See Figure 4-3).

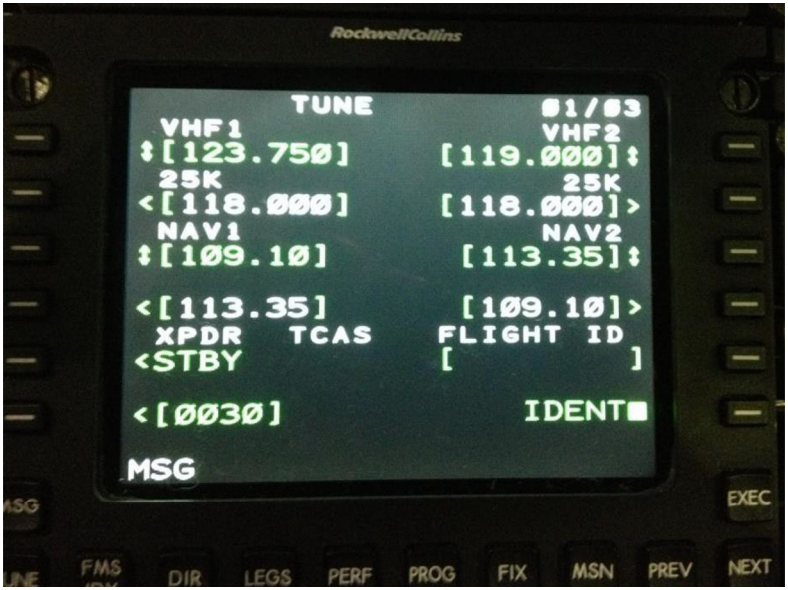

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Figure 4-1 MCDU Radio Tuning page when TUNE key is pressed

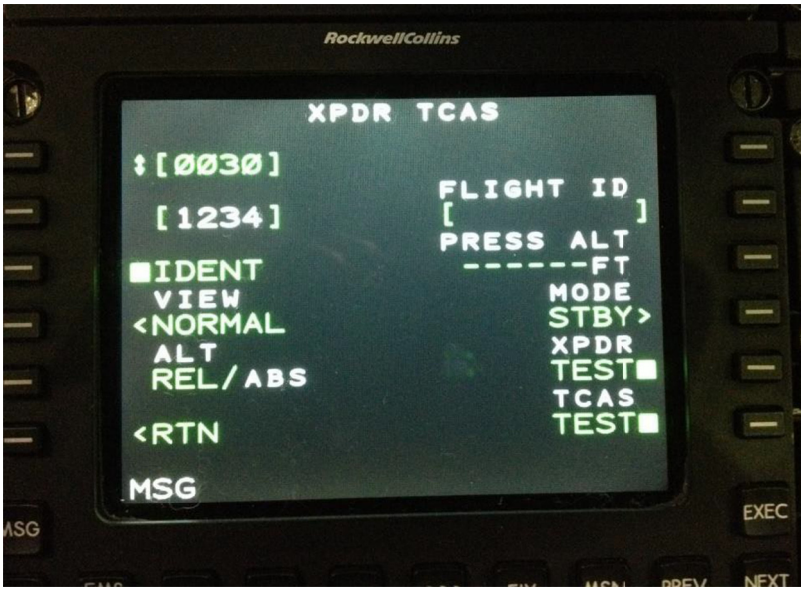

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Figure 4-2 MCDU XPDR/TCAS Detail page when LSK-6 key (XPDR CODE) is pressed in the TUNE page

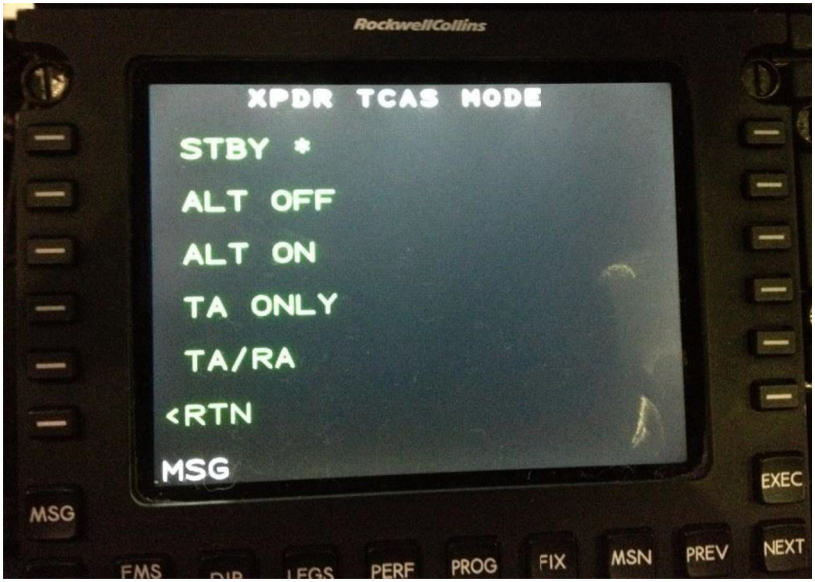

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Figure 4-3 MCDU XPDR/TCAS MODE page when LSK-5 key is pressed in the TUNE page

The TCAS II mode controls "TA ONLY" and "TA/RA" are added to the Transponder mode controls into the MCDU XPDR/TCAS Radio Tuning pages, so the integrated XPDR-TCAS mode have the following mode selection:

- **STBY:** The TCAS and XPDR systems are always forced to STBY mode. This setting is the default at helicopter electrically power on.
- **ALT OFF:** Transponder Mode A Operation (XPDR only operative);
- **ALT ON:** Transponder Mode C Operation (XPDR only operative);
- **TA ONLY:** Traffic Alert (Both TCAS and XPDR operative);
- **TA/RA:** Traffic and Resolution Alerts (Both TCAS and XPDR operative)

The TCAS system is operative selecting the modes TA/RA and TA ONLY. The TCAS and XPDR system works coupled: since the TCAS detects the transponder signals transmitted by other aircraft, the on board the AW189 transponder is automatically muted through a dedicated suppression line when the TCAS scans for traffic.

The TA/RA mode selection is accepted as valid if the TCAS II system echoes indifferently TA ONLY or TA/RA.

Although the TCAS RA function is inhibited, with the system selected on, when an aircraft is on the ground and also at low altitudes when airborne, it is very important for operational safety that the system is selected on before take-off, to ensure that the RA function will be active as soon as the built-in system constraints allow this during the initial climb. In any case, the CDS continues to provide flight crew with useful TCAS situational awareness, both below the RA inhibit altitudes and on the ground.

When TA ONLY or TA/RA is selected, the avionics system forces the Transponder in the ALT ON condition (if not) before the relevant TCAS II control mode.

When STBY, ALT OFF or ALT ON is selected, the TCAS II control mode is forced to TCAS STBY; when the command TCAS STBY is received from the display, the TCAS is forced to TCAS STBY and the Transponder mode ALT ON is selected.

The MCDU XPDR/TCAS Radio Tuning page (see Figure 4-4) provides a control for the altitude view of the traffic (ALT LIMITS); this defines the TCAS Display Volume for TCAS intruders filtering (see Figure 4-3):

- **ABOVE:** TCAS Display Volume is - Altitude Limit -2700ft to Altitude Limit 9000ft
- **BELOW:** TCAS Display Volume is - Altitude Limit -9000ft to Altitude Limit 2700ft
- **NORMAL:** TCAS Display Volume is - Altitude Limit -2700ft to Altitude Limit +2700ft
- **ABV/BLW:** no filtering is performed

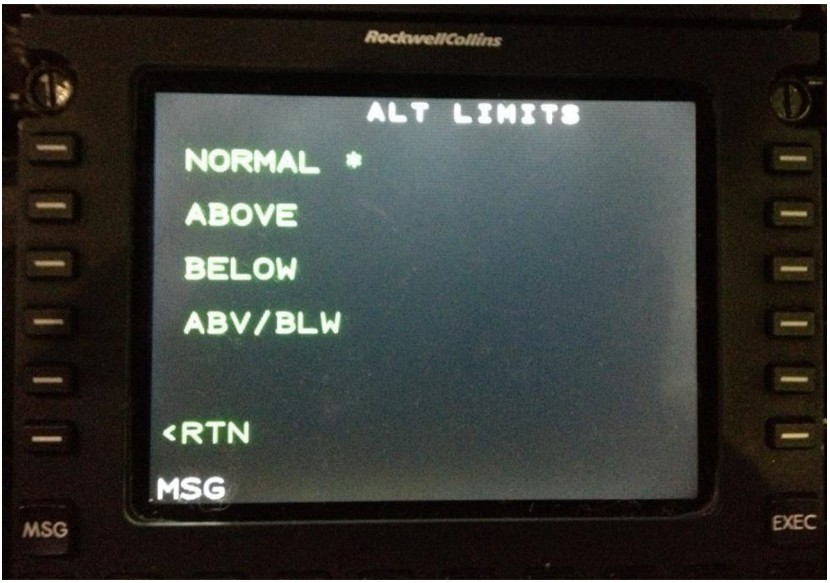

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Figure 4-4 MCDU XPDR/TCAS ALT LIMITS (VIEW) page when LSK-4 key is pressed in the XPDR/TCAS detail page

The MCDU XPDR/TCAS Radio Tuning page provides a control for the intruder altitude reference selection (See Figure 4-2):

- **Relative (REL)**
- **Absolute (ABS)**

The TCAS test functionality is activated by mean of the TEST actuation RSK-6 in the XPDR/TCAS detail page (See Figure 4-2). When the pilots switch the Test ON the system provides self-test for TCAS II system. During the TCAS self-test the MCDU status display will read "TEST" and then "PASS" or "FAIL" depending on the TCAS test result (See TCAS II TEST FUNCTION).

Note that if the TSS-4100 is installed:

- the XPDR TEST push button (Figure 4-2) is no more available because of the XPDR/TCAS integration in one box. The TCAS TEST function is able to test also the XPDR part inside the TSS-4100.
- the TCAS II TEST is inhibited in flight. It means that the TCAS II TEST push button is available only when the a/c is on ground.

MFD CONTROLS

On pilot and co-pilot MFDs the TCAS II controls are available (See Figure 4-5) when the B-8 key is pressed on MFD. These controls are usable via the on-side CCD in the interseat console or CCJ on the cyclic. The functionalities are the same described for MCDU (See GENERAL).

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Figure 4-5 MFD TCAS II controls when CTRL button key (B-8) is pressed on the MFD (Sheet 1 of 2)

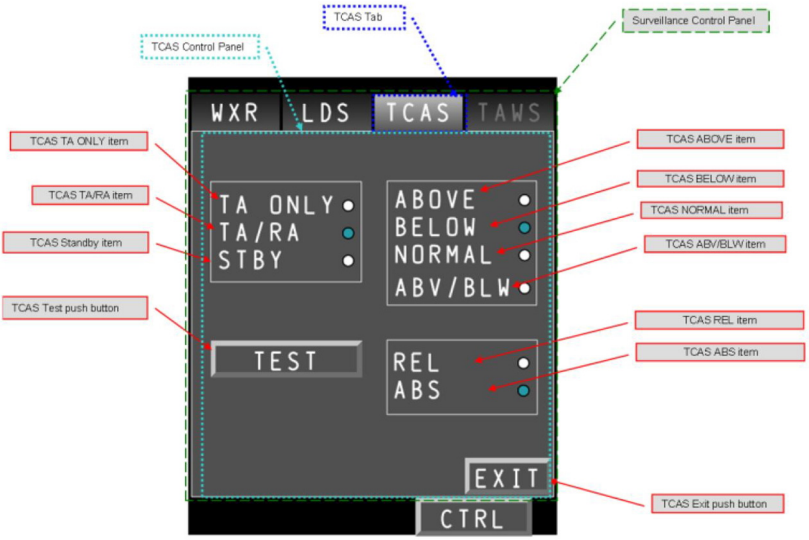

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Figure 4-5 MFD TCAS II controls when CTRL button key (B-8) is pressed on the MFD (Sheet 2 of 2)

TCAS II ON PFD

Traffic Visualization and Controls annunciations

To enable the TCAS on PFD, at power-up TCAS OVERLAY is set to "selected", so the TCAS data are displayed on the PFD Map format's flight plan when the pilot selects the appropriate overlay for the display.

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Figure 4-6 PFD Menu Bar

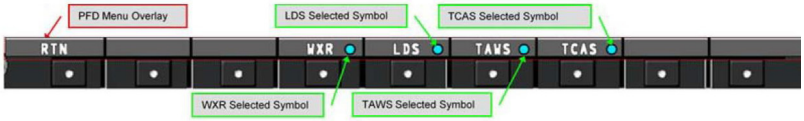

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Figure 4-7 PFD Overlay Menu Bar

As long as TA or RA is detected, and if MAP format is not displayed, of MAP Menu label is replaced by TCAS Pop-up Label as black "TCAS" text over amber background annunciation. In this situation the TCAS bezel key is armed and when it is pressed, the alarm is to considered acknowledged.

When the TA alert is no more active, the TCAS alert annunciation is removed from MAP Menu Bar.

A traffic advisory, displayed on the display's map page, warns the flight crew to the position of nearby aircraft threats and possible threats. This warning improves the ability of the flight crew to see the intruder aircraft before answering the esolution advisory. The display can manage up to 30 TCAS intruders and visualizes them both in 360 MAP and ARC MAP format; the intruder altitude is displayed near the intruder symbol. If a directional antenna is tracking the intruder, TCAS displays an intruder aircraft symbol on the traffic advisory display. The symbol position on the display shows relative range and bearing of the intruder. Moreover, the intruder symbols are displayed using the intruder range and the intruder relative bearing information received by TCAS unit. The symbols shape and colors, provided by TCAS II system, are in accordance with the standard TCAS II symbology developed by FAA (See Figure 4-9). There are four different types (TCAS II) of traffic symbols, based on threat level, used in the TCAS traffic display.

They are Resolution Advisory (RA), Traffic Advisory (TA), Proximate Traffic (PT), and Other Traffic (OT). The classification of the targets is done by the TCAS computer.

No threat	Diamond		Haloed cyan
Proximate Traffic	Solid diamond		Haloed cyan
Traffic Advisory	Solid circle		Haloed yellow
Resolution Advisory	Solid square		Haloed red

If the intruder is reporting altitude, intruder relative altitude is shown on the display near the threat traffic symbol. The relative altitude data tag will consist of two digits indicating hundreds of feet and the color match the color of the corresponding traffic symbol. The data tag shall be centered above the traffic symbol preceded with a "+" if the intruder aircraft is above own aircraft's altitude and centered below the traffic symbol preceded with a "-" if the intruder aircraft is below own aircraft's altitude. In addition, the arrow points down for descending traffic and up for ascending traffic.

The TCAS system is able to display also the Flight Level (absolute altitude), of the intruder aircraft, in place of the relative altitude, when selected from the TCAS II menù on MFD or MCDU.

TA and RA traffic for which TCAS cannot calculate a bearing (No Bearing Advisories) show on a two-line annunciator field at the bottom middle of the display. The a NBA annunciation shows the type (TA or RA), range displayed in NM (XX,X ; for example 2NM = 02,0), and relative or absolute altitude of the traffic displayed in hundreds of feet as a two digit value with leading zeros. The annunciator shows in amber for TA traffic and in red for RA traffic. Range shows as two-number readout in nautical miles with a resolution of one-tenth of a nautical mile.

The altitude data has two numbers and, in the relative mode, a preceding (+) or (–) sign. The number on the left shows thousands of feet of altitude and the number on the right shows hundreds of feet of altitude (i.e., +22 = 2200 ft above the aircraft and –02 = 200 feet below the aircraft.

TCAS NBA Intruder Vertical Trend Vector using Vertical Sense information as received from the TCAS with following logic:

Vertical Sense = "Level Flight": blank (no Vertical Trend Vector displayed)

Vertical Sense = "Climbing": display up arrow

Vertical Sense = "Descending": display down arrow

Vertical Sense = "No data" blank (no Vertical Trend Arrow displayed)

The RA and TA targets which are off scale are indicated by placing one half of the symbol at the edge of the active display area, while the Proximate and Other Intruders which are outside of the current display area shall not be displayed.

The Proximate and No threat intruders are not displayed when the relative intruder altitude falls outside the selected TCAS display volume. The volume is defined by the TCAS Altitude selection:

- Normal
- Below
- Above
- Above/Below (unrestricted)

On the PFDs the TCAS Status annunciations are displayed in two reserved fields on the left side of the compass rose (See Figure 4-8). In the first field the following TCAS Status annunciation can be displayed:

- "TCAS STBY" (green colored for CORE AVIONICS S/W PH3 and white colored for CORE AVIONICS S/W PH4, PH5, PH6 and PH7);
- "TCAS FAIL" (amber colored)
- "TCAS TEST" (amber colored)
- "TA-ONLY" (green colored)
- "TA/RA" (green colored)

In the second field, the following TCAS green annunciations can be exclusively displayed:

- "NORMAL"
- "ABOVE"
- "BELOW"
- "ABV/BLW"

The Altitude select annunciation is completed with "ABS" annunciation when the absolute altitude is selected.

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Figure 4-8 PFD TCAS II STATUS Annunciations

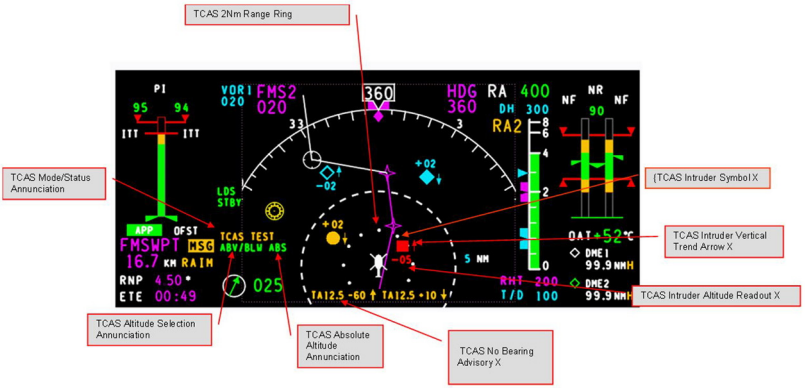

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Figure 4-9 PFD TCAS II Intruders symbols

ADI TCAS "TRAFFIC"ADVISORIES

On the PFDs, the TCAS Advisory information is visualized on the upper left corner of the attitude indication.

As a dangerous intruder is detected a Traffic Advisory (TA) is generated on the PFD as follow:

- The TCAS Traffic Advisory Message "TRAFFIC" is displayed (See Figure 4-10) to the left of the attitude indication shall be displayed as long as at least one TA intruder is received from the TCAS computer. The TCAS Traffic Advisory Message flashes for the first five seconds (500ms amber text on black background, 500ms black text on amber background then steady back text on yellow background).

In case of RA:

- "TRAFFIC" annunciation (See Figure 4-10): it is displayed to the left of the attitude indication as long as at least one RA intruder is received from the TCAS computer. The annunciation flashes flash for the first five seconds (500ms red on black, 500ms white on red then steady white text on red background).

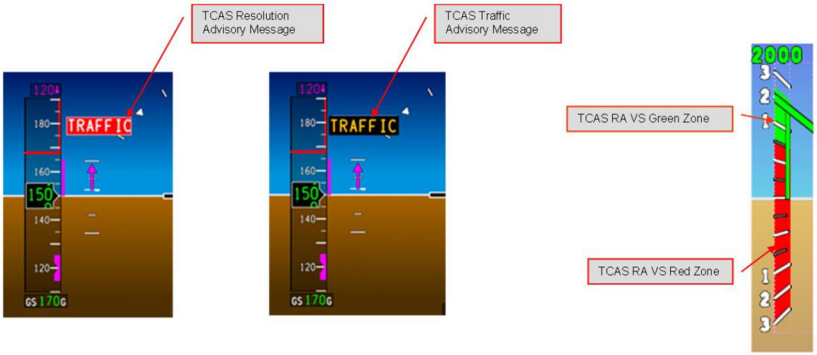

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Figure 4-10 PFD TCAS Advisory Messages and RA

PFD TCAS II RESOLUTION ADVISORIES on VS TAPE

When TCAS II generates a resolution advisory, the pilot has the ability to view RA guidance on the vertical speed tape (See Figure 4-11). From a pilot's standpoint there are two types of resolution advisories:

- Preventive - A preventive RA instructs the pilot to avoid certain deviations from the current vertical speed.
- Corrective - A corrective RA instructs the pilot to deviate from the current vertical speed to avoid the intruder.

Another way to categorize an RA is into down advisories and up advisories. Down advisories are associated with an up avoidance zone, and up advisories are associated with down avoidance zones.

When an RA occurs, the TCAS vertical speed guidance is presented on the vertical speed tape.

- A preventive down advisory displays a red up avoidance zone from the top of the vertical speed tape down to the vertical speed corrective guidance given from the TCAS.
- A corrective down advisory displays a green fly-to band at the down advisory's recommended descent rate, and a red up avoidance zone extends from the top of the fly-to band to the top of the vertical speed tape.
- A preventive up advisory displays a red down avoidance zone from the bottom of the vertical speed tape up to the vertical speed corrective guidance given from the TCAS.
- A corrective up advisory displays a green fly-to band at the up advisory's recommended climb rate, and a red down avoidance zone extends from the bottom of the fly-to band to the bottom of the vertical speed tape (See Figure 4-10).

It is possible to have a preventive down advisory and a preventive up advisory at the same time. For simultaneous up and down preventive advisories, there is both a red up avoidance zone and a red down avoidance zone with a green space between the two zones which looks like a fly-to band.

See the TCAS II AURAL WARNINGS for the TCAS II RA Audio Messages.

TCAS II ON MFD

To enable the TCAS on MFD, at power-up TCAS OVERLAY is set to "selected", so the TCAS data are displayed on the MFD Map format's flight plan when the pilot selects the appropriate overlay for the display.

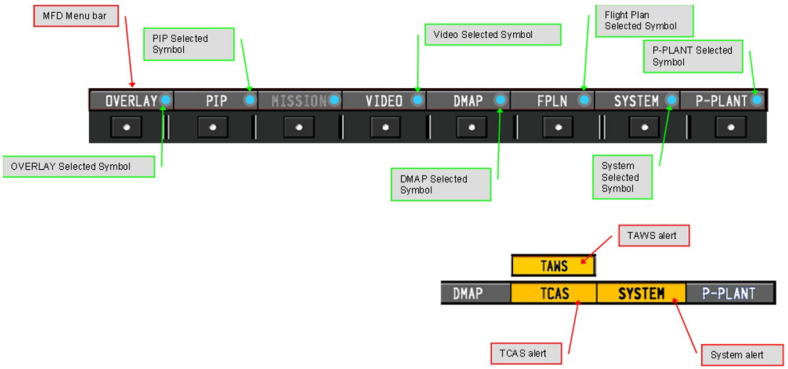

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Figure 4-11 MFD Menu Bar

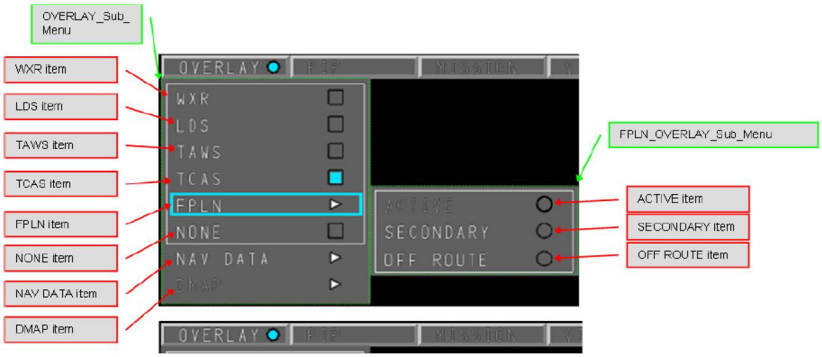

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Figure 4-12 MFD Overlay Menu

As long as TA or RA is detected, and if Overlay format is not displayed, of FPLN Menu label is replaced by TCAS Pop-up Label as black "TCAS" text over amber background annunciation. In this situation the TCAS bezel key is armed and when it is pressed, the alarm is to considered acknowledged. When the TA alert is no more active, the TCAS alert annunciation is removed from FPLN Menu Bar.

The TCAS Intruders are represented on MFD consistently with the representation given on PFD (See Figure 4-13 and Figure 4-14).

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Figure 4-13 MFD TCAS II STATUS Annunciations

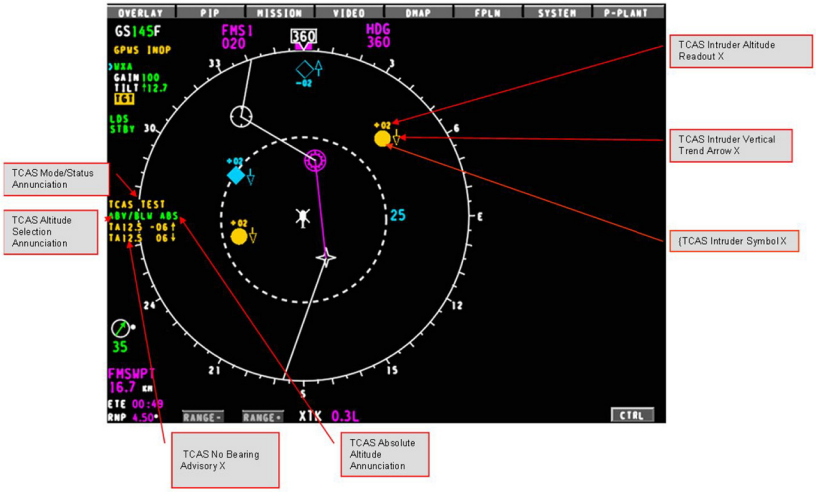

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Figure 4-14 MFD TCAS II STATUS Annunciations and Intruder symbols

Note

In the MFD DMAP page, select the TCAS overlay only when the aircraft position setting (MOVE entry on MCDU) is CENTER. The traffic symbols are not correctly displayed on the MFD DMAP page when the aircraft position setting is BOTTOM.

TCAS II TEST FUNCTION

The TCAS self-test is manually enabled by mean of the MCDU or MFD. When the IBIT is running all the TCAS II functionalities are inhibited. The avionics system displays on the MCDU the TCAS TEST RESULT:

- **TEST PASS** if the system has completed its functional tests and has not detected a failure;
- **TEST FAIL** if any of the test criteria are not satisfied.

During the TCAS II test in progress, the following indications are displayed:

- TCAS TEST displayed on the MCDUs in the AMMC/MAINTENANCE/ EQ STATUS PAGE;
- an amber "TCAS TEST" annunciation is displayed on all the four displays in the first TCAS annunciator line;
- The following traffic symbols are displayed on the CDS (See Figure 4-15):
  - A solid red square RA symbol at 2 nmi, at 200 feet relative altitude, above (+02), with no VS arrow, at a relative bearing of +90°;
  - A solid yellow circle TA symbol at 2 nmi, at 200 feet relative altitude, below (–02), with ascending arrow, at a relative bearing of –90°;
  - A solid cyan diamond symbol at 3.625 nmi, at 1000 feet relative altitude, below (–10), with descending arrow, at a relative bearing of +33.75°;
  - An open cyan diamond OT symbol at 3.625 nmi, at 1000 feet relative altitude, above (+10), with no arrow, at a relative bearing of -33.75°;
- The following TCAS corrective RA is displayed on the Vertical Speed tape:
  - 0ft/min advisory rate to maintain (red band and green band threshold to 0ft/min)
  - UP advisory Corrective (green band for positive rate)
  - Don't descend (red band for negative rate)
  - Don't climb > 2,000fpm (green band until 2,000FPM)
- The message "TRAFFIC" (it flashes for the first five seconds, 500ms red on black, 500ms white on red then steady white text on red background) is displayed during the test in progress, on both the PFDs, to the left of the attitude indication;

After the test is completed:

- "TCAS SYSTEM TEST OK" is annunciate in the audio system on both pilot and co-pilot headsets (See TCAS II AURAL WARNINGS);
- The RA on the VS tape, the "TRAFFIC" message and the traffic symbols are removed;
- The TCAS II system comes back to the previous state in terms of controls;

Note

If the test recognizes problem with the TCAS system the aural message "TCAS SYSTEM TEST FAIL" (See TCAS II AURAL WARNINGS) is reproduced throughout the pilot and co-pilot headsets and the annunciation "TCAS FAIL" is displayed as TCAS status.

Note

(*) The TCAS self-test is only available on ground.

Note

(*) Wait at least 15 seconds between two consecutive TCAS self-tests.

(*): only if TSS-4100 is installed

TCAS II AURAL WARNINGS

The TCAS II System is capable to generate aural annunciations throughout the crew headsets interfacing the ICS system.

The following Aural Messages are played at the end of the TCAS II functional test:

- TCAS SYSTEM TEST OK: repeated one cycle

  Or

- TCAS SYSTEM TEST FAIL: repeated one cycle

The following Aural Message is played when a Traffic Advisory (TA) is generated:

- TRAFFIC TRAFFIC: repeated one cycle

  (Threat aircraft is approaching and the pilot should try to acquire visually and prepare for possible manoeuvre)

The following Aural Messages is played when a Resolution Advisory (RA) is generated:

- CLIMB CLIMB: repeated one cycle

  (Climb at the rate depicted by the green (fly to) arc on VSI nominally between 1500 and 2000 fpm)

- DESCEND DESCEND: repeated one cycle

  (Descend at the rate depicted by the green (fly to) arc on the VSI nominally between 1500 and 2000 fpm)

- CLIMB CROSSING CLIMB - CLIMB CROSSING CLIMB: repeated one cycle

  Climb at the rate depicted by the green (fly to) arc on VSI nominally between 1500 and 2000 fpm. Safe separation will be best achieved by climbing through the threats flight path)

- DESCEND CROSSING DESCEND - DESCEND CROSSING DESCEND: repeated one cycle

  Descend at the rate depicted by the green (fly to) arc on the VSI nominally between 1500 and 2000 fpm. Safe separation will be best achieved by descending through the threats flight path)

- LEVEL OFF LEVEL OFF: repeated one cycle

  Reduce rate of climb or descent to achieve level flight)

- CLIMB CLIMB NOW - CLIMB CLIMB NOW: repeated one cycle

  (Climb at the rate depicted by the green (fly to) arc on VSI nominally between 1500 and 2000 fpm. Received after 'DESCEND' resolution advisory and indicates a reversal in direction is required to achieve safe vertical separation from a manoeuvring threat aircraft)

- DESCEND DESCEND NOW - DESCEND DESCEND NOW: repeated one cycle

  (Descend at the rate depicted by the green (fly to) arc on the VSI nominally between 1500 and 2000 fpm. Received after a 'CLIMB' resolution advisory and indicates a reversal in direction is required to achieve safe vertical separation from a manoeuvring threat aircraft)

- INCREASE DESCENT - INCREASE DESCENT: repeated one cycle

  (descend at the rate depicted by the green (fly to) arc on the VSI, nominally between 2500 and 3000 fpm. Received after 'DESCEND' resolution advisory and indicates additional descent rate is required to achieve safe separation from manoeuvring aircraft)

- MAINTAIN VERTICAL SPEED MAINTAIN: repeated one cycle

  (Continue the existing climb or descent rate, or other vertical speed, as depicted by the green (fly to) arc on VSI)

- MAINTAIN VERTICAL SPEED CROSSING MAINTAIN: repeated one cycle

  (Continue the existing climb or descent rate, or other vertical speed, as depicted by the green (fly to) arc on VSI. Safe separation will be best achieved by not altering the existing vertical speed and climbing or descending through the threats flight path)

- MONITOR VERTICAL SPEED: repeated one cycle

  (Ensure that vertical speed is out of the red arc on VSI ,until RA is completed)

The following Aural Messages is always played when the Resolution Advisory (RA) threat ends:

- CLEAR OF CONFLICT: repeated one cycle

  (Range is increasing, and separation is adequate. Return to the applicable ATC clearance, unless otherwise directed by ATC)

TCAS II SYSTEM INHIBITS

The following TCAS II inhibits are active on AW189:

INHIBIT	PARAMETERS
Increase Descent RA	Inhibited below 1650 ft AGL while climbing and inhibited below 1450 ft AGL while descending
Descend RA	Inhibited below 1200 ft AGL while climbing and inhibited below 1000 ft AGL while descending
TA Voice Messages	Inhibited below 400 ft AGL while descending and inhibited below 600 ft AGL while climbing
RAs	Inhibited below 1100 ft AGL while climbing, and inhibited below 900 ft AGL while descending. (TCAS II automatically reverts to TA only)
Increase Climb	Always Inhibited

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Figure 4-15 TCAS II Active Inhibits

SECTION V

LIMITATIONS, NORMAL AND EMERGENCY PROCEDURES

Limitations, Normal and Emergency Procedures are provided within TCAS II RFM Supplement 8.

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APPENDIX A

LIST OF ACRONYMS

ABS	Absolute
ABV	Above
AFDX	Avionic Full DupleX Ethernet
AMMC	Aircraft & Mission Management Computer
AMMS	Aircraft & Mission Management System
AWG	Aural Warning Generator
BLW	Below
CB	Circuit Breaker
CCD	Cursor Control Device
CDS	Cockpit Display System
CPA	Closest Point Of Approach
CRA	Corrective Resolution Advisory
DME	Distance Measuring Equipment
DU	Display Unit
ECDU	Enhanced Control Display Unit
FMS	Flight Management System
GND	Ground
GPS	Global Positioning System
H/C	Helicopter
ICS	Interphone Communication System
PFD	Primary function display
MCDU	Multifunction Control Display Unit
MFD	Multi Function Display
NM	Nautical Mile
OT	Other Traffic
PFD	Primary Flight Display
PRA	Preventive Resolution Advisory

PT	Proximate Traffic
RA	Resolution Advisory
RAD	Radalt
REL	Relative
REPU	Remote Electrical Power Unit
RTN	Return
SL	Sensitivity Level
STBY	Stand-By
SW	Sofware
TA	Traffic Advisory
TCAS	Traffic and Collision Avoidance System
TSS	Traffic and Surveillance System
XPDR	Transponder
WOW	Weight on Wheel