TABLE OF CONTENTS

TRADEMARKS

SECTION 1.0
DRIP OVERVIEW

1.1 DrIP MESSAGE STRUCTURE

All DrIP messages use printable ASCII characters. Upper case and lower case alpha characters are generally interchangeable. Lower case characters are converted to upper case alpha in the unit before parsing. Exceptions are passwords and unit IDs, which can contain lower case alpha characters and are case sensitive.

Each message has the following general format with message elements and notation, as shown in the table below. Valid DrIP messages are limited to 80 characters.

>ABB{C}[;ID=DDDDDDDD]<

DrIP MESSAGE ELEMENTS	
Element	**Meaning**
>	Start of new message
<	End of message
A	Message qualifier (Q, R, S, F, or D)
BB	2-character Message identifier
C	Data string
DDDDDDDD	4 to 8 character alphanumeric unit ID string
{X}	Signifies that x can occur zero or more times
[X]	Signifies that x can optionally occur once

1.2 MESSAGE FRAMING

Each DrIP message is framed by the start and end ASCII characters > and < respectively. These characters are not allowed other than as start-of-message and end-of-message indicators. Carriage return (0x0D) and line feed (0x0A) characters are appended to all Response messages.

1.3 MESSAGE QUALIFIERS

A one-character message qualifier is used to describe the action to be taken on the message. The table below lists the valid qualifiers.

MESSAGE QUALIFIERS	
Qualifier	**Action**
Q	Query for data or parameters (sent to the CDS9020 unit).
S	Set or configure parameters (sent to the CDS9020 unit.)
R	Response to a query or a scheduled or autonomous report (from the CDS9020 unit).
F, D	Schedule a report from the CDS9020 unit based on elapsed time and/or distance traveled (Time & Distance Reporting - TDR).

General information about using message qualifiers is provided in this overview section. Details for individual messages, are included in the DrIP-Formatted Message Summary, Section 3. Messages sent with an illegal qualifier are ignored.

1.4 MESSAGE IDENTIFIER

A unique two-character, alphanumeric message identifier is used to identify each DrIP-formatted message. The complete list of DrIP message IDs is shown in the DrIP-Formatted Message Summary Table, p. 31.

1.5 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 may use the ; character (semicolon) as field separator.

1.6 UNIT ID

Unit identification (ID) can optionally be used in all communications with the CDS9020 unit. The unit can be assigned an alphanumeric ID of up to eight characters, using the Unit ID (ID) message. See ID Message Description, p. 61, for details and restrictions. The default ID is set to **no SID**.

If a blank is specified with the SID command, **no SID** is appended to **R** responses.

1.7 QUERY / RESPONSE MESSAGES

Query commands are used to request configuration parameter settings and status information from the CDS9020 unit. Responses to queries are sent in Response messages. For a list of messages supported by the Query and Response qualifiers, see DrIP-Formatted Message Summary, Section 3.

1.7.1 Query Messages

are identified by the **Q** (Query) qualifier and have the following format:

>QAA{B}<

where **AA** is the requested message identifier and **B** is an optional (message-specific) parameter string. The Query parameter string may be empty, an in the following request for current position:

>QPV<
>RPV.....[;ID=CCCCCCCC]<

The Query parameter may specify one of a set of elements to be returned in the response, as in the following request for the current state of Digital Input 0 (IP0):

>QSSIP0<
>RSSIP000[;ID=CCCCCCCC]<

1.7.2 Response Messages,

identified by the Response **R** qualifier, have the following format:

>RAA{B}[;ID=CCCCCCCC]<

where **AA** is the two-character message identifier and {**B**} specifies the data string within the message. Response messages report to queries and are used for scheduled and autonomous reports from the CDS9020 unit.

Unit ID is included in response messages when enabled, see ID message description, p. 61.

1.8 SET MESSAGES

Set commands set configuration parameters in the CDS9020 unit. For a list of messages supported by the **S** qualifier, see DrIP-Formatted Message Summary, Section 3.

Set messages are identified by the **S**et qualifier and have the following format:

>SAA{B}[;ID=CCCCCCCC]<

where **AA** is the two-character message identifier and {**B**} specifies the data string.

The Set parameter string may specify a set of non-delimited parameters in fixed format, as in the following configuration of EV timer/counter 01:

>SGC01TR00005<

or may specify one or more specific parameters accepted by the message type.

Set commands produce no response from the CDS9020 unit. A Set message that contains an illegal parameter string is ignored.

1.9 FREQUENCY AND DISTANCE SCHEDULING MESSAGES

The **F** and **D** qualifiers schedule Time and Distance Reports (TDR) for individual DrIP message types. **F** and **D** messages specify the message type to be reported and a set of four parameters that are the time and/or distance criteria to be met to trigger a message report. (See TDR description, p. 9.) DrIP message types that support the **F** and **D** qualifiers are listed in the DrIP-Formatted Message Summary, p. 31.

F and D messages have the following format:

>TAABBBB[CCCC[DDDD[EEEE]]][;PORT=P]<

As indicated by the option brackets ([ ]), the set of four TDR parameters can be truncated to three, two or one parameters. Omitted parameters are set to 0. Parameters are identified in the following table:

TDR (F & D) MESSAGE PARAMETERS

Element	Meaning
T	F or D message qualifier for TDR message scheduling.
AA	Message to report. (e.g., PV means Position Velocity message)
BBBB	Minimum time between reports or Report Interval (seconds).
CCCC	Offset for staggered and regulated reports.
DDDD	Distance traveled threshold (meters).
EEEE	Maximum time between reports (seconds).
P	Port/Channel ID for scheduled outputs: 0 for Communications channel 1 for DTE0 port (Main DTE port) 2 for DTE1port (Aux DTE port) 3 for RAM buffer If a PORT is not specified, reports are scheduled for the port from which this message was received.

The **F** and **D** qualifiers are interchangeable. Time can be entered as seconds (xxxx), as minutes (xxxm) or as hours (xxxh). Distance can be entered in meters (xxxx) or kilometers (xxxk). (See Scale Factors description, p. 16.) However, F and D parameter values are limited to the range 0-65535, so 65k, 18h and 1091m are valid entries, but 66k, 19h and 1092m are not. **F** and **D** messages are ignored if invalid entries are detected.

DrIP TDR reports can be scheduled independently for each message type, if TDR is supported for that type, and for each channel/port available on the unit.

All TDR reports may be cleared with using:

>STD*U<

to "undefine" all Timer-Distancers.

The current **F** and **D** settings for a specified message type can be retrieved via the TD message (see TD message description, p. 67), using:

>QTDAA<

where **AA** is the message ID. The response format is:

>RTDAABBBBCCCCDDDDEEEE<

where the fields are defined in the TDR Message Parameters table, p. 7.

1.10 TIME AND DISTANCE REPORTING

Time and distance reporting (TDR) allows triggering of reports when time and/or distance criteria are met. TDR is available via EV events triggered by TD signals (See TD Message Description, p. 67.) and via DrIP F and D scheduling. (See Frequency and Distance Scheduling Messages, p. 7.) Additionally, individual Timers and Distancers can be configured via the GC message and used as EV event triggers.

Time and distance criteria are specified by the following TDR parameters:

- Minimum Time between reports, or Report Interval
- Epoch/Offset for staggered and regulated reports
- Distance Traveled threshold
- Maximum time between reports

These parameters can be set to configure the following TDR modes:

- Time Reporting
- Time and Distance Reporting
- Time-Staggered Reporting
- The TDR modes are described below:

1.10.1 Time Reporting:

The simplest form of TDR is Time-Only. For Time-only TDR, reports can be triggered at regular intervals such as every five seconds or every 10 minutes. Time-Only reporting is useful to acquire periodic heartbeat data, particularly when a vehicle is stationary. To Configure Time-Only reporting, the Report Interval parameter is set to the interval value in seconds, and the other TDR parameters are set to 0.

Examples:

- Schedule EV reports for every 25 seconds:

  >FEV0025<

The value 25 is used as the Report Interval, and the other TDR parameters are set to 0

- Configure TD signal 1 to trigger every 3 minutes:

  >STD1003m<

1.10.2 Time and Distance Reporting:

When a vehicle is moving, it may be desirable to trigger reports based on distance traveled. Position reports regulated by distance provide a smooth record of movement for map displays and vehicle logs.

However, when a vehicle is moving quickly, the distance traveled triggers more frequently and may generate more reports than necessary. To eliminate unnecessary reports, a minimum time between reports can be specified in addition to the distance traveled threshold. Conversely, when a vehicle is moving slowly, a significant time can elapse between reports. To ensure that reports are received even when moving slowly, an optional maximum time between reports may be specified.

The combination of TDR criteria allows reporting when a specified distance is traveled or when a maximum time has elapsed, whichever occurs first, but with at least a minimum time between reports. Distance traveled is the accumulated distance since the last report, and elapsed time is the time since the last report.

For Time and Distance Reporting, the Minimum and Maximum Times and Distance Traveled threshold are set to desired values, and the Epoch/Offset is set to 0.

Since reports are triggered at most every “min time” seconds, the minimum time can be considered the first gate in determining when to report. After “min time” seconds, since the last report, the accumulated distance since last report is compared to the distance threshold. If the distance threshold is reached or the maximum time since last report is triggered, and a new basis (time of last report and distance of last report) is established. If it is not time to report, the time and distance checks are repeated every second until a report is triggered.

A Distance-Only variation can be configured by setting the Maximum Time parameter to 0. When Maximum Time is 0, a report is not triggered until the Distance Traveled threshold is reached. The Minimum Time between reports is still valid for Distance-Only reporting.

Examples:

- Schedule ET messages to be reported every 1500 meters or 10 minutes, but no more often than every 123 seconds:

  >FET012300001500010M<

The offset must be set to 0 to avoid configuration of Time-Staggered Reporting.

- Schedule PV messages for Distance-Only Reporting with reports every 250 meters, but no more often than every 20 seconds:

  >FPV0020000002500000<

- Configure TD signal 8 to trigger every 20 kilometers or 200 seconds, but no more often than every 100 seconds:

  >STD801000000020k0200<

1.10.3 Time-Staggered Reporting:

When TDR reports are scheduled for a fleet of vehicles, it can be useful to regulate the reports to minimize potential collisions between incoming messages at the base station. This can be done by staggering reports by a different time offset for each vehicle, and allowing reports only at specified intervals. For example, starting at the top of the hour, reports from each of 20 vehicles could be staggered (offset) by N * 10 seconds, where N is the vehicle number (1-20), and the interval between reports could be set to five minutes (300 seconds). This offset would ensure that reports from the 20 vehicles could be received (at most) at interval times shown below:

TIME-STAGGERED REPORTING	
Vehicle	**Interval Times - Seconds Past the Hour**
1	10, 310, 610, 910, ..., 3010, 3310
2	20, 320, 620, 920, ..., 3020, 3320
3	30, 330, 630, 930, ..., 3030, 3330
∘	∘
20	200, 500, 800, 1100, ..., 3200, 3500

Time-Staggered Reporting can be visualized as an overlay on Time-Only or Time and Distance Reporting. TDR reports would normally occur at times determined by the Min Time, Max Time and Distance parameters. When Time-Staggered Reporting is configured, the Min Time is used as the Report Interval, and each TDR report (triggered by Distance or Maximum Time) is delayed until the next time interval occurs. This reporting differs from simple Time and Distance reporting in that the Report intervals occur as regulated clock times, not as elapsed time since last report. Thus TDR reports can be based on time and/or distance and still be regulated for staggered reporting from vehicles in a fleet.

To configure Time-Staggered Reporting, the Epoch/Offset should be set to a (non-zero) value as determined by the unit ID, and the Report Interval should be set to the report period. In the table above, the Offset for Vehicle #3 would be 30 seconds and the interval would be five minutes. Distance and Maximum Time values can be set as in non-staggered reporting. However, when the (maximum) time or distance is reached, the report is not triggered until the next regulated report interval. Therefore, Vehicle #3 triggers reports at the times specified in the table, but only if the Time/Distance criteria were met in the last interval.

The Offset parameter is referenced to the start of the week. For example, Sunday 00:00:00 UTC. Therefore, if the fleet reporting cycle is to repeat every hour, the report interval should divide evenly into one hour.
For staggered Time-Only Reporting, the Distance and Maximum Time parameters should be set as for Time and Distance Reporting mode.

Examples:

- Schedule EV messages to be reported every 1500 meters or every 10 minutes, but regulated at 5-minute intervals and staggered by 1 minute from the start of the week:

  >FEV005m001m1500010m<

Potential report times are then 1, 6, 11, 16, 21, 26, 31, ... minutes past the hour. At these times, a report is triggered if the vehicle has traveled 1500 meters since the last report or if it has been 10 minutes since the last report.

- Schedule ST messages to be reported every 30 minutes, and stagger reports by five minutes from the start of the week:

  >FST18000300<

Report times are then five and 35 minutes past the hour.

- Configure TD signal 7 to trigger at 10-minute intervals, offset by five minutes from the start of the week, but only of 16 kilometers has been traveled since the last report:

  >STD7010m005m016k<

- Configure TD signal 3 to trigger when 90 seconds or 8500 meters has been exceeded since the last report, but make report times regulated at 60 seconds between reports and offset five minutes from the start of the week:

  >STD30060005m85000090<

TDR Notes:

- The Minimum Time parameter is used as a switch to enable TDR. For example, when Minimum Time is set to 0, TDR reporting is disabled.

- The Maximum Time Between Reports feature can be disabled by setting Max Time to 0. Reports are then sent only if the distance traveled exceeds the threshold parameter.

- The Epoch/Offset is used as a switch between configuration of Staggered Reporting (non-zero value) and Non-Staggered Reporting (0 value). Therefore, staggered reports cannot be offset by 0 seconds from the reference time.

- Time can be entered as seconds (xxxx), as minutes (xxxm) or as hours (xxxh). Distance can be entered in meters (xxxx) or kilometers (xxxk). (See Scale Factors description, p. 16.)

- For Non-Staggered Reporting, the reference time (time since last report) is initially the time when TDR is configured. For example, time starts when the F and D or TD message is received.

- For Time-Staggered Reporting, the offset from the start of the week creates a dead time; no reports are triggered between the start of the week and the offset time. Therefore, an offset of 24 hours effectively disables triggers from 00:00:00 UTC Sunday to 00:00:00 UTC Monday.

1.11 SCALE FACTORS

Since most DrIP parameter fields are fixed in length, parameter values are limited by field length. For example, the TDR time and distance parameters all have a field size of four, limiting their range to 0-9999. To overcome this limitation, a scale factor character is allowed in the last position of the field to indicate a value by which the field is scaled. The following scale factors are supported:

h or H:	Hours - scale by 3600
m or M:	Minutes - scale by 60
k or K:	Kilometers - scale by 1000

For example, to schedule TDR for the PV message every five hours or 25 kilometers traveled, but not more frequently than every 145 minutes:

>FPV145m0000025k005h<

If a scale factor sets a parameter value, the parameter value is reported with scale factor only if the field would otherwise overflow. Therefore, the TDR schedule for PV messages, shown above, would be reported as:

>QTDPV<
>RTDPV87000000025k300m<

The 145 m field (145 minutes) is replaced with 8700 and the 0005h field (five hours) is replaced with 300m.

The use of scale factors is currently limited to the following messages (see the message descriptions for specific use and restrictions):

F&D, TD, PM, GR

1.12 POSITION REPORT FORMATS

The Position/Velocity Solution (PV) message is a typical position report message. Latitude and longitude are expressed as signed degrees with an implied decimal point. Time is expressed as seconds into the current GPS day. The PV message format follows and the message is described below:

>RPV15714+3739438-1220384601512612;ID=1234<

SAMPLE PV MESSAGE ELEMENTS	
Field Value	**Meaning**
R	Response Qualifier
PV	PV Message Identifier
15714	GPS Time of Day: 15714 seconds
+3739438	Latitude: N 37.39438 degrees
-12203846	Longitude: W 122.03846 degrees
015	Speed: 15 mph
126	Heading: 126 degrees
1	Source of Data: 3D GPS
2	Age of Data: Fresh (<10 seconds old)
;ID=1234	Unit ID

1.13 LATITUDE AND LONGITUDE CONVERSION

DrIP reports latitude as positive north decimal degrees and longitude as positive east decimal degrees, using the WGS-84 datum. Decimal degrees can be converted to degrees, minutes and seconds as shown by the following example:

Given latitude and longitude in decimal degrees:

Latitude: +37.39438 degrees
Longitude: -122.03846 degrees

Convert latitude by multiplying the decimal fraction of degrees by 60 to convert to minutes:

0.39438 x 60 = 23.6628 minutes

Retain the integer (23) portion as the minutes, then multiply the decimal fraction by 60 to convert to seconds:

0.6628 x 60 = 39.768 seconds

Since the sign of the latitude in this example is positive, the result is:

Latitude: N 37° 23' 39.77"

The longitude is converted in the same fashion:

Longitude: W 122° 02' 18.46"

Note: At the earth's equator, one degree of latitude and longitude represents 68.7 miles. Therefore, 0.00001 degrees represents approximately 3.6 feet or 1.1 meters. Each second represents approximately 100.76 feet (30.7m).

1.14 DATA SOURCE AND DATA AGE INDICATORS

DrIP messages that report GPS position data include a Data Source parameter indicating the source or type of position data. The Data Source indicates whether the position was computed as 2D or 3D, whether differential corrections have been applied, and whether the position was computed by Dead Reckoning. Data Source codes and corresponding descriptions are shown below:

1.14.1

DATA SOURCE CODES		
Value	**Data Source**	**Description**
0	2D GPS	Two-dimensional (latitude, longitude and time) autonomous GPS position.
1	3D GPS	Three-dimensional (latitude, longitude, altitude and time) autonomous GPS position.

Additionally, position report messages include an Age of Data/Data Validity indicator, shown in the table below. This indicator shows whether the reported position is not valid, whether it is an old position (greater than 10 seconds old) or a fresh position (no more than 10 seconds old).

1.14.2

AGE OF DATA CODES		
Value	**Age of Data**	**Description**
0	Position data not available.	Message data is invalid
1	Old position data.	Position data is more than 10 seconds old.
2	Fresh position data.	Position data is no more than 10 seconds old.

1.15 TIME REPORT FORMATS

DrIP position and event reports contain either time-only or time and date information. Reports that contain time (PV, CP) express time as UTC seconds into the day. For example, time is relative to the current day. The TM message also provides time/date information in standard Day, Month, Year and Hours, Minutes, Seconds format.

Reports that contain both time and date information (EV, and ET) express time as UTC week number (GPS week as offset by the GPS/UTC offset), day of week (0-7) and time of day. The time and date for EV is the GPS time of position fix.

SECTION 2.0
EVENTS

2.1 EVENT ACTIONS

Events may be used to cause one or more actions:

- Report data to base
- Log data
- Send data through the DTE0 port to an external PC or other mobile data device
- Erase Data Log
- Start, stop or change Time-Distance Reporting (TDR)
- Turn an output device on/off
- Start a timer
- Start a distancer
- Start a counter
- Increment a counter
- Set a user flag to true or false
- Alter any event definition or register
- Execute a DrIP command

2.2 EVENT DEFINITION

Events are defined using the **ED** message. The DrIP example below defines an event that transmits a report to the base station and turns on an output device when the vehicle enters a region.

```
>SED12NV0;R37+;ACT=SSSXP011<
```

The following sections examine each part of the example to show the basic structure and capabilities of event definitions. For complete syntax and technical details, see **ED** message, p.38.

2.3 EVENT ID NUMBER

Up to 50 Events can be programmed into the Event Engine. Each event is distinguished by its ID number, such as the **12** in the following example:

>SED12NVO;R37+ACT=SSSXP011<

The event ID can be any number from 00 to 49. This ID is used in any resulting event report, such as:

>REV12020966315714+3739438-1220384606231432<

Likewise, the event ID number is used to query the Event Engine for an event definition, such as:

>QED12<

which would then respond with the event definition:

>RED12NV0;R37+ACT=SSSXP011<

2.4 ROUTING AND HANDLING

When the event is triggered, a report can be generated and routed to either communications channel, data log, or output from the DTE0 or DTE1 ports.

>SED12NVO;R37+ACT=SSSXP011<

- **N** means send a normal priority report over the communications channel.
- **A** can be specified for an alarm priority report, which likewise sends via the communications channel.
- **L** writes the report to the Data Log.
- **X** sends the report out the DTE0 port to another device, such as a computer terminal.
- **Y** sends the report out the DTE1 port.
- **U** means undefined, and clears an event definition.
- **S** indicates signal only. In this case, the event does not send a report or execute the optional DrIP Action.

2.5 EVENT REPORT

The type of event report to be generated when the event is triggered, or no report at all, can be specified.

>SED12NVO;R37+ACT=SSSXP011<

The **V** in this example specifies that an EV type report will be generated, and will include the event ID, time and date, position, velocity and heading, as in the following:

>REV12020966315714+3739438-1220384606231432<

Alternative specifications are:

- **T** for ET type report (time only), which includes only event ID, time and date.
- **N** specifies no report at all. In this case, no report is generated, and only the optional DrIP Action occurs (if included) when the event is triggered.

See DrIP Message Summary, Section 3, for syntax and technical details on the EV and ET event reports.

2.6 DESTINATION ADDRESS

When reports are sent via the communications channel, up to 10 different phone numbers, generically called destination addresses, can be sent. These destination addresses are entered using the DA message. (See DA message, p. 33, for details.)

>SED12NV0;R37+;ACT=SSSXP011<

The **0** in this example specifies that the report should be routed to the phone number specified in DA number 0. This character can be a number from 0 to 9, matching one of the 10 destination addresses.

This destination address number applies only when the routing is specified as normal (N) or alarm-priority (A) reporting to the base station. If the routing is set to the Data Log (L), DTE0 port (X) or other, this number is ignored and can be left as an arbitrary zero.

2.7 SIGNALS

An event is triggered when signals become true or false, like a state machine:

>SED12NV0;R37+;ACT=SSSXP011<

In this example, **R37** is a signal representing user-defined Region #37. Signal R37 would be true when the vehicle is inside the user-defined region, and false when outside.

Signals are always three characters, and they are either true or false. The Signal Reference Table on page 75 details all signals available in the Event Engine.

To check whether a signal is currently true (1) or false (0), use the **SS** DrIP message to query it. The following example checks the status of the FIX signal:

>QSSFIX<
>RSSFIX01<

The **01** response indicates that the FIX signal is true.

2.8 TRIGGER SYNTAX

The event trigger can use just a single signal, or it can combine multiple signals by using the logical operators AND, OR and NOT.

The ampersand (&) represents logical AND. It operated on the two preceding items. The example below triggers when the vehicle is in Region 37 AND the speed is over Speed Threshold #02.

>SED12NV0;R37S02&+<

The pipe character (|) represents logical OR. It operates on the two preceding items. The example below triggers when the vehicle is in Region #37 OR Region #38 OR Region #39.

>SED12NV0;R37R38|R39|+<

The exclamation mark (!) represents logical NOT. It operates on the preceding item. The example below triggers when the speed is NOT over Speed Threshold #02 (i.e., speed is at or below the threshold).

>SED12NV0;S02!+<

The syntax used in event triggers is called post-fix notation. All signals and operators are evaluated from left to right, so operator precedence is not required, nor are parentheses. The post-fix notation examples below are explained in terms of standard algebraic logic:

R37R38½R39½S02!&

(In Region #37 OR #38 OR #39) AND NOT over Speed #02

R37S02&R38S03&½

(In Region #37 and over Speed #02) OR (in Region #38 AND over Speed #03)

R37!R38!&

NOT in Region #37 AND NOT in Region #38

R37R38½!

NOT (in region #37 OR in Region #38)--same meaning as above.

2.9 TRIGGER TRANSITION

Events occur when the trigger (i.e., the combination of signals and logical operators) transitions to either true or false.

>SED12NVO;R37IP1&+ACT=SSSXP011<

- The plus sign (+) at the end of the trigger means the event occurs when the trigger transitions to true.
- The minus sign (-) means the event occurs when the trigger transitions to false.
- The asterisk (*) means the event occurs when the trigger transitions to either state.

In the above example, the event occurs the moment the vehicle is in Region #37 and Input #1 is on, which could mean either:

- If the vehicle is already in the region, the event occurs when the input is switched on.
- If the input is already on, the event occurs the moment the vehicle enters the region.

The event occurs only once during the transition; it does not repeat while the trigger remains true (or false).

Note: Signals are updated only once per second. This means that if an input switch is pressed once per second, the input signal remains true every second and does not have time to transition to false. The fastest any event using + or - can occur is once every two seconds: one second for the trigger to transition to true and one second for the trigger to transition back to false.

2.10 DrIP ACTION

When an event is triggered, it can optionally execute a DrIP command, such as starting a timer, setting a user flag, sending a text message or getting the value of a counter. This optional DrIP Action can be in addition to or instead of sending an event report.

>SED12NV0;R37+;ACT=SSSXP011<

The **;ACT=** marks the beginning of a DrIP Action and **SSSXP011** in the above is the DrIP command to be executed, in this case to turn on Output #0. Another example is below:

>SED13LN0;R37+;ACT=QGC09V<

In the case where the DrIP Action is a query, such as the above example, the resulting DrIP Response message is routed to the same destination specified for the event report. In this example, the DrIP Action queries the value of Counter #09, which generates a DrIP Response message. Because the routing is specified as **L** for the Data Log, the value of the counter is written to the Data Log. Likewise, Response messages can be routed to the base station (**N** or **A**) or to the DTE0 port (**X**).

>SED13LV0;R37+;ACT=QGC09V<

If an event definition results in both an event report and a Response to a DrIP Action, the event report is sent first, followed by the DrIP Response. The above example writes the following two entries to the Data Log:

>REV13020966315714+3739438-1220384606231432<
>RGC09V00047<

2.11 MULTIPLE EVENT ACTIONS

A single event definition can cause one event report and/or one DrIP Action at a time. If, however, more than one event report and/or DrIP Action is required, additional event definitions based on the same trigger can be written.

```
>SED21LV0;R37R38|R39|S02&+;ACT=SGC05TR00030<
>SED22NV0'E21+;ACT=SSSXP01<
```

In the above example, the signal **E21** is true when the trigger of Event #21 is true. This means both Event #21 and #22 trigger at the same time. (Actually #21 is first; #22 follows immediately.) As a result, it:

1. Logs an event report
2. Starts a timer
3. Sends an event report to the base station
4. Turns on an output

Note: The event signals E00 - E49 are all updated in sequence, so it is best to use only preceding events signals. For example, Event #08 may use the E04 signal, but Event #04 should not use the E08 signal.

SECTION 3.0
DrIP – FORMATTED MESSAGE SUMMARY

3.1 DrIP MESSAGE SUMMARY

DrIP-FORMATTED MESSAGE SUMMARY					
ID	**DESCRIPTION**	**QUALIFIERS**			
		Q	**R**	**S**	**F&D**
CP	Compact Position	*	*		*
DA	Destination Address	*	*	*	
DL	Data Logging	*	*	*	
ED	Event Definition	*	*	*	
ET	Event Report (Time-Only Format)	*	*		*
EV	Event Message	*	*		*
GC	Counter/Timer/Distancer	*	*	*	
GH	Heading Window	*	*	*	
GR	Region Window	*	*	*	
GS	Speed Limit	*	*	*	
GT	Time Window	*	*	*	
ID	Unit ID	*	*	*	
PV	Position/Velocity Solution	*	*		*
PW	Password	*	*	*	
SS	Signal Status	*	*	*	
TD	Time and Distance Reporting Parameters	*	*	*	
TM	Time/Date	*	*	*	*
TX	Text Message		*	*	
VR	Version Number	*	*		

3.2 COMPACT POSITION SOLUTION (CP)

The Compact Position Solution (CP) message queries the GPS receiver for the most recent position solution. The data string format and fields are described below.

AAAAABBBCCCCDDDEEEEFG

COMPACT POSITION SOLUTION (CP) DATA STRING FORMAT				
Chars	**Item**	**Format**	**Value**	**Meaning**
5	GPS Time	AAAAA	Seconds	GPS time of day when position solution is computed, rounded to nearest second.
7	Latitude	BBB.CCCC	Degrees	WGS-84 Latitude coordinate (positive = north).
8	Longitude	DDDD.EEEE	Degrees	WGS-84 Longitude coordinate (positive = east).
1	Data Source	F	Flag	Data Source for position solution. 0: 2D GPS (3 satellites) 1: 3D GPS (4+ satellites)
1	Data Age	G	0, 1, 2	Age of the data: 0: Not available 1: Old, >10 seconds 2: Fresh, ≤ 10 seconds
Total: 22 characters				

3.3 DESTINATION ADDRESS (DA)

The Destination Address (DA) message sets and retrieves communications addresses where autonomously generated messages (such as event messages) are to be sent. There are 10 potential Destination Address slots, numbered 0-9.
The data string format and fields are described below.

A[BC{D}]

DESTINATION ADDRESS (DA) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
1	Index	A	0-9	Specifies one of 10 Destination Addresses, numbered 0-9.
1	Address Type	B	P/A	Address type for Communications Protocol: P: Phone number A: Force analog dial for this phone number
1	Address Subtype	C	0	Subtype specified for Address Type. If not used, this field is set to 0.
1-32	Address	DDD....	String	Address string for Destination Address: P: Phone Number is Hayes-compatible format. It can contain the digits 0-9 and the characters *, ! and #. Other characters (such as -) can be included, but are ignored.
Total: varies				

Example:

- Set Destination Address 0 as phone number 555-1234:

  >SDA0P0555-1234<

3.4 DATA LOG (DL)

The Data Log (DL) message requests, examines and erases data stored in the on-board data log. Writing to the log can also be suspended or resumed (W and Z commands). All commands (see Commands table, p. 35) except **W** and **Z** are used only with **Q**uery qualifier. The DL message can be issued over the air or via the DTE0 port.

Logged data includes:

- Event data, when Log routing is specified in the Event Definition (ED) message
- Text (TX) messages received from the DTE0 port, when Log routing is specified in the DTE0 Mode (MT) message
- DrIP response messages resulting from Event Actions, when Log routing is specified in the Event Definition (ED) message

The data string format and fields are described in the table below:

A[BBBBBB]

DATA LOG (DL) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
1	Command	A	A, B, C, E, L, R, S, T, W, Z	Executes one of the commands listed in the following table.
6	Data Length	BBBBBB	Hex value	Identifies length (number of bytes) of data recorded in Data Log. (Used only with **R, S,** and **E** commands.)
Total: 1 or 7 characters				

3.4.1

COMMANDS (VALUE OF A)	
Command	**Meaning**
A: Available	Returns the number of bytes of available data in logging memory.
C: Cancel	Cancel an active log retrieval request. Any messages generated from retrieved log data before issue of this command continue to be transmitted.
E: Erase	Erase data from memory without sending it. Data Length parameter is optional. If not specified, the entire log is erased.
L: Logged	Returns the number of bytes of logged data.
R: Retrieve	Requests data without erasing it from memory after transmission. Data Length parameter is required.
S: Retrieve & Erase	Requests data and erases it after transmission. Data Length parameter is required.
W: Resume	Resume all writes to Data Log.
Z: Suspend	Suspend all writes to Data Log.
T: Terminate	Terminates Data Log retrieval requests. This command is currently equivalent to Cancel.
B: Busy	Busy Response to Data Log retrieval request when a previous request is still in progress.

3.4.2 Data Length: When the **R** or **S** commands are used, the Data Length must be included as a command argument. (See the following Notes.) The Event Engine responds by transmitting complete messages from the binary data stored in the Data Log, starting with the oldest data, until the next message transmitted causes the total number of bytes retrieved to be greater than the value specified in the Data Length argument, or until no more data is available. After transmitting the data, a Data Log (DL) response message is sent to indicate the actual number of bytes retrieved. The **R** and **S** commands are ignored when the message has no Data Length argument.

The Data Length argument is optional for the **E** command. If the **E** command is used without a Data Length argument, the entire contents of the data logging memory are erased. If the Data Length argument is included, log entries are erased from the Data Log, starting with the oldest data, until the next entry to be erased causes the total number of erased bytes to be greater than the Data Length value.

Examples:

- To request the current Data Log space used:

  >QDLL<

The Event Engine responds by returning the number of logged bytes as a hexadecimal number. For example, the following response indicated the amount of logged data is 13562 bytes (0x34FA):

>RDLL0034FA<

- To request the current data Log space available:

  >QDLA<

The Event Engine responds by indicating the amount of available memory. For example, the following response indicates that 68,644 bytes (0x10C24) are available:

>RDLA010C24<

- To request up to 512 (0x200) bytes of data and erase the data:

  >QDLS000200<

Data is returned followed by >RDLS...<, indicating that 508 bytes have been transferred and erased from memory:

>REV01...<
>REV01...<
>REV01...<
>RDLS0001FC<

- To check the Data Log space now available (after sending the previous messages):

  >QDLA<

The Event Engine responds with the following message, indicating the presence of 68,136 bytes (0x32FE) available in the Data Log:

>RDLA010A28<

- To erase up to, but no more than, 832 bytes (0x340) of logged data:

  >QDLE000340<

The Event Engine responds with the following message:

  >RDLE00032F<

- To erase all logged data:

  >QDLE<

The Event Engine responds, indicating that 12,238 bytes (0x2FCF) of data was erased:

  >RDLE002FCF<

- To verify the status of data logging memory after sending the preceding commands:

  >QDLL<

The Event Engine responds with the following message:

  >RDLL0000000<

- To suspend writes to the Data Log:

  >SDLS<

- To check that Data Log writes are currently suspended:

  >QDLZ<

The Event Engine responds with the following message:

  >RDLSUSP=T<

- To cancel a log retrieval currently in progress:

  >QDLT<

The Event Engine responds with the following message, assuming 234 (hex) bytes have currently been retrieved:

  >RDLT000234<

3.5 EVENT DEFINITION (ED)

The Event Definition (ED) message defines events for the Event Engine. The Event trigger, Event Routing and optional Event action are specified. The data string format and fields are described in the table below:

AABCD;EEE{[EEE][F]}G[;ACT=HH...]

EVENT DEFINITION (ED) DATA STRING FORMAT				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Event ID	AA	00-49 or **	2-digit Event and Event Signal ID Range: 00-49 (or ** for wildcard Set/ Clear, as in >SED**U<)
1	Event Routing	B	N, A, L, X, Y, S, U	Event message routing: N: Normal--Route the event message to the specified Destination Address (DA) with normal handling. (See Notes.) A: Alarm--Route the event message to the specified DA with special alarm handling. (See Notes.) L: Data Log--Log the event message to Data Log. X: DTE0 Port--Output the event message to the DTE0 port. Y: DTE1 Port—Output the event message to the DTE1 port. S: Signal Only--Do not generate a message when event is triggered. An Event Action cannot be executed for Signal-Only events. U: Undefined--No event definition for this ID (event disabled).
1	Message ID	C	V, T, N	Event message generated when the trigger occurs: V: EV message T: ET message N: No event message

EVENT DEFINITION (ED) DATA STRING FORMAT				
Chars	**Item**	**Format**	**Value**	**Meaning**
1	Destination Address	D	0-9	The Destination Address field only applies when the Event Handling field is set to N or A. This is the destination address of the event message. The value of this field is the index of the desired Destination Address as defined by the DA message.
1	Logical Operator	F	& (AND) | (OR) ! (NOT)	Logical operator for expressing compound signals
1	Event Sense	G	+: positive transition -: negative transition *: both positive and negative transitions	Edge of signal (or compound signal) used to trigger event: + Trigger transitions True - Trigger transitions False * Trigger transitions either True or False
Varies	Event Action	HH...	message	A valid DrIP-formatted message without the opening (>) and closing (<) delimiters. Validity checks are: Q, R, S, F D qualifier DrIP message ID Length <50 characters Invalid event actions will be ignored.
Total: varies				

3.6 EVENT-BASED REPORTING

Event-based reporting is based on the concept of signals and events. The ED message uses a unique Event ID to identify each event. Up to 50 events (00-49) can be defined. An Event Signal (E00-E49) is also associated with each event.

Signals are internal variables representing the CDS9020 unit's internal states. EV Signal names are always three characters long. (See Signal Reference, p. 75.) Signals are either True (1) or False (0) and are periodically updated. The Signal Status (SS) message can be used to query for signal values.

The Event Definition (ED) message defines an event trigger by a simple signal name or by a combination of signals and logical operators that make up a compound signal. (See Event Trigger Syntax, p. 26.) The ED message also defines the Event Sense, for example, the rising and/or falling edge of the signal that triggers the event.

The ED message defines which type of event message, if any, is generated when the event is triggered: Short-Format Event (EV) or Time-Only Event (ET). The ED message Event Routing field specifies where the generated event message is sent (Communications channel, Data Log, DTE0 or DTE1).

To define Event ID 00 to generate and log a Short-Format Event (EV) message when the rising edge of the IP1 (discrete input 1) signal is detected:

>SED00LV0;IP1+<

To define Event ID 04 to generate and send to DA 0 a Time only Event (ET) alarm message when the rising edge of the FIX signal is detected:

>SED04AT0;FIX+<

To query for the definition of Event ID 00:

>QED00<

The Event Engine responds with:

>RED00LV0;IP1+<

To set Event ID 00 as undefined:

>SED00U<

Note: All event definitions can be undefined in a single command using the *wildcard* event ID (**). To undefine all event definitions, send >SED**U<.

3.7 EVENT TRIGGERS

All of the signals described in the Signals List, p. 75, are referred to as simple signals. Each simple signal can be used individually to trigger an event. Simple signals can be combined using the logical operators, listed in the table on p. 26, to define compound signals.

All events have an associated Event Signal. An Event Signal can indicate the status of a simple signal or it can represent the logical combination of several signals (compound signal).

To define Event ID 00 to send a Short-Format Event (EV) message to the log when the two simple signals XP1 and IP0 become True:

>SED00LV0;IP0XP1&+<

The previous message uses the combination of the IP0 and XP1 signals to trigger an event whenever Output Driver 1 (XP1) is active when Discrete Input 0 (IP0) becomes active. The combination of signal IDs and logical operators is specified in the description of Postfix notation below.

A maximum of 50 characters is allowed in the Trigger Signal(s)/Logical Operator fields of the ED message. It is the responsibility of the user to ensure that combinations of signals are meaningful. The event signal associated with an event can itself be used as a signal in another Event Definition. In the following examples, Event ID 00 is combined with a Time and Distance Reporting (TD) signal to trigger events with a minimum of 15 minutes between reports.

To define Event ED 00 to set Event Signal E00 to True when both simple signals IP0 and XP1 become True:

>SED00SV0;IP0XP1&+<

To define the TD1 (Time and Distance Reporting 1) signal to trigger every 15 minutes:

>STD1015M<

To define Event ID 01 to send a Short-Format Event (EV) message to the log when both signals E00 and TD1 become True:

>SED01LV0;E00TD1&+<

In the above examples, the Event Definition (ED) message for Event 00 has an Event Routing field specification of **S** for Signal-Only. The signal name for Event 00 is E00. When an event is only to be combined with other signals and not to generate an event message itself, the **S** Event Routing specification and the N Message ID are to be used to prevent an event message from being generated when the event triggers.

Only one Event Sense is used for an event definition, because only the states of the signals are used to evaluate the expression, not the transitions of the signals. The Event Sense field determines which transition(s) of the event signal trigger the event, for example, False to True (+), True to False (-) or both True and False transitions (*). Event triggers can reference any simple signal, regardless of whether the simple signal is defined or not. During the evaluation of a Compound signal, if an undefined signal is encountered, the value of that signal is assumed to be 0 (False). It is the responsibility of the user to ensure that the configured Compound signals make logical sense.

Since event signal states are evaluated in numerical order, compound signals must only reference other event signals of a lesser numeric value if signal states are to be consistent for each update cycle. For example, if Event 03 is based on Event 10, then Event 10 must be evaluated first. Otherwise, the state of Event 10 from the previous update cycle is used to evaluate Event 03. All references in Event 03 should be to simple signals or Signals E00-02.

Notes:

- The Trigger Signal(s)/Logical Operator string for compound signals is limited to 50 characters.
- Events are evaluated once per second and are triggered on transitions only, so a trigger must occur at less than a one-second rate to generate an event. For example, a TD signal defined with a two-second period makes the transition from True to False (and False to True) and generates a positive and a negative transition every other second. A one-second period does not generate periodic transitions, since the state is only evaluated 1/second, and always evaluates True. To use a TD signal to trigger every second, the period should be set to 2 seconds and the Event Sense to ANY (*).

3.8 POSTFIX NOTATION

The Trigger Signal(s)/Logical Operator string for compound signals is specified in postfix evaluation order. Postfix notation requires no parentheses to ensure a discrete order of precedence of evaluation of operators. The logical operators & and | always operate on the last two elements. The ! operator always operates on the last element. Some examples are shown below.

The string A & B | C & D could be evaluated many different ways depending on which operator takes precedence. Parentheses are used in the next two examples to show the evaluation order.

Example 1: If the AND operator takes precedence, the evaluation is: ((A & B) | (C & D))
Example 2: If the OR operator takes precedence, the evaluation is: (A & (B | C) & D)

With the addition of parentheses, the expression would always be evaluated correctly. The postfix notation requires no parentheses for the evaluation to be completed correctly. If the first example (where AND takes precedence) is converted to postfix, the expression becomes A B & C D & | . There is no other way for this expression to be evaluated except for the equivalent of example 1. The second example would be converted into the postfix expression A B C | D & . This expression could not be evaluated any other way except for the equivalent of Example 2.

3.9 EVENT ACTIONS

An optional Event Action can be specified with each event definition. This is a DrIP-formatted message that is executed when the event is triggered. For example, the occurrence of an event could activate a digital output signal using the Signal Status (SS) message with the Set qualifier (for example, SSSXP01). When a query message is specified as an Event Action, the response message is routed according to the Event Handling specified in the Event Definition (ED) message.

For example, a Position/Velocity (PV) message can be logged when an event is triggered if the Event Handling is **L** and QPV is the Event Action. If the Event Handling is set to Signal-Only (**S**), an Event Action cannot be executed. (For Action-only events, the event message can be suppressed via the Message ID field.)

Note: Event action strings are limited to 50 characters or fewer. Only the DrIP qualifier, message ID and length are validated when the event is defined. It is the user's responsibility to verify that the syntax of the action message is valid.

3.10 EVENT REPORT (ET) - TIME-ONLY FORMAT

The Time-Only Event Report (ET) message is generated when an event is triggered and ET is specified in the Event Definition. (See ED message, p. 38.) The ET message is also issued in response to query (>QET<), in which case the Event ID is reported as ##. The data string format and fields are described in the table below.

AABBBBCDDDDD

TIME-ONLY EVENT REPORT (ET) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Event ID	AA	00-49 or ##	2-digit Event ID assigned to event, or ## for Response to Query
4	Week number	BBBB	Weeks	Number of weeks since 0:00 a.m. UTC, Jan. 6, 1980
1	Day of week	C	Day (0-6)	Day of week, where 0 = Sunday
5	Event Time	DDDDD	Seconds into day	Reports the Event Occurrence time, in UTC
Total: 12 characters				

Notes:

- Although GPS Week in the GPS satellite downlink is restricted to range 0-1023, the GPS Week reported in Event messages is adjusted to extend beyond 1023. Therefore, GPS Week Number Rollover (WNRO) is not an issue in Event messages.

- If time is not available, the week, day and Event Time fields are all reported as 0.

3.11 EVENT MESSAGE (EV) - SHORT FORMAT

The Short-Format Event (EV) message is generated when a simple or compound signal triggers an event and EV is specified in the Event Definition. (See ED message, p. 38.) The EV message is also issued in response to query (>QEV<), in which case the Event ID is reported as ##. The data string format and fields are described in the table below.

AABBBBCDDDDDEEEFFFFFGGGGHHHHHIIIJJJKL

SHORT-FORMAT EVENT MESSAGE (EV) DATA STRING FIELDS

Chars	Item	Format	Value	Meaning
2	Event ID	AA	00-49	2-digit Event ID assigned to event, or ## for Response to Query.
4	Week Number	BBBB	Weeks	Number of weeks since 0:00 a.m., Jan. 6, 1980.
1	Day of Week	C	Day (0-6)	Day of week, where 0=Sunday.
5	GPS Time or Event Time	DDDDD	Seconds into day	Reports the UTC time of the last GPS position fix is reported, and Age of Data Indicator field reports 1 or 2.
8	Latitude	EEE.FFFFF	Degrees	WGS-84 Latitude coordinate (positive = north).
9	Longitude	GGGG. HHHHH	Degrees	WGS-84 Longitude coordinate (positive = east).
3	Speed	III	mph	Horizontal speed of vehicle, in miles per hour.
3	Heading	JJJ	Degrees	Heading, in degrees from True North, increasing eastwardly.
1	Data Source	K		Data source for last position. 0: 2D GPS (3 satellites) 1: 3D GPS (4+ satellites)

SHORT-FORMAT EVENT MESSAGE (EV) DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
1	Age of Data Indicator	L	Flag	Age of data used to compute position and source of Event Time: 0: Not available 1: Old, ≥10 seconds. Event Time is GPS time of fix. 2: Fresh,< 10 seconds. Event Time is GPS time of fix.
Total: 37 characters				

Notes:

- The date in this message is invalid and should not be used if the Age of Data Indicator field is equal to 0, signifying data not available.

- Although GPS Week in the GPS satellite downlink is restricted to range 0-1023, the GPS Week reported in Event messages is adjusted to extend beyond 1023. Therefore, Week Number Rollover (WNRO) is not an issue in Event messages.

3.12 COUNTER / TIMER / DISTANCER (GC)

The Counter/Timer/Distancer (GC) message configures and manipulates internal counters used to trigger events. Each counter can be configured as a user-controlled Counter, a Timer (counter updated by elapsed time) or a Distancer (counter updated by distance traveled). Counters can have a maximum value of 99999. The effective maximum can be extended by specifying a delta value. For example, the counter is incremented by one for every delta count. The data string format and fields are described in the table below.

AAB[[C][DDDDD[EEEEE[FFFFF]]]

3.12.1

COUNTER/TIMER/DISTANCER (GC) MESSAGE DATA STRING FIELD				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Counter ID	AA	00-99	Identification code assigned to the Counter. Range: 00-09. Each counter is associated with a counter signal (CAA) that can be used to trigger events. The counter signal becomes active when the specified threshold value is reached.
1	Command	B	C, T, D, S, R, I, V, U	A counter can be configured in one or three modes using the Counter (**C**), Timer (**T**) or Distancer (**D**) command. See following table for other values.
1	Recycle Flag	C	R, C, X	Action performed when the counter threshold is reached: R: Recycle counter (set to zero) C: Continue counter X: Use existing or default Recycle flag Note: This field is optional when setting or incrementing a counter value. For example, both >SGC00V01234< and >SGC00VX01234< are valid and equivalent; also >SGC00I00012< and >SGC00IX00012< are valid and equivalent.
5	Threshold or Counter Value	DDDDD	0-99999	Threshold or counter increment when used with the **I** command or set with the **V** command.
5	Delta Value	EEEEE	0-99999	Delta Increment value for Counter modes. For Timers, the counter value is incremented by 1 for every Delta elapsed seconds. For Distancers, the Counter value is incremented by 1 for every Delta accumulated meters traveled.
1-5	Preserve Value Flag	FFFFF	0-99999 or X	If X is present in this field when defining a Counter/Timer/Distancer (**C**, **T**, **D** command) and the counter is already defined, the existing counter value is preserved. (If counter is not already defined, it is set to 0.)
Total: varies				

3.12.2

COMMAND (VALUE OF B)	
Value	**Meaning**
C	**Counter**, threshold = DDDDD. The C command configures the counter is Counter mode, where counter value changes only by specific command, that is, the Increment (**I**) or Value (**V**) command.
T	**Timer**, threshold = DDDDD, time increment = 1 or EEEEE seconds. The T command configures and starts a Timer counter, where the counter value is incremented automatically according to the unit's Real-time Clock. The counter is incremented every N seconds, where N is the increment value (EEEEE) in the Timer (**T**) command or 1 (default when EEEEE is omitted).
D	**Distancer**, threshold = DDDDD; distance increment = 1 or EEEEE meters. The D command configures and starts a Distancer counter, where the counter value is incremented automatically according to distance traveled. The counter is incremented every N meters traveled, where N is the increment value (EEEEE) in the Distancer (**D**) command or 1 (default when EEEEE is omitted).
S	**Suspend** counter--If the command character is **S** for suspend, counter update and signal update are suspended. However, counter value can be explicitly changed via the **I** or **V** command while the counter is suspended; in this case potential change to signal value does not occur until the counter is Resumed.
R	**Resume** counter--If counted is suspended and the **R** (resume) command is sent, counter update resumes and the counter value picks up where it was when suspended. A new basis is established when the counter is resumed, so if a Timer is suspended for two minutes, the two minutes are not included in the Timer value. For example, a suspended counter does not *catch up* when resumed.
I	**Increment** counter by 1 or DDDDD (Counter mode only).
V	**Value** of counter -- set counter to DDDDD. This command can also be used with a query to retrieve the current counter value.
U	**Undefine** / Disable counter -- If the command character is U, the counter and associated counter signal are disabled. (Counter signal is set to False.) All counters may be disabled by the command >SGC**U<.

Examples:

- Set Counter 0 with threshold of 9,999 and initial value of 0, then let the counter continue to run after reaching threshold:

  >SGC00CC09999<

- Set Counter 0 to 1234:

  >SGC00VX01234<

- Retrieve the value of Counter 0:

  >QGC00V<

  The CDS9020 responds with this message:

  >RGC00V01234<

- Increment Counter 0 by 1:

  >SGC00I<

  The CDS9020 responds with this message:

  >RGC00V012355<

- Start Timer Counter 7 to count elapsed hours and activate Counter signal C07 every 8 hours (threshold = 8, delta = 1 hour):

  >SGC07TR0000803600<

- Start Distance Counter to count accumulated miles and activate Counter signal C05 every 100 miles (threshold = 100, delta = 1 mile [1609 meters]):

  >SGC05DR0010001609<

3.13 HEADING WINDOW (GH)

The Heading Window (GH) message defines Heading Windows that can trigger events. A Heading Window is defined by the heading sweep, in a clockwise direction, from the start heading to the end heading.

The associated heading signal becomes active when the vehicle's heading is in the range (including end points) specified by the heading window. To change from inside-to-outside or outside-to-inside, the heading must be in the new state for three seconds for the transition to be detected.
If the Heading Window is already defined, the existing Heading Window parameters are changed to those in the message.

The data string format and fields are described in the following table.

AABCCCDDD

Caution: The Event Engine maintains the current vehicle heading when the vehicle is stopped. For example, the heading is not updated when the vehicle speed slows below the stationary threshold (2.77 mph).

HEADING WINDOW (GH) MESSAGE DATA STRING FIELDS

Chars	Item	Format	Value	Meaning
2	Heading Window ID	AA	Index	Identification code assigned to Heading Window. Range: 00-50.
1	Active Flag	B	1, U	Determines whether the Heading Window is enabled or disabled: U: Inactive--the Heading Window and associated signal are disabled. All Heading Windows may be disabled by sending >SGH**U<. 1: Active
3	Start Heading	CCC	0-359°	Start-of-window heading in degrees.
3	End Heading	DDD	0-359°	End-of-window heading in degrees.
Total: 9 characters				

Examples:

- Define a Heading Window to activate a heading signal when the vehicle is traveling southerly (heading in range 175-185):

  >SGH02175185<

- Query for configuration of Heading Window 2:

  >QGH02<
  >RGH021175185<

- Disable Heading Window 2:

  >SGH02U<

- Clear all Heading Window configurations:

  >SGH**U<

3.14 REGION (GR)

The Region (GR) message defines the size, shape and location of regions that can trigger events. A region may be defined as a circular or rectangular area. The associated region signal becomes *active* when the unit enters the defined region. To change from *inside-to-outside* or *outside-to-inside*, the unit must be in the new state for three seconds for the transition to be detected. If Region ID is already defined, the existing region's parameters are changed to those in the message.

The command is ignored when attempting to set parameters to invalid values. The following parameter validity checks are made:

- Latitude or Longitude or Extent 1 or 2 missing
- Latitude <-90° or >+90°
- Longitude <-180° or >+180°
- Extent 1>0

Although it is possible to define regions smaller than 100 meters across, the inherent inaccuracies of GPS, coupled with the spatial hysteresis applied, may prevent accurate detection of regions smaller than 100 meters.

The data string format and fields are described in the following table.

AABCCCCCCCDDDDDDDDEEEEEEEFFFFFF

REGION (GR) MESSAGE DATA STRING FIELD				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Region ID	AA	Index	Identification code assigned to region definition. Range: 00-50.
1	Active Flag	B	1, U	Determines whether the Region is enabled or disabled: 1: Active U: Inactive--The region and associated signal are disabled. All regions may be disabled by sending >SGR**U<.
7	Origin Latitude	CCC.CCCC	Degrees	Latitude at region origin, in degrees. This is the center of a circular region or the southwestern corner of a rectangular region.

REGION (GR) MESSAGE DATA STRING FIELD				
8	Origin Longitude	DDDD.DDDD	Degrees	Longitude at region origin in degrees. This is the center of a circular region or the southwestern corner of a rectangular region.
6	Extent-1	EEEEEE	1-999999 meters	Extent-1 and Extent-2 define the shape and size of the region. If Extent-2 is 0, then Extent-1 is the radius of a circular region centered at Origin (Lat., Lon.). If Extent-2 is non-0, it is the north-south extent of a rectangular region whose southwest (lower-left) corner is at Origin (Lat., Lon.) and whose east-west extent is determined by Extent-1.
6	Extent-2	FFFFFF	0, 1-999999 meters	See Extent-1 above.
Total: 30 characters				

3.15 DYNAMIC REGIONS

The Origin Latitude and Origin Longitude are set to the current vehicle position if the CCCCCCCDDDDDDDD field is “CURRENTLOCATION”. If a valid position is not available when the command is entered, the region definition takes effect the position is set to 0. The Extent-1 and Extent-2 are entered in the same manner as when an absolute origin is specified; however, if a rectangular region is specified, the origin is at the center rather than the lower left corner of the rectangle.

Examples:

- Assuming that the CDS9020 unit has a valid position fix, define Region 34 as a circular region with radius 1234 meters, centered at the current position:

  >SGR341CURRENTLOCATION001234000000<

- Define Region 02 as a rectangular region with north-south dimension 400 meters and east-west dimension 1200 meters, and southwest corner at 37.3924 N, 122.0378 W:

  >SGR021+373924-1220378001200000400<

3.16 SPEED LIMIT (GS)

The Speed Limit (GS) message configures the speed limits that can be used to trigger events. The associated speed signal becomes *active* when the speed measured by the sensor exceeds the Speed Limit. To change from *under-limit* to *over-limit* or *over-limit* to *under-limit*, the CDS9020 unit must be in the new state for three seconds for the transition to be detected. If the Speed Limit ID has already been defined, the existing parameters are changed to those in the message.

The data string format and data string fields are described in the table below.

AABCCCC

SPEED LIMIT (GS) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Speed Limit ID	AA	Index	Identification code assigned to speed limit. Range: 00-50.
1	Active Flag	B	1, U	Determines whether speed limit is enabled or disabled: 1: Active U: Inactive - the speed limit and associated signal are disabled. All speed limits may be disabled by sending >SGS**U<.
4	Speed Limit	CCCCC	0-9999	Speed limit, in miles per hour times 10.
Total: 7 characters				

Examples:

- Set Speed Signal 1 to become active when vehicle speed exceeds 65 mph:

  >SGS0110650<

- Configure an event to trigger when the vehicle speed does not exceed 25 mph and digital input 0 is activated:

  >SGS0210250<
  >SED02NV0;S02!IP0&+<

The NOT (!) operator reverses the sense of the S02 signal, that is, S02! is True when the speed limit is *not* exceeded.

3.17 TIME WINDOW (GT)

The Time Window (GT) message configures the Time Windows that can be used to trigger events. The signal associated with a Time Window becomes *active* when the time-of-day is the same or later that TMin and is before or the same as TMax. The year is specified first, as in 01/04/23 (April 23, 2001). Times are specified in UTC.

The data string format and data string fields are described in the following table.

AABCCCCCCDDDDDDEEEEEEFFFFFF

TIME WINDOW (GT) MESSAGE DATA STRING FIELDS

Chars	Item	Format	Value	Meaning
2	Time Window ID	AA	Index	Identification number assigned to time window. Range: 00-50.
1	Active Flag	B	1,U	Determines whether time window is enabled or disabled: 1: Enable U: Disabled, the time window and associated signal are disabled. All time windows may be disabled by sending >SGT**U<.
6	TMin (Day)	CC/CC/CC	yy/mm/dd	Date at beginning of time window.
6	TMin (Time)	DD:DD:DD	hh:mm:ss	Time at beginning of time window.
6	TMax (Day)	EE/EE/EE	yy/mm/dd	Date at end of time window.
6	TMax (Time)	FF:FF:FF	hh:mm:ss	Time at end of time window.
Total: 27 characters				

3.17.1 Absolute Mode:

If both day and time are specified (TMin[Day] and Tmax[Day] are non-0), the window is an absolute (one-time) window. In this mode, TMax must be greater than TMin.

3.17.2 Periodic Mode:

If day is not specified (TMin[Day] and TMax[Day] are both 000000), TMin[Time] and TMax[Time] specify a periodic window. The day is taken to be the current date, and the window is evaluated each day. If TMax[Time]<TMin[Time], then the date on TMax is assumed to be the *next* day, as the time window spans midnight.

Note:
Although UTC time is used to define and evaluate time windows, the event message (EV or EL) used to report time window signal transitions may report time as time of GPS position fix. If the position fix is not current, the time may not match the actual time window transition.

Examples:

- Set Time window 15 to become active from 6:00 p.m./ UTC, January 2, 2001, and 6:00 a.m. UTC, January 3, 2000:

  >SGT152001102180000990103060000<

- Set Time Window 4 to become active every day from 8:15 a.m. to 5:30 p.m.:

  >SGT410000000815000000000173000<

3.18 IDENTIFICATION NUMBER (ID)

The Identification Number (ID) message reports or sets the unit's unique user-assigned ID. The Data String format and data string fields are described in the following table.

AAAA

IDENTIFICATION NUMBER (ID) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
4-8	Unit ID	AAAA	Alphanumeric String	Unique user-defined identification code assigned to each unit. Characters must be decimal digits or upper/lower case letters. The factory default is no SID enabled.
Total: 4-8 characters				

Examples:

- Set the unit ID to 101:

  >SID101<

- Query for unit ID

  >QID<

  Response is:

  >RID0101;ID=101<

Note: If the SID is set to blank, no SID field is sent in R messages.

3.19 POSITION / VELOCITY SOLUTION (PV)

The Position/Velocity Solution (PV) message reports the vehicle's current position, velocity, heading, source of position information and the age of the data.

The data string format and fields are described in the table below.

AAAAABBBCCCCCDDDDEEEEEFFFGGGHI

POSITION/VELOCITY SOLUTION (PV) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
5	UCT Time of Day	AAAAA	Seconds	Time of fix rounded to the nearest second.
8	Latitude	BBB.CCCCC	Degrees	WGS-84 Latitude coordinate (positive = north).
9	Longitude	DDDD.EEEEE	Degrees	WGS-84 Longitude coordinate (positive = east).
3	Speed	FFF	m. p. h.	Vehicle speed.
3	Heading	GGG	Degrees	Vehicle heading, in degrees from True North, increasing eastwardly.
1	Data Source	H		Data Source for last position/velocity solution. 0: 2D GPS (3 satellites) 1: 3D GPS (4+ satellites)
1	Age of Data Indicator	I	Flag	Age of data used to compute last position/velocity solution: 0: Not available (message data is invalid) 1: Old, >10 seconds 2: Fresh, $\leq$ seconds
Total: 30 characters				

3.20 PASSWORD (PW)

The Password (PW) message sets and verifies the password that controls DrIP access via the Communications Channel and the DTE0 or DTE1 Channels.

The data string format and fields are described below.

{A}[;{B}]

PASSWORD (PW) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
0-16	Current Password	AAA....	String	Current password.
1-16	New Password	BBB....	String	New password or END_SESSION.
Total: varies				

Valid passwords may be composed of any ASCII text characters except ;, ?, >, < and the string END_SESSION. None may be any longer than 16 characters and all are case sensitive. When the password is set with the **S** qualifier, both the current password and the new password arguments are required. When the password is required for an over-the-air session, the **Q** qualifier is used with the current password and the second argument is omitted.

When the password is defined, the CDS9020 expects to see a >QPWpassword< message to initiate a password-protected session for each channel. If the password is not sent or is invalid, an >RPW?< message is returned. The valid password only needs to be sent once (via >QPWpassword<) at the start of a data session, and the CDS9020 refuses to respond to any other messages until the valid password is sent.

A password-protected session for a CDMA communications channel starts when a valid >QPWpassword< message is received and ends when the connection is terminated. A password-protected session for the DTE0 channel starts when the >QPWpassword< message is sent and ends when the DTE0 input activity timeout occurs.

Examples:

- Set the password for a new unit (assuming no password has been set) to My_Password:

  >SPW;My_Password<

  The unit responds with:

  >RPWMy_Password<

- Password-protected sequence:

  >QPV<

  The unit responds with:

  >RPW?< requesting password

- Send the password to enable the password-protected session:

  >QPWMy_Password<

  The unit responds with:

  >RPWMy_Password<

  to acknowledge the password.

A password-protected session can then take place, ending when a connection is terminated (CDMA communications channel) or when the DTE0 inactivity timeout expires (DTE0 channel) or when explicitly terminated via >SPW;END_SESSION<.

- To change the current password:

  >SPWMy_Password;new_password<

Note: The default condition is NO password. When the password is set to blank, no password is enabled. The password must be set using the PW message before use.

3.21 SIGNAL STATUS (SS)

The Signal Status (SS) message allows for the inspection of all Event Engine signal states and the setting of certain signals. The current value of any supported signal can be queried via the >QSSAAA< message, where AAA is the signal name. The **S** qualifier is supported for discrete outputs and User signals only.

The data string format and fields are described in the following table.

AAA[B[C]]

SIGNAL STATUS (SS) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
3	Signal ID	AAA	Char string	The 3-character identifier (including wildcards--see the following Notes) of the signal. (See Signals list, Section 4)
1	Signal Status	B	0 or 1	Status for the specified signal is either 0 (False) or 1 (True) and is updated periodically by the Event Engine. A digital input is recognized as 1 when connected to ground for at least the debounce time of 32 MS.
Total: 5 characters				

Examples:

- Query for the state of discrete input 2:

  >QSSIP2<

  The unit responds with:

  >RSSIP200<

- Set User 3 Signal to 1:

  >SSSU0311<

Notes:

- The **Q** qualifier may be used to inspect the state of any signal output. The signal or input name must be supplied. (For example >QSSIP0<.)

- The **S** qualifier may be used to set discrete outputs and User Signals only.

3.22 TIME AND DISTANCE REPORTING (TD)

The Time and Distance Reporting (TD) message sets or queries for the time and distance reporting (TDR) parameters that are associated with Event Engine TD signals (TD0-TD9). TDR parameters can be set to configure several TDR modes: Time Reporting, Time and Distance Reporting and Time-Staggered Reporting. (See Time and Distance Reporting in the DrIP Overview, p. 9, for a description of TDR mode configuration and operation.)

The data string format and fields are described in the table below.

A[A]BBBB[CCCCDDDDEEEE]

TIME/DISTANCE REPORTING (TD) MESSAGE DATA STRING FIELDS

Chars	Item	Format	Value	Meaning
1 or 2	TDR Index or DrIP Message ID	A or AA	0-9,*, or 2-character message ID	TD signal index number. DrIP message ID is used for query/ response only.
4	Minimum Time between reports or Report Interval	BBBB	Seconds	For Time Reporting mode, this is the report interval between TD signal triggers. Other parameters should be set to 0. For Time and Distance Reporting mode, this is the minimum time between TD Signal triggers. Setting this time to zero disables the TD signal.
4	Epoch/offset for staggered reports	CCCC	Seconds	Offset from reference time (00:00:00 Sunday, UTC) for Time-Staggered Reporting mode.
4	Distance traveled threshold	DDDD	Meters	Threshold for accumulated distance traveled (meters) between reports. For Time and Distance Reporting mode, the TD signal triggers when this distance has accumulated or the Maximum Time has elapsed since last report.
4	Maximum Time between reports	EEEE	Seconds	For Time and Distance Reporting mode, the TD signal triggers when this time elapses or the Distance Traveled threshold is reached since last report.
Total: 17 or 18 characters				

Examples:

Set up Event 01 to report an event based on the TD3 signal.

- To set Time and Distance Signal 3 (TD3) to trigger when the unit has traveled 3 km or 30 minutes has elapsed:

  >STD309000000003K030m<

  TD3 triggers no more often than every 90 seconds. Note: To enable time reporting, only the BBBB Report Interval parameter is required, and this may be specified as one, two or three characters, with or without scaling. For example, >STD45< sets TD4 to trigger every 5 seconds, while >STD41m< sets TD4 to trigger every minute.

- To define Event 01 to be triggered on the rising edge of the TD3 signal:

  >SED01AV0;TD3+<

  Now when the rising edge of the TD3 signal triggers the event, an EV message is generated and queued as an alarm to Destination Address 0.

- To set the TD3 signal to trigger the every 15 minutes:

  >STD3015m<

  An EV message is generated each time the TD3 signal triggers the event.

- Configure TD signal 7 to trigger at 10-minute intervals, offset by 5 minutes from the start of the week, but only if 16 kilometers has been traveled since the last report:

  >STD701m005m016k<

- Configure TD signal 3 to trigger when 90 seconds or 8500 meters has been exceeded since the last report, but make report times regulated at 60 seconds between reports and offset 5 minutes from the start of the week:

  >STD30060005m85000090<

See also TDR description in DrIP overview, and ED Event Definition message.

Notes:

- Scale Factors may be used with all time and distance parameters. For example, 60 seconds can be entered as 001m (1 minute), 2 hours can be entered as 002h, 1000 meters can be entered as 001k. (See DrIP Overview, Scale Factors.)

- TD signals can trigger at a maximum rate of once every two seconds. For example, the TD signal must be True for one Event Engine cycle (one second) and False for at least one cycle.
- All TD signals can be disabled by the following command: >STD*0<.

- The TD message may be used to query for current TDR parameters set by the **F** and **D** qualifiers. The format is >QTDXX[;PORT=N]<, where XX is the DrIP message ID and N is an optional port ID (0 for Communications Channel, 1 for the DTE0 port, 2 for the DTE1 port). For example, if TDR is set to report the PV message every 30 seconds to the DTE0 port,

  >QTDPV;PORT=1<

  results in this response:

  >RTDPV0030000000000000<.

3.23 TIME / DATE (TM)

The Time/Date (TM) message outputs the time and date as computed by the GPS receiver. The time is most accurate when the unit is calculating GPS positions. It is less accurate but still usable when the unit is not doing fixes.

The data string format and fields are described in the table below.

AABBCCDDDEEFFGGGGHHIJJKLLLLL

TIME/DATE (TM) MESSAGE DATA STRING FIELD				
Chars	**Item**	**Format**	**Value**	**Meaning**
2	Hours	AA	Hour	Hour of UTC Time of Day.
2	Minutes	BB	Minutes	Minutes of UTC Time of Day.
5	Seconds	CC.DD	Seconds	Seconds of UTC Time of Day.
2	Day	EE	Day	Date of UTC Time of Day.
2	Month	FF	Month	Month of UTC Time of Day.
4	Year	GGGG	Year	Year of UTC Time of Day.
2	GPS/UTC Time Offset	HH	Seconds	Difference between GPS and UTC time in seconds.
1	Data Source	I		Data source for last position fix. 0: 2D GPS (3 satellites) 1: 3D GPS (4+ satellites)
2	Number of Usable SVs	JJ	04	Number of usable satellites.
1	GPS/UTC Offset Flag	K	1	UTC Time of Day is only valid if the GPS/UTC Offset Valid Flag is set to Valid: 0: Invalid 1: Valid
5	Reserved	LLLLL	00000	Reserved for future use.
Total: 28 characters				

3.24 TEXT MESSAGE (TX)

The Text (TX) message transfers plain-text messages between the DTE0 port and a base station. Normally, messages are received via the Communications Channel are transferred to the DTE0 port, and messages input at the DTE0 port are sent over the Communications Channel. Routing exceptions are:

- TX message used as an Event Action is routed to the channel specified in the routing field of the Event Definition message. If L is specified as event routing, the TX message is routed to the Data Log.
- A TX message that is sent as other than an Event Action may use the PORT=P suffix to specify the message destination.

The **S** qualifier is used to send a text message.
The data string format and fields are described in the following Table.

[A. . . .][;PORT=P]

3.24.1

TEXT (TX) MESSAGE DATA STRING FIELDS

Chars	Item	Format	Value	Meaning
1-110	Text String	{A}	String	The data string format is free-field. It may contain any printable character (including blanks) except **;**, < and >. These characters, and other non-printing characters, may be "escaped" using the character sequences described in the table below.
		P		Port/Channel ID or scheduled outputs: 0 for Communications channel 1 for DTE0 port 2 for DTE1port 3 for RAM buffer

3.24.2

CHARACTER SEQUENCES	
Sequence	**Meaning**
\a	0x07 (alert)
\b	0x08 (backspace)
\e	0x1B (escape)
\f	0x0C (form feed)
\n	0x0A (linefeed)
\\	0x5C (\)
\t	0x09 (tab
\r	0x0D (carriage return)
\s	0x3B (;)
\y	0x3E (>)
\z	0x3C (<)
\XX	Character sequence\XX, where XX is a two-digit hex constant, represents any character, printable or not.

Examples:

- >STX\e[2J< Clears a remote ANSI terminal display.
- >STXHello World< blanks and lower case allowed.

3.25 VERSION NUMBER (VR)

The Version Number (VR) message identifies the product and version of the CDS9020 unit's embedded firmware. The length of the message varies depending on the length of the Version string.

The data string format and fields are described in the table below.

{A};{B}

VERSION NUMBER (VR) MESSAGE DATA STRING FIELDS				
Chars	**Item**	**Format**	**Value**	**Meaning**
n	Product Name	{A}	String	Product description.
A/2	Version	B.BB...		Firmware version.
Total characters: 3 + length of product name				

The DrIP Version Number identifies the version of DrIP supported by the embedded firmware.

Example:
Query a CDS9020 unit for version data:

>QVR<

Response:

>RVRDatraremote DrIP protocol, Version 1.0C 05/31/01<

SECTION 4.0
SIGNAL REFERENCE

3.26 SIGNAL REFERENCE

Signals are used to trigger Event Engine events. Signals are identified by a three-character ID and have a value of either True or False. (See the **ED** DrIP message for the event definition trigger syntax.)

To check the state of any signal, use the **SS** DrIP message to query its value. For example:

>QSSFIX<

indicates whether the FIX signal is true or false.

The Event Engine signals are described in the table below.

EVENT ENGINE SIGNAL		
ID	**Signal**	**Description**
C00-C09	Counters, Timers Distancers	True when the corresponding counter reaches its defined threshold value. (See the GC DrIP message.)
COM	Communications Available	True when a communications link with a base cellular service is available.
CON	Communications Connection Open	True when a communications data call is in progress.
DLA	Data Log Available	True when at least 20% of the data log space is available (less than 80% full).
DTE	Select the active DTE port for serial communications	0 = DTE0 for "non-DrIP" comm's 1 = DTE1 for "non-DrIP" comm's NOTE: This flag bit resets to DTE0 when system power is cycled.
E00-E49	Event Triggers	True when the corresponding event trigger is True. (See the ED DrIP message.)
FFX	First Fix	True when the first position fix is established after the unit is powered up (including Power Management wake from sleep mode); remains true until powered down.

EVENT ENGINE SIGNAL		
ID	**Signal**	**Description**
H00-H49	Heading Windows	True when the vehicle's heading is within the corresponding heading window. (See the GH DrIP message.)
IGN	Ignition	True when the ignition sense (IP0) is on.
IP0-IP5	Input #0-5	True when the corresponding discrete input is on. (Note: IP0 is the ignition input.)
PWC	IGN system power control	0 = no IGN system power control. 1 = System power on for IGN true.
R00-R49	Regions	True when the position is within the corresponding region definition. (See the GR DrIP message.)
S00-S19	Speed Thresholds	True when the vehicle's speed is faster than the corresponding speed threshold. (See the GS DrIP message.)
T00-T49	Time Windows	True when the time and date are within the corresponding time window. (See the TD DrIP message.)
TD0-TD9	Time-Distance Schedules	True when the time and date are within the corresponding time window. (See the TD DrIP message.)
U00-U09	User Flags	These signals can be set true or false at any time. This may be useful for writing a complex series of events.
XP0-XP5	Outputs #0-5	True when the corresponding output is on. (See the SS DrIP message to set outputs.)