TN-856-AN TM8000 Conventional Direct Connect GPS

TN-856-AN
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This application note provides an introduction to the Direct Connect GPS feature that can be provided by Tait with the TM8000 series of conventional mobiles.

This application note is intended for System Integrators who intend to develop an AVL system using the direct connect capabilities of the TM8000.

The examples used within this document reference the TM8100 series of mobile radios. Most of the examples, however, also apply to the high-tier TM8200 mobile operating in conventional mode.

1 Overview

The TM8000 series of radios have, as standard, inbuilt AVL (Automatic Vehicle Location) functionality.

This allows a remote radio to be "polled" for longitude, latitude and speed. This information is derived from an attached GPS receiver, and compressed to reduce the amount of time taken to relay the information back to the base radio.

A base radio will either send out a poll request to a remote radio or the remote radio will report back to the base radio when the PTT (Press To Talk) is pressed, or an emergency or alarm line is triggered, depending on radio programming.

Short data messages (SDMs) are used to relay the poll request and responses.

These SDMs conform to the CCDI standard (Computer Controlled Data Interface, Tait Electronics Ltd proprietary data interface), and are transferred using the TM8000's 1200-baud internal modem.

A useful application for this feature is AVL, where a base PC application polls remote radios for their position and speed.

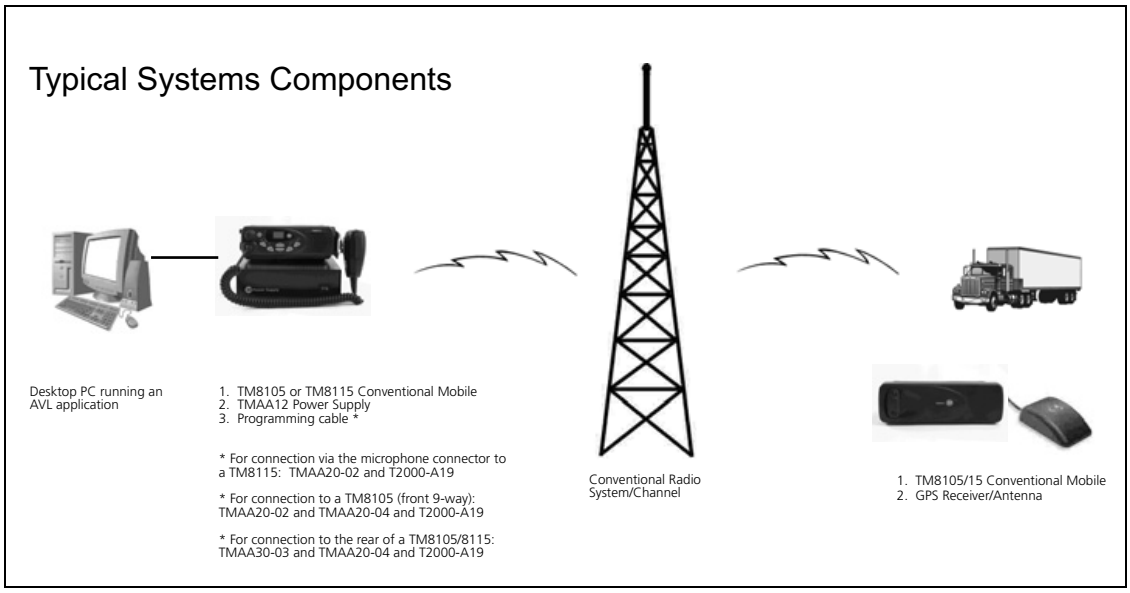
Glossary

AVL	Automatic Vehicle Location
CCDI	Computer Controlled Data Interface
GPS	Global Positioning System
NMEA	National Marine Electronics Association
RMC	Recommended Minimum (specific GPS/transit data)
SDM	Short Data Message
UTC	Universal Time Code

2 System Overview

A typical AVL system comprises:

- A GPS receiver, connected to the remote radio
- A remote TM8000 radio optionally fitted with either a TMAA01-01 or TMAA01-02 options board to connect the GPS receiver to the radio
- A base TM8000 radio at the central control. It is recommended that a TMAA01-02 RS232 options board is used to connect the radio to the PC.
- A central control personal computer (PC) running an AVL application, connected to the base radio via a serial lead



3 Sequence of Events for a Poll Request

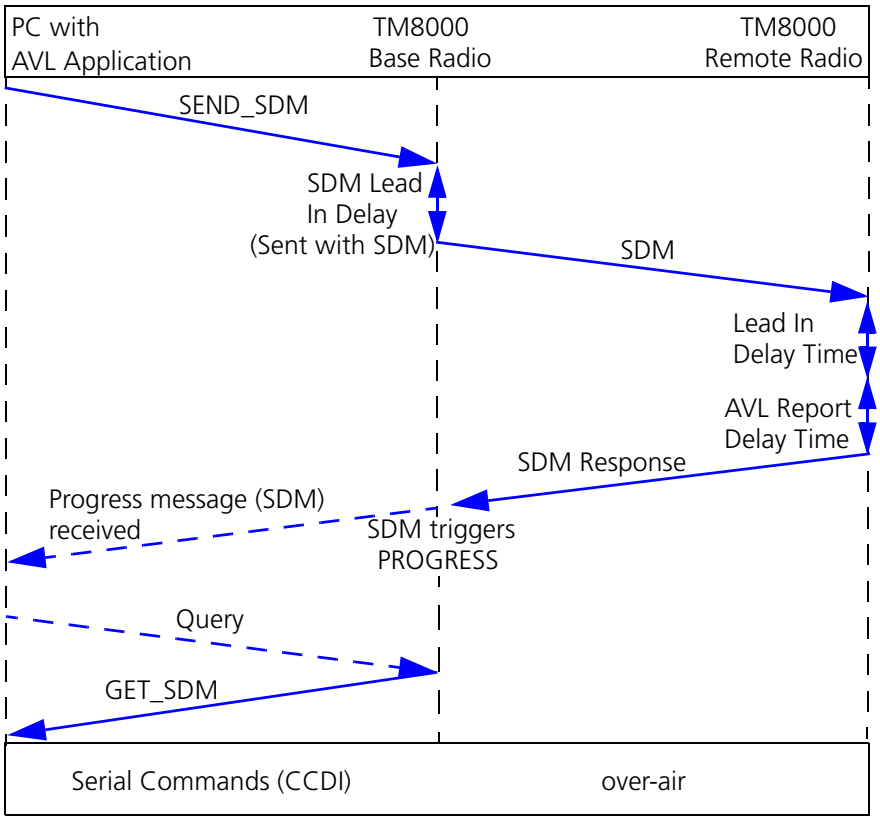
A poll request is sent serially from the AVL application to the base radio, using a "send SDM" CCDI command. The poll request can either specify that the poll response be sent to the default address (as defined in the remote radio's database) or to a specific radio address which is appended to the poll request.

Most often, a poll request that sends the poll response back to a default AVL dispatcher address is used.

The base radio will then process the SDM request and attempt to send an SDM over the air to the specified radio.

If the poll request was successful, the remote radio will then send an SDM back to the base radio as specified in the poll command.

The SDM from the remote radio will contain compressed AVL information derived from the attached GPS receiver.



This sequence of events can be simplified by choosing the programming option "output SDMs automatically" for the base radio (available in TM8000 release 3 programming software).

This option will output an SDM automatically, and the SDMs will not be queued. This will remove the need for the progress message (SDM received) and the query command to retrieve the SDM.

If the radio is programmed to overwrite the internal SDM buffer (check box "SDM Buffer Overwrite" in the Data/SDM page), then any subsequent SDM received will overwrite the last saved SDM in the buffer. It is important to be aware that, if this option (check box) is not selected, then a CCDI query command must be applied to retrieve the SDM. Otherwise any new SDM received will be ignored.

If the poll is unsolicited (for example an emergency or alarm function) then the SEND SDM and the SDM from the base radio would not appear, instead the SDM response would be an SDM sent directly from the remote radio.

4 GPS Receivers

It is possible to plug an NMEA 0183 GPS receiver/antenna directly into the 15-way accessory socket of the TM8000, provided the GPS will run off 13.8V.

The GPS unit will need to be fitted with a suitable 15-way low-density plug.

The TMAA05-01 (Garmin GPS16-HVS) GPS receiver is available from Tait and is provided with an adaptor that allows connection to the 15-way Aux connector.

For example, the connection details for a Garmin GPS16-HVS are as follows:

TM8000 15-way	GPS wire colour	Function
Pin 3	White	GPS Rx Data Out
Pin 15	Black	GND
Pin 15	Braid	Shield
Pin 15	Yellow	GPS Remote On/Off
Pin 8	Red	13.8V

The Rx data line on the TM8000 is 3V3 CMOS logic, however, it is inverted with respect to normal CMOS logic, and is able to cope with RS232 levels. Therefore, most RS232 GPS receivers can be connected directly to the Rx data line.

For 5 Volt GPS receivers, the TMAA01-05 Options extender board or TMAA01-02 RS232 options board can be fitted. This provides a 5 Volt supply.

The GPS receiver will need to supply the NMEA 0183 RMC sentence.

5 NMEA-0183 RMC Sentence Format

An explanation of the NMEA-0183 RMC sentence is given here for reference. The RMC sentence is used by the remote TM8000 to obtain the parameters needed for the AVL report. It is important to note that not all of the RMC parameters are transmitted. To reduce the amount of time taken to transmit the information back to the base radio, only some parameters are transferred.

These parameters are compressed into an SDM ready to be sent back to the base radio when requested.

The RMC sentence structure is:

s- - RMC,hhmmss.ss, A,4925.345,N,yyyyy.yy,a,x.x, x.x,ddmmyy,x.x,a*hh<CR><LF>

Sentence part	Information type	Definition
- -	GPS receiver ID	
hmmss.ss	time (UTC)	hh = hours: two fixed digits mm = minutes: two fixed digits ss.ss = seconds: two fixed digits plus two optional decimal points
A	status	A navigation receiver warning. A = valid data V = invalid data
4925.345	latitude	49 degrees: two fixed digits 25.345 minutes: two fixed digits plus up to three optional decimal points
N	latitude reference	N = North S = South
12345.123	longitude	123 degrees: three fixed digits 45.123 minutes: two fixed digits plus up to three optional decimal points
W	longitude reference	E = East W = West
xxx	speed over ground (knots)	variable length field with up to three digits
yyy.y	course over ground (degrees true)	variable length field with up to three digits plus one decimal point. **Not sent in the AVL report**
ddmmyy	date	dd = day: two fixed digits mm = month: two fixed digits yy = year: two fixed digits **Only dd (day) sent in AVL report**
020.3	magnetic variation	20.3 degrees magnetic variation **Not sent in the AVL report**
E	magnetic variation reference	E = East: subtracts from the True course W = West: adds to the True course **Not sent in the AVL report**
*hh	checksum	* is a delimiter only cc = checksum calculated as an 8-bit exclusive OR (no start or stop bits) of all characters in the sentence between the '$' and the '*'. All ',' delimiters are counted. **Not sent in the AVL report**
<CR>	carriage return	**Not sent in the AVL report**
<LF>	line feed	**Not sent in the AVL report**

6 CCDI Commands

CCDI serial commands are used by the base radio to poll the remote radio and to receive an SDM response from the remote radio.

All CCDI messages take the general form:

[IDENT][SIZE][PARAMETERS][CHECKSUM]<CR>

Field	Description
[IDENT]	The message identifier
[SIZE}	The number of characters that make up the [PARAMETERS] fields
[PARAMETERS]	An optional field, or fields
[CHECKSUM]	An 8-bit checksum of fields [IDENT], [SIZE] and [PARAMETERS]
<CR>	The packet terminator (carriage return)

For example, some of the CCDI commands used in conjunction with AVL are listed below.

The format of the "send SDM" command (sent to the radio) is as follows:

Field	Usage
[IDENT]	(CCDI send SDM command "s")
[SIZE]	The number of characters that make up the following parameter fields up to the checksum.
[LEAD_IN_DELAY]	Two ASCII hex characters representing the key-up lead in delay
[DATA_MESSAGE-ID]	This is an 8-character ident of the radio that the SDM is sent to
[MESSAGE]	Maximum 32 characters of SDM data
[CHECKSUM]	8-bit checksum of previous fields
<CR>	Packet terminator

The format of an SDM received message (received from the radio) is as follows:

Field	Usage
[IDENT]	(CCDI SDM "s")
[SIZE]	The number of characters that make up the following parameter fields up to the checksum.
[MESSAGE]	SDM data
[CHECKSUM]	8-bit checksum of previous fields
<CR>	Packet terminator

The format of a progress message (received from the radio) is as follows:

Field	Usage
[IDENT]	CCDI progress message "p"
[SIZE]	The number of characters that make up the following parameter fields up to the checksum.
[Ptype]	Two ASCII Hex characters, which identify the progress category.
[CHECKSUM]	8-bit checksum of previous fields
<CR>	Packet terminator

The format of a query message (sent to the radio) is as follows:

Field	Usage
[IDENT]	CCDI progress message "q"
[SIZE]	The number of characters that make up the following parameter fields up to the checksum.
[QUERY_TYPE]	A single ASCII character representing the query type required.
[CHECKSUM]	8-bit checksum of previous fields
<CR>	Packet terminator

Calculating the CCDI [Checksum]

[CHECKSUM] is calculated by applying the following algorithm:

a. Take the modulo-2 sum of all message bytes preceding [CHECKSUM].

b. Retain bits 0 to 7, discarding any higher order bits resulting from the summation.

c. Form the two's complement of the remainder.

d. Convert the binary number into two ASCII-hex digits, MSD first.

Checksum Example **s0D050800TESTHi!DA**

a. Take the modulo-2 sum of all message bytes preceding [CHECKSUM].
s = 73h, 0 = 30h, D = 44h etc. therefore the modulo-2 sum is:

73 + 30 + 44 + 30 + 35 + 30 + 38 + 30 + 30 + 54 + 45 + 53 + 54 + 48 + 69 + 21 = 426h

b. Retain bits 0 to 7, discarding any higher order bits resulting from the summation.
26h

c. Form the two's complement of the remainder.
26h = 0010 0110
two's complement = 1101 1010

d. Convert the binary number into two ASCII-hex digits, MSD first.
1101 1010 = DA

7 Polling the Remote Radio

POLL Command

The POLL command is issued to a remote radio to request its current position. When the POLL command is sent to the remote radio, the remote radio responds with the GPS response data.

A CCDI SDM is used to poll the radio; the polling message is contained in the [MESSAGE] part of the SDM.

There is a choice of two polling commands:

- The remote radio sends its report back to the default address programmed in the radio:
  Poll command 0x00
- The remote radio sends its report back to a pre-defined address:
  Poll command 0x08 followed by 8 characters for the return address, eg "00008000"

An example of a “send SDM” to poll a remote radio, address 00008001 message is:

s0B0A00008001*21 <CR>

Parameter	Usage
s	Send SDM command
0B	Length of the SDM up to the checksum (11 characters = 0x0B)
0A	Lead in delay for SDM in 20ms steps (0A = 10 = 200ms LID)
00008001	This is the 8-character ident of the radio that the SDM is sent to
*	Poll command (actual poll command is 0x00, however, as this hex value cannot be displayed in this document, an ‘*’ is substituted)
21	Checksum (see “Calculating the CCDI [Checksum]” on page 9)
<CR>	Packet terminator

An example of a specific poll where the remote radio will send the poll response back to an address defined in the poll command is as follows;

s130A00008001*1234567883

Parameter	Usage
s	Send SDM command
13	Length of the SDM up to the checksum (19 characters = 0x13)
0A	Lead in delay for SDM in 20ms steps (0A = 10 = 200ms LID)
00008001	This is the 8-character ident of the radio that the SDM is sent to
*	Poll command (actual poll command is 0x08, however, as this hex value cannot be displayed in this document, an ‘*’ is substituted)
12345678	Ident of the radio to send the poll to
83	Checksum
<CR>	Packet terminator

8 Responses From the Remote AVL Radio

An AVL response from the remote radio will also be in the form of a CCDI SDM. The AVL response message is contained in the [MESSAGE] part of the SDM.

Certain bits (shaded) are always set to “1” or “0”. This is to prevent the occurrence of long strings of “1”s or “0”s that can cause the data transmission to fail.

Byte #	MSB							LSB	Description
1	c	c	c	c	c	c	c	c	Report response (see below for details)
2	Radio ID5				Radio ID6				Radio ID
3	Radio ID7				Radio ID8				Radio ID
4	1	HH							Hour
5	1	MM							Minute
6	1	SS							Second
7	1	F			Ld				Ref (North, South, East, West), Latitude Degrees + 1 bit spare
8	Ld				1	Lm			Latitude Degrees, Minutes
9	Lm				Ls				Latitude Minutes, Decimal
10	Ls								Latitude Decimal
11	1	0	1	Gd					Longitude Degrees
12	Gd				1	Gm			Longitude Degrees, Minutes
13	Gm				Gs				Longitude Minutes, Decimal
14	Gs								Longitude Decimal
15	1	0	DD						Day
16	Vk								Speed over ground, knots
17	Vk				Vp				Speed over ground, knots, Decimal knots

Where:

Value	Description
cccccccc	Report response (see below for details)
Radio ID 5678	4 BCD value of the last 4 digits of the radio ID in database item 5. If a digit is not convertible to a BCD value then it sets hex value 'F'.
DD	2 BCD value for Day
HH	2 BCD value for Hour
MM	2 BCD value for Minute
SS	2 BCD value for Second
F	4 bit value for Reference information: Bit 4: 0 for North, 1 for South Bit 5: 0 for East, 1 for West Bit 6 & 7 are not used
Ld	2 BCD value for Latitude (Degrees)
Lm	2 BCD value for Latitude (Minutes)
Ls	3 BCD value for latitude (Decimal Minutes)
Gd	3 BCD value for Longitude (Degrees)
Gm	2 BCD value for Longitude (Minutes)
Gs	3 BCD value for Longitude (Decimal Minutes)
Vk	3 BCD value for speed over ground (Knots)
Vp	1 BCD value for speed over ground (Decimal Knots)

Report Response

The report response has the following format:

Bit	7	6	5	4	3	2	1	0
	1	Response Type			Radio Status / Ack Parameter			

Bit 7: always 1

Bit 6 to 4: 000 (0) Report GPS SDM data for the response to the POLL command

Bit 3: set to '1', if Alarm Callout, otherwise set to '0'

Bit 2: if 0, Emergency mode is OFF
if 1, Emergency mode is ON

Bit 1 and 0: if 00, AVL report success (new data)
if 01, AVL report, no fix (old data)
if 10, AVL report, GPS not operational (no data)
if 11, AVL report, format error (no data)

An AVL report success (new data) mode is set when the Quality Status = "A" (valid data) appears in the received RMC message.

An AVL report, no fix (old data) mode is set when the Quality Status = "V" (invalid data) in the received RMC message. In this situation 'old' valid GPS data will be sent.

An AVL report, GPS not operational (no data) mode is set when no RMC message has been received in a defined period of connection Timeout. In this case, only the Report response and Radio IDs field will be sent.

An AVL report, format error (no data) is sent when there is a serial port error or an invalid checksum occurs. In this case, only the Report response and Radio IDs field will be sent.

9 Example Poll Response

The following shows the CCDI communications between the base radio and the base AVL application. For more information on the CCDI commands, please see the CCDI manual.

TO TM8000: **s0B0A00008001x21**: CCDI send SDM poll request to radio id 00008001 (x represents 0x00)

FROM TM8000: **p0205C9**: Progress message, channel busy

FROM TM8000: **p0219C4**: Progress message, FFSK received (release 3 firmware only)

FROM TM8000: **p031E186**: Progress message GPS data SDM received

TO TM8000: **q011FD**: Query command, request SDM

FROM TM8000: **s11xxxxxxxxxxxxxxx98**: SDM containing valid poll data, the x's represent the compressed poll data, which is not printable ASCII.

FROM TM8000: **p020608**: Channel not busy.

(All commands are terminated with a carriage return).

Two other CCDI progress messages, which are useful in an AVL system, are **p0207C7** and **p0208C6**. These commands are PTT activated and de-activated respectively (the microphone PTT or the external PTT).

These commands are able to tell you if the microphone PTT has been pressed or any external PTT has been activated. In this situation the AVL application should not send out any poll requests until a pre-defined time after the radio stops transmitting.

Note It is recommended to use a separate base radio for AVL polling, so that polling is not interrupted.

The SDM AVL response, (**s11xxxxxxxxxxxxxxxx98**) converted into Hexadecimal, is as follows:

73 31 31 80 80 01 84 83 D8 A5 88 20 22 A2 09 53 90 A6 00 10 39 38

73: SDM wrapper (s, CCDI SDM)

31: SDM wrapper, first byte of length (1)

31: SDM wrapper, second byte of length (1)

The [MESSAGE] portion of the SDM is as follows:

Byte	MSB							LSB	Description
80	c	c	c	c	c	c	c	c	Report response
80	Radio ID5				Radio ID6				Radio ID
01	Radio ID7				Radio ID8				Radio ID
84	1	HH							Hour
83	1	MM							Minute
D8	1	SS							Second
A5	1	F			Ld				Ref (North, South, East, West), Latitude Degrees + 1 bit spare
88	Ld				1	Lm			Latitude Degrees, Minutes
20	Lm				Ls				Latitude Minutes, Decimal
22	Ls								Latitude Decimal
A2	1	0	1	Gd					Longitude Degrees
09	Gd				1	Gm			Longitude Degrees, Minutes
53	Gm				Gs				Longitude Minutes, Decimal
90	Gs								Longitude Decimal
A6	1	0	DD						Day
00	Vk								Speed over ground, knots
10	Vk				Vp				Speed over ground, knots, Decimal knots

39: SDM wrapper, first byte of checksum (9)

38: SDM wrapper, second byte of checksum (8)

From this table, the following parameters can be obtained:

- Successful poll, new data, alarm and emergency modes are off
- Radio Ident = 8001 (last four digits of remote radios SDM address)
- Time of response = 04:03:58
- Latitude = 58.02.022 North
- Longitude = 020.15.390 West
- Day = 26
- Speed = 001.0 Knots

10 Radio Programming Parameters

A number of AVL parameters can be changed in the programming software of the base and remote radios.

For demonstrating AVL, a zip package is available to System Integrators, which contains a demonstration PC application, two radio programming files, and instructions.

The programming files contain default values for an AVL system and are a useful starting point.

The on-line help within the programming software is also an important resource for AVL values.

Related Documentation

TN1063-AN SmartTRAC - Tait Configuration guide and SmartTRAC workstation

11 Publication Information

Compliance Issues

None

CSO Instruction

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