KLJ INSTRUMENTS

Product Information

ADS-B Squitter Generators

KLJ Instruments designs and build test equipment for ground and airborne ADS-B equipment. KLJ products can be configured to meet specific customer testing requirements. KLJ equipment is used by ground station manufacturers, airborne equipment manufacturers, and government agencies.

SQTR-5 UAT Ramp Test Set

The SQTR-5 Ramp Test Set provides portable testing capability for Universal Access Transceiver (UAT).

The SQTR-5 is housed in a rugged case and is supplied with a tablet computer (stored in case lid) for control of the SQTR-5 via a Wi-Fi connection. Test results can be monitored on the tablet computer while sitting in the aircraft.

The SQTR-5 is supplied with an RF antenna for over-the-air testing of the UAT transceiver that is mounted on the case lid and connected to SUM antenna connection. The SQTR-5 antenna connection is designed to be used with a variety of optional antennas which may be connected to the SQTR-5 using the SUM and DIFF (Difference) connections. A Wi-Fi wireless antenna is supplied with the SQTR-5.

Front-panel BNC connectors allow connection of an oscilloscope for monitoring of various signals: RECEIVER FSK allows viewing of demodulated signal coming from UAT and VIDEO allows viewing of UAT data pulse or Mode S reply), UAT TRANSMITTER (Scope sync provides pulse relative to the first pulse of the UAT signal being transmitted by the SQTR-5 and the VIDEO allows viewing of the SQTR-5 transmitted pulse), and MODE S TRANSMITTER (Scope sync provides pulse relative to the first pulse of the Mode S interrogation and the VIDEO allows viewing of the Mode S data pulse).

The SQTR-5 receives UAT data from the aircraft being tested and displays the information on the tablet computer.

The SQTR-5 can be setup to transmit a single UAT target that can be viewed on the UAT display in the aircraft.

The SQTR-5 can be operated using an internal battery or using external 115/230 VAC 50/60 Hz.

SQTR-3B/-3BR ADS-B Squitter Generator

The SQTR-3B provides capability for generating the following signals:

- Simulation of forty-five (45) 1090 MHz targets (10 moving and 35 stationary)
- Simulation of ten (10) UAT moving targets
- Simulation of 1030 MHz (Modes A, C, Mode A/Mode S All Call, Mode C/Mode S All Call, and Mode S) interrogations

The SQTR-3B provides capability for generating scenarios with airborne targets transmitting data via ADS-B, either UAT messages or 1090 MHz DF-17/18/19 squitters.
The Waypoint data for each moving target can be set. The GPS position (latitude, longitude, and altitude) of each target can be set to occur at a selected time. The SQTR-3B will generate the moving GPS position between each waypoint. The scenario can be set to run for a specific time or the SQTR-3B will continue to simulate a moving target after passing the last selected waypoint (unless a scenario run-time length is set in the System Setup screen.

Each target can be configured for specific event-points in which various actions can be programmed to occur. The actions that can be configured include:

- Event Squitter Data – Event-driven squitters
- Surveillance Status
    - Special Position Identification (18 second)
    - Permanent Emergency Alert (Alert)
    - Temporary Alert (Squawk)
- RF Level Offset from RF Level selected in System Setup screen (0 to +31 dB)
- Change status (change or unchanged) of Squitter types (DF 11 Acquisition, DF 17/18 Surface Position, DF17/18, DF17/18 Airborne Position, DF 17/18 Airborne Velocity, or DF17/18 Identification and Category) selected in 1090 Target Setup screen
- Encode data in Type 23 (Test), Type 28 (Aircraft Status), Type 29 (Target State), or Type 31 (Aircraft Operational Status) Squitters

The SQTR-3BR features a receiver for testing of Mode S and UAT Squitters.

SQTR-2M ADS-B Squitter Generator

The SQTR-2 product family is available in a number of configurations including:

- SQTR-2 - Used to perform de-garbling and retriggering performance testing as specified in DO-260B for Mode S receivers
- SQTR-2U - Used to perform DO-282A MOPS tests for Universal Access Transceivers (UAT)
- SQTR-2M - Used to perform de-garbling and retriggering performance of Mode S receivers, DO-282A MOPS testing, and testing of Wide Area Multilateration receivers

The document describes the SQTR-2M as it includes all of the functions of the various SQTR-2 units.

DO-260B Testing

The SQTR-2M can be used to perform the following DO-260B tests via user-generated test files:

2.4.4.3.1.1.1	Verification of In-Band Acceptance
2.4.4.3.1.1.2	Verification of Dynamic Range
2.4.4.3.1.2	Verification of Re-Triggerable Capability
2.4.4.3.2	Verification of Out-of-Band Rejection
2.4.4.3.3	Verification of Dynamic Minimum Trigger Level (DMTL)
2.4.4.3.4.2	Verification of Narrow Pulse Discrimination
2.4.4.3.4.7.1	Verification of Criteria for ADS-B Message Transmission Pulse Detection
2.4.4.3.4.7.3	Verification of Criteria for Data Block Acceptance in ADS-B Message Signals
2.4.4.4.2.1.1	Mode A/C Fruit Signal Source Requirements
2.4.4.4.2.1.2	Mode S Fruit Signal Source Requirements
2.4.4.4.2.2	Four-Pulse Preamble Detection Tests
2.4.4.4.2.3	Preamble Validation Tests
2.4.4.4.2.4	Combined Preamble and Data Block Tests with Mode A/C FRUIT
2.4.4.4.2.5	Data Block Tests with Mode S FRUIT
2.4.4.4.2.6	Re-Triggering Performance (Fixed Position and Varying Position)
2.4.6.1.2	ADS-B and TIS-B Message Reception Function Output Message Delivery Requirements
2.4.8.1.1.1	State Vector Report Type and Structure Identification
2.4.8.1.3	Verification of the Address Qualifier
2.4.8.1.4.1	Time of Applicability for Estimated Position/Velocity
2.4.8.1.4.2.1	Position Time of Applicability when “TIME” (T)=0
2.4.8.1.4.2.2	Position Time of Applicability when “TIME” (T)=1 and UTC Time of Message Receipt is Available
2.4.8.1.4.3	Velocity Time of Applicability
2.4.8.1.5	Latitude Reporting
2.4.8.1.7	Altitude, Geometric (WGS-84) Reporting
2.4.8.1.8	North/South Velocity Reporting
2.4.8.1.9	East/West Velocity Reporting
2.4.8.1.10	Ground Speed Reporting While on the Surface

2.4.8.1.11 Heading While on the Surface Reporting
2.4.8.1.12 Altitude, Barometric (Pressure Altitude) Reporting
2.4.8.1.13 Vertical Rate, Geometric/Barometric
2.4.8.1.14 Vertical Rate, Geometric (WGS-84) Reporting
2.4.8.1.15 Barometric Altitude Rate Reporting
2.4.8.1.16 Navigation Integrity Code (NIC)
2.4.8.1.17 Estimated Latitude (WGS-84) Reporting
2.4.8.1.19 Estimated North/South Velocity Reporting
2.4.8.1.20 Estimated East/West Velocity Reporting
2.4.8.1.21 Surveillance Status / Discretes Reporting
2.4.8.1.22 Report Mode Reporting
2.4.8.2.1.1 Mode Status Report Type and Structure Identification
2.4.8.2.4 Mode Status Report – Report Time of Applicability
2.4.8.2.5 Mode Status Report – ADS-B Version Number
2.4.8.2.6 Mode Status Report – Call Sign
2.4.8.2.7 Mode Status Report – Emitter Category
2.4.8.2.8 A/V Length and Width Code
2.4.8.2.9 Mode Status Report – Emergency / Priority Status
2.4.8.2.10 Mode Status Report – Capability Class Codes
2.4.8.2.11 Mode Status Report – Operational Mode Data
2.4.8.2.12 Mode Status Report – SV Quality - NAC_P
2.4.8.2.13 Mode Status Report – SV Quality – NAC_V
2.4.8.2.14 Mode Status Report – SV Quality - SIL
2.4.8.2.15 Mode Status Report – SV Quality - GVA
2.4.8.2.16 Mode Status Report – SV Quality – NIC_{BARO}
2.4.8.2.17 Track/Heading and Horizontal Reference Direction (HRD)
2.4.8.2.18 Mode Status Report – Vertical Rate Type
2.4.8.2.19 (Reserved for) Flight Mode Specific Data
2.4.8.3.1.1 Target State Report Type and Structure Identification
2.4.8.3.1.2 Target State and Status Vaidity Flags
2.4.8.3.1.5 Target State Report Type – Time of Applicability
2.4.8.3.1.6 Selected Altitude: Selected Altitude Type
2.4.8.3.1.7 Selected Altitude: MCP/FCU Selected Altitude or FMS Selected Altitude
2.4.8.3.1.8 Barometric Pressure Setting (Minus 800 millibars)
2.4.8.3.1.9 Selected Heading
2.4.8.3.1.10 Mode Indicators: Autopilot Engaged
2.4.8.3.1.11 Mode Indicators: VNAV Mode Engaged
2.4.8.3.1.12 Mode Indicators: Altitude Hold Mode
2.4.8.3.1.13 Mode Indicators: Approach Mode
2.4.8.3.1.14 Mode Indicators: LNAV Mode Engaged
2.4.8.3.2.1.1 ARV Report Type and Structure Identification
2.4.8.3.2.1.2 ARV Report Validity Flags
2.4.8.3.2.4 Report Time of Applicability
2.4.8.3.2.5.1 True Airspeed (TAS) Reporting
2.4.8.3.2.5.2 Indicated Airspeed (IAS) Reporting
2.4.8.3.2.6 Airspeed Type
2.4.8.3.2.7 Heading While Airborne
2.4.8.5.1 Precision Installations
2.4.8.5.2 Non-Precision Installations
2.4.9.1.2 ADS-B Mode Status Reports for Class A Equipage
2.4.10.1.3 ADS-B Message Temporary Retention
2.4.10.3.1 Report Assembly Acquistion State – Airborne Participant
2.4.10.3.2 Report Assembly Acquistion State – Surface Participant
2.4.10.4.1.1 Report Assembly Track State Initialization – Airborne Participant
2.4.10.4.1.2 Report Assembly Track State Maintenance – Airborne Participant
2.4.10.4.1.3 Report Assembly Track State Termination – Airborne Participant
2.4.10.4.2.1 Report Assembly Track State Initialization – Surface Participant
2.4.10.4.2.2 Report Assembly Track State Maintenance – Surface Participant
2.4.10.4.2.3 Report Assembly Track State Termination – Surface Participant
2.4.10.5 Minimum Number of Participant Track Files

2.4.10.6.2 Reasonableness Test Applied to Positions Determined from Globally Unambiguous CPR Decoding
2.4.10.6.2 Reasonableness Test Applied to Positions Determined from Locally Unambiguous CPR Decoding
2.4.10.7.1 Candidate Duplicate Address Reporting
2.4.10.7.2 Duplicate Address Conditions
2.4.10.7.3 Candidate Duplicate Report Capability

As specified above, the SQTR-2M can be programmed by the user to verify de-garbling and retriggering performance for an ADS-B Receiver for the following tests:

2.4.4.4.2.4 Combined Preamble and Data Block Tests with Mode A/C FRUIT
2.4.4.4.2.5 Data Block Tests with Mode S FRUIT
2.4.4.4.2.6 Re-Triggering Performance (Fixed Position and Varying Position)

De-garbling and retriggering performance is tested by specific synchronous and asynchronous interference scenarios. Synchronous interference is ATCRBS or Mode S interference that aligns with the ADS-B message of interest. Asynchronous interference is random interference that occurs at predefined rates and power levels.

Synchronous Interference Test

The SQTR-2M can generate at least six overlapping messages with independent power, frequency, phase, message content, and transmission time.

Channel 0, the ‘master’ channel, will generate ADS-B squitters.

Channels 1-5, the ‘slave’ channels, are able to generate the three following message types during a scenario.

- ATCRBS
- Short Mode S
- Long Mode S

The User is able to specify a valid sequence of ADS-B messages such as two position squitters per second, two velocity squitters per second, and one identity squitter per second.

The SQTR-2M can generate all surface and airborne ADS-B message types as defined in RTCA DO-260A. The User is able to set the minimum timing between any two successive ADS-B transmissions.

The rise times, fall times, pulse widths, and modulation of all Mode S messages comply with the applicable sections of DO-185A and DO-260A/260B. The rise times, fall times, pulse widths, and modulation of all ATCRBS messages comply with the applicable sections of DO-185A.

The User is able to set the power for each channel in dBm. The power is fully adjustable over 90 dBm range and accurate to within 0.5 dB. The User is able to specify an exact power or range of powers for each channel. The power will be normally distributed over the User defined range.

The frequency is adjustable from 1090 MHz +/- 3 MHz for each channel. The User is able to specify an exact frequency or range of frequencies for each channel. The frequencies will be normally distributed over the User defined range.

The User is able to specify the average number of bits for the ensemble of ATCRBS messages that make up a scenario when a channel is set for ATCRBS message types. The average number of bits includes the framing pulses.

The message type, content, and address fields will be random when a channel is set for Short Mode S or Long Mode S messages.

The transmission time of each channel relative to the ADS-B channel is adjustable from -120 microseconds to + 120 microseconds +/- 1 microsecond. The timing is referenced to the leading edge of the first preamble pulse of each ADS-B message. The User is able to specify the exact time offset or range of time offsets for each non-ADS-B channel. The time offset will be normally distributed over the User defined range.

The User is able to define a scenario that consists of a fixed number of ADS-B messages i.e. inject 500 even and 500 odd position squitters and stop.

The SQTR-2M stores the time of transmission, power and message content for each transmission using the internal PC.

Asynchronous Interference Test

The SQTR-2M is able to generate at least six overlapping messages with independent power, frequency, phase, message content, and transmission time.

Channel 0, the ‘master’ channel, will generate up to 250 ADS-B targets.

Channels 1-5, the ‘slave’ channels, are able to generate the three following message types during a scenario.

- ATCRBS
- Short Mode S
- Long Mode S

The User is able to specify a valid sequence of ADS-B messages such as two position squitters per second, two velocity squitters per second, and one identity squitter per second. Refer to the ‘CHANNEL 0 TARGET SETUP’ menu.

The SQTR-2M is capable of generating all surface and airborne ADS-B message types as defined in RTCA DO-260A/260B.

The SQTR-2M is able to generate at least 10,500 Mode S messages per second and 58,000 ATCRBS messages per second.

The rise times, fall times, pulse widths, and modulation of all Mode S messages comply with the applicable sections of DO-185A and DO-260A/B. The rise times, fall times, pulse widths, and modulation of all ATCRBS messages comply with the applicable sections of DO-185A.

The SQTR-2M will equally distribute the asynchronous interference over each available channel. The SQTR-2M will randomly distribute the asynchronous interference over each second of the scenario.

The message type, content, and address fields will be random when a channel is set for Short Mode S or Long Mode S asynchronous interference.

The frequency is adjustable from 1090 MHz +/- 3 MHz for each channel. The User is able to specify an exact frequency or range of frequencies for each channel. The frequencies will be normally distributed over the User defined range.

The User is able to specify the average number of bits for the ensemble of ATCRBS messages that make up a scenario when a channel is set for ATCRBS message types. The average number of bits includes the framing pulses.

The User is able to define a scenario that consists of a fixed number of ADS-B messages i.e. inject 500 even and 500 odd position squitters and stop.

The SQTR-2M stores the time of transmission, power and message content for each transmission using the internal PC.

Pre-Programmed Scenarios

For performing DO-260B MOPS testing, the SQTR-2 must be programmed by the test set user. KLJ offers an option to the SQTR-2M for pre-programmed scenarios for the following sections of DO-260B (additional pre-programmed scenarios available upon request):

2.4.4.3.3 Dynamic Minimum Trigger Level (DMTL)
2.4.4.3.4.2 Narrow Pulse Discrimination
2.4.4.4..2.2 Four-Pulse Preamble Detection Tests
2.4.4.4.2.3 Preamble Validation Tests

This option allows the user to select specific tests within the paragraphs described above. The user interface is modified so that a user selection for MOPS TESTS is added.

The MOPS TESTS have a data entry box for cable loss and four selections: Dynamic Minimum Trigger Level, Narrow Pulse Discrimination, Extended Squitter Enhanced Reception, and Preamble Validation.

Each of the MOPS TESTS menus has a RUN button that causes the selected test to execute 1,000 times and stop.

- Dynamic Minimum Trigger Level
    - All Inputs will use the same valid ADS-B message
        - DF = 17
        - CA = 0
        - AA = hardcoded valid address
        - Hardcoded data
        - Message Rate = 50/s
        - Frequency = 1090 MHz
    - A drop down list box will allow the selection of one of six inputs
        - Input A
            - ADS-B message power = -69 dBm
            - Single pulse interference
                - Pulse Position = 0.7 ± 0.2 μs after first preamble pulse of ADS-B message
                - Pulse Width = 120 ± 1 μs
                - Pulse Rise Time = 0.05 to 0.1 μs
                - Pulse Fall Time = 0.05 to 0.2 μs
                - Frequency = 1090 MHz
                - Power = -69 dBm
        - Input B
            - ADS-B message power = -40 dBm
            - Single pulse interference
                - Pulse Position = 0.7 ± 0.2 μs after first preamble pulse of ADS-B message
                - Pulse Width = 120 ± 1 μs
                - Pulse Rise Time = 0.05 to 0.1 μs
                - Pulse Fall Time = 0.05 to 0.2 μs
                - Frequency = 1090 MHz
                - Power = -49 dBm
        - Input C
            - ADS-B message power = 0 dBm
            - Single pulse interference

                - Pulse Position = 0.7 ± 0.2 µs after first preamble pulse of ADS-B message
                - Pulse Width = 120 ± 1 µs
                - Pulse Rise Time = 0.05 to 0.1 µs
                - Pulse Fall Time = 0.05 to 0.2 µs
                - Frequency = 1090 MHz
                - Power = -30 dBm
        - Input D
            - ADS-B message power = 0 dBm
            - ADS-B message
                - Message Position = 129 ± 1 µs after first preamble pulse of ADS-B message
                - DF = 17
                - CA = 0
                - AA = hardcoded valid address
                - Hardcoded valid data
                - Frequency = 1090 MHz
                - Power = -60 dBm
        - Input E
            - ADS-B message power = -70 dBm
            - Single pulse interference
                - Pulse Position = 4 µs before first preamble pulse of ADS-B message
                - Pulse Width = 0.5 µs
                - Pulse Rise Time = 0.05 to 0.1 µs
                - Pulse Fall Time = 0.05 to 0.2 µs
                - Frequency = 1090 MHz
                - Power = -60 dBm
        - Input F
            - ADS-B message power = -70 dBm
            - Single pulse interference
                - Pulse Position = 9 µs before first preamble pulse of ADS-B message
                - Pulse Width = 0.5 µs
                - Pulse Rise Time = 0.05 to 0.1 µs
                - Pulse Fall Time = 0.05 to 0.2 µs
                - Frequency = 1090 MHz
                - Power = -60 dBm
- <u>Narrow Pulse Discrimination</u>
    - All steps will use the same valid ADS-B message
        - DF = 17
        - CA = 0
        - AA = hardcoded valid address
        - Hardcoded data
        - Message Rate = 50/s
        - Frequency = 1090 MHz
    - Steps 1 and 2 will use Input A at different power levels
        - Pulse Position = 1.0 ± 0.2 µs before first preamble pulse of ADS-B message
        - Pulse Width = 0.20 ± 0.05 µs
        - Pulse Rise Time = 0.05 to 0.1 µs
        - Pulse Fall Time = 0.05 to 0.2 µs
        - Frequency = 1090 MHz
        - Power = Selectable -61, -56, -51, -46, -41, -36, -31, -26, -21 dBm
    - Steps 3 and 4 will use Input B at different power levels
        - Pulse Position = 4.0 ± 0.2 µs before first preamble pulse of ADS-B message

        - Pulse Width = 3.00 ± 0.2 µs
        - Pulse Rise Time = 0.6 ± 0.1 µs
        - Pulse Fall Time = 0.6 ± 0.1 µs
        - Frequency = 1090 MHz
        - Power = Selectable -61, -56, -51, -46, -41, -36, -31, -26, -21 dBm
    - A drop down list box will allow selection of one of twenty test steps
        - Step 1: -61dBm Narrow Pulse
        - Step 2a: -56dBm Narrow Pulse
        - Step 2b: -51dBm Narrow Pulse
        - Step 2c: -46dBm Narrow Pulse
        - Step 2d: -41dBm Narrow Pulse
        - Step 2e: -36dBm Narrow Pulse
        - Step 2f: -31dBm Narrow Pulse
        - Step 2g: -26dBm Narrow Pulse
        - Step 2h: -21dBm Narrow Pulse
        - Step 3: -61dBm TACAN/DME Pulse
        - Step 2a: -56dBm TACAN/DME Pulse
        - Step 2b: -51dBm TACAN/DME Pulse
        - Step 2c: -46dBm TACAN/DME Pulse
        - Step 2d: -41dBm TACAN/DME Pulse
        - Step 2e: -36dBm TACAN/DME Pulse
        - Step 2f: -31dBm TACAN/DME Pulse
        - Step 2g: -26dBm TACAN/DME Pulse
        - Step 2h: -21dBm TACAN/DME Pulse

- <u>Extended Squitter Enhanced Reception</u>
    - All steps will use the same valid ADS-B message
        - DF = 17
        - CA = 0
        - AA = hardcoded valid address
        - Hardcoded data
        - Message Rate = 50/s
        - Frequency = 1090 MHz
        - Power = Selectable -65, -23 dBm
    - A drop down list box will allow selection of one of fifty two test steps
        - Step 1: Input A, -23dBm
        - Step 2: Input A, -65dBm
        - Step 3: Input B, -23dBm
        - Step 4: Input B, -65dBm
        - Step 5: Input C, -23dBm
        - Step 6: Input C, -65dBm
        - Step 7: Input D, -23dBm
        - Step 8: Input D, -65dBm
        - Step 9: Input E, -23dBm
        - Step 10: Input E, -65dBm
        - Step 11: Input F, -23dBm
        - Step 12: Input F, -65dBm
        - Step 13: Input G, -23dBm
        - Step 14: Input G, -65dBm
        - Step 15: Input H, -23dBm
        - Step 16: Input H, -65dBm
        - Step 17: Input I, -23dBm

- Step 18: Input I, -65dBm
- Step 19: Input J, -23dBm
- Step 20: Input J, -65dBm
- Step 21: Input K, -23dBm
- Step 22: Input K, -65dBm
- Step 23: Input L, -23dBm
- Step 24: Input L, -65dBm
- Step 25: Input M, -23dBm
- Step 26: Input M, -65dBm
- Step 27: Input N, -23dBm
- Step 28: Input N, -65dBm
- Step 29: Input O, -23dBm
- Step 30: Input O, -65dBm
- Step 31: Input P, -23dBm
- Step 32: Input P, -65dBm
- Step 33: Input Q, -23dBm
- Step 34: Input Q, -65dBm
- Step 35: Input R, -23dBm
- Step 36: Input R, -65dBm
- Step 37: Input S, -23dBm
- Step 38: Input S, -65dBm
- Step 39: Input T, -23dBm
- Step 40: Input T, -65dBm
- Step 41: Input U, -23dBm
- Step 42: Input U, -65dBm
- Step 43: Input V, -23dBm
- Step 44: Input V, -65dBm
- Step 45: Input W Part 1, -23dBm
- Step 46: Input W Part 2 -65dBm
- Step 47: Input W Part 3, -23dBm
- Step 48: Input W Part 4, -65dBm
- Step 49: Input W Part 5, -23dBm
- Step 50: Input W Part 6, -65dBm
- Step 51: Input A, -23dBm
- Step 52: Input A, -65dBm

Input A:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-161: Input A: Preamble Pulse Characteristics

Input A: Preamble Pulse Characteristics					
Pulse	**Rise Time (μsec)**	**Fall Time (μsec)**	**Δ Width (μsec)**	**Δ Position (μsec)**	**Δ Amplitude (dB)**
1	0.05 – 0.1	0.05 – 0.2	+0.05	--	--
2	0.05 – 0.1	0.05 – 0.2	-0.05	+0.100	+2
3	0.05 – 0.1	0.05 – 0.2	+0.05	+0.100	+2
4	0.05 – 0.1	0.05 – 0.2	-0.05	+0.100	0

Input B:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

<u>Table 2-162:</u> Input B: Preamble Pulse Characteristics

Input B: Preamble Pulse Characteristics					
Pulse	**Rise Time (µsec)**	**Fall Time (µsec)**	**∆ Width (µsec)**	**∆ Position (µsec)**	**∆ Amplitude (dB)**
1	0.05 – 0.1	0.05 – 0.2	+0.05	--	--
2	0.05 – 0.1	0.05 – 0.2	-0.05	-0.100	+2
3	0.05 – 0.1	0.05 – 0.2	+0.05	-0.100	+2
4	0.05 – 0.1	0.05 – 0.2	-0.05	-0.100	0

<u>Input C:</u>

Same as the **Reference input**, but having the following preamble pulse characteristics:

<u>Table 2-163:</u> Input C: Preamble Pulse Characteristics

Input C: Preamble Pulse Characteristics					
Pulse	**Rise Time (µsec)**	**Fall Time (µsec)**	**∆ Width (µsec)**	**∆ Position (µsec)**	**∆ Amplitude (dB)**
1	0.05 – 0.1	0.05 – 0.2	-0.3	--	--
2	0.05 – 0.1	0.05 – 0.2	-3.5	0	0
3	Pulse Not Present				
4	Pulse Not Present				

<u>Note:</u> *Input C sets up a preamble where only P1 and P2 have actual leading edges, while P3 and P4 have pulse positions provided by the extended P2 pulse. All pulse positions and leading edges are at nominal positions. This test input verifies that the UUT accepts a preamble with the minimum 2 actual leading edges using P1 and P2. The test procedure requires that the UUT accepts this input at a rate of at least 90%.*

<u>Input D:</u>

Same as the **Reference Input**, but having the following preamble pulse characteristics:

<u>Table 2-164:</u> Input D: Preamble Pulse Characteristics

Input D: Preamble Pulse Characteristics					
Pulse	**Rise Time (µsec)**	**Fall Time (µsec)**	**∆ Width (µsec)**	**∆ Position (µsec)**	**∆ Amplitude (dB)**
1	0.05 – 0.1	0.05 – 0.2	+1.0	--	--
2	Pulse Not Present				
3	0.05 – 0.1	0.05 – 0.2	+1.0	0	0
4	Pulse Not Present				

<u>Note:</u> *Input D sets up a preamble where only P1 and P3 have actual leading edges, while P2 and P4 have pulse positions provided by the extended P1 and P3 pulses. All pulse positions and leading edges are at nominal positions. This test input verifies that the UUT accepts a preamble with the minimum 2 actual leading edges using P1 and P3. The test procedure requires that the UUT accepts this input at a rate of at least 90%.*

<u>Input E:</u>

Same as **Reference Input**, but having the following preamble pulse characteristics:

<u>Table 2-165:</u> Input E: Preamble Pulse Characteristics

Input E: Preamble Pulse Characteristics					
Pulse	Rise Time (µsec)	Fall Time (µsec)	∆ Width (µsec)	∆ Position (µsec)	∆ Amplitude (dB)
1	0.05 – 0.1	0.05 – 0.2	+3.5	--	--
2	Pulse Not Present				
3	Pulse Not Present				
4	0.05 – 0.1	0.05 – 0.2	0	0	0

<u>Note:</u> *Input E sets up a preamble where only P1 and P4 have actual leading edges, while P2 and P3 have pulse positions provided by the extended P1 pulse. All pulse positions and leading edges are at nominal positions. This test input verifies that the UUT accepts a preamble with the minimum 2 actual leading edges using P1 and P4. The test procedure requires that the UUT accepts this input at a rate of at least 90%.*

<u>Input F:</u>

Same as the **Reference input**, but having the following preamble pulse characteristics:

<u>Table 2-166:</u> Input F: Preamble Pulse Characteristics

Input F: Preamble Pulse Characteristics					
Pulse	Rise Time (µsec)	Fall Time (µsec)	∆ Width (µsec)	∆ Position (µsec)	∆ Amplitude (dB)
1	0.05 – 0.1	0.05 – 0.2	+1.3	-0.3	--
2	Pulse Not Present				
3	0.05 – 0.1	0.05 – 0.2			
4	0.05 – 0.1	0.05 – 0.2			

<u>Note:</u> *Input F sets up a preamble where only P3 and P4 provide actual leading edges within the allowable position limits, while P1 and P2 have pulse positions provided by the extended P1 pulse. Pulse positions and leading edges are located at nominal positions. This test input verifies that the UUT accepts a preamble with the minimum 2 actual leading edges using P3 and P4. The test procedure requires that the UUT accepts this input at a rate of at least 90%.*

<u>Input G through W:</u>

The inputs for G through W are the same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-167: Inputs G through W: Preamble Pulse Characteristics

Input Set	Pulse	Rise Time (µsec)	Fall Time (µsec)	∆ Width (µsec)	∆ Position (µsec)	∆ Amplitude (dB)
Input G	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	0	0
	3	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	0

Input Set	Pulse	Rise Time (μsec)	Fall Time (μsec)	∆ Width (μsec)	∆ Position (μsec)	∆ Amplitude (dB)
	4	0.05 – 0.1	0.05 – 0.2	0	0	0
Input H	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	0	0
	3	0.05 – 0.1	0.05 – 0.2	+1.0	0	0
	4	Pulse Not Present				
Input I	1	0.05 – 0.1	0.05 – 0.2	-0.3	--	--0
	2	0.05 – 0.1	0.05 – 0.2	-0.3	0	0
	3	0.05 – 0.1	0.05 – 0.2	-0.3	0	0
	4	0.05 – 0.1	0.05 – 0.2	-0.3	0	
Input J	1	0.05 – 0.1	0.05 – 0.2	+4.5	--	--
	2	Pulse Not Present				
	3	Pulse Not Present				
	4	Pulse Not Present				
Input K	1	0.05 – 0.1	0.05 – 0.2	0	--	--
	2	0.05 – 0.1	0.05 – 0.2	+3.5	-0.2	0
	3	Pulse Not Present				
	4	Pulse Not Present				
Input L	1	0.05 – 0.1	0.05 – 0.2	0	--	--
	2	0.05 – 0.1	0.05 – 0.2	+3.5	+0.2	0
	3	Pulse Not Present				
	4	Pulse Not Present				
Input M	1	0.05 – 0.1	0.05 – 0.2	+1.0	--	--
	2	Pulse Not Present				
	3	0.05 – 0.1	0.05 – 0.2	+1.0	-0.2	0
	4	Pulse Not Present				
Input N	1	0.05 – 0.1	0.05 – 0.2	+1.0	--	--
	2					
	3	0.05 – 0.1	0.05 – 0.2	+1.0	+0.2	0
	4	Pulse Not Present				
Input O	1	0.05 – 0.1	0.05 – 0.2	+3.5	--	--
	2	Pulse Not Present				
	3	Pulse Not Present				
	4	0.05 – 0.1				
Input P	1	0.05 – 0.1	0.05 – 0.2	+3.5	--	--
	2	Pulse Not Present				
	3	Pulse Not Present				
	4	0.05 – 0.1	0.05 – 0.2	0	+0.2	0
Input Q	1	0.05 – 0.1	0.05 – 0.2	+1.3	-0.3	--
	2	Pulse Not Present				
	3	0.05 – 0.1	0.05 – 0.2	0	-0.125	0
	4	0.05 – 0.1	0.05 – 0.2	0	+0.125	0
Input R	1	0.05 – 0.1	0.05 – 0.2	+1.3	-0.3	--
	2	Pulse Not Present				
	3	0.05 – 0.1	0.05 – 0.2	0	0.125	0
	4	0.05 – 0.1	0.05 – 0.2	0	-0.125	0
Input S	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	-0.1250	0
	3	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	0
	4	0.05 – 0.1	0.05 – 0.2		+0.1250	0

Input Set	Pulse	Rise Time (μsec)	Fall Time (μsec)	∆ Width (μsec)	∆ Position (μsec)	∆ Amplitude (dB)
Input T	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	+0.125	0
	3	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	0
	4	0.05 – 0.1	0.05 – 0.2	0	-0.125	0
Input U	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	-0.125	0
	3	0.05 – 0.1	0.05 – 0.2	+1.0	+.125	
	4	Pulse Not Present				
Input V	1	0.05 – 0.1	0.05 – 0.2	+0.3	-0.3	--
	2	0.05 – 0.1	0.05 – 0.2	0	+0.125	0
	3	0.05 – 0.1	0.05 – 0.2	+1.0	-.125	0
	4	Pulse Not Present				
Input W	1	Pulse Not Present				
	2	0.05 – 0.1	0.05 – 0.2	0	0	0
	3	0.05 – 0.1	0.05 – 0.2	0	0	0
	4	0.05 – 0.1	0.05 – 0.2	0	0	0

- <u>Preamble Validation</u>
  - All steps will use the same valid ADS-B message
    - DF = 17
    - CA = 0
    - AA = hardcoded valid address
    - Hardcoded data
    - Message Rate = 50/s
    - Frequency = 1090 MHz
    - Power = Selectable -65, -23 dBm
  - A drop down list box will allow selection of one of twelve test steps
    - Step 1: Missing First Data Bit, -23dBm
    - Step 2: Missing First Data Bit, -65dBm
    - Step 3: Missing Second Data Bit, -23dBm
    - Step 4: Missing Second Data Bit, -65dBm
    - Step 5: Missing Third Data Bit, -23dBm
    - Step 6: Missing Third Data Bit, -65dBm
    - Step 7: Missing Third and Fourth Data Bit, -23dBm
    - Step 8: Missing Third and Fourth Data Bit, -65dBm
    - Step 9: Missing Fourth and Fifth Data Bit, -23dBm
    - Step 10: Missing Fourth and Fifth Data Bit, -65dBm
    - Step 11: Missing Sixth Data Bit, -23dBm
    - Step 12: Missing Sixth Data Bit, -65dBm
  - Missing First Data Bit has the first data bit 7dB lower than all others (-30dBm, -72dBm)
  - Missing Second Data Bit has the second data bit 7dB lower than all others (-30dBm, -72dBm)
  - Missing Third Data Bit has the third data bit 7dB lower than all others (-30dBm, -72dBm)
  - Missing Third and Fourth Data Bit has the third and fourth data bits 7dB lower than all others (-30dBm, -72dBm)
  - Missing Fourth and Fifth Data Bit has the fourth and fifth data bits 7dB lower than all others (-30dBm, -72dBm)
  - Missing Sixth Data Bit has no energy in the sixth data bit

DO-282 Testing

The SQTR-2M provides pre-programmed scenario capability for testing DO-282B:

- Simulation of ten (10) UAT targets (called Generic Testing) with data for each target selectable by the test set user
- Simulation of following tests as specified in DO-282B Minimum Operational Performance Standards (called MOPS Testing) for Universal Access Transceiver (UAT) Automatic Dependent Surveillance - Broadcast (ADS-B)
    - 2.4.8.2.1.1 Verification of Long ADS-B Message as Desired Signal
    - 2.4.8.2.1.2 Verification of Basic ADS-B Message as Desired Signal
    - 2.4.8.2.1.3 Verification of Ground Uplink Message as Desired Signal
    - 2.4.8.2.2 Verification of Receiver Desired Signal Dynamic Range
    - 2.4.8.2.3 Verification of Receiver Selectivity
    - 2.4.8.2.4 Verification of Receiver Tolerance to Pulsed Interference
    - 2.4.8.2.5 Verification of Receiver Tolerance to Overlapping ADS-B Messages (Self-Interference
    - 2.4.8.2.7 Verification of Trigger Processing Rate
    - 2.4.8.3.1.1 Verification of ADS-B Messages
    - 2.4.8.3.2 Verification of Receiver Discrimination Between ADS-B and Ground Uplink Message Types
    - 2.4.8.3.3 Verification of Receiver Processing of ADS-B Synchronization "Trigger"
    - 2.4.8.3.4 Verification of Receiver Processing of Ground Uplink Synchronization "Trigger"
    - 2.4.8.3.5 Verification of Receiver Time of Message Receipt
    - 2.4.10.2 Verification of Capacity for Successful Message Reception
    - 2.4.10.3 Verification of Applicable Messages
    - 2.4.11.1 Verification of Transmit-Receive Turnaround Time

Wide Area Multilateration

In addition to the Mode S and UAT test capability, the SQTR-2M adds testing for Wide Area Multilateration (WAM) or Multilateration (MLAT) systems.

WAM systems locate aircraft by measuring the time of arrival (TOA) of transmissions at multiple points in space and calculating the time difference of arrival (TDOA) between receiver pairs. In order to test WAM, the SQTR-2M simulates RF transmissions from aircraft received at multiple points in space. The SQTR-2M simulates transmission received for four independent WAM receivers. Testing for additional WAM receivers can be added based on customer requirements.

The SQTR-2M automatically transmits messages at the correct TOA based on the three dimensional location of the targets and receivers. The timing accuracy between the true TOA calculated from the target's true position and receiver locations shall not exceed +/- 10 ns.

The SQTR-2M can generate Mode S and ATCRBS targets:

- Mode S - Mode S replies (DF4, DF5, and DF11) and Mode S Extended Squitters (DF11 Acquisition, Surface Position, Airborne Position, Airborne Velocity, and Identification) squitters from 500 Mode S targets (20 moving and 480 stationary)
- ATCRBS - 250 ATCRBS targets (10 moving and 240 stationary).

The User can define six geographical waypoints for each target scenario and apply each waypoint to each moving target independently. The User can configure the output power from 0 to -90 dBm and frequency over 1090 +/- 3 MHz for each scenario. External cable loss up to 70 dB can be programmed by the user.

The SQTR-2M can generate asynchronous interference using two RF channels. The user can select up to 23,564 ATCRBS interference targets and up to a combination of 4,184 Mode S Short or Long interference targets. The user can select frequency range and average number of ATCRBS pulses.