

3 GENERAL INFORMATION

3.1 TYPE DESIGNATION

The equipment has been designated by ACSS as models TT-95x T²CAS Computer Units, P/Ns 9000000-20001 (TT-952), 9000000-55001 (TT-951), 9000000-1001 (TT-950).

3.2 SERVICE AND RULE FOR INTENDED OPERATION

Air Traffic Control
Part 87, Subpart A

3.3 DESCRIPTION OF EQUIPMENT

3.3.1 TAWS/Windshear Functionality

The TAWS/Windshear function is implemented as an independent processor and I/O circuitry from the TCAS function. The TAWS/Windshear circuitry is contained on a unique circuit card assembly (CCA), which is added to the existing TCAS-2000 unit design in a spare card slot

The TAWS function uses vertical speed, ground speed, track angle, flight path angle, latitude, longitude, flap status, steep approach status, static air temperature, roll angle, pressure altitude system inputs. A database, which includes terrain data, airport data, aircraft performance data and climb rate models, is used for the determination of the alerts and display of terrain information.

The TAWS/Windshear CCA will also provide a reactive windshear alert which meets the requirements of TSO-C117a. The windshear alert is active during take-off and final approach phases and produces aural and visual annunciations. The windshear alert measures vertical and horizontal components of air mass accelerations and determines if a windshear caution or warning should be generated. Windshear alert is not yet implemented; however, all current circuitry and processor will be utilized.

3.3.2 TCAS Functionality

3.3.2.1 Type of Emission

18MOP1D

3.3.2.2 Frequency Range

1030 + 0.01 MHz

3.3.2.3 Power Rating

0.4 to 500 Watts Peak Effective Radiated Power (Pulsed)

3.3.2.4 Final Power Amplifier

Solid State Balanced Amplifier (Class C) using two Motorola MRF10501 silicon bipolar transistors.

3.3.2.5 Active Device Functions

<u>Function</u>	<u>Device Type</u>	<u>Manufacturer</u>
Oscillator		
Temperature Compensated Crystal Oscillator (TCXO)	6206	Oscillatek
Microwave Low Noise Transistor--Amplifier	AT-41511	HP
Transmitter		
Monolithic Amplifier .1 Watt, Microwave Pulse Power	VNA – 25	Mini-Circuit
<u>Function</u>	<u>Device Type</u>	<u>Manufacturer</u>
Transmitter		
Transistor--Amplifier, 1 watt	MRF1000MB	Motorola
Microwave Pulse Power Transistor--Amplifier, 5 watt	MRF10005	Motorola
Microwave Pulse Power Transistor--Amplifier, 30 watt	MRF10031	Motorola
Microwave Pulse Power Transistor--Amplifier, 150 watt	MRF10120	Motorola
Microwave Pulse Power Transistor--Amplifier, 500 watt	MRF10502 (2 ea)	Motorola
Pulse Modulator		
N Channel FET Modulator	IRFR220	Motorola
N Channel FET Envelope Modulator	IRFR9220	International Rectifier
DPSK Modulator		
NPN Transistor (1) Modulator	BSR14	Generic
NPN Transistor (2)	BSR16	Generic

Modulator

3.3.3 Circuit Diagram

A block diagram and schematics will be provided with the FCC Form 731 when the application for certification is filed with the FCC.

3.3.4 Instruction Book

An ACSS document, System Description and Installation Manual, 8000451-001, provides instructions for the proper installation of the T2CAS computer on a given aircraft.

3.3.5 Tune-up Procedure

No field tuning is required. Alignment is performed in the factory.

3.3.6 Oscillator Circuit

The 1030 MHz source consists of the following: 1.) a phase locked oscillator (PLO) is locked to a Temperature Compensated Crystal Oscillator (TCXO). The TCXO provides the required frequency stability for the 1030 MHz source. 2.) the output of the PLO is fed to a prescaler divider, which in turn provides the input to a multiplier circuit. 3.) the output of the multiplier is band pass filtered, and then amplified and distributed to both the receiver and transmitter circuits.

3.3.7 Frequency Stabilization

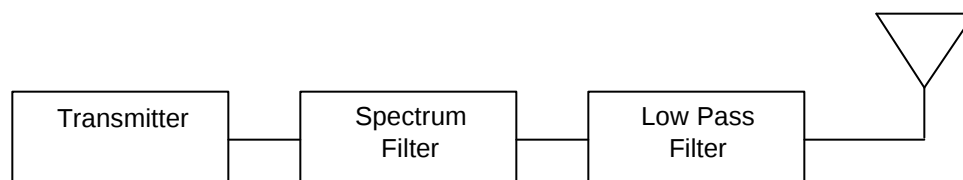
Temperature Compensated Crystal Oscillator (TCXO).

3.3.8 Modulation Limiting

Not Applicable

3.3.9 Radiated Interference Suppression

At the output of the transmitter is a two-pole high power cavity filter designed to attenuate spurious created by the DPSK modulation. This filter also offers good rejection of the even harmonics of the carrier. Following the high power cavity filter is a five pole reflective microstrip low pass filter designed for maximum rejection of the 2nd through 9th harmonics of the carrier



The spectral output of the 1030 MHz transmitter will be limited to the following schedule:

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Frequency difference
(MHz from carrier)

Relative power
(dB below maximum)

≥ 4, < 6	6
≥ 6, < 8	11
≥ 8, < 10	15
≥ 10, < 20	19
≥ 20, < 30	31
≥ 30, < 40	38
≥ 40, < 50	43
≥ 50, < 60	47
≥ 60, < 90	50
≥ 90	60

4 MODULATION DETAILS

4.1 ATCRBS Interrogations.

Interrogations are sent out on an intentionally jittered 1+0.2 second interval in increasing power levels according to the schedules shown in Table 4, Table 5, and Table 6. By transmitting the weakest signals first only the closest aircraft will reply. The interrogations progress in a roughly circular pattern weighted toward the front of the aircraft since that is the area from which the greatest closing speeds originate. In areas of high density the sequence is halted when the computer has reached a limit defined by a complex set of three inequalities. In this manner, interference to other TCAS equipped aircraft in the area is minimized since the strongest interrogations are the first to be dropped. The priority of elimination of steps for interference limiting is also shown in Table 4, Table 5, and Table 6. This priority is inversely related to the order of the step sequence.

Pulse Widths: $0.8 + 0.05 \text{ usec}$
 Rise Times (10% to 90%): $\geq 0.05 \text{ usec.}, < 0.1 \text{ usec}$
 Fall Times (90% to 10%): $\geq 0.05 \text{ usec.}, < 0.2 \text{ usec}$

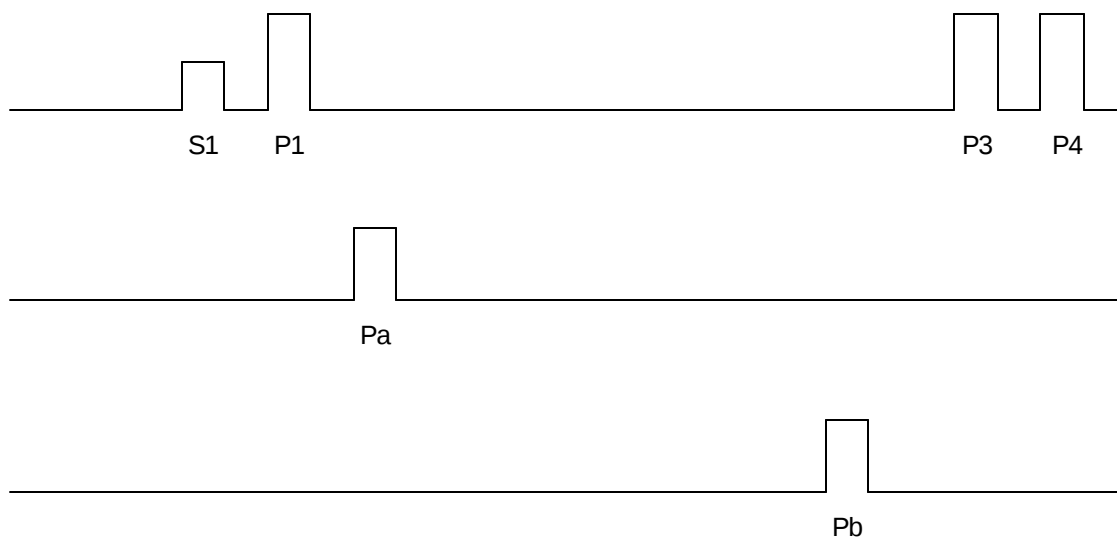


Figure 1: ATCRBS Interrogations

Pulses P1, P3, and P4 will appear in all interrogation steps of the whisper / shout sequence and will be at the same power level. Pulse S1 will appear in all steps except the initial step on each antenna direction and at a level two or three dB below the level of P1, etc. according to the schedules shown in Figures 1 through 3. The steps occur at intervals of two milliseconds until the entire program is complete. The program length depends upon the individual aircraft installation. Options are available from using either an omni-directional bottom antenna or a directional bottom antenna. The top antenna is always directional. Pulses Pa and Pb are transmitted on the antenna. They are used for suppression of sensitivity of the receiving aircraft to the indicated pulses:

S1 = -2 microseconds
 P1 = 0 microseconds
 PA = 2 microseconds
 PB = 19 microseconds
 P3 = 21 microseconds
 P4 = 23 microseconds

4.2 Mode S Interrogations

Details of the Mode S interrogations are shown in Figure 2 below. The preamble and the synchronizing phase reversal (SPR) will appear the same in all interrogations. The data block will be either 56 or 112 chips of 0.25 microseconds, depending upon the type of reply desired. The data chips will be reversed phase from their previous chips if their data bit are 1, they will remain the same phase as the previous chips is their data bits are 0. The allowable transition time of the phase reversals is a maximum of 80 nanoseconds. The Mode S interrogations are transmitted after the whisper/shout sequence of ATCRBS interrogations. When no Mode S equipped aircraft are replying, the TCAS CU sends out Mode S broadcast interrogations based upon a 10 second pattern with 2 or 3 seconds between transmissions on the four lobes of the antenna. The time remaining after the Mode S transmissions are completed is used as a listening period for other unacquired aircraft.

- Preamble Pulse Widths: 0.8 + 0.05 usec
- Rise Times (10% to 90%): < 0.1 usec
- Fall Times (90% to 10%): < 0.2 usec

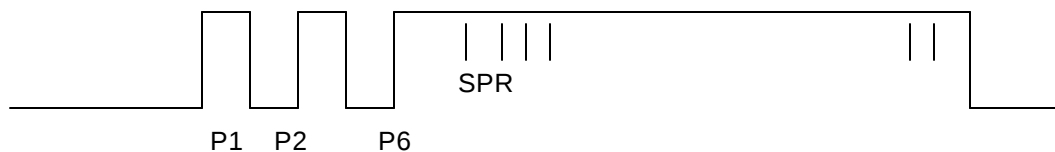


Figure 2: Mode S Interrogations

Timing of the Mode S interrogations is as follows, referenced to the leading edge of the P1 pulse:

P1	0.0 microseconds
P2	2.0 microseconds
P6	3.5 microseconds
SPR	4.75 microseconds
Bit 1	5.25 microseconds
End P6	19.75 microseconds (56 bits) 33.75 microseconds (112 bits)

Table 2: Mode S Interrogation Timing

Nominal Power Levels (dB relative to full power)		
Level	P1,P3, P4 Pulses	S1 Pulse
00	-13	-16
01	-15	-18
02	-17	-20
03	-19	-22
04	-21	-24
05	-23	-26
06	-25	none

Table 3: Mode S Interrogations, Omni-Directional Antenna

Directional Antenna			
Nominal Power Levels (dB relative to full power)			
Level	P1,P3, P4	S1 Pulse	Pa, Pb Pulse
D0	0	-3	-2
D1	-1	-3	-3
D2	-2	-5	-4
D3	-3	-5	-5
D4	-4	-7	-6
D5	-5	-7	-7
D6	-6	-9	-8
D7	-7	-9	-9
D8	-8	-11	-10
D9	-9	-11	-11
D10	-10	-13	-12
D11	-11	-13	-13
D12	-12	-15	-14
D13	-13	-15	-15
D14	-14	-17	-16
D15	-15	-17	-17
D16	-16	-19	-18
D17	-17	-19	-19
D18	-18	-21	-20
D19	-19	-21	-21
D20	-20	-23	-22
D21	-21	-23	-23
D22	-22	-25	-24
D23	-23	-25	-25
D24	-24	-27	-26
D25	-25	-27	-27
D26	-26	--	-16 (P4 only)

Table 4: Mode S Directional Antenna Interrogation Transmission Levels

Bottom Omni-Directional Antenna			
Interference Limiting Priority / Interrogation Level			
98 / 06			
97 / 05			
96 / 04			
95 / 03			
94 / 02			
93 / 01			
92 / 00			
Top Directional Antenna			
Interference Limiting Priority / Interrogation Level			
0'	180'	90'	270'
91 / D26	-	-	-
90 / D25	-	-	-
89 / D24	-	-	-
88 / D23	-	87 / D26	86 / D26
85 / D22	-	84 / D25	83 / D25
82 / D21	-	81 / D24	80 / D24
79 / D20	-	78 / D23	77 / D23
76 / D19	-	75 / D23	74 / D22
73 / D18	72 / D26	71 / D21	70 / D21
69 / D17	68 / D25	67 / D20	66 / D20
65 / D16	64 / D24	63 / D20	62 / D19
61 / D15	60 / D23	59 / D18	58 / D18
57 / D14	56 / D22	55 / D17	54 / D17
49 / D12	48 / D20	47 / D15	46 / D15
45 / D11	44 / D19	43 / D14	42 / D14
41 / D10	40 / D18	39 / D13	38 / D13
37 / D9	36 / D17	35 / D12	34 / D12
33 / D8	32 / D16	31 / D11	30 / D11
29 / D7	28 / D15	27 / D10	26 / D10
25 / D6	24 / D14	23 / D9	22 / D9
21 / D5	20 / D13	19 / D8	18 / D8
17 / D4	16 / D12	15 / D7	14 / D7
13 / D3	12 / D11	11 / D6	10 / D6
9 / D2	8 / D10	7 / D5	6 / D5
5 / D1	4 / D10	3 / D4	2 / D4
1 / D0	-	-	-

(Interrogation sequence is right to left, top to bottom)

Table 5: Top Directional / Bottom Omni-Directional Interrogation Sequence

Interference Limiting Priority / Interrogation Level		
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Top Directional Antenna				Bottom Directional Antenna			
0'	180'	90'	270'	0'	180'	90'	270'
113 / D26	-	-	-	112 / D26	-	-	-
111 / D25	-	-	-	-	110 / D25	-	-
109 / D24	-	-	-	108 / D24	-	-	-
107 / D23	-	-	-	106 / D23	-	-	-
-	-	105 / D26	104 / D26	-	-	103 / D26	102 / D26
101 / D22	-	-	-	100 / D22	-	-	-
-	-	99 / D25	98 / D25	-	-	97 / D25	96 / D25
95 / D21	-	-	-	94 / D21	93 / D26	-	-
-	-	92 / D24	91 / D24	-	-	90 / D24	89 / D24
88 / D20	-	-	-	87 / D20	86 / D25	-	-
-	-	85 / D23	84 / D23	-	-	83 / D23	82 / D23
81 / D19	-	-	-	80 / D19	79 / D24	-	-
-	-	78 / D22	77 / D22	-	-	76 / D22	75 / D22
74 / D18	-	-	-	73 / D18	-	-	-
-	72 / D26	71 / D21	70 / D21	Interrogations for each sector that has a TA or RA present			
69 / D17	68 / D25	67 / D20	66 / D20				
65 / D16	64 / D24	63 / D19	62 / D19				
61 / D15	60 / D23	59 / D18	58 / D18				
57 / D14	56 / D22	55 / D17	54 / D17				
53 / D13	52 / D21	51 / D16	50 / D16				
49 / D12	48 / D20	47 / D15	46 / D15				
41 / D10	40 / D18	39 / D13	38 / D13				
37 / D9	36 / D17	35 / D12	34 / D12				
33 / D8	32 / D16	31 / D11	30 / D11				
29 / D7	28 / D15	27 / D10	26 / D10				
25 / D6	24 / D14	23 / D9	22 / D9				
21 / D5	20 / D13	19 / D8	18 / D8				
17 / D4	16 / D12	15 / D7	14 / D7				
13 / D3	12 / D11	11 / D6	10 / D6				
9 / D2	8 / D5	7 / D5	6 / D5				
5 / D1	4 / D9	3 / D4	2 / D4				
1 / D0	-	-	-				
				1 / D17	1 / D23	1 / D21	1 / D21
				1 / D16	1 / D22	1 / D20	1 / D20
				1 / D15	1 / D21	1 / D19	1 / D19
				1 / D14	1 / D20	1 / D18	1 / D18
				1 / D13	1 / D19	1 / D17	1 / D17
					1 / D18	1 / D16	1 / D16
					1 / D17	1 / D15	1 / D15
					1 / D16	1 / D14	1 / D14
					1 / D15	1 / D13	1 / D13
					1 / D14		
					1 / D13		

(Interrogation sequence is right to left, top to bottom)

Table 6: Top Directional / Bottom Directional Interrogation Sequence