KLJ INSTRUMENTS

SQTR-3
1030/1090/UAT
ADS-B Squitter Generator

Operators Manual

REVISION

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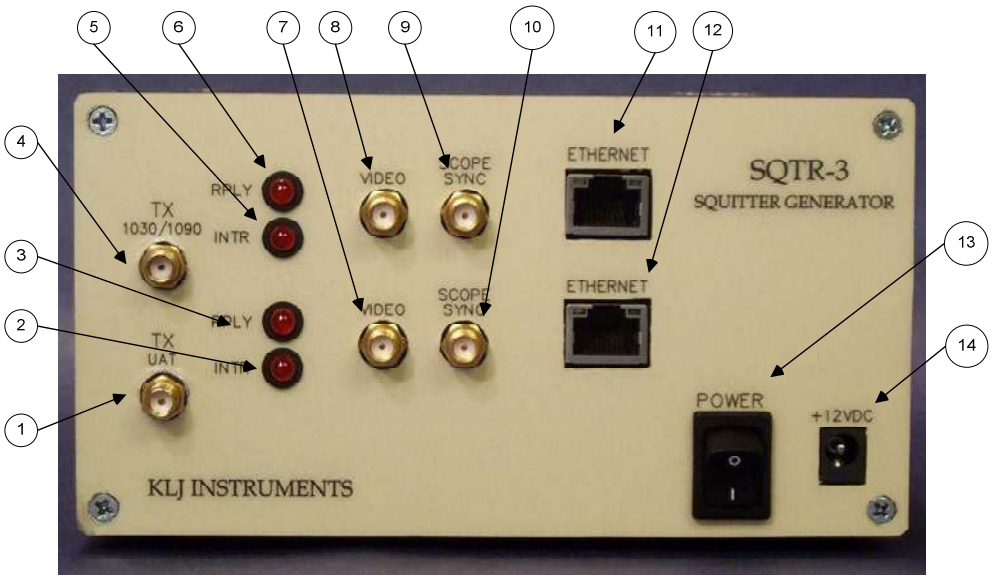
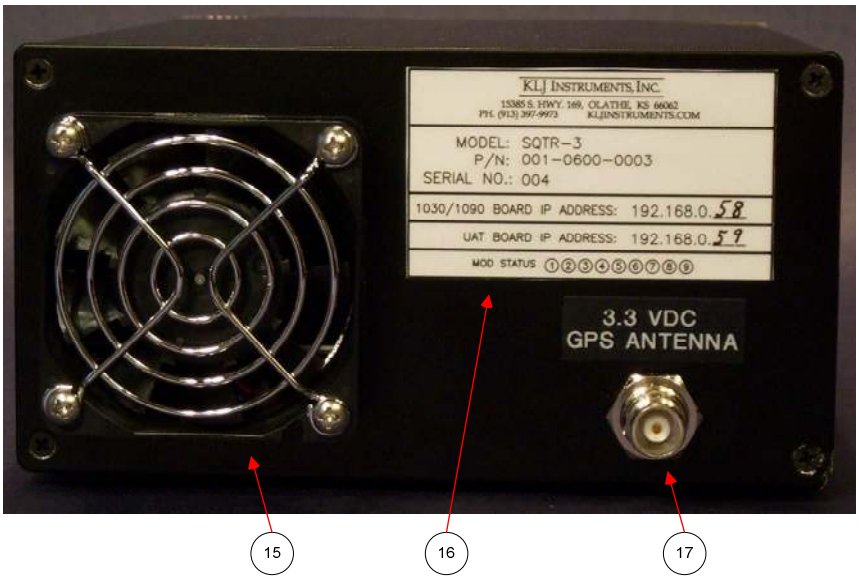
INTRODUCTION

1.1 Manual Description

The SQTR-3 provides capability for generating ADS-B information (1090 MHz DF17 Squitters and Universal Access Transceiver (UAT) Messages) and 1030 MHz Mode S Interrogations. The purpose of this manual is to provide instructions for use of the SQTR-3.

1.2 Front and Rear Panel Description





SQTR-3 Front and Rear Panel		
1	TX UAT	Output for UAT Messages
2	UAT INTR	Future use
3	UAT REPLY	Flashes when transmitting UAT messages
4	TX 1030/1090	Output for 1030 Interrogations or 1090 DF17 Squitters
5	1030/1090 INTR	Future use
6	1030/1090 REPLY	Flashes when transmitting 1030 Interrogations or 1090 DF17 Squitters
7	UAT VIDEO	Detected waveform of UAT Messages
8	1030/1090 VIDEO	Detected waveform of 1030 Interrogations or 1090 DF17 Squitters
9	1030/1090 SCOPE	Scope Sync output for each 1030 Interrogation or 1090 DF17 Squitters
10	UAT SCOPE	Scope Sync output for each UAT Messages
11	1030/1090 ETHERNET	Ethernet connection for 1030/1090 Board
12	UAT ETHERNET	Ethernet connection for UAT Board
13	POWER	Power Switch
14	+12 VDC	Connection for external power supply
15	FAN	
16	SERIAL TAG	Shows SQTR-3 information as well as Ethernet IP Address for UAT and 1030/1090 Board
17	3.3 VDC GPS ANTENNA	Connection for external GPS antenna

1.3 SQTR-3 Function

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

- Simulation of forty-five (45) 1090 MHz squitters (10 moving and 35 stationary)
- Simulation of ten (10) UAT messages
- 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-3 provides capability for generating scenarios for generating airborne targets transmitting data via ADS-B, either UAT messages or 1090 MHz DF-17/18/19 squitters.
The Waypoint data for each target can be set. The GPS position (latitude and longitude) of each target can be set to occur at a selected time. The SQTR-3 will generate the moving GPS position between each waypoint. The scenario can be set to run for a specific time or the SQTR-3 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

1.4 Initial Setup

The SQTR-3 consists of two transmit channels, one for either 1030 or 1090 MHz and the second for UAT messages. Each of the two transmitter channels is controlled using an Ethernet connection. The IP address for each board is shown on a tag mounted on the rear of the SQTR-3. The SQTR-3 is shipped from the factory with the following IP addresses:

- 1030.1090 Board: 192.168.0.58

- UAT Board: 192.168.0.59

The address for each board can be changed using instructions described in the Lantronix XPort Direct™ User Guide, Section 5, Page 22, Setup Mode: Server Configuration. Follow the instructions for changing the IP Address only – do not change any of the other options. After changing the IP Address, save the configuration and exit.

The SQTR-3 can be controlled using the graphical user interface (GUI) that is supplied with the unit or by the use of a terminal emulation program. KLJ recommends the use of a terminal emulation program called Tera Term Pro Web (instructions in this manual are written around Tera Term Version 3.1.3) which is a freeware program that can be downloaded from www.ayera.com/teraterm. After downloading the Tera Term program to your computer, connect to the SQTR-3 via your local Ethernet network or directly from your computer to the SQTR-3 via a CAT 5E X-Over patch cable. If using the X-over patch cable, your computer IP Address must be configured to "talk" to the SQTR-3 (suggest address of 192.168.0.40 for your computer) using START/CONTROL PANEL/NETWORK CONNECTIONS/LOCAL AREA CONNECTIONS/INTERNET PROTOCOL (TCP/IP). If you are using the Tera Term Web 3.1 program, FILE/NEW CONNECTION. Select TCP/IP and set Host to 192.168.0.58. Select OTHER and set TCP Port # to 10001. Press OK. You should see 192.168.0.58 VT if TeraTerm has connected to the SQTR-3. Select SETUP/TERMINAL and check the box next to LOCAL ECHO. To test the connection, type RFR?. The Tera Term program will show the current version of the RF board software loaded in the SQTR, i.e. SQTR 3(DA2): 0,9; Date 2/24/09. Some types of firewall programs can block the return of data from the SQTR-3. You may need to configure your firewall to accept the SQTR-3 data.

1.5 User Control – General Description

The SQTR-3 can be controlled using a graphical user interface that allows limited control of the SQTR-3 functions or through the use of manual user commands that allows control of all test set functions. The manual user commands can be sent to the SQTR-3 using the Tera Term Web program.

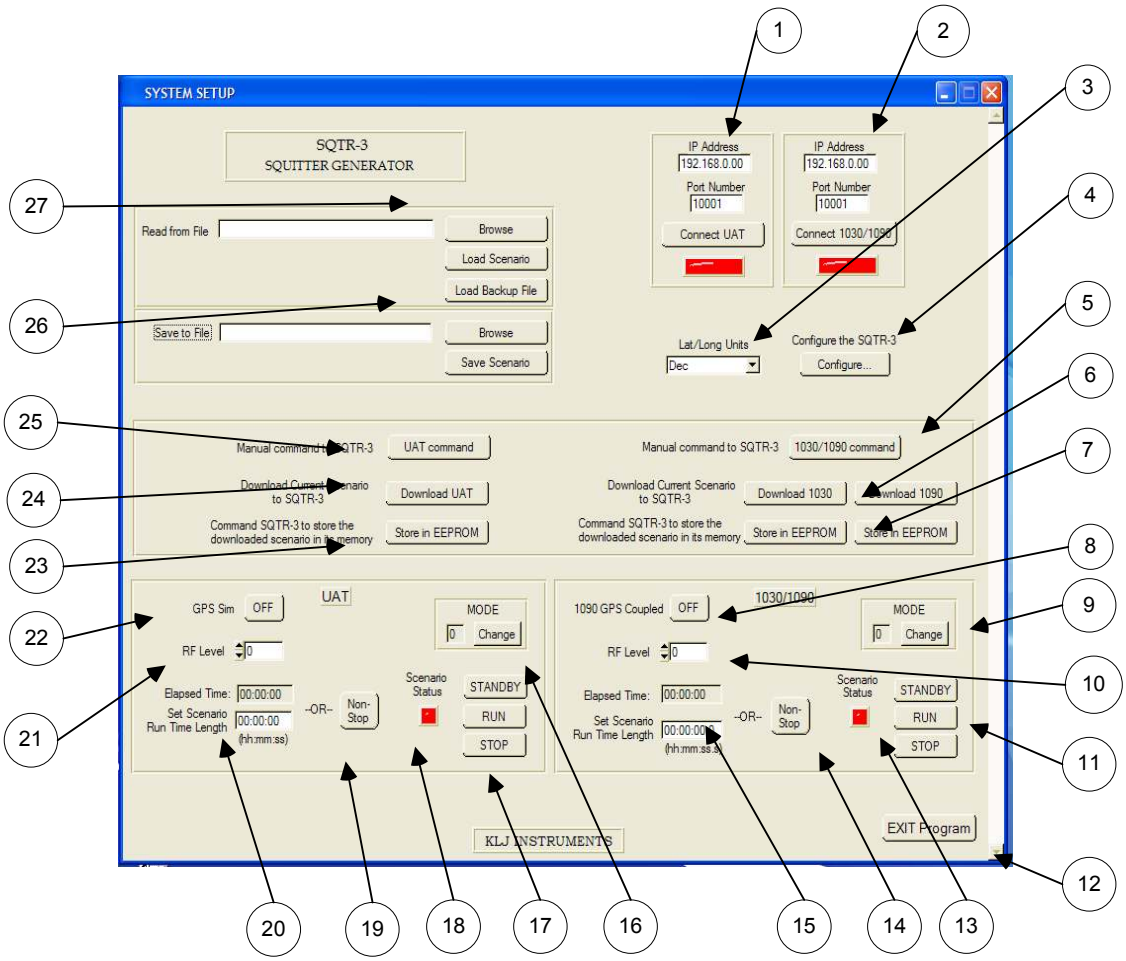
1.5.1 Graphical User Interface (GUI)

The graphical user interface (GUI) is shipped with the SQTR-3 on a CD-ROM. To install the GUI on your computer, insert the CD-ROM into your CD/DVD drive. Using your Windows Explorer program, view the files contained on the CD-ROM. Select SETUP using your computer mouse. The SQTR-3 will install the GUI on your computer (Note: Press OK if you get a message asking you to insert Disk 2, select OK). The GUI can be started using the CLIENT.EXE file.

The SQTR-3 GUI is launched by selecting CLIENT.EXE in the directory where the GUI is installed (unless changed during installation, the directory will be C:\KLJ\SQTR3GEN). The following screen will be shown:

1.5.1.1 System Setup

The System Setup Screen is used to connect the control computer containing the GUI and setup the system parameters of the SQTR-3.



SYSTEM SETUP Screen

System Setup Screen	
1	UAT - Used to connect GUI control to UAT Board. The computer must be connected to the UAT Ethernet connector. The UAT indicator light will turn green if connection is successful.
2	1030/1090 - Used to connect GUI control to 1030/1090 Board. The computer must be connected to the 1030/1090 Ethernet connector. Press 1030/1090 button and the screens shown in Figures 1 and 2 will pop-up. The UAT indicator light will turn green if connection is successful.
3	Lat/Long Units - Used to select Decimal or Degrees/Minutes/Seconds for display of GPS coordinates
4	SQTR-3 Configure - Used to configure the output of the SQTR-3. Press the Configure button and the screen shown in Figure 1 will pop-up. Select function to be configured. Depending on selection, the 1090 MHz ADS-B (see Figure 7), UAT ADS-B (Figure 10) or, 1030 MHz interrogations.
5	1030/1090 Manual Commands - Used to send user-defined commands to SQTR-3 that do not have a control on a GUI screen (see Appendix A for list of commands). Press 1030/1090 button and Figure 2 will pop-up.
6	Download 1030 or Download 1090 - Used to download the configuration or scenario for 1030 Interrogations or 1090 ADS-B from the control computer to the SQTR-3 (a screen will pop-up indicating that the configuration is being downloaded to the SQTR-3). The SQTR-3 1030/1090 Board can transmit 1030 Interrogations or 1090 ADS-B – not both at the same time.

7	Store EEPROM - Used to store in EEPROM the 1030 or 1090 configuration currently downloaded in the SQTR-3. Press the Store in EEPROM and a warning button (Figure 4) will pop-up with the stating that storing the information will take approximately 3.5 minutes. Press the “Yes, Continue” or “No, Cancel” button.
8	1090 GPS Coupled - Used to set the time applicability of the 1090 position messages. GPS Coupled On means that the latitude and longitude of the targets are set exactly to the 0.2 second UTC epoch to which the position data is extrapolated. GPS Coupled Off means that the latitude and longitude are extrapolated to the time of message transmission.
9	1030/1090 Mode - Used to select the SQTR-3 Start-Up Mode for 1030 and 1090. Press the Mode button and the SQTR Generator Mode 1030/1090 screen shown in Figure 3 will pop-up. Mode 0 is the default mode where the user must configure the SQTR-3 1030 and 1090 functions. For Mode 1, the SQTR-3 at power-on will load the 1090 configuration stored in EEPROM and wait for the user to press the 1030/1090 Run button (item 11) to begin transmitting 1090 ADS-B (GUI must be re-connected to SQTR-3. For Mode 2, the SQTR-3 at power-on will load the 1090 configuration stored in EEPROM and run the scenario until the time specified in the Set Scenario Run Time Length (item 16). For Mode 3, the SQTR-3 at power-on will load the 1090 configuration stored in EEPROM and run the scenario until the time specified in the Set Scenario Run Time Length (item 16) and then keep repeating the scenario. For Mode 4, the SQTR-3 at power-on will load the 1030 configuration stored in EEPROM and wait for the user to press the Run button (item 11) to begin transmitting 1090 ADS-B (GUI must be re-connected to SQTR-3. For Mode 5, the SQTR-3 at power-on will load the 1030 configuration stored in EEPROM and continuously run the scenario. If the SQTR-3 has been sent a Mode 1, 2, 3, or 4, a Mode 0 must be sent to the SQTR-3 in order to return to normal operation where a new scenario can be configured and loaded.
10	RF Level - Used to set the RF level of the 1030 and 1090 transmissions from +13 to -91 dBm
11	Standby/Run/Stop - Used to control scenario – Run starts scenario, Standby pauses scenario (hit Run to continue), and Stop (hit Run to re-start scenario)
12	Exit Program – Used to exit and close GUI
13	Scenario Status – Indicates if 1030 or 1090 scenario is running (green), in standby (yellow) or stopped (red)
14	Non-Stop – Used to set scenario as configured with Waypoint settings to continuously run versus using Scenario Run Time Length (item 15)
15	Set Scenario Run Time Length and Scenario Elapsed Time – Used to show scenario run and stop times as configured with Waypoint settings and the elapsed time for the 1030 or 1090 scenario.
16	UAT Mode – Used to select the SQTR-3 Start-Up Mode for UAT. Press the Mode button and the SQTR Generator Mode 1030/1090 screen shown in Figure 6 will pop-up. Mode 0 is the default mode where the user must configure the SQTR-3 UAT function. For Mode 1, the SQTR-3 at power-on will load the UAT configuration stored in EEPROM and wait for the user to press the UAT Run button (item 18) to begin transmitting 1090 ADS-B (GUI must be re-connected to SQTR-3. For Mode 2, the SQTR-3 at power-on will load the UAT configuration stored in EEPROM and run the scenario until the time specified in the Set Scenario Run Time Length (item 21). For Mode 3, the SQTR-3 at power-on will load the UAT configuration stored in EEPROM and run the scenario until the time specified in the Set Scenario Run Time Length (item 21) and then keep repeating the scenario. If the SQTR-3 has been sent a Mode 1, 2, or 3, a Mode 0 command must be sent to the SQTR-3 in order to return to normal operation where a new scenario can be configured and loaded.
17	Standby/Run/Stop - Used to control scenario – Run starts scenario, Standby pauses scenario (hit Run to continue), and Stop (hit Run to re-start scenario)
18	Scenario Status – Indicates if UAT scenario is running (green), in standby (yellow) or stopped (red)
19	Non-Stop – Used to set scenario as configured with Waypoint settings to continuously run versus using Scenario Run Time Length (item 20)
20	Set Scenario Run Time Length and Scenario Elapsed Time – Used to show set scenario run time and the elapsed time for the UAT scenario.
21	RF Level - Used to set the RF level of the UAT transmissions from 0 to -101 dBm
22	GPS Simulator – Used to internally generate 1 PPS timing signal if external GPS signal not available for SQTR-3

23	Store EEPROM - Used to store in EEPROM the UAT configuration currently downloaded in the SQTR-3. Press the Store in EEPROM and a warning button (Figure 5) will pop-up with the stating that storing the information will take approximately 3.5 minutes. Press the “Yes, Continue” or “No, Cancel” button.
24	Download UAT - Used to download the configuration or scenario for UAT ADS-B from the control computer to the SQTR-3 (a screen will pop-up indicating that the configuration is being downloaded to the SQTR-3).
5	Save to File – Used to store the current configuration currently downloaded into the SQTR-3. UAT/1090 or UAT/1030 is saved in a file on the control computer. Use the Browse button to select the location for the file. Type a name for the file to be saved and then press the Save Scenario button to store the file. If you are going to replace a file or use the name of an existing file, use the Browse button to locate the file and press save. A message will pop-up asking if the file is going to be replaced – press Yes, and then press the Save Scenario button to store the file.
26	Read from File – Used to load a configuration file that was previously stored on the control computer. Use the Browse button to locate the file. Select the file to be loaded. Press the Load Scenario button to load the file. The file must then be downloaded into the SQTR-3 using the appropriate Download buttons (items 7 and 26) – the control computer must be connected to the correct Ethernet port for downloading.

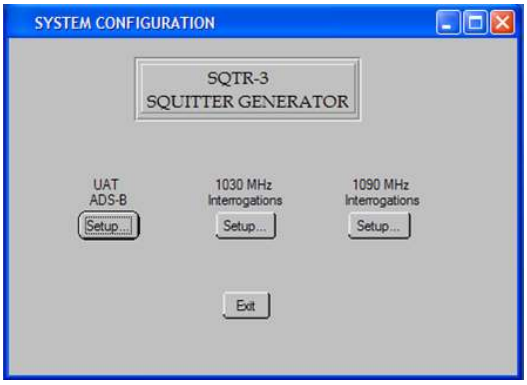


Figure 1

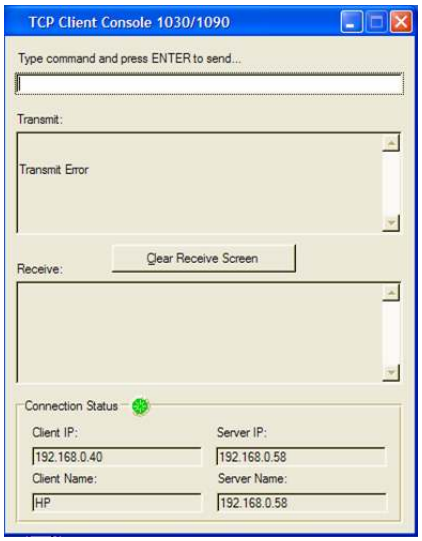


Figure 2

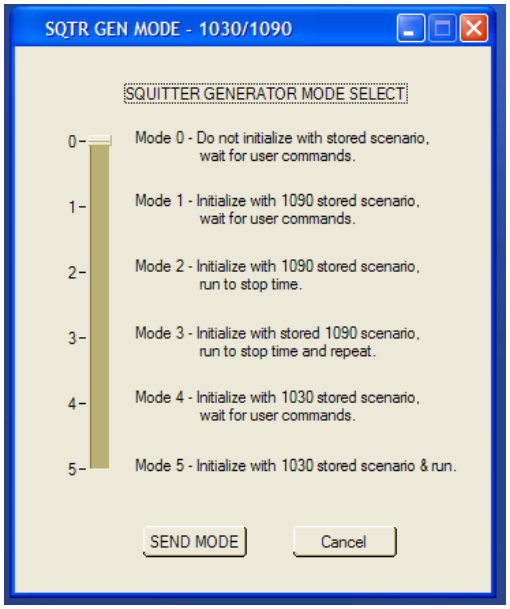


Figure 3

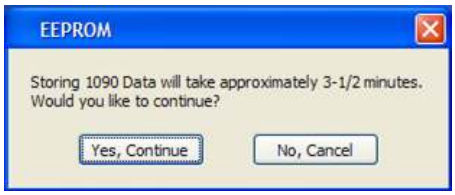


Figure 4

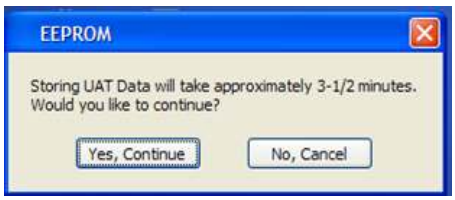
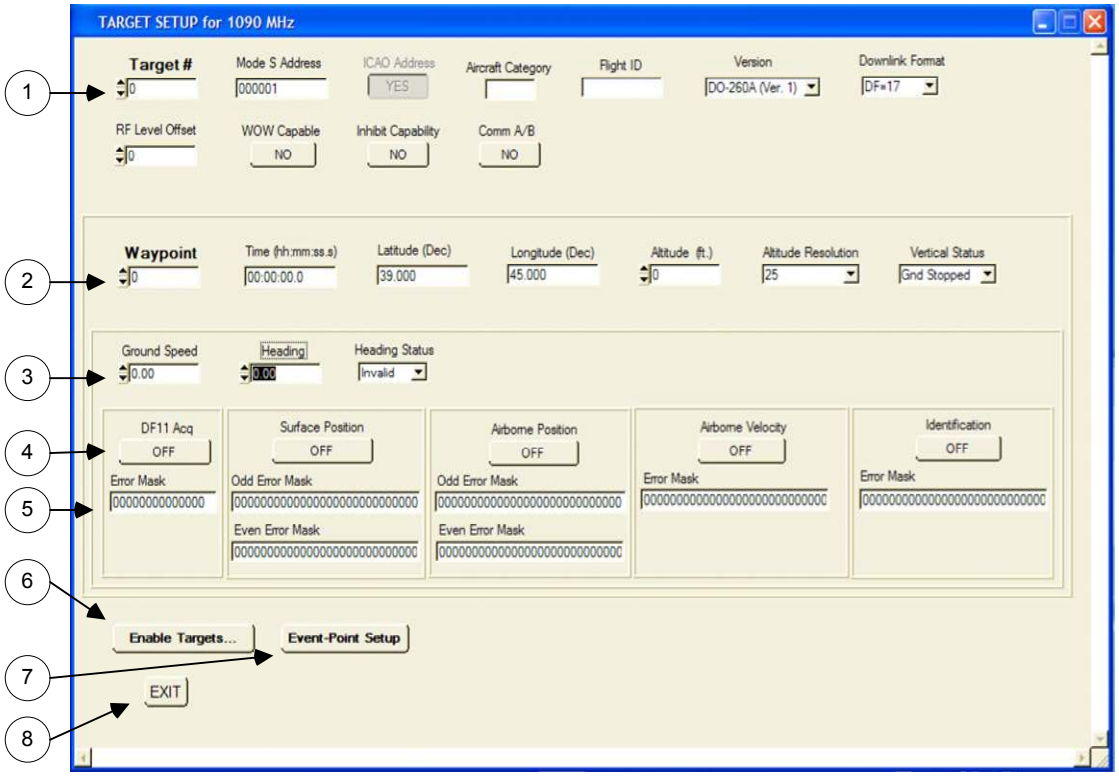


Figure 5

Squitter Generator Start-up Mode
Figure 6

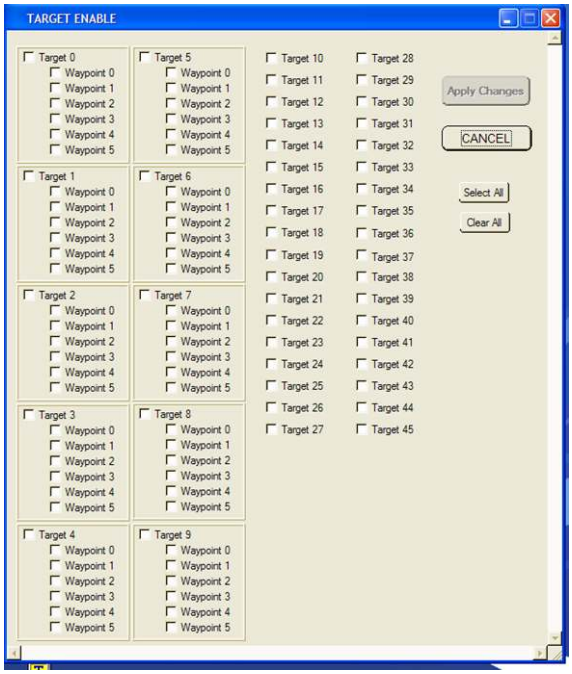
1.5.1.2 1090 MHz Squitters

The Target Setup for 1090 MHz screen is used to configure the 1090 MHz Squitter scenario. T

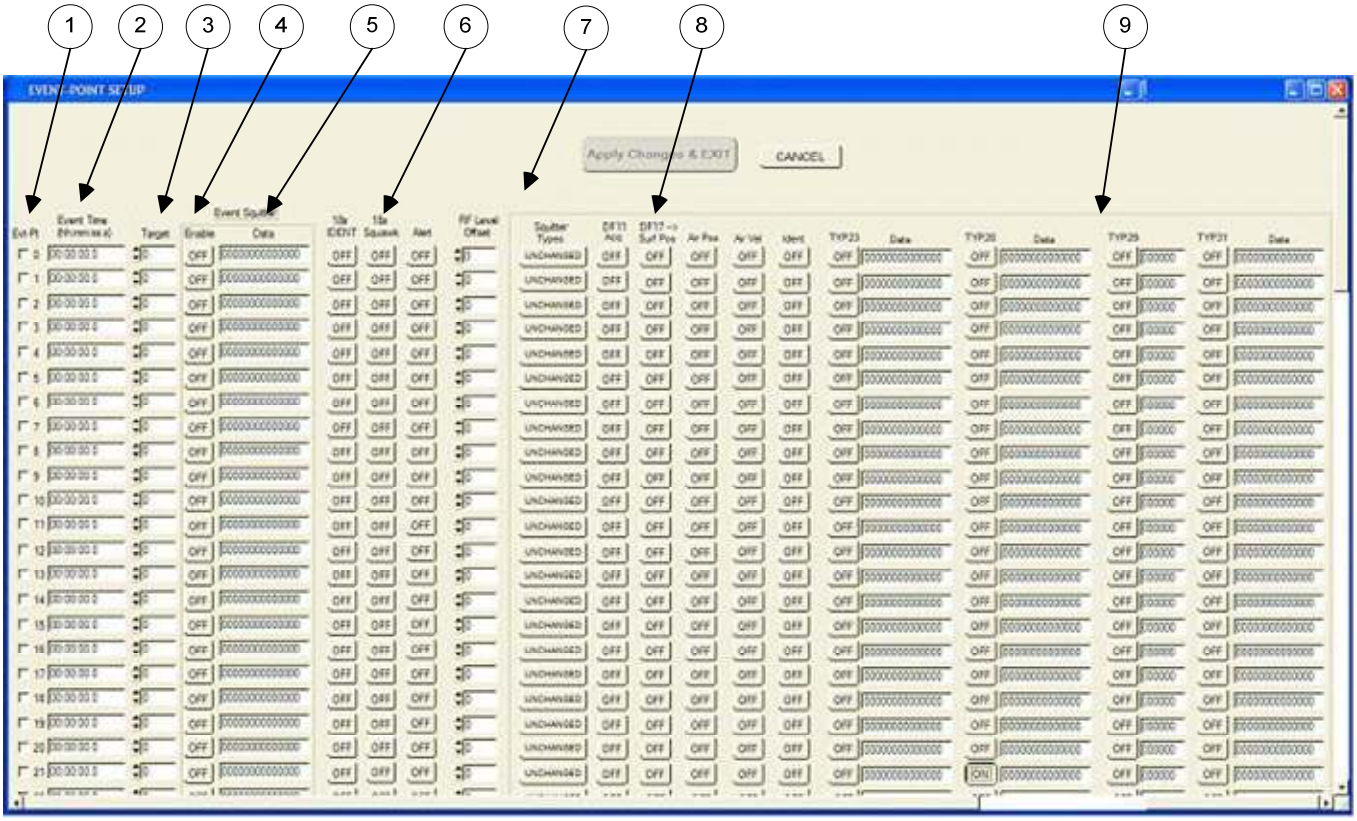


TARGET SETUP for 1090 MHz Screen
Figure 7

Target Setup Screen for 1090 MHz		
1	Target Setup	Used to setup Target parameters
2	Waypoint Setup	Used to setup Waypoint parameters for each Target
3	Surface Movement Setup	Used to setup Surface Movement parameters
4	Acquisition Type Activation Buttons	Used to activate squitter types
5	Error Mask	Used to XORed squitter data with information contained in mask
6	Enable Targets	Used to access TARGET ENABLE setup screen (Figure 8)
7	Event-Point Setup	Used to access EVENT POINT setup screen
8	Exit	



TARGET ENABLE SETUP Screen
Figure 8



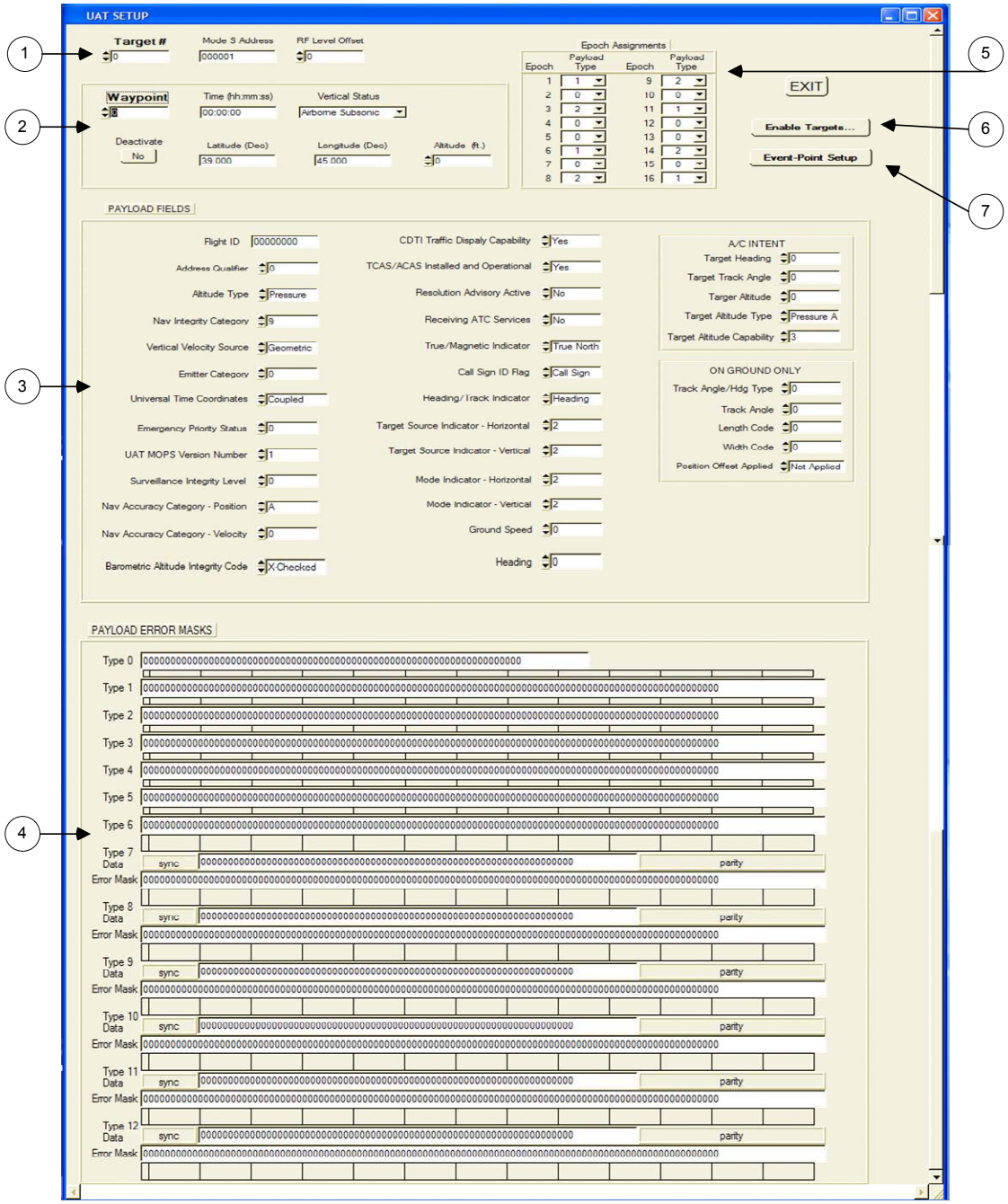
EVENT POINT SETUP Screen
Figure 9

Event Point Setup Screen		
1	Event Point Select	Used to enable an event point
2	Event Time	Used to set time for event point
3	Target #	Used to set Target # for this event

4	Event Driven Enable	Used to enable an event squitter
5	Event Squitter Data	Used to configure data contained in event squitter
6	Surveillance Status	Used to set Surveillance Status bits in this event
7	RF Level Offset	Used to set RF Level Offset from RF Level set in System Setup screen
8	Change Squitter	Used to enable specific squitter types for this event
9	Event Squitters (periodic)	Used to enable and to configure data contained in Squitter Types 23, 28, 29, and 31

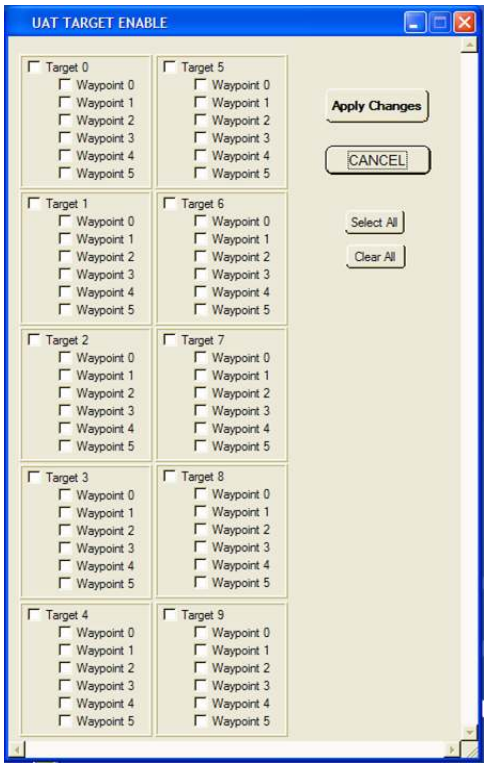
1.5.1.3 UAT Messages

The UAT Target Setup screen is used to configure the UAT Message scenario.

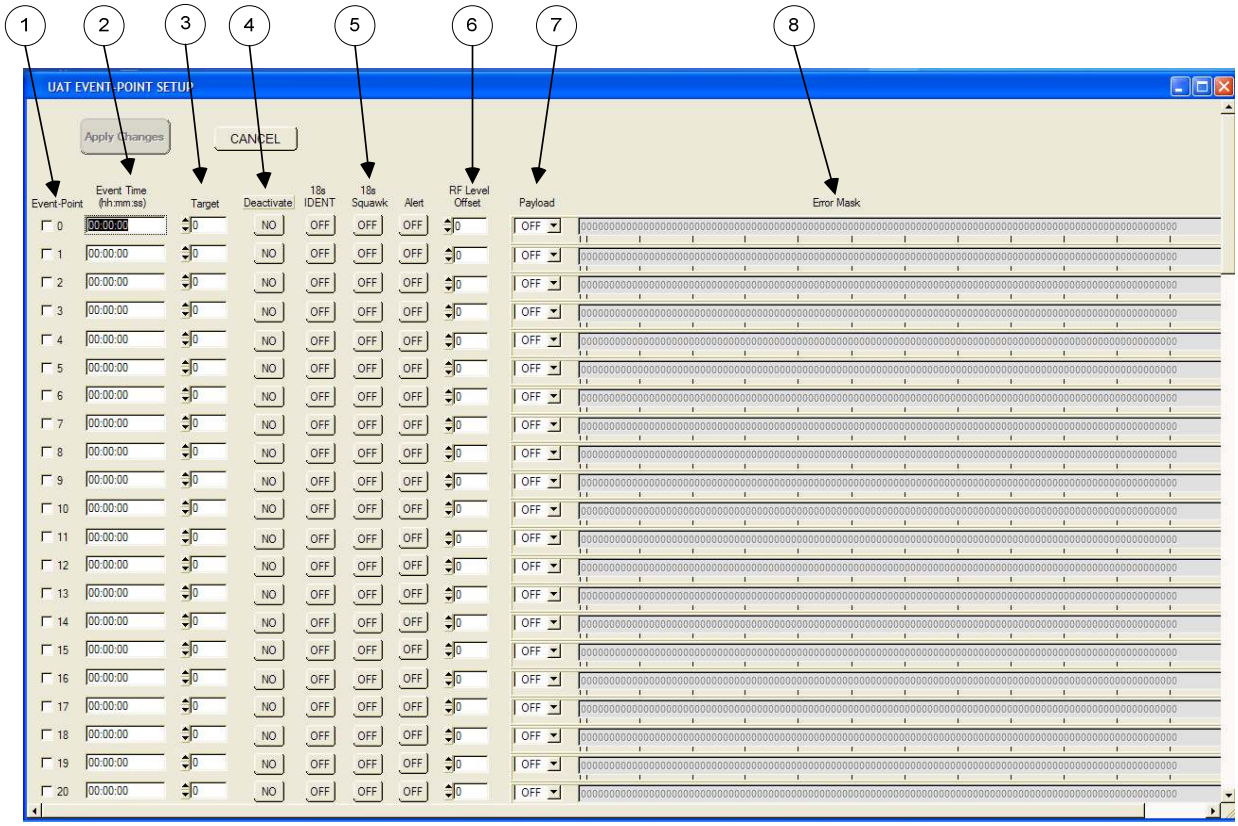


UAT MESSAGE SETUP
Figure 10

UAT Message Setup Screen		
1	Target Setup	Used to configure Target parameters
2	Waypoint Setup	Used to configure Waypoint parameters for each Target
3	Payload Fields	Used to configure data contained in Payload Fields
4	Payload Error	Used to XORed message data with information contained in mask
5	Epoch Assignments	Used to configure Payload Type for each Epoch
6	Enable Targets	Used to access TARGET ENABLE setup screen (Figure 11)
7	Event-Point Setup	Used to access EVENT Point setup screen (Figure 12)



UAT TARGET ENABLE Screen
Figure 11

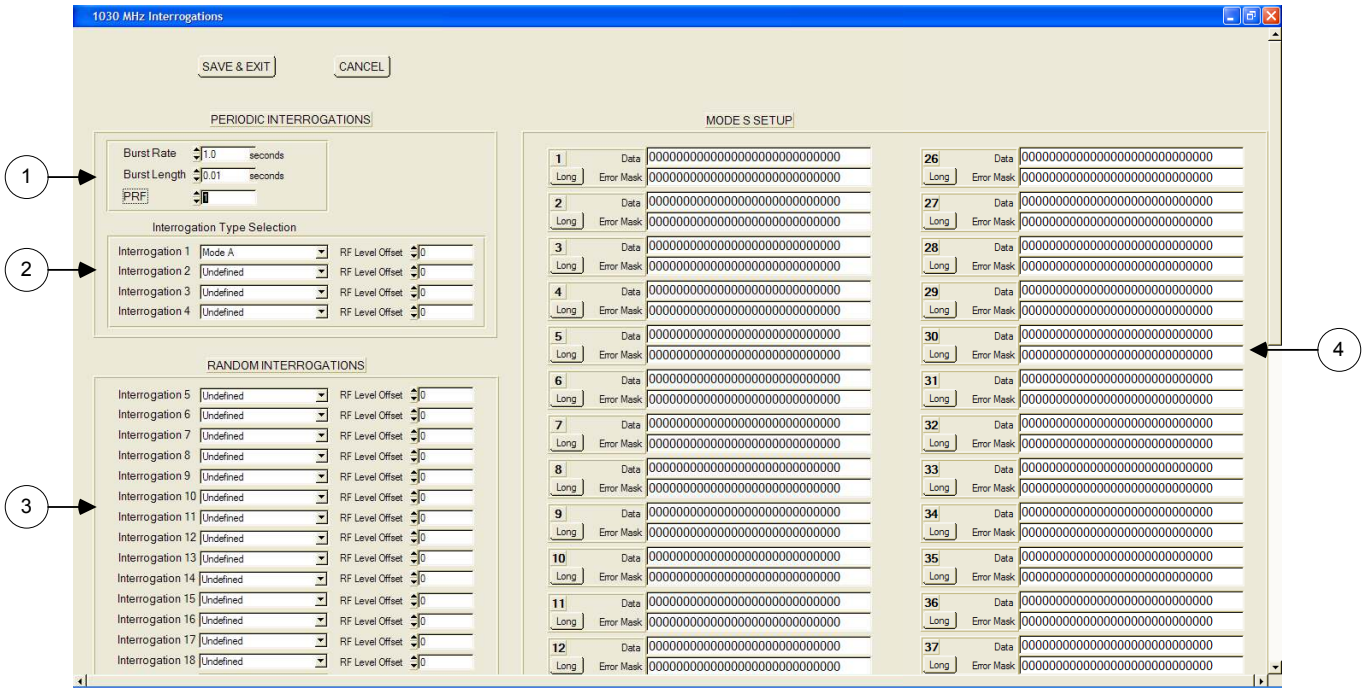


UAT EVENT POINT SETUP
Figure 12

UAT Event Point Setup Screen		
1	Event Point Select	Used to enable an event point
2	Event Time	Used to set time for event point
3	Target #	Used to set Target # for this event
4	Deactivate	Used to deactivate an event point
5	Surveillance Status	Used to set Surveillance Status bits in this event
6	RF Level Offset	Used to set RF Level Offset from RF Level set in System Setup screen
7	Payload	Used to select Payload Type for this event
8	Payload Error	Used to XORed message data with information contained in mask

1.5.1.4 1030 MHz Interrogations

The 1030 MHz Interrogations screen is used to configure the 1030 Interrogations.



1030 MHz INTERROGATIONS
Figure 13

1	Periodic Interrogations	Setup	Used to set Burst Rate, Burst Length, and PRF of interrogations
2	Periodic Interrogations	Type	Used to set Interrogation Type and RF Level Offset from value set in System Setup Screen for each Periodic Interrogation
3	Random Interrogations		Used to set Interrogation Type and RF Level Offset from value set in System Setup Screen for each Random Interrogation
3	Mode S Setup		Used to set Mode S type (Short or Long), Data, and Error Mask for each of 50 interrogations

1.5.2 Manual Commands

A list of manual commands for the SQTR-3 is contained in Appendix A of this manual. Scenarios can be created for each of the three functions using MS Notepad. After creating the scenario file, it can be downloaded to the SQTR-3 using Tera Term Pro Web (see Section 1.3). Each time that a scenario is configured and downloaded from the GUI to the SQTR-3 (1030 MHz Interrogation, 1090 Squitters, or UAT messages), the SQTR-3 generates three files in the directory containing the SQTR-3 program. The three files (1030 commands, 1090 commands or UAT commands) can be used by a new user of the SQTR-3 to view an example of the structure of the commands used to generate a scenario. This is useful for learning how to manually program the SQTR-3.

Appendix A

1030/1090 Commands

SYSTEM COMMANDS

Command	Format	Definition
DLD		Download the microprocessor code
PGM	PGM – Programs the FPGA directly from the downloaded file PGM0 – store the downloaded file in the onboard EEPROM for FPGA1 PGM1 – Programs the FPGAs with the images contained in the onboard EEPROM PGM2 – store the downloaded file in the onboard EEPROM for FPGA2	Download RF Board FPGA code
RST		Reset the RF Board to its power-up state
TXF	TXF<float>, 952.00 – 1223.00 MHz	Set the Transmit synthesizer frequency
BTR?	Return example: SQTR3 Boot Rev: 0.1; Date: 03/28/2008	Request the BOOT code revision string.
GAR?	Return example: FPGA Rev Number: 65	Request the FPGA1 revision string
RFR?	Return example: SQTR Gen Rev: 0.01; Date: 10/12/07	Request the RF board revision string
SBY		Pauses the scenario
RUN		Starts the scenario
STOP		Stop the scenario
STOP	STOP<long>	Set the stop time for the scenario. LSB is 100ms. Setting the stop time to the maximum value (2147483647) essentially makes the scenario infinite. Range: 0 to 2147483647 Resolution: 100ms

LVL	LVLd	Set the RF Level. Range: 13 to –111dBm Resolution: 1dBm
SAVE		Save the scenario to EEPROM
MODE	MODEd	Set the operating mode of the SQTR1. 0 = do not initialize with stored scenario, wait for user commands 1 = initialize with the stored scenario, wait for user commands 2 = initialize with the stored scenario, run to stop time 3 = initialize with the stored scenario, run to stop time and repeat
RAW?	return example:	Return the average raw temperature reading.
TMP?	return example:	Return the computed temperature (using the average raw temperature reading, calibrated slope and calibrated offset).
TMPO	TMPO<float>	Set the offset for the temperature sensor transfer function.
TMPO?	return example:	Return the offset for the temperature sensor transfer function.
TMPS	TMPS<float>	Set the slope for the temperature sensor transfer function.
TMPS?	return example:	Return the slope for the temperature sensor transfer function.

CATT	CATT<coarse attenuation cal table>	Download the coarse attenuation calibration table. The CATT table is a two dimensional table (RF level vs. attenuator) containing values to be written to the 4 digital attenuators and an index into the FATT tables used to set the pin diode attenuator for each RF level setting from 13 to -111.
FATT	FATTd<fine attenuation cal table> FATT0 – download the FATT table for the UAT frequency of 978 MHz FATT1 - download the FATT table for the ground station frequency of 1030 MHz FATT2 - download the FATT table for the squitter frequency of 1090 MHz	Download the fine attenuation tables. The FATT tables are two dimensional tables (index from the CATT table vs. temperature) containing values to be written to the pin-diode to achieve the "tweak" required to achieve the requested RF level once the four digital attenuators are set to get as close to it as possible
CW	CW<channel><on/off> CW10 – turn CW OFF on channel 1 CW11 – turn CW ON on channel 1 CW20 – turn CW OFF on channel 1 CW21 – turn CW ON on channel 1 CW30 – turn CW OFF on channel 1 CW31 – turn CW ON on channel 1	Turn CW mode on or off on each of the three channels.
CAL	CAL<on/off> CAL0 – turn CAL mode OFF CAL1 – turn CAL mode ON	Turn CAL mode off and on.
ATT	ATT<attenuator><level> Where attenuator is 1, 2, 3 or 4 and <level> must be a 2 digit hex number. Valid values for <level> are 0 through 31 corresponding to 0dB through 31dB. The upper 3 bits are masked and so are therefore no cares.	Set the digital attenuators.

STD	STD<delay> Where delay is a decimal multiple of 12.5ns and can range from 0 to 255.	Set the scope trigger delay.
STD?	return the scope trigger delay, a number from 0 to 255	Return the scope trigger delay.
TXMODE	TXMODEd TXMODE0 – 1090 mode TXMODE1 – 1030 mode	Set the transmit mode of the 1090/1030 board.

1090 NON-WAYPOINT SPECIFIC COMMANDS

Command	Format	Definition
TARG	TARG<int>, 0 to 45	Select the target to define. Only targets 0-9 can have associated waypoints
DF=	DF=17 DF=18 DF=19	Select what type of squitters we are transmitting.
DF17	various (see below) The 14 hex digits accompanying each of the various DF17 commands are bytes 5 through 11 of the reply data with the msb being bit 1 of byte 5.	Set the default DF17 data for the selected target. The AA field will be overwritten by the provided mode S address. If no mode S address is provided all zeroes will be used. The latitude, longitude and altitude will be overwritten by values as determined while the scenario is running. The airborne velocities will be overwritten by values as determined while the scenario is running. The CA and SSS fields will be overwritten by values as determined while the scenario is running based on TI and TC timers and the ALERT flag. The PI field will be calculated.
DF17	DF170xhhhhhhhhhhhhh	Set the default DF17 Ident data
DF17SPO	DF17SPO0xhhhhhhhhhhhhh	Set the default DF17 Surface Position data – ODD epoch

DF17SPE	DF17SPE0xhhhhhhhhhhhhh	Set the default DF17 Surface Position data – EVEN epoch
DF17APO	DF17APO0xhhhhhhhhhhhhh	Set the default DF17 Airborne Position data – ODD epoch
DF17APE	DF17APE0xhhhhhhhhhhhhh	Set the default DF17 Airborne Position data – EVEN epoch
DF17AV	DF17AV0xhhhhhhhhhhhhh	Set the default DF17 Airborne Velocity data for the selected target.
MSAD	MSADhhhhhh	Set the mode S address for the selected target in hex
UNIT	UNIT0 = DMS UNIT1 = floating point	Define the units for the LAT and LONG commands
WOW	WOW0 = no weight on wheels WOW1 = weight on wheels	Set the weight on wheels detection capability for the present target
COMM	COMM0 = no COMM1 = yes	Set the COMM A/B capability for the present target
ICAO	ICAO0 = non-ICAO address in the AA field ICAO1 = ICAO address in the AA field	Set whether the AA field of a DF18 squitter will hold an ICAO address or a non-ICAO address
VER	VER0 = DO-260 VER1 = DO-260A	Set whether we use DO-260 defined type codes (version 0) or DO-260A defined type codes (version 1)
LVLO	LVLOd	Set the attenuation for the present target. Range: 0 to 31dBm Resolution: 1dBm

1090 WAYPOINT COMMANDS

Command	Format	Definition
WAYP	WAYP<int>, 0 to 5	Select the waypoint to define for the selected target.
TIME	TIMEd, 0 to 214748364.6s, lsb is 100ms	Set the TIME for the present waypoint/target
MODS	MODShh, Enable (1) or Disable (0): bit 0 –DF11 Acq Squitter bit 1 –DF17 Ident Squitter bit 2 –DF17 Surface Position Squitter bit 3 –DF17 Airborne Position Squitter bit 4 –DF17 Airborne Velocity Squitter bit 5 – inhibit mode	Enable/Disable the squitter types for the selected target Note: inhibit mode is not waypoint data.

LAT	if the UNIT0 command was received, the LAT command will be:
	
	LAT<deg>,<min>,<sec>
	
	<deg>, degrees, 0 to 90 for North, 0
	
	to -90 for South
	
	<min>, minutes, 0 to 59
	<sec>, seconds, 0 to 59
	
	if the UNIT1 command was received, the LAT command will be:
	
	LAT<float>, 0.0 to 90.0 for North, 0.0 to -90.0 for South
		Set the latitude for the present waypoint/target

LONG	if the UNIT0 command was received, the LONG command will be:
	
	LONG<deg>,<min>,<sec>
	
	<deg>, degrees, 0 to 180 for East, 0 to -180 for West
	<min>, minutes, 0 to 59
	<sec>, seconds, 0 to 59
	
	if the UNIT1 command was received, the LONG commands will be:
	
	LONG<float>, 0.0 to 180.0 for East, 0.0 to -180.0 for West
		Set the longitude for the present waypoint/target

ALT	ALT<int>, -1000 to 126500 feet	Set the altitude for the present waypoint/target (will be rounded IAW the ALTR command)
ALTR	ALTR1 = 25 foot resolution ALTR0 = 100 foot resolution	Set the altitude resolution for the present waypoint/target
VS	VS0 = in the air VS1 = on the ground	Set the vertical status for the present waypoint/target
MOV	MOV0 = stopped MOV1 = moving	Set the on-the-ground moving status for the present waypoint/target
GSPD	GSPD<float>	Set the ground speed (kts) for the present waypoint/target
HDG	HDG<float>, 0 to 359.	Set the heading in degrees clockwise from north (True or Magnetic) for the present waypoint/target
HDGS	HDG0 – invalid HDG1 – valid	Set the heading status for the present waypoint/target
ERRM	various (see below), the error mask will be XORed with the DF17 data prior to transmission	Define the error mask for a specific squitter type for the selected target
ERRM11	ERRM110xhhhhhhhhhhhhhh	Set the DF11 error mask
ERRM	ERRM0xhhhhhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Ident error mask
ERRMSPO	ERRMSPO0xhhhhhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Surface Position – ODD epoch error mask

ERRMSPE	ERRMSPE0xhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Surface Position – EVEN epoch error mask
ERRMAPO	ERRMAPO0xhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Airborne Position – ODD epoch error mask
ERRMAPE	ERRMAPE0xhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Airborne Position – EVEN epoch error mask
ERRMAV	ERRMAV0xhhhhhhhhhhhhhhhhhhhhhhhhhhh	Set the DF17 Airborne Velocity error mask

Note: The waypoint commands, with the exception of WAYP and TIME are also valid for non-moving targets.

1090 EVENT-POINT COMMANDS

ETIME	ETIMEd, 0 to 214748364.6s, lsb is 100ms	Set an event and its associated time for the present target. Events must be defined in sequential order. You may define up to 100 event points total across all of the targets. An event point can have any or all of the event types associated with it.
IDENT		Set an IDENT event point for the selected target
SQUAWK		Set a SQUAWK event point for the selected target
ALERT		Set an ALERT event point for the selected target. If you want to turn the ALERT off send an ETIME command followed by no event types
DF17E	DF17E0xhhhhhhhhhhhhh The 14 accompanying hex digits are bytes 5 through 11 of the reply data with the msb being bit 1 of byte 5.	Set DF17 Event Driven Squitter data
DF17HTC	DF17HTCd0xhhhhhhhhhhhhh where: d = 0 for high type code 23 (ver 1) d = 1 for high type code 29 (ver 0/1) d = 2 for high type code 31 (ver 0)/28 (ver 1) The 14 accompanying hex digits are bytes 5 through 11 of the reply data with the msb being bit 1 of byte 5.	Set DF17 HTC (high type code) Event Driven Squitter data
LVLO	LVLOd	Set an ATTENuation for the selected target. Range: 0 to 31dBm Resolution: 1dBm

EVSQ	EVSQhh, Enable (1) or Disable (0): bit 0 –DF11 Acq Squitter bit 1 –DF17 Ident Squitter bit 2 –DF17 Surface Position Squitter bit 3 –DF17 Airborne Position Squitter bit 4 –DF17 Airborne Velocity Squitter for VERSION ZERO targets: bit 6 – DF17 type code 29 bit 7 – DF17 type code 31 for VERSION ONE targets: bit 5 – DF17 type code 23, subtype 7 bit 6 – DF17 type code 29 bit 7 – DF17 type code 28	Enable/Disable the squitter types for the selected target at an event point.

1030 COMMANDS

BRAT	BRAT<float>, 1.0 – 16.0 seconds	Define the burst rate, i.e. the rotation rate of the antenna. Resolution is 0.1 second.
BLEN	BLEN<float>, 1.0 – 16.0 seconds	Define the burst length, i.e. the “beam width” of the antenna. Resolution is 0.01 second. Must be no bigger than the burst rate.
IT	ITdd,<type> where dd is the interrogation number: • 01-04 are beam interrogations • 05-50 are random interrogations and <type> is one of the following: A – ATCRBS mode A AA – ATCRBS mode A, all call AOA – ATCRBS mode A only, all call C – ATCRBS mode C CA – ATCRBS mode C, all call COA – ATCRBS mode C only, all call Sdd, where the dd selects one of up to 50 different possible mode S definitions	Define the 4 different interrogations that will appear only in the antenna beam as well as up to 46 random interrogations.
PRF	PRF<int>, 1 to 500 interrogations per second	Define the interrogation rate for the interrogations in the antenna beam
SDAT	SDATdd<14 hex characters> or SDATdd<28 hex characters> where dd, 01 to 50, must be two characters	Specify the data for one of the 50 possible mode S interrogations. Provide 14 hex characters to define a short mode S, 28 hex characters to define a long mode S.

SMSK	SMSKdd<14 hex characters> or SMSKdd<28 hex characters> where dd, 01 to 50, must be two characters	Specify the error mask for one of the 50 possible mode S interrogations. Provide 14 hex characters for a short mode S, 28 hex characters for a long mode S. The error mask is XORed with the mode S data so a one bit in the mask introduces an error.
STON	STONdd where dd is the interrogation number: • 01-04 are beam interrogations • 05-50 are random interrogations	Turn the scope trigger ON for the specified beam or random interrogation.
STOFF	STOFFdd where dd is the interrogation number: • 01-04 are beam interrogations • 05-50 are random interrogations	Turn the scope trigger OFF for the specified beam or random interrogation.
LVLO	LVLOdd<offset> where dd is the interrogation number: • 01-04 are beam interrogations • 05-50 are random interrogations <offset> is 0 to 31 dBm	Set the attenuation for the specified beam or random interrogation. Range: 0 to 31dBm Resolution: 1dBm

UAT Commands

SYSTEM COMMANDS

Command	Format	Definition
DLD		Download the microprocessor code
PGM	PGM – Programs the FPGA directly from the downloaded file PGM0 – store the downloaded file in the onboard EEPROM for FPGA1 PGM1 – Programs the FPGAs with the images contained in the onboard EEPROM PGM2 – store the downloaded file in the onboard EEPROM for FPGA2	Download RF Board FPGA code
RST		Reset the RF Board to its power-up state
TXF	TXF<float>, 952.00 – 1223.00 MHz	Set the Transmit synthesizer frequency
BTR?	Return example: KOR RF Bd Boot Rev: 0.1; Date: 02/24/2006	Request the BOOT code revision string.
GAR?	Return example: FPGA Rev Number: 65	Request the FPGA1 revision string
RFR?	Return example: SQTR Gen Rev: 0.01; Date: 10/12/07	Request the RF board revision string
SBY		Pauses the scenario
RUN		Starts the scenario
STOP		Stop the scenario
STOP	STOP<long>	Set the stop time for the scenario. LSB is 100ms. Setting the stop time to the maximum value (2147483647) essentially makes the scenario infinite. Range: 0 to 2147483647 Resolution: 100ms
LVL	LVLd	Set the RF Level. Range: 13 to –111dBm Resolution: 1dBm

SAVE		Save the scenario to EEPROM
MODE	MODEd	Set the operating mode of the SQTR1. 0 = do not initialize with stored scenario, wait for user commands 1 = initialize with the stored scenario, wait for user commands 2 = initialize with the stored scenario, run to stop time 3 = initialize with the stored scenario, run to stop time and repeat
RAW?	return example:	Return the average raw temperature reading.
TMP?	return example:	Return the computed temperature (using the average raw temperature reading, calibrated slope and calibrated offset).
TMPO	TMPO<float>	Set the offset for the temperature sensor transfer function.
TMPO?	return example:	Return the offset for the temperature sensor transfer function.
TMPS	TMPS<float>	Set the slope for the temperature sensor transfer function.
TMPS?	return example:	Return the slope for the temperature sensor transfer function.
CATT	CATT<coarse attenuation cal table>	Download the coarse attenuation calibration table. The CATT table is a two dimensional table (RF level vs. attenuator) containing values to be written to the 4 digital attenuators and an index into the FATT tables used to set the pin diode attenuator for each RF level setting from 13 to -111.

FATT	FATTd<fine attenuation cal table> FATT0 – download the FATT table for the UAT frequency of 978 MHz FATT1 - download the FATT table for the ground station frequency of 1030 MHz FATT2 - download the FATT table for the squitter frequency of 1090 MHz	Download the fine attenuation tables. The FATT tables are two dimensional tables (index from the CATT table vs. temperature) containing values to be written to the pin-diode to achieve the "tweak" required to achieve the requested RF level once the four digital attenuators are set to get as close to it as possible
CW	CW<channel><on/off> CW10 – turn CW OFF on channel 1 CW11 – turn CW ON on channel 1 CW20 – turn CW OFF on channel 1 CW21 – turn CW ON on channel 1 CW30 – turn CW OFF on channel 1 CW31 – turn CW ON on channel 1	Turn CW mode on or off on each of the three channels.
CAL	CAL<on/off> CAL0 – turn CAL mode OFF CAL1 – turn CAL mode ON	Turn CAL mode off and on.
ATT	ATT<attenuator><level> Where attenuator is 1, 2, 3 or 4 and <level> must be a 2 digit hex number. Valid values for <level> are 0 through 31 corresponding to 0dB through 31dB. The upper 3 bits are masked and so are therefore no cares.	Set the digital attenuators.
STD	STD<delay> Where delay is a decimal multiple of 20ns and can range from 0 to 255.	Set the scope trigger delay.
STD?	return example:	Return the scope trigger delay.
GPS	GPS0 – use internal created PPS GPS1 – use PPS from GPS board	Select internal or external source for PPS.

NON-WAYPOINT SPECIFIC COMMANDS

Command	Format	Definition
TARG	TARG<int>, 0 to 9	Select the target to define.
ACT	ACT<int>, 0 to 9	Activates a target
DATA	DATA <payl><36 or 68 hex digits> (<payl> must be two digits)	Set the default data for the specified payload for the selected target. Payloads 0 to 6 correspond to payload types 0 to 6. (Most of the bits will be overwritten by data for the specific fields.) Payloads 7 to 12 are not defined to be certain payload types and can be defined by the user. (Since these payloads are not defined to be any specific type they will not be overwritten by data for specific fields.)
MSAD	MSADhhhhhh	Set the mode S address for the selected target in hex
UNIT	UNIT0 = DMS UNIT1 = floating point	Define the units for the LAT and LONG commands
LVLO	LVLOd	Set the attenuation for the present target. Range: 0 to 31dBm Resolution: 1dBm

EPOCH	EPOCHdd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd,dd dd, 0 through 12, is the slot number for the message area of the present target. In the message area slots 0 to 6 correspond to payload types 0 to 6. Slots 7 to 12 are not defined to be certain payload types and can be defined by the user. Each of the 16 elements are initialized to 0x20 to indicate undefined.	Define the payload type for each of the 16 epochs for the present target.
AQ	AQd, 0 to 7	Define the address qualifier field for the selected target
AT	AT0 = pressure AT1 = geometric	Define the altitude type for the selected target
NIC	NIC.h, 0 to f note: the . between the command and the data is necessary when the command is less than four characters and the data is alpha i.e. the characters a-f in hex numbers.	Define the NIC field for the selected target
LENG	LENGd, 0 to 7	Define the length code field for the selected target.
WID	WIDd, 0 or 1	Define the width code field for the selected target.
POA	POA0 = not applied POA1 = applied	Define the position offset applied flag for the selected target.
VVSRC	VVSRC0 = geometric VVSRC1 = barometric	Define the vertical velocity source field for the selected target.
UTC	UTC0 = not coupled UTC1 = coupled	Define the UTC field for the selected target.
EMIT	EMIT<int>, 0 to 39	Define the emitter category for the selected target.

FLID	FLIDaaaaaaaa, where aaaaaaaa is 8 ascii characters, 0-9, A-Z, or space. If you want to set one of the characters to one of the other available values use the following: \ = 37 (not available)] = 38 (reserved) ^ = 39 (reserved)	Define the call sign/flight id for the selected target.
EPS	EPSd, 0 to 7	Define the Emergency Priority Status field for the selected target.
UMV	UMVd, 0 to 7	Define UAT MOPS Version Number field for the selected target.
SIL	SILd, 0 to 3	Define Surveillance Integrity Level field for the selected target.
NACP	NACPh, 0x0 to 0xf	Define NACP field for the selected target.
NACV	NACVd, 0 to 7	Define NACV field for the selected target.
BAIC	BAIC0 = Barometric Pressure Altitude has NOT been cross checked BAIC1 = Barometric Pressure Altitude has been cross checked	Define the Barometric Altitude Integrity Code for the selected target
CC1	CC10 = no CC11 = yes	Define the CDTI Traffic Display Capability flag for the selected target
CC2	CC20 = no CC21 = yes	Define the TCAS/ACAS Installed and Operational flag for the selected target
RA	RA0 = no RA1 = yes	Define the Resolution Advisory Active flag for the selected target
RAS	RAS0 = no RAS1 = yes	Define the Receiving ATC Services flag for the selected target
TM	TM0 = referenced to true north TM1 = referenced to magnetic north	Define the True/Magnetic Indicator flag for the selected target
CSID	CSID0 = flight plan ID CSID1 = call sign	Define the Call Sign ID flag for the selected target

HT	HT0 = heading HT1 = track	Define the Heading/Track Indicator flag for the selected target
TSIH	TSIHd, 0 to 3	Define the Target Source Indicator (Horizontal) for the selected target
MIH	MIHd, 0 to 3	Define the Mode Indicator (Horizontal) for the selected target
TSIV	TSIVd, 0 to 3	Define the Target Source Indicator (Vertical) for the selected target
MIV	MIVd, 0 to 3	Define the Mode Indicator (Vertical) for the selected target
THDG	THDGd, 0 to 360 degrees	Define the Target Heading for the selected target
TTRK	TTRKd, 0 to 360 degrees	Define the Target Track Angle for the selected target
TALT	TALT<int>, -1000 to 101150 feet	Define the Target Altitude for the selected target (100 foot resolution)
TAT	TAT0 = Pressure Altitude ("Flight Level") - target altitude is above transition level TAT1 = Baro-Corrected Altitude ("MSL") - target altitude is below transition level	Define Target Altitude Type for the selected target
TAC	TACd, 0 to 3	Define the Target Altitude Capability for the selected target
SYNC	SYNChhhhhhhhhh, where hhhhhhhhhh represents the 36 bits of left justified SYNC	Define the 36 bit synchronization sequence if you want them to be non-standard. If you do not send this command the synchronization sequence will default to the defined ADS-B sequence.

WAYPOINT COMMANDS

Command	Format	Definition
WAYP	WAYP<int>, 0 to 5	Select the waypoint to define for the selected target.
TIME	TIMEd, 0 to 2147483646s, lsb is 1 UTC second	Set the UTC TIME for the present waypoint/target

LAT	if the UNIT0 command was received, the LAT command will be:
	
	LAT<deg>,<min>,<sec>
	
	<deg>, degrees, 0 to 90 for North, 0 to -
	
	90 for South
	
	<min>, minutes, 0 to 59
	<sec>, seconds, 0 to 59
	
	if the UNIT1 command was received, the LAT command will be:
	
	LAT<float>, 0.0 to 90.0 for North, 0.0 to -90.0 for South
		Set the latitude for the present waypoint/target

LONG	if the UNIT0 command was received, the LONG command will be:
	
	LONG<deg>,<min>,<sec>
	
	<deg>, degrees, 0 to 180 for East, 0 to -180 for West
	<min>, minutes, 0 to 59
	<sec>, seconds, 0 to 59
	
	if the UNIT1 command was received, the LONG commands will be:
	
	LONG<float>, 0.0 to 180.0 for East, 0.0 to -180.0 for West
		Set the longitude for the present waypoint/target

ALT	ALT<long>, -1000 to 101338 feet	Set the altitude for the present waypoint/target

AG	AG0 = airborne – subsonic AG1 = airborne – supersonic AG2 = on the ground	Set the A/G state for the present waypoint/target
TAH	TAHd, 0 to 3	Define the track angle/heading type field for the selected waypoint/target
TRK	TRK<int>, 0 to 360 degrees	Define the track angle for the selected waypoint/target
HDG	HDG<int>, 0 to 360 degrees	Define the heading for the selected waypoint/target
GSPD	GSPD<int>, 0 to 1022 knots	Define the ground speed for the selected waypoint/target
DACT	DACT1 – deactivate the target at this waypoint DACT0 – activate the target at this waypoint	Deactivate/activate the selected target at the selected waypoint.
ERRM	ERRMddhhhhhhhh..... where dd selects which payload the error mask applies to, 0 to 12 (must be two digits) where hhhh.... is the 69 (payload 0) or 105 (payloads 1 to 12) hex digits	Define the error mask for a specific payload type for the selected target

Note: The waypoint commands, with the exception of WAYP and TIME are also valid for non-moving targets.

EVENT-POINT COMMANDS

ETIME	ETIMEd, 0 to 2147483646s, lsb is 100ms	Set an event and its associated time for the present target. Events must be defined in sequential order. You may define up to 100 event points total across all of the targets. An event point can have any or all of the event types associated with it.
IDENT		Set an IDENT event point for the selected target
SQUAWK		Set a SQUAWK event point for the selected target
ALERT		Set an ALERT event point for the selected target. If you want to turn the ALERT off send an ETIME command followed by no event types
LVLO	LVLOd	Set an ATTENuation event point for the selected target. Range: 0 to 31dBm Resolution: 1dBm
EVDA	EVDA1 – deactivate the target EVDA0 – activate the target	Deactivate/activate the selected target at the selected eventpoint.
ERRME	ERRMEddhhhhhhhh..... where dd selects which payload the error mask applies to, 0 to 12 (must be two digits) where hhhh.... is the 69 (payload 0) or 105 (payloads 1 to 12) hex digits	Define the error mask for a specific payload type for the selected target