Clock Synchronization with NMEA

Overview

The NMEA_READ program is based on the National Maritime Electronics Association (NMEA) 0183 standard. It is a clock synchronization program that uses satellites to obtain the correct time for the system clock. The program is an alternative solution for synchronizing with the national atomic clock using the Network Time Protocol (NTP) and the Internet. NMEA defines the standard protocol used by Global Positioning System (GPS) receivers to send coordinates and time.

The program uses NMEA $GPRMC protocol sentence to get the time source. The NMEA GPRMC sentence contains UTC time, UTC date, longitude, and latitude. Table 1 contains the values used in the following example:

```
$GPRMC ,173234,A, 3737.4462,N, 12207.6465,W,000.0,202.8,040119,015.0,E* 6F
```

Table 1: RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	173234		hhmmss
Status	A		A=data valid or V=data not valid
Latitude	3737.4462		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12207.6465		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	000.0	Knots	
Course Over Ground	202.8	Degrees	True
Date	040119		ddmmyy
Magnetic Variation	015.0	Degrees	000.0 to 180.0
Magnetic Variation Direction	E		E=east or W=west
Checksum	* 6F		
<CR> <LF>			End of message termination

The time: 4-JAN-2019 09:32:34 was acquired in this example.

Settings for the NMEA_READ Program

The communication speed with GPS receiver is 4800 baud and is set in
`Mnet$COM: CONFIGURE_GENERIC.COM`.

```
$    @Mnet$COM:rtuport NMEA_DEVICE 4800 TTB0:
```

The port characteristics will be:

```
Terminal: _TTB0:      Device_Type: Unknown       Owner: NMEA_READ
                                                Username: SYSTEM
   Input:    4800     LFfill:  0      Width: 255      Parity: None
   Output:   4800     CRfill:  0      Page:   24
Terminal Characteristics:
 Passall           No Echo           Type_ahead         No Escape
 No Hostsync       No TTsync         Lowercase          No Tab
 No Wrap           Scope             No Remote          Eightbit
 No Broadcast      No Readsync       No Form            Fulldup
 No Modem          No Local_echo     No Autobaud        No Hangup
 No Brdcstmbx      No DMA            Altypeahd          Set_speed
 No Commsync       No Line Editing   Overstrike editing No Fallback
 No Dialup         No Secure server  No Disconnect      Pasthru
 No Syspassword    No SIXEL Graphics No Soft Characters No Printer Port
 Numeric Keypad    No ANSI_CRT       No Regis           No Block_mode
 No Advanced_video No Edit_mode      No DEC_CRT         No DEC_CRT2
 No DEC_CRT3       No DEC_CRT4       No DEC_CRT5        No Ansi_Color
 VMS Style Input
```

The NMEA_READ program runs continuously and is included in:
`Mnet$data:start_node_name.dat`

```
RUN NMEA_READ -
!       /mailbox -
        /DELAY="0 00:01:25.00" -
        /PROCESS_NAME=NMEA_READ -
        /NOSWAP -
        /ERROR=MNET$DATA:NMEA_READ.ERR -
        /OUTPUT=MNET$DATA:NMEA_READ.LOG -
        /PRIORITY=22
```

NMEA_READ Program Source Files

```
Directory SYS$SYSDEVICE:[MISER.SOURCE.FIELD.NMEA_READ]
CONTROL.BDF;1               1  30-MAY-2006 09:11:44.63
CPUCLK.FOR;1                2  25-APR-2005 16:55:23.12
DESCRIP.MMS;3              10   1-OCT-2008 12:43:12.67
GET_POINT_VALUE.FOR;2       6  11-MAR-2008 12:00:10.45
GPSTIM.C;52                17  13-DEC-2006 13:07:04.86
NMEA_READ.C;44             60  15-DEC-2009 16:19:46.04
PM.H;2                      7  11-MAR-2008 12:12:15.61
POINT_ACCESS.C;8            8  17-APR-2008 08:57:28.01
POINT_ACCESS_FOR.FOR;12     8   4-DEC-2008 16:34:19.60
SETUP_TERMINAL.C;1         25  30-DEC-2005 12:16:11.05
SET_POINT_VALUE.FOR;2       7  11-MAR-2008 12:00:08.60
VERSION.OPT;4               1  22-DEC-2009 09:23:36.33
Total of 12 files, 152 blocks.
```

The NMEA_READ program will update the following points:

ACRONYM	NAME	REC TYPE	VALUE	ENG UNITS
NMEA-DELTA	DELTA TIME	ANA	-1.0	SEC
NMEA-LATITUDE	GPS LATITUDE	ANA	3737.0	MIN
NMEA-LINMON	LINMON	BIN	OFF	
NMEA-LONGITUDE	GPS LONG	ANA	-12207	MIN
NMEA-RMC-RTIM	GPS RMC RTIM	ACC	3672.35	
NMEA-RMC-STS	GPS RMC STS	BIN	VALID	
NMEA-STATUS	GPS NMEA STS	BIN	UP	

- NMEA-DELTA displays the difference (in seconds) between the system time and the time obtained from the GPS device.
- When NMEA-LINMON is started, trace information will be written into the [USERS.SYSTEM]NMEA_READ.LOG file.
- NMEA-STATUS indicates the status of communications with the GPS device.
- NMEA-RMC-STS indicates the status of communications between the GPS device and the satellites.
- NMEA-RMC-RTIM is a runtime accumulator for NMEA-RMC-STS that indicates how long the GPS device was in contact with the satellite.

The system time is updated when NMEA-DELTA is greater than three seconds after receiving sixty valid samples. The update is done only once every ten minutes.

At 2300 hours every day the update is performed if NMEA-DELTA is greater than zero.

The update is not done if NMEA-DELTA is greater than half an hour.

```
ANALOG                                                          15640

ACRONYM  NMEA-DELTA        NODE ID   DEMVS4  INPUT  SUBTYPE CALC
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NONE
NAME     DELTA TIME        RTU  ID           FILTER CONSTANT 0.00000
AREA                       MUX  ID           COS REPORTING Y TOLERANCE 0.01 %
BUILDING              IN  ADD                INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT ADD                AUTO LAST COMMAND RE-ISSUE  N

ENGINEERING UNITS SEC      DISPLAY DECIMAL PLACES 1  RATE POINT N RATE/UNIT
SENSOR HI LIMIT (ENG UNITS) 1800.00     SENSOR LO LIMIT (ENG UNITS) -1800.0
SENSOR HI LIMIT (COUNTS)      1800      SENSOR LO LIMIT (COUNTS)     -1800
OUTPUT HI LIMIT (ENG UNITS) NONE        OUTPUT LO LIMIT (ENG UNITS) NONE

ALARM HI LIMIT 10.0000      HI HI LIMIT  60.0000       HI DEADBAND  0.00000
ALARM LO LIMIT -10.000      LO LO LIMIT  -60.000       LO DEADBAND  0.00000
RATE OF CHANGE NONE         LIMIT ALARMS N    SETPOINT DEVIATION ALARMS N
ALARM DELAY                 CRITICAL ALARM N
```

```
BINARY                                                          15634

ACRONYM  NMEA-LINMON       NODE ID   DEMVS4  INPUT  SUBTYPE NONE
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NORMAL
NAME     LINMON            RTU  ID
AREA                       MUX  ID           COS REPORTING Y
BUILDING              IN  ADD                INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT ADD                AUTO LAST COMMAND RE-ISSUE  N

ON CODE    ON         OFF CODE    OFF         INTERMEDIATE CODE   MID
ON STATUS    1        OFF STATUS    0         INTERMEDIATE STATUS   0
START VERB START      STOP VERB   STOP
```

```
ACCUMULATOR                                                     15637

ACRONYM  NMEA-RMC-RTIM       NODE ID DEMVS4
SEGMENT   0
NAME     GPS RMC RTIM
AREA
BUILDING
UNIT

ENGINEERING UNITS HOURS      DISPLAY DECIMAL PLACES 3
RESET INTERVAL NONE
ROLL OVER LIMIT (ENG UNITS) 1000000
```

```
BINARY                                                          15636

ACRONYM  NMEA-RMC-STS      NODE ID   DEMVS4  INPUT  SUBTYPE CALC
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NONE
NAME     GPS RMC STS       RTU  ID
AREA                       MUX  ID           COS REPORTING Y
BUILDING              IN   ADD               INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT  ADD               AUTO LAST COMMAND RE-ISSUE  N

ON CODE    VALID     OFF CODE    DOWN        INTERMEDIATE CODE   MID
ON STATUS    1       OFF STATUS    0         INTERMEDIATE STATUS   0
START VERB START     STOP VERB   STOP

MINIMUM ON TIME           MINIMUM OFF TIME
VERIFICATION DELAY        RUN TIME LIMIT          POWER DEMAND

ON ALARM N  OFF ALARM Y  INTERMEDIATE ALARM N  UNCOMMANDED COS ALARM N
ALARM DELAY                 CRITICAL ALARM N    UNDEFINE STATE ALARM N

ALARM PRINTERS 0           EVENT PRINTERS 0           MESSAGE NUMBER
ACK CATEGORY    INTO       PRINT CATEGORY ALARMS
RELATED TASK               POINT ASSOCIATION RUNTIM   ASSOC POINT NMEA-RMC-
RTIM
POINT ACCESS LEVEL 100     POINT CONTROL LEVEL 100    SLIDE NUMBER
```

```
BINARY                                                          15635

ACRONYM  NMEA-STATUS       NODE ID   DEMVS4  INPUT  SUBTYPE CALC
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NONE
NAME     GPS NMEA STS      RTU  ID
AREA                       MUX  ID           COS REPORTING Y
BUILDING              IN   ADD               INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT  ADD               AUTO LAST COMMAND RE-ISSUE  N

ON CODE    UP        OFF CODE    DOWN        INTERMEDIATE CODE   MID
ON STATUS    1       OFF STATUS    0         INTERMEDIATE STATUS   0
START VERB START     STOP VERB   STOP

MINIMUM ON TIME           MINIMUM OFF TIME
VERIFICATION DELAY        RUN TIME LIMIT          POWER DEMAND

ON ALARM N  OFF ALARM Y  INTERMEDIATE ALARM N  UNCOMMANDED COS ALARM N
ALARM DELAY                 CRITICAL ALARM N    UNDEFINE STATE ALARM N

ALARM PRINTERS 0           EVENT PRINTERS 0           MESSAGE NUMBER
ACK CATEGORY    INTO       PRINT CATEGORY ALARMS
RELATED TASK               POINT ASSOCIATION RUNTIM   ASSOC POINT NMEA-RMC-
RTIM
POINT ACCESS LEVEL 100     POINT CONTROL LEVEL 100    SLIDE NUMBER
```

```
ANALOG                                                          15638
ACRONYM  NMEA-LATITUDE     NODE ID   DEMVS4  INPUT  SUBTYPE CALC
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NONE
NAME     GPS LATITUDE      RTU  ID           FILTER CONSTANT 0.00000
AREA                       MUX  ID           COS REPORTING Y TOLERANCE 0.01
%
BUILDING              IN  ADD                INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT ADD                AUTO LAST COMMAND RE-ISSUE  N

ENGINEERING UNITS MIN      DISPLAY DECIMAL PLACES 1  RATE POINT N RATE/UNIT
SENSOR HI LIMIT (ENG UNITS) 9000.00     SENSOR LO LIMIT (ENG UNITS) -9000.0
SENSOR HI LIMIT (COUNTS)      9000      SENSOR LO LIMIT (COUNTS)     -9000
OUTPUT HI LIMIT (ENG UNITS) NONE        OUTPUT LO LIMIT (ENG UNITS) NONE
```

```
ANALOG                                                          15639

ACRONYM  NMEA-LONGITUDE    NODE ID   DEMVS4  INPUT  SUBTYPE CALC
SEGMENT   0                NCC  ID           OUTPUT SUBTYPE NONE
NAME     GPS LONG          RTU  ID           FILTER CONSTANT 0.00000
AREA     LONGITUDE         MUX  ID           COS REPORTING Y TOLERANCE 0.01
%
BUILDING              IN  ADD                INTERVAL TYPE NONE   INTERVAL
UNIT                  OUT ADD                AUTO LAST COMMAND RE-ISSUE  N

ENGINEERING UNITS MIN      DISPLAY DECIMAL PLACES 1  RATE POINT N RATE/UNIT
SENSOR HI LIMIT (ENG UNITS) 18000.0     SENSOR LO LIMIT (ENG UNITS) -18000
SENSOR HI LIMIT (COUNTS)     18000      SENSOR LO LIMIT (COUNTS)    -18000
OUTPUT HI LIMIT (ENG UNITS) NONE        OUTPUT LO LIMIT (ENG UNITS) NONE
```

The error log will indicate how the NMEA_READ program is working:

```
DEMVSB$ err/sin=10:00
[2018-JUL-18 10:00:14.53] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   10:00:14.495, VMS Time = 18-JUL-2018
                                   10:00:14.3
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
[2018-JUL-18 10:00:19.85] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   10:00:19.820, VMS Time = 18-JUL-2018
                                   10:00:19.6
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
[2018-JUL-18 10:00:24.62] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   10:00:24.592, VMS Time = 18-JUL-2018
                                   10:00:24.4
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
[2018-JUL-18 10:00:29.80] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   10:00:29.768, VMS Time = 18-JUL-2018
                                   10:00:29.6
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
[2018-JUL-18 10:00:35.09] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   10:00:35.059, VMS Time = 18-JUL-2018
                                   10:00:34.8
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
[2018-JUL-18 10:32:44.26] DEMVSB   NMEA_READ CLEANUP
                                    %SYSTEM-F-TIMEOUT, device timeout
[2018-JUL-18 10:45:15.26] DEMVSB   NMEA_READ CLEANUP
                                    %SYSTEM-F-TIMEOUT, device timeout
[2018-JUL-18 11:10:35.16] DEMVSB   NMEA_READ GPS Time = 18-JUL-2018
                                   11:10:35.129, VMS Time = 18-JUL-2018
                                   11:10:34.8
                                    %SYSTEM-S-NORMAL, normal successful
                                   completion
```