

# TrailTrac Integrationguide

(Advance)

Version 1.0

## Theory of Operation

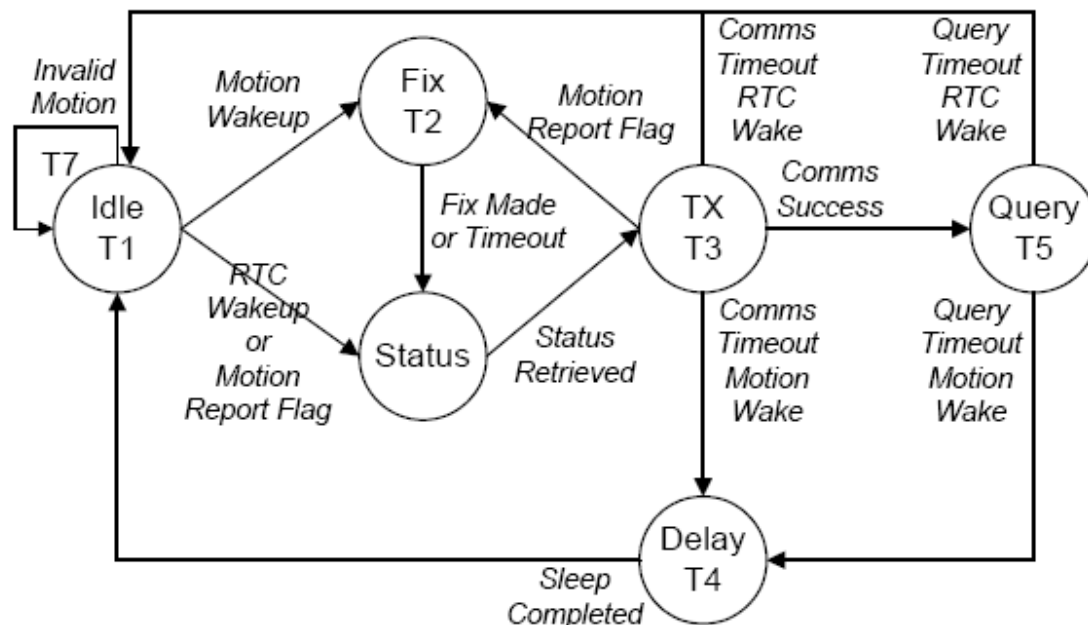
### Introduction

In most applications, motion-based reporting is the fundamental operating premise of the TrailTrac. This generally means that the unit computes and reports new GPS position fixes only if the unit is in motion and once more after coming to rest.

To conserve power and minimize communication costs, the TrailTrac attempts to be in a sleep mode as much as possible. Sleep modes occur both during the IDLE and DELAY states. In general, the TrailTrac will spend a majority of its time in the IDLE state during periods of no motion. How frequently the unit computes a new position fix while in motion is determined predominantly by the setting of the DELAY Timeout, T4.

Two configurable software-based motion filters determine how much movement it takes to trigger a new position or report. During the IDLE state, for instance, the IDLE Wakeup Motion Timeout, T7, and its associated IDLE Wakeup Motion Second Count parameter, are the primary means to filter detected movement. During the TRANSMIT (TX), QUERY and DELAY states, the Rolling Motion Window, T21, and its associated Rolling Motion Second Count parameter, are applied to any detected movement.

The TrailTrac state machine transitions through each state based on motion, external inputs, timeouts, and as a result of completing defined actions (i.e communicating to the server), as follows:



**IDLE:** The TrailTrac device spends the majority of its time in the IDLE state. Detection of Motion results in a transition to the FIX state if the Motion Report Flag is set “0=Disabled”. If the Motion Report Flag is set “1=Enabled” then motion will cause a transition to STATUS. Expiration of IDLE Timeout, T1, causes a transition to the STATUS state. The programmable IDLE Timeout, T1, is stored as seconds and is typically on the order of 12 to 48 hours. There are also optional IDLE State Polling Mode settings that allow the device to run the communications protocol stack during the IDLE state to receive and process incoming messages.

**FIX:** The device attempts to fix a position until expiration of FIX Timeout, T2. If a fix is achieved, the position is read by the application, the internal real-time clock (RTC) is updated, and the TrailTrac transitions to the STATUS state.. If no position fix is achieved prior to expiration of the FIX Timeout, T2, the TrailTrac transitions to the STATUS state with status of “no new fix”. The FIX Timeout, T2, parameter is programmable and is stored as seconds and is typically on the order of 3 to 5 minutes, except during almanac collection.

**STATUS:** The TrailTrac device retrieves the latest status information and then transitions to the TRANSMIT state. In addition to any position and associated information, the status information includes various operational metrics such as conditional alerts, battery condition, battery change events and other such information.

**TRANSMIT:** The device attempts to transmit alert, position and/or status information to the server. First, the latest status information is combined with the position information in messages per the TrailTrac Application Protocol. Such messages are then sent to the GSM protocol stack to attempt transmission. If the Motion Report Flag is set “1=Enabled” and the message was a Motion Report Message then the TrailTrac transitions back to the FIX state. If the message was not a Motion Report Message then it does not transition to the FIX state, instead if the transmission was successful, the TrailTrac transitions to the QUERY state. If the transmission fails, the TrailTrac transitions to the DELAY state or, if the TriggerType was an IDLE timeout, to the IDLE state. The programmable TRANSMIT Timeout, T3, is stored in seconds and is typically on the order of 1 to 5 minutes.

**QUERY:** The device waits to receive any requests from the server for a programmable QUERY Timeout, T5. If any requests are received, they are processed in order and responses are sent if requested. After expiration of the QUERY Timeout, T5, the device transitions to the DELAY state if the TriggerType was motion, or to IDLE state if the TriggerType was an IDLE timeout. The programmable QUERY Timeout, T5 is stored as seconds and is typically on the order of 1 to 2 minutes. Normally, the TrailTrac can only receive and process SMS messages sent from the server application while in the QUERY state; however, it can receive such messages during the IDLE and DELAY states as well if polling capabilities are enabled. The unit can be polled for information, including new or logged position information during the IDLE and DELAY states if so configured.

**DELAY:** The device disables the motion sensor wakeup and goes to sleep for a programmable DELAY Timeout, T4. When the unit wakes up it transitions to the IDLE state by enabling the motion sensor and going back to sleep. The programmable DELAY Timeout, T4, is stored as seconds and is typically on the order of 10 to 20 minutes. If DELAY State Polling Mode is set "1=OnDemand", then the GSM modem will remain operational during DELAY and the unit will be able to receive and process SMS messages.

## ***Application State Machine Design Details***

The application state machine has six primary states that represent the operation of the device. This section gives a detailed description of each state, what events trigger transitions from each state, and the processing that occurs within each state and its transitions.

There are two status variables used along with the state of the TrailTrac: TriggerType; and ReportType. The TriggerType variable refers to what event caused the device to transition from the IDLE state. There are five TriggerTypes:

- 0=IDLE Timeout, T1
- 1=Motion Detected
- 2=Not used
- 3=Query
- 4=Scheduled Report

The ReportType variable can be either a: STATUS\_MSG or REPORT\_POS.

The principal difference between a STATUS\_MSG and a REPORT\_POS is that a REPORT\_POS contains position and related information whereas a STATUS\_MSG does not contain such information.

A Position Age flag is set depending upon whether motion has been detected since the most recent position fix. The Position Age flag is set as follows:

- 0=Current (i.e.no motion since last position)
- 1=Aged (i.e. motion has occurred since last position)

### ***IDLE State***

The IDLE State is the state that the device enters when it goes to sleep waiting for a TriggerType event to occur. Upon the occurrence of any TriggerType event, the unit will transition from IDLE in accordance with TriggerType and current configuration settings. While in the IDLE state all hardware is turned off except for the Motion Sensor Wakeup Logic and the RTC; provided, however, if the IDLE State Polling Mode is set to either "1=Cycled" or "2=OnDemand", then the GSM hardware and software will operate some or all of the time and the unit is able to receive and process SMS messages during IDLE.

1. When the unit enters the IDLE State it checks if motion since the last position fix attempt has been detected. If yes, the TriggerType is set "1=Motion Detected" and the device immediately transitions to the FIX State bypassing all of the other IDLE state checks detailed below.
2. When the unit enters the IDLE State and no motion has been detected, it starts the IDLE Timeout, T1, and waits for a TriggerType event to occur.

3. Upon the occurrence of a TriggerType event, the unit will wake up and transition out of the IDLE state based upon the TriggerType event and the current configuration settings.
4. Upon expiration of the IDLE Timeout, T1, the TriggerType is set "0=IDLE Timeout, T1", the TrailTrac will transition to the STATUS state (bypassing the FIX state).
5. If motion is detected while in the IDLE state, the TrailTrac will activate the IDLE Wakeup Motion Timeout, T7, and apply the IDLE Wakeup Motion Second Count. If there is sufficient continued motion, the TriggerType becomes set "1=Motion Detected" and the unit will transition to the FIX State if the Motion Report Flag is set "0=None" or to the STATUS state if the Motion Report Flag is set "1=Report IDLE Motion". If there is insufficient motion to satisfy the IDLE Wakeup Motion Second Count while the IDLE Wakeup Motion Timeout, T7, is running, then the unit will return to the IDLE state sleep mode and wait for a subsequent TriggerType event to occur.
6. If the IDLE State Polling Mode is set to "2=OnDemand", the unit keeps the GSM modem operational and the device is ready to receive messages from the sever at any time while the IDLE Timeout, T1, is running. Upon receipt of any SMS messages, the TriggerType is set "3=Query" and the unit transitions immediately to the QUERY state to process any such received messages.
7. If the IDLE State Polling Mode is set to "1=Cycled", the TrailTrac will power duty-cycle the GSM modem on and off during the IDLE state. Each time the IDLE State Polling Cycle Interval, T19, timer expires, the GSM modem will power up and the IDLE State Polling Cycle Duration, T20, timer will start. The GSM modem hardware will remain on until the expiration of IDLE State Polling Cycle Duration, T20, or an SMS message is received. Upon receipt of any SMS messages, the TriggerType is set "3=Query" and the unit transitions immediately to the QUERY state to process any such received messages; else it goes back into IDLE sleep until the next TriggerType event occurs or the next time the IDLE State Polling Cycle Interval, T19, timer expires.
8. If the Scheduled Reporting Mode is set to either "1=Daily" or "2=Weekly" the TriggerType will be set "4=Scheduled Report" upon expiration of Scheduled Report Time, T18, timer regardless of the Report Delay Flag setting. If the Position Age flag is set "0=Current", then the device transitions to the STATUS state; else if Position Age flag is set "1=Aged", then the device transitions to the FIX state.

### ***FIX State***

The FIX State is the state where the GPS engine is running trying to get a fix. While in this state the GPS hardware is turned on and the GSM radio hardware is turned off.

1. When the unit enters the FIX State it enables the GPS hardware and starts the FIX Timeout, T2.
2. Upon completion of a successful position fix, the relevant position related information is extracted and the internal the RTC is updated.
3. After the position fix is achieved, or upon expiration of the FIX Timeout, T2, the GPS engine is turned off and the unit transitions to the STATUS state if the TrailTrac has a complete valid almanac. If the unit does not have a complete, valid almanac after computing the position fix, or if Almanac Timeout, T6, has

expired, the TrailTrac will leave the GPS engine operational for up to fifteen (15) minutes more to collect almanac. Upon collection of a complete, valid almanac or expiration of the fifteen (15) minute almanac collection timer, the unit will then transition to the STATUS state after powering off the GPS engine.

### **STATUS State**

The TrailTrac enters the STATUS State based upon the occurrence of TriggerType events or, if entering from the FIX state, upon the computation of a new position fix or expiration of the FIX Timeout, T2.

1. When the unit enters the STATUS State it retrieves the battery, alert and operational status information and stores it in the report structure to be used during the TRANSMIT state.
2. If entering from the FIX state and the position fix attempt was successful, the Position Age flag is set "0=Current".
3. It then transitions to the TRANSMIT State. The TrailTrac dwells in the STATUS state only long enough to update the report structure. This process is virtually instantaneous and all alerts shall have no effect on STATUS state.

### **TRANSMIT State**

Upon entering the TRANSMIT state from the STATUS state, the TrailTrac will:

1. Power up the GSM hardware;
2. Start the TRANSMIT Timeout, T3;
3. Attempt find a suitable 900, 1800 or 1900 MHz GSM network, establish SIM communication and register on the network; AND
4. If a suitable GSM network connection is made, transmit the latest queued messages before expiration of the TRANSMIT Timeout, T3. The TrailTrac will transition from the TRANSMIT state whenever any of the following occurs:
  - a. The GSM protocol stack confirms successful transmission of queued TrailTrac messages; OR
  - b. The TrailTrac has made Position Report Transmit Attempts, N1, or Status Message Transmit Attempts, N2, whichever the case may be, before the GSM protocol stack has confirmed successful transmission of queued TrailTrac messages; OR
  - c. Expiration of TRANSMIT Timeout, T3.

Upon occurrence of any of the foregoing, the TrailTrac will transition from the TRANSMIT state to either the IDLE, FIX, QUERY or DELAY states as follows:

1. To the IDLE state if:
  - a. The TriggerType had become set "0=IDLE Timeout, T1" during the most recent IDLE state; AND

- b. The TRANSMIT Timeout, T3, expires or the TrailTrac has made Status Message Transmit Attempts, N2, before the GSM protocol stack has confirmed successful transmission of queued TrailTrac messages.
2. To the FIX state if:
    - a. The TriggerType had become set "1=Motion Detected" during the most recent IDLE state; AND
    - b. Motion Report Flag is set "1=Motion in IDLE"; AND
    - c. The GSM protocol stack confirms that the attempt to send the queued Motion Report succeeded; the TRANSMIT Timeout, T3, has expired or Status Message Transmit Attempts, N2, have been made.
  3. To the QUERY state if the GSM protocol stack confirms that the attempt to send queued TrailTrac messages, other than a Motion Report, succeeded.
  4. To the DELAY state if the TriggerType is set "1=Motion Detected"and:
    - a. The TrailTrac has already cycled through the FIX state due to the Motion Report Flag being set "1=Report Motion in IDLE"; OR
    - b. The TRANSMIT Timeout, T3, expires or the TrailTrac has made Position Report Transmit Attempts, N1, or Status Message Transmit Attempts, N2, whichever the case may be, before the GSM protocol stack has confirmed successful transmission of queued TrailTrac messages.

### **QUERY State**

The QUERY State is where the Application waits for incoming messages from the server. During this state the GPS hardware is powered off and the GSM radio is powered on.

1. Upon entering the QUERY state, the TrailTrac starts QUERY Timeout, T5.
2. The application then waits until the QUERY Timeout, T5, expires or a valid SMS message arrives.
3. If a valid SMS message arrives it is processed and one or more messages may be generated in response to the received query. If the QUERY Timeout, T5, changes due to a received message the current QUERY state is terminated.
4. For each of the responses the TrailTrac waits for a conformation from the GSM protocol stack that it was sent.
5. If the QUERY Timeout, T5, expires while the application is sending responses to the received query the TrailTrac will continue to send the responses and accept new queries.
6. When the QUERY Timeout, T5, has expired and there are no messages waiting to be sent then the TrailTrac transitions to the DELAY State if the TriggerType was set "1=Motion Detected". If the TriggerType was set "0=IDLE Timeout, T1" then the TrailTrac transitions to the IDLE state.
7. If Query Hold Flag is set "1=Enabled", the TrailTrac will attempt to re-establish any GSM network connection that may have been lost prior to the expiration of QUERY Timeout, T5. It will continue attempting to reestablish the lost GSM network connection until the QUERY Timeout, T5, has expired.
8. If DELAY State Polling Mode is set "1=OnDemand", the QUERY Timeout, T5, is automatically set to 10 seconds..

## ***DELAY State***

The DELAY State is where the TrailTrac normally dwells after a state machine cycle and ignores any detected motion. This effectively restricts the unit to reporting no more often than the DELAY Timeout, T4; provided, however, all Vehicle Adapter Module alerts are in the "0=Normal" condition or otherwise set to be ignored.

1. The unit will transition from DELAY state as follows:
  - a. To the IDLE state upon the earlier of:
    - i. Expiration of DELAY Timeout, T4; or
    - ii. Expiration of Scheduled Report Time, T18, if Scheduled Reporting Mode is set "1=Enabled".
  - b. To the QUERY state upon receipt of an SMS message if DELAY State Polling Mode is set "1=OnDemand".
2. To further conserve power during the DELAY state, the software filtering of the motion sensor can be disabled by setting DELAY State Extended Motion Detection to "0=Disabled". While in this disabled condition, the Rolling Motion Window, T21, and Rolling Motion Second Count parameters are ignored.

# TrailTrac Application Protocol

## ***Introduction***

The TrailTrac Application Protocol is used to communicate with and control TrailTracs that have already been provisioned and deployed to the field. The TrailTrac communicates with the server application by sending and receiving SMS messages based on an ASCII-like protocol. For security reasons, the only parameters that cannot be changed over-the-air using the TrailTrac Application Protocol are the Unit ID, Security Password, and SIM PIN.

## ***Message Format***

### **Basic Message**

All TrailTrac Application Protocol messages use printable ASCII characters. Upper case and lower case alpha characters are generally interchangeable, i.e., lower case characters are converted to upper case alpha in the TrailTrac before parsing.

Each message has the following general format with the contents of the data string being message dependant. Valid messages are limited to 128 characters.

>ABB{C}[:PW=PPPPPPPP];ID=YYYYYYYY;\*ZZ<

### **Element Meaning**

>	Start of new message
<	End of message
A	Message Qualifier (Q, R, or S)
BB	2-character Message Identifier (Must be TK)
C	Data string.
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY. Default 00000000
YYYYYYYY	Unit ID. Always 8 alphanumeric characters, UPPER CASE ONLY. Default 00000000
ZZ	2-character checksum.

{x} Signifies that x can occur zero or more times

[x] Signifies that x may optionally occur once

### **Message Framing**

Each TrailTrac Application Protocol message is framed by the start, end ASCII characters '>', '<', respectively. These characters are not allowed other than as start-of-message and end-of-message indicators.

### **Message Qualifiers**

A one-character Message Qualifier is used to describe the action to be taken on the message. The following table lists the valid qualifiers:

**Qualifier Action**

**Q** Query for data or parameters (sent to TrailTrac)

**S** Set or configure parameters (sent to TrailTrac)

**R** Response to a query or a scheduled or autonomous report (from the TrailTrac)

**Data String**

The Message Qualifier and the Message Identifier dictate the format and length of the data string. The Data String can consist of any printable ASCII characters with the exception of the > and < characters. Most messages are length sensitive and many use the ';' character as field separator. Data fields are fixed length regardless of the values entered.

**Security Password**

A Security Password (denoted as "PW" in messages) must be used in all communications with the TrailTrac. The default Security Password is set to "00000000"; however, the TrailTrac may be assigned any numeric password of up to eight characters while the TrailTrac is connected to a Provisioning Module.

The TrailTrac checks all incoming messages for a Security Password and all incoming message must include a Security Password. If the Security Password included in a message sent to TrailTrac does not match the Security Password configured in the TrailTrac device, then the message is ignored.

**Unit ID**

The Unit ID must be used in all communications with the TrailTrac. The TrailTrac may be assigned an alphanumeric Unit ID of eight characters only while the TrailTrac is connected to a Provisioning Module (available separately). The default Unit ID is set to 00000000.

The TrailTrac checks all incoming messages for a Unit ID and all incoming message must include a Unit ID. If the Unit ID included in a message sent to TrailTrac does not match the Unit ID configured in the TrailTrac device, then the message is ignored.

**Checksum**

The checksum field is always required and provides for a two-digit hexadecimal checksum value, which is computed by XOR'ing all characters from the beginning of the message up to and including the \* character. The checksum is always the last element of the message before the end-of-message delimiter.

# CONFIGURATION MESSAGES

The following messages are sent to the TrailTrac to configure application, GPS and GSM parameters and application parameters.

## SET\_APP\_CONFIG

The SET\_APP\_CONFIG message is used by the server application to set the TrailTrac Application parameters in the TrailTrac. When received the TrailTrac will send a RESP\_APP\_CONFIG message in response.

>STKABBBBBBCCCCCDDDDDEEEEEFFFFFGGGTTHIJK;PW=PPPPPPP;  
ID=YYYYYYYY;\*ZZ<

<b>A</b>	TrailTrac Configuration Set: 'A' = Application Parameters
<b>BBBBBB</b>	<b>IDLE Timeout, T1.</b> In seconds (10 – 999990). Default 43200
<b>CCCCCC</b>	<b>FIX Timeout, T2.</b> In seconds (10 – 3600). Default 300
<b>DDDDDD</b>	<b>TRANSMIT Timeout, T3.</b> In seconds (10 – 3600). Default 120
<b>EEEEEE</b>	<b>DELAY Timeout, T4.</b> In seconds (10 – 86400). Default 900
<b>FFFFFF</b>	<b>QUERY Timeout, T5.</b> In seconds (10 – 3600). Default 60
<b>GGG</b>	<b>Almanac Timeout, T6.</b> In hours (10 – 990). Default 168
<b>TT</b>	<b>IDLE Wakeup Motion Timeout, T7.</b> In seconds (0 – 90). Note: T7 is used exclusively while in the IDLE state; however, it is superseded by the Rolling Motion Window, T21, whenever IDLE State Polling Mode is set "2=OnDemand" OR while IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set "1=Cycled". WARNING: IDLE Wakeup Motion Timeout, T7, must always be set greater than or equal to IDLE Wakeup Motion Second Count; else unit may not exit IDLE state due to motion. Default 15
<b>H</b>	<b>Motion Report Flag.</b> 0=None; 1=Report Motion in IDLE (before attempting new GPS fix. Default 0
<b>I</b>	<b>Report Delay Flag.</b> 0=Transmit All Messages; 1=Transmit NO Messages; 2=Transmit Motion-related Messages-only; 3= Transmit IDLE Timeout, T1 Status Messages-only. Default 0
<b>J</b>	<b>Diagnostics Mode.</b> 0= None; 1= LED. Default 1
<b>K</b>	<b>Communication Mode.</b> 0= SMS; 1= Future. Default 0
<b>PPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## SET\_EXT\_APP\_CONFIG

This message is used to set the Extended Application parameters in the TrailTrac device. When received the TrailTrac device will send a RESP\_EXT\_APP\_CONFIG message in response.

>STKABCCCCCDEFFFFFFGGGGGGHIJJJKKKLLMMNNO;PW=PPPPPPP;  
ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'X' = Extended Application Parameters
<b>B</b>	<b>Scheduled Reporting Mode.</b> 0=None; 1=Daily; 2=Weekly
<b>CCCCCC</b>	<b>Scheduled Report Time, T18.</b> In Seconds (0-604799). Note: This is either the seconds into the day or into the week for the device to schedule a report when this feature is enabled. If Scheduled Reporting Mode is set "0=None", then enter 0. Default 0.
<b>D</b>	<b>DELAY State Polling Mode.</b> 0=Disabled; 1=OnDemand. Note: If set to "1=OnDemand", the unit is able to receive and process SMS commands during the QUERY and DELAY states. Default 0
<b>E</b>	<b>IDLE State Polling Mode.</b> 0=Disabled; 1=Cycled; 2=OnDemand. Default 0. Note: DELAY State Polling Mode is treated as always "1=Enabled" when IDLE State Polling Mode is set to "2=OnDemand".
<b>FFFFFF</b>	<b>IDLE State Polling Cycle Interval, T19.</b> In Seconds (10-999990). Note: Determines the interval at which the IDLE State Polling Cycle Duration, T20, timer is started if and only if the IDLE State Polling Mode is set to "1=Cycled". WARNING: IDLE State Polling Cycle Interval, T19, must always be set greater than IDLE State Polling Cycle Duration, T20, or QUERY Timeout, T5, whichever applies. Default 3600.
<b>GGGGGG</b>	<b>IDLE State Polling Cycle Duration, T20.</b> In Seconds (0, 10-3600). Note: Determines how long the unit is able to receive and process SMS messages each time IDLE State Polling Cycle Interval, T19, expires. A value of zero causes the QUERY Timeout, T5, value to be used WARNING: IDLE State Polling Cycle Interval, T19, must always be set greater than IDLE State Polling Cycle Duration, T20, or QUERY Timeout, T5, whichever applies. Default 60.
<b>H</b>	<b>Query Hold Flag.</b> 0=Disabled; 1=Enabled. Note: Unit attempts to reconnect to the GSM network if the connection is lost during the QUERY state prior to the expiration of QUERY Timeout, T5. Default 0.
<b>I</b>	<b>DELAY State Extended Motion Detection.</b> 0=Disabled; 1=Enabled. Note: Allows the unit to filter spurious motion detections in DELAY state when set to "1=Enabled". The unit does not power off during DELAY state and power consumption will increase. Default 1.
<b>JJJ</b>	<b>Position Report Transmit Attempts, N1.</b> 0=Until T3 Expires; 1-255=Number of Tx Attempts. Default 1.
<b>KKK</b>	<b>Status Message Transmit Attempts, N2.</b> 0=Until T3 Expires; 1-255=Number of Tx Attempts. Default 1.
<b>LL</b>	<b>IDLE Wakeup Motion Second Count.</b> In Seconds (1-90). Note: This parameter is used only while IDLE Wakeup Motion Timeout, T7, is running. It is superseded by Rolling Motion Second Count whenever IDLE State Polling Mode is set "2=OnDemand" OR while IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set

	"1=Cycled". WARNING: IDLE Wakeup Motion Second Count must always be set equal to or less than IDLE Wakeup Motion Timeout, T7; else unit may not exit IDLE state due to motion. Default 1.
<b>MM</b>	<b>Rolling Motion Window, T21.</b> In Seconds (1-90). Note: T21 applies in all states except IDLE and FIX; provided, however, that is also automatically enabled for IDLE state whenever IDLE State Polling Mode is set "2=OnDemand" OR when IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set "1=Cycled". WARNING: Rolling Motion Window, T21, must always be set equal to or greater than Rolling Motion Second Count; else the unit may not exit QUERY state. Default 20.
<b>NN</b>	<b>Rolling Motion Second Count.</b> In Seconds (1-90). Note: This parameter is enabled only when Rolling Motion Window, T21, is active. Default 10.
<b>O</b>	<b>Motion Override.</b> 0=Normal; 1=Motion Always; 2=Motion Never. Note: Overrides the motion sensor if set to a value other than "0=Normal". If set to "1=Motion" Always, then the TrailTrac will override the motion sensor such that the unit operates as if motion is always present. If set to "2=Motion Never", then the TrailTrac will ignore all motion and never generate a fix until the configuration is changed or otherwise commanded to do so (see QUERY_POSITION message). Default 0.
<b>PPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. . Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## SET\_GPS\_CONFIG

The SET\_GPS\_CONFIG message is used by the server application to set the TrailTrac GPS parameter values in the TrailTrac. When received the TrailTrac will send a RESP\_GPS\_CONFIG message in response. Please note that these GPS configuration parameters will seldom need to be changed from default values. It is NOT recommended that they be changed.

>STKABBCCDDDEEFF;PW=PPPPPPP;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'G' = GPS Parameters
<b>BB</b>	<b>GPS Elevation Mask.</b> In degrees (0-30). Default 5
<b>CCC</b>	<b>GPS PDOP Mask.</b> In tenths of PDOP (60 – 200). Default 120
<b>DDD</b>	<b>GPS PDOP Switch.</b> In tenths of PDOP (40 – 120). Default 60
<b>EEE</b>	<b>GPS Signal Level.</b> In tenths of AMUs (10 – 80). Default 10
<b>F</b>	<b>GPS Dynamics Mode.</b> 5=Automobile. Default 5
<b>PPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## SET\_PROV\_CONFIG

The SET\_PROV\_CONFIG message is used by the server application to set the Communication values in the TrailTrac. When received by the TrailTrac, the unit will send a RESP\_PROV\_CONFIG message in response.

>STKABBBBBBBBBBBBBBBBBBBBBB;PW=PPPPPPPP;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'V' = Provisioning Parameters
<b>BBBBBB</b> <b>BBBBBB</b> <b>BBBBBB</b> <b>BBBBBB</b>	<b>Destination Address.</b> 24 characters including international dialing "+" sign and country code. Field padding is in spaces before the international dialing "+" sign. Default <Empty>.
<b>PPPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## QUERY MESSAGES

### QUERY\_CONFIG

This QUERY\_CONFIG message is used by the server application to request the TrailTrac send its TrailTrac Application, GPS or Communication parameters in the appropriate RESP\_APP\_CONFIG, RESP\_PROV\_CONFIG or RESP\_GPS\_CONFIG message.

>QTKA;PW=PPPPPPPP;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'G' = GPS Parameters 'A' = Application Parameters 'V' = Provisioning Parameters
<b>PPPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. . Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## QUERY\_LOG

This message is used by the server application to request Report Sequence Number past REPORT\_POS or STATUS\_MSG messages that may not have been received at the server application. The TrailTrac will send the corresponding messages to the server application in response to this message at the rate of REPORT\_POS or STATUS\_MSG per message. At the end of the messages a RESP\_QUERY\_LOG or RESP\_QUERY\_AGGR is sent.

>QTKABBBBCCCC[DE[FGHIJJJK[LLLLMMMMMM[NNNNOOOOOO]]];PW=PPPPPPP;  
ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>Always 'R':</b> Indicates a query for old REPORT messages
<b>BBBB</b>	<b>Beginning Protocol Sequence Number.</b> 16-bit Hex (0000-FFFF) incrementing by 1 for each logged report.
<b>CCCC</b>	<b>Ending Protocol Sequence Number.</b> 16-bit Hex (0000-FFFF) incrementing by 1 for each logged report
<b>PPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. . Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

### Optional

<b>D</b>	<b>Aggregate Log Reporting Flag:</b> 'T' = enabled, 'F' = disabled. When enabled, aggregate reports may be returned.
<b>E</b>	<b>Stop RESP_QUERY_LOG</b> message from being sent: 'T' = do not send, 'F' = send. Used to stop the unit from fulfilling previous QUERY_LOG requests
<b>F</b>	<b>Filter 1:</b> 'Z' = All, 'U' = Unsent only.
<b>G</b>	<b>Filter 2:</b> 'Z' = All, 'P' = Position only, 'S' = Status only.
<b>H</b>	<b>Filter 3:</b> 'Z' = All, 'A' = Alert only
<b>I</b>	Time range: 'Z' = Unused, 'N' = Newest, 'O' = Oldest
<b>JJJ</b>	Maximum Number of Messages to be sent in response to the current QUERY_LOG message. If non-zero then this limits the total number of message that can be sent from the log. If zero then the number of messages sent from the log has no limit. Applicable if Time range is not 'Z'.
<b>K</b>	<b>Last Message:</b> '1' = automatically include the last message in the log regardless of the filter settings, '0' = don't automatically include the last message in the log.
<b>LLLL</b>	<b>GPS week number of starting date</b>
<b>MMMMMM</b>	<b>GPS seconds into week of starting date.</b>
<b>NNNN</b>	<b>GPS week number of ending date.</b> 'Most recent' if not present.
<b>OOOOO</b>	<b>GPS seconds into week of ending date.</b> 'Most recent' if not present.

## QUERY\_POSITION

This message is used to command the TrailTrac device to report either its current or its most recently logged position. The unit will compute and report new position fix if the QUERY\_POSITION Operation Mode is set "S=Compute" and there has been motion since the last position fix. The unit will respond by sending a new REPORT\_POS message (with TriggerType set to '3'=Query); provided, however, that the TrailTrac was able to compute a new position fix prior to expiration of the GPS Fix Timeout specified in the QUERY\_POSITION message. The unit will send a single SMS message containing a new STATUS\_MSG and the most recently logged REPORT\_POS if:

1. The QUERY\_POSITION has the Operation Mode set 'L'=Logged; OR
2. The QUERY\_POSITION has the Operation Mode set 'S'=Compute, but there has been no motion since the last logged position (i.e. Position Aged is set 0); OR
3. The QUERY\_POSITION has the Operation Mode set 'S'=Compute and there has been motion since the last logged position (i.e. Position Aged is set 1), but the unit was unable to compute a new position fix prior to expiration of the GPS Fix Timeout specified in the QUERY\_POSITION message.

The new STATUS\_MSG will have the TriggerType set to "3"=Query and the Position Aged flag will be set '1'=Aged if there has been motion since the last logged position.

>QTKABCCCC;PW=PPPPPPPP;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>Always 'D'</b>
<b>B</b>	<b>Position Query Mode.</b> S=Compute and report current position; L=Status Report with Last logged position
<b>CCCC</b>	<b>Position Query Fix Timeout.</b> In Seconds (10-3600). Note: Temporarily overrides current FIX Timeout, T2, if Position Query Mode set to "S=Compute" and report current position. Settings longer than 600 minutes are generally not recommended. No default value.
<b>PPPPPPPP</b>	<b>Security Password.</b> Always 8 alphanumeric characters, UPPER CASE ONLY. . Default 00000000
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## Position, Status and Response Messages

### REPORT\_POS and STATUS\_MSG

These two messages are the most common. The difference between the REPORT\_POS and STATUS\_MSG is that the REPORT\_POS message contains position information. STATUS\_MSG does not contain any position.

```
>RTKABBBBCDDDEFFFFGGGGGGSTVOPQRUUUUU[HHHHHHHHJJJJKKK
KKKKLLLLLLMMMNNN];ID=YYYYYYYY;*ZZ<
```

<b>A</b>	<b>TrailTrac Report Type:</b> 'P' = Position Report 'S' = Status Report
<b>BBBB</b>	<b>Protocol Sequence Number.</b> 16-bit Hex (0000-FFFF) incrementing by 1 for each logged report.
<b>C</b>	<b>TriggerType</b> 0=IDLE Timeout, T1 1=Motion Detected 2=Not used 3=Query 4=Scheduled Report
<b>DDD</b>	<b>Battery Level.</b> 0-100%.
<b>E</b>	<b>Battery Changed Flag.</b> T=True F=False
<b>FFFF</b>	<b>GPS Week Number.</b> Always 4 Digits
<b>GGGGGG</b>	<b>GPS Seconds into Week.</b> Always 6 Digits.
<b>S</b>	<b>GPS Status Code.</b> 0=3D GPS Fix 1=2D GPS Fix 2=Fix Timeout, 0 SVs 3=Fix Timeout, 1 SV 4=Fix Timeout, 2 SVs 5=Fix Timeout, 3 SVs 6=GPS Error 7=No Fix attempted
<b>T</b>	<b>GSM Status Code</b> 0=Network Available 1=Message Logged (i.e. Report Delay Flag set=1) 2=Network Timeout 3=SIM Error / No SIM 4=SIM PIN Error 5=Pre-TX log (Low battery)
<b>V</b>	Position Age: 0=Current (i.e. no motion since last position) 1=Aged (i.e. motion has occurred since last position)
<b>O</b>	HPA Status: 0=Normal; 1=Activated; 2=Sent; 3=Acknowledged (NOT USED)
<b>P</b>	MPA Status: 0=Normal; 1=Activated; 2=Sent; 3=Acknowledged (NOT USED)
<b>Q</b>	LPA Status: 0=Normal; 1=Activated; 2=Sent; 3=Acknowledged (NOT USED)
<b>R</b>	External Power: 0=Bad (Below 5 VDC); 1=Good (5 VDC or higher)
<b>UUUUU</b>	Reserved for future use
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

**Optional (Provided only if Position Report)**

<b>HHH. IIIIII</b>	<b>Latitude.</b> WGS-84 Coordinates. Units of Degrees to 7 decimal places plus '+' sign = North and '-' = South. (-90.0000000 to +90.0000000)
<b>JJJJ. KKKKKKK</b>	<b>Longitude.</b> WGS-84 Coordinates. Units of Degrees to 7 decimal places plus '+' sign = East and '-' = West. (-180.0000000 to +180.0000000)
<b>LLLLLL</b>	<b>Altitude.</b> WGS-84 Altitude reference to MSL. In Feet, always 5 Digits plus sign (-99999 to +99999)
<b>MMM</b>	<b>Horizontal Speed.</b> Miles Per Hour. Always 3 Digits.
<b>NNN</b>	<b>Heading.</b> Relative to True North, increasing Easterly. Units of Degrees. Always 3 Digits. (000-359).

Each new outbound REPORT\_POS and STATUS\_MSG message is given a Report Sequence number. The sequence number is 16 bits and increments by one with each message created and rolls over to 0000 once the maximum 16 bit value of FFFF is reached. The TrailTrac Application saves the message in non-volatile memory each time one is created; this is called the Message Log. The Message Log is a FIFO log of the last 128 REPORT\_POS or STATUS\_MSG messages (whether transmitted or only logged) such that when it is full the oldest one is deleted. The Message Log can be queried with the QUERY\_LOG message from the server application.

**RESP\_APP\_CONFIG**

This is the response message to the SET\_APP\_CONFIG and QUERY\_CONFIG messages containing the Application Parameter values.

>RTKABBBBBBCCCCCDDDDDEEEEEFFFFFGGGTTHIJKLLLLMMMMMMNPP;  
ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'A' = Application Parameters
<b>BBBBBB</b>	<b>IDLE Timeout, T1.</b> In seconds (10 – 999990)
<b>CCCCCC</b>	<b>FIX Timeout, T2.</b> In seconds (10 – 3600)
<b>DDDDDD</b>	<b>TRANSMIT Timeout, T3.</b> In seconds (10 – 3600)
<b>EEEEEE</b>	<b>DELAY Timeout, T4.</b> In seconds (10 – 86400)
<b>FFFFFF</b>	<b>QUERY Timeout, T5.</b> In seconds (10 – 3600)
<b>GGG</b>	<b>Almanac Timeout, T6.</b> In hours (10 – 990)
<b>TT</b>	<b>IDLE Wakeup Motion Timeout, T7.</b> In seconds (0 – 90). Note: T7 is used exclusively while in the IDLE state; however, it is superseded by the Rolling Motion Window, T21, whenever IDLE State Polling Mode is set "2=OnDemand" OR while IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set "1=Cycled". WARNING: IDLE Wakeup Motion Timeout, T7, must always be set greater than or equal to IDLE Wakeup Motion Second Count; else unit may not exit IDLE state due to motion.
<b>H</b>	<b>Motion Report Flag.</b> 0=None; 1=Report Motion in IDLE (before attempting new GPS fix)
<b>I</b>	<b>Report Delay Flag.</b> 0=Transmit All Messages; 1=Transmit NO Messages; 2=Transmit Motion-related Messages-only; 3= Transmit IDLE Timeout, T1 Status Messages-only

<b>J</b>	<b>Diagnostics Mode.</b> 0= None; 1= LED
<b>K</b>	<b>Communication Mode.</b> 0= SMS; 1= Future
<b>LLLL</b>	Battery Change Week.
<b>MMMMMM</b>	Battery Change Seconds into Week.
<b>N.PP</b>	Firmware version number
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## RESP\_EXT\_APP\_CONFIG

This is the response message to the SET\_EXT\_APP\_CONFIG and QUERY\_CONFIG message containing the Extended Application Parameter values.

>RTKABCCCCCDEFFFFFFGGGGGGHIJJKKLLMMNNO;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set:</b> 'X' = Extended Application Parameters
<b>B</b>	<b>Scheduled Reporting Mode.</b> 0=None; 1=Daily; 2=Weekly
<b>CCCCCC</b>	<b>Scheduled Report Time, T18.</b> In Seconds (0-604799). Note: This is either the seconds into the day or into the week for the device to schedule a report when this feature is enabled. If Scheduled Reporting Mode is set "0=None", then enter 0.
<b>D</b>	<b>DELAY State Polling Mode.</b> 0=Disabled; 1=OnDemand. Note: If set to "1=OnDemand", the unit is able to receive and process SMS commands during the QUERY and DELAY states.
<b>E</b>	<b>IDLE State Polling Mode.</b> 0=Disabled; 1=Cycled; 2=OnDemand. Default 0. Note: DELAY State Polling Mode is treated as always "1=Enabled" when IDLE State Polling Mode is set to "2=OnDemand".
<b>FFFFFF</b>	<b>IDLE State Polling Cycle Interval, T19.</b> In Seconds (10-999990). Note: Determines the interval at which the IDLE State Polling Cycle Duration, T20, timer is started if and only if the IDLE State Polling Mode is set to "1=Cycled". WARNING: IDLE State Polling Cycle Interval, T19, must always be set greater than IDLE State Polling Cycle Duration, T20, or QUERY Timeout, T5, whichever applies. Default 3600. Note: Determines the frequency at which the QUERY state is enabled while in the IDLE state if and only if the IDLE State Polling Mode is set to "1=Cycled".
<b>GGGGGG</b>	<b>IDLE State Polling Cycle Duration, T20.</b> In Seconds (0, 10-3600). Note: Determines how long the unit is able to receive and process SMS messages each time IDLE State Polling Cycle Interval, T19, expires. A value of zero causes the QUERY Timeout, T5, value to be used WARNING: IDLE State Polling Cycle Interval, T19, must always be set greater than IDLE State Polling Cycle Duration, T20, or QUERY Timeout, T5, whichever applies. Default 60.
<b>H</b>	<b>Query Hold Flag.</b> 0=Disabled; 1=Enabled. Note: Unit attempts to reconnect to the GSM network if the connection is lost during the QUERY state prior to the expiration of QUERY Timeout, T5.
<b>I</b>	<b>DELAY State Extended Motion Detection.</b> 0=Disabled; 1=Enabled. Note: Allows the unit to filter spurious motion detections in DELAY state when set to "1=Enabled". The unit does not power off during DELAY state and power

	consumption will increase.
<b>JJJ</b>	<b>Position Report Transmit Attempts, N1.</b> 0=Until T3 Expires; 1- 255=Number of Tx Attempts.
<b>KKK</b>	<b>Status Message Transmit Attempts, N2.</b> 0=Until T3 Expires; 1- 255=Number of Tx Attempts.
<b>LL</b>	<b>IDLE Wakeup Motion Second Count.</b> In Seconds (1-90). Note: This parameter is used only while IDLE Wakeup Motion Timeout, T7, is running. It is superseded by Rolling Motion Second Count whenever IDLE State Polling Mode is set "2=OnDemand" OR while IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set "1=Cycled". WARNING: IDLE Wakeup Motion Second Count must always be set equal to or less than IDLE Wakeup Motion Timeout, T7; else unit may not exit IDLE state due to motion. Default 1.
<b>MM</b>	<b>Rolling Motion Window, T21.</b> In Seconds (1-90). Note: T21 applies in all states except IDLE and FIX; provided, however, that is also automatically enabled for IDLE state whenever IDLE State Polling Mode is set "2=OnDemand" OR when IDLE State Polling Cycle Duration, T20, is running due to IDLE State Polling Mode being set "1=Cycled". WARNING: Rolling Motion Window, T21, must always be set equal to or greater than Rolling Motion Second Count; else the unit may not exit QUERY state. Default 20.
<b>NN</b>	<b>Rolling Motion Second Count.</b> In Seconds (1-90). Note: This parameter is enabled only when Rolling Motion Window, T21, is active. Default 10.
<b>O</b>	<b>Motion Override.</b> 0=Normal; 1=Motion Always; 2=Motion Never. Note: Overrides the motion sensor if set to a value other than "0=Normal". If set to "1=Motion" Always, then the TrailTrac will override the motion sensor such that the unit operates as if motion is always present. If set to "2=Motion Never", then the TrailTrac will ignore all motion and never generate a fix until the configuration is changed or otherwise commanded to do so (see QUERY_POSITION message). Default 0.
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum</b>

## RESP\_GPS\_CONFIG

This is the response message to the SET\_GPS\_CONFIG and QUERY\_CONFIG message containing the GPS Configuration.

>RTKABBBCCDDDEEFF;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set: 'G' = GPS Parameters</b>
<b>BB</b>	<b>GPS Elevation Mask.</b> In degrees (0-30)
<b>CCC</b>	<b>GPS PDOP Mask.</b> In tenths of PDOP (60 – 200)
<b>DDD</b>	<b>GPS PDOP Switch.</b> In tenths of PDOP (40 – 120)
<b>EEE</b>	<b>GPS Signal Level.</b> In tenths of AMUs (10 – 80)
<b>F</b>	<b>GPS Dynamics Mode</b> 5=Automobile
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum</b>

## RESP\_PROV\_CONFIG

This is the response message to the SET\_PROV\_CONFIG and QUERY\_CONFIG message containing the provisioning information.

>RTKABBBBBBBBBBBBBBBBBBBBBBBBB;ID=YYYYYYYY;\*ZZ<

<b>A</b>	<b>TrailTrac Configuration Set: 'V' = Provisioning Parameters</b>
<b>BBBBBBBB</b> <b>BBBBBBBB</b> <b>BBBBBBBB</b>	<b>Destination Address.</b> 24 characters including international dialing “+” sign and country code. Field padding in spaces before the international dialing “+” sign
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum</b>

## RESP\_QUERY\_AGGR

This message is sent by the TrailTrac locator after a QUERY\_LOG request is received and processed, and if Aggregate Log Reporting Flag is ‘enabled’. It will contain messages in aggregated format as shown below. The entire message can be no more than 160-byte SMS message.

>RTKA{B};ID=YYYYYYYY;\*ZZ<

<b>A</b>	1' to '4': Indicates number of REPORT_POS messages contained in this RESP_QUERY_AGGR message.
<b>B</b>	Message fields from Report Type to the first semi-colon (excluded).
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>

## RESP\_QUERY\_LOG

This message is sent after a QUERY\_LOG request is received and processed. It will contain the number of messages actually retrieved from the Message Log and sent to the server application.

>RTKABBBB;ID=YYYYYYYY;\*ZZ<

<b>A</b>	Always 'R': Indicates a response to a QUERY_LOG
<b>BBBB</b>	Number of message sent from the log.
<b>YYYYYYYY</b>	<b>Unit ID.</b> Always 8 alphanumeric characters, UPPER CASE ONLY
<b>ZZ</b>	<b>Checksum.</b>