

# Brookhouse NMEA Multiplexers

## NMEA data manipulation, filtering, monitoring, alarm & control signal activation

### Introduction

In addition to its primary NMEA combine function, Brookhouse multiplexers offer the user powerful, yet easy to use features, for a high degree of NMEA data-manipulation, filtering and monitoring. These functions have turned the Brookhouse multiplexer into an effective real-time NMEA controller. The combine or multiplex function of NMEA and Seataalk data is still the primary task, but the extra functions enable the user to optimise integrated instrument systems and iron out NMEA incompatibility problems in an elegant and efficient way.

It is possible to convert and/or restructure complete NMEA sentences. The user can control the various functions by uploading easy to create and understand scripts into the multiplexer. A webpage is available with examples of scripts, which can be copied and pasted and adapted for specific purposes.

The reader will appreciate that modifying data “on the fly”, as it passes through the multiplexer is not a simple task and that there are some limitations. Throughput and speed have to be maintained to ensure that no data-loss occurs.

The following functions are offered in the latest Brookhouse NMEA multiplexer firmware version:

- Filtering of NMEA data at sentence-level, port-selective.
- Data manipulation (“on the fly” editing) at NMEA sentence and parameter level, port selective:
  - Deletion of NMEA parameters (with or without parameter separator)
  - Re-naming (replacing) of NMEA ID and/or sentence ID.
  - Saving a parameter and using (inserting) it elsewhere in the same or in another NMEA sentence.
  - Inserting fixed alpha-numeric data at parameter level, including parameter separators.
  - Adding or replacing a checksum at the end of NMEA sentences.
  - Adding or subtracting a signed value from any parameter (depth offset, wind angle correction, other calibration values)
  - Conversion of wind angles 180 degrees left/right of bow to 0-360 degrees.
  - Truncation of a sentence.
- Testing of NMEA parameter values and setting or clearing of externally available control signals. The control signals can be used for warning lights, alarm buzzers or to drive relays to switch lights or equipment on/off. There are 4 signals available. NMEA parameter

conditions that can be tested are:

> (Greater than), <(Smaller than) and = (Equal). Signals can be turned on or off if the condition is “true”.

- NMEA data traffic control
  - Automatic backup-switching (primarily for GPS)
  - NMEA data-pacing for NMEA talkers that transmit sentences at high rates, such as electronic compasses, to prevent congestion.

Filtering and data manipulation are controlled from script files, which can be uploaded to the multiplexer. The traffic control functions can be activated directly from the mux setup menu.

## **NMEA sentence filtering and data manipulation**

Brookhouse NMEA Multiplexers can be programmed by the user to filter out unwanted NMEA sentences. In addition, a unique feature allows the user to modify NMEA sentences “on the fly” as they pass through the multiplexer.

With the increasingly advanced instrument configurations and integrated computer systems on boats, extensive use is made of the NMEA protocol for the connection of instruments and computers. The NMEA Multiplexer plays an important role herein. With many NMEA “talkers” active, it is advantageous for various reasons to be able to filter out (suppress) certain NMEA sentences. There is also an increasing number of situations, where the ability to change the contents of NMEA sentences can resolve various compatibility problems. For example, somewhat older instruments may use an older NMEA version and produce NMEA sentences that are not recognized by the latest navigation software or by a repeater instrument. The user can now program the Brookhouse NMEA multiplexer in a straightforward way to change these NMEA sentences to a recognized format.

Simple directives that instruct the multiplexer which sentence changes are required are placed in a text file that can be loaded into the multiplexer. No special software is required, just a text editor such as Notepad or Wordpad to prepare the directives and a terminal program such as standard MS Windows program Hyperterminal. If the multiplexer is started up in “setup-mode”, a dialogue with the user is held via the RS232 or USB port and the multiplexer will prompt the user to upload the text file with directives. If directives need to be loaded after the multiplexer was installed, no connections need to be changed and the multiplexer does not need to be opened. The directives are stored in flash memory and stay there permanently until new directives are loaded.

A number of directives for filter and editing functions are available. For maximum flexibility, the user can select to which sentence(s) each directive applies:

- Sentences, received via a specific multiplexer port or via all ports and/or

- Sentences with a certain NMEA talker ID (e.g. \$GP) and/or
- Sentences with a certain sentence ID (e.g. GLL)

Directives include:

- Delete sentence (Filter function)
- Substitute NMEA talker ID (e.g. substitute \$GP for \$II)
- Substitute NMEA sentence ID (e.g. substitute DBT for DBS)
- Delete single parameter from sentence, leave empty parameter field.
- Remove single parameter from sentence (including the parameter separator).
- Insert text or new parameter.
- Add or subtract a correction or calibration value to/from a numeric parameter.
- Store (save) a parameter.
- Retrieve the stored parameter and insert at a designated position in the same or in another NMEA sentence.
- Add an LRC checksum to a sentence without checksum or recalculate and replace.
- Convert wind angle in degrees from bow to 0-360 degrees.

*If the original NMEA sentence had a checksum at the end of the sentence, the multiplexer replaces this automatically by a new checksum, computed for the new sentence contents.*

Multiple directives can apply to the same NMEA sentence(s)

The available directives provide enough flexibility even to make complete NMEA sentence conversions. This can best be illustrated with an example:

The original NMEA sentence:

**\$GPGGA,160635.27,0311.98242,S,13823.79928,E,1,12,2.0,100,M,100.0,M,,\*5C**

was translated by the multiplexer into:

**\$GPRMC,160635.27,A,0311.98242,S,13823.79928,E,,,,,D\*44**

Using the following mux editing directives:

```
*S,9,GPGGA,GPRMC
*I,9,GPGGA,2,A,
*D,9,GPGGA,6
*D,9,GPGGA,7
*D,9,GPGGA,8
*D,9,GPGGA,9
*D,9,GPGGA,10
*I,9,GPGGA,11,D
*R,9,GPGGA,11
*R,9,GPGGA,12
*R,9,GPGGA,13
*R,9,GPGGA,14
*E
```



## Detailed description of directives.

### General

Each directive starts with a \* and consists of a number of fields, separated by commas:

**\*Dir,portno,ids,field4,field5,field6,field7**

Field 1: (Dir) - Directive identifier.

Field 2: (portno) - Multiplexer input port number.

Field 3: (ids) -NMEA talker ID and Sentence ID.

Fields 4-7: directive-dependent

### Directive identifier

The first position is always a \* (asterisk). This identifies the following data as a filtering/editing directive.

The second position is the directive identification letter. This has to be an UPPER CASE character. The following directives are available:

- \*W** - Wipe sentence. Completely remove the NMEA sentence.
- \*S** - Substitute new NMEA ID and/or sentence ID.
- \*D** - Delete parameter, leave parameter separator (comma).
- \*R** - Remove parameter, including parameter separator (comma).
- \*I** - Insert ASCII characters (comma's are allowed).
- \*A** - Add or subtract a signed numeric value from parameter field.
- \*L** - Add LRC checksum to end of sentence.
- \*M** - (Memorize) Store parameter value in mux memory.
- \*U** - (Use) Insert stored parameter at designated position.
- \*T** - Truncate the sentence at the specified parameter position.
- \*Q** - Converts wind angle 0-360° to left or right from bow.
- \*C** - Test a condition (Compare a NMEA parameter with the value in the C-directive) and set or clear a signal to drive an audible alarm, a warning light or a relays.
- \*E** - Indicates end of filtering/editing directives.

### Port number

Specifies the port number (1-4) of the multiplexer the rest of the directive pertains to. Data received via other ports remains unaffected. If the number 9 is used here, the directive applies to all ports.

If more than one directive is used to change an NMEA sentence, the directives must be in sequence of the parameter numbers they refer to (from low to higher, left to right).

### NMEA talker and Sentence ID

The NMEA talker ID is 2 characters, followed by the 3-character sentence ID. For example, in **GPGGA**, GP is the NMEA talker ID (GPS) and GGA is the sentence ID. For any of the characters in the NMEA and Sentence ID field,

“wild card” characters may be specified. **II???** means that the directive applies to all NMEA sentences WITH id **II**, no matter what the sentence ID is. Wildcard characters are useful e.g. to replace the NMEA ID in all sentences from a certain instrument, connected via a certain mux port. Do not use them if multiple directives apply to the same sentence.

#### **Field 4 as Parameter number**

The field (parameter) number in the NMEA sentence the directive applies to. For example, \*D,1,XYABC,3 means: delete parameter number 3 (following the 3<sup>rd</sup> comma in the sentence) from sentences received via port 1 with NMEA/Sentence ID XYABC.

The parameter number always refers to the position of the parameter in the original sentence, even if \*R or \*I directives are used to change the sentence structure. If more than 1 directive applies to the same sentence, the directives should be placed in sequence of parameter numbers.

#### **Field 4 as Substitute NMEA ID/Sentence ID**

The 4<sup>th</sup> field of the \*S directive replaces any occurrence of the NMEA/Sentence ID as specified in the 3<sup>rd</sup> field. If the field contains spaces, the corresponding original letters from the received NMEA ID/Sentence ID are retained. Example: \*S,9,??DBT, DPT means: Replace the DBT sentence ID preceded by any NMEA ID, received via any of the input ports by the DPT sentence ID and retain the original NMEA ID.

**Field 5-7** Refer to individual directive descriptions hereunder.

#### **\*W – directive**

“Wipe” entire sentence.

Examples:

\*W,9,GPGGA            Remove all occurrences of the \$GPGGA sentences.

\*W,1,GPGGA            Remove all \$GPGGA sentences received from mux port 1.

#### **Special format – conditional wipe.**

Example:

\*W,1,GPGGA,C

Remove \$GPGGA sentence received from port 1, **but only if no condition time out has occurred.** The condition time-out is reset if condition #2 is set to “true” with the special format of the \*C directive.

If condition 2 is never set, the timeout is never reset after the initial time-out period of 5 secs and the wipe is not executed.

#### **\*S- Directive**

Substitute NMEA and/or sentence ID.

Example:

\*S,3,II???,WI            Replace NMEA ID II by WI for all sentences received via

port 3.

### **\*D- Directive**

Delete parameter from sentence, leave parameter field empty (retain separator comma).

Example:

\*D,4,??VHW,3      Remove parameter #3 (magnetic heading) from VHW sentences with any NMEA ID on port 4.

### **\*R-Directive**

Remove parameter, including parameter separator (comma) from NMEA sentence. This directive modifies the structure of the sentence and should be used with great caution. Normally used in combination with the \*S directive to “convert” one sentence to another and re-position parameter(s).

Example:

```
*S,2,??VHW,HEHDM
*R,2,??VHW,1
*R,2,??VHW,2
*R,2,??VHW,5
*R,2,??VHW,6
*R,2,??VHW,7
*R,2,??VHW,8
*E
```

Converts      \$VWVHW,315.0,T,320.0,M,6.0,N,11.1,K\*65 into:

\$HEHDM,320.0,M\*2E

Note: \*M and \*R are used for the same field, \*R has to come first.

### **\*I-Directive**

Insert parameter. Up to 5 characters can be inserted at the specified parameter position. A parameter separator (comma) may be included. If a comma is included, this effectively inserts a new parameter and the field numbering of the sentence changes. Normally used in combination with the \*S directive to “convert” one sentence to another and/or re-position parameter(s).

Examples:

```
*I,9,GPGGA,2,A,
```

This inserts “**A**,” (Valid flag) behind the second comma in the GPGGA sentence as part of the conversion from GPGGA to GPRMC in the example on page 3.

\*I,1,ABXYZ,3,, inserts a single comma behind the 3<sup>rd</sup> comma of sentence ABXYZ, received via mux port 1.

### **\*A-Directive**

Add/Subtract signed numeric value to/from NMEA parameter field. The total number of positions of the correction value, incl. sign and decimal point should not exceed 6. This directive is ideal for calibration and to add/subtract offsets.

Example:

`*A,1,VWVHW,5,-1.5`

This subtracts 1.5 knots from the waterspeed in \$VWVHW sentences received on channel 1.

The \*A directive also defines the number of decimals in the result value. If the value added is e.g. 1.500, the result will have 3 decimals, even if the original parameter had less decimals. By adding a zero-value, the number of decimals can be changed without changing the parameter value.

By adding 0 without the decimal point, the decimals including the decimal point will be removed from the original value. E.g., by adding 0 to an original parameter value of 4.3, the result will be 4 without decimal point.

Special format: If the sign of the offset is an uppercase A (absolute), the sign of the parameter value in the sentence is removed. The position of the decimal point and the precision are still determined by the following value, which should be zero in this case. Example A0.00

### **\*L-Directive**

The L-directive tells the multiplexer to add a checksum at the end of the original NMEA sentence. This directive is only necessary if a checksum has to be placed behind a sentence that has no checksum or in combination with the \*T (truncate directive). If the original sentence has a checksum, it is recalculated and the multiplexer replaces the old by the new checksum automatically. If the \*L directive is used for sentences that already have a checksum, the newly calculated checksum replaces the old one, even if no modifications to the sentence are made.

The parameter number in the \*L directive can have any value as long as it points to an existing parameter. If the L directive is used in combination with other on the fly editing parameters the parameter number has to be in ascending sequence, as applies to all directives. By always using 1 for the parameter number and placing the \*L directive in the first position, no mistakes can be made.

If the parameter number is 0, the \*L directive has the opposite effect: In this case the checksum is omitted.

Example:

`*L,3,SDDBS,1`

This adds a checksum to \$SDDBS sentences received via channel 3.

### **\*M-Directive**

The M directive saves a parameter in the multiplexer's RAM memory for later use. This is useful if a parameter found in the beginning of a sentence has to be moved to a position further in the sentence. The saved parameter can also

be inserted in a different sentence. The M directive is always used in combination with the \*U directive for recalling it. Only the parameter value, without comma, is saved.

Data saved by consecutive \*M directives will be concatenated until the buffer is full. If each \*M should overwrite the previously saved data, an extra parameter (,O) has to be added at the end of the string.

Example:

```
*M,2,GPRMC,1,O
```

This saves the time (UTC) found in the \$GPRMC sentence received via channel 2. The previously saved data is overwritten.

The M-directive can also be executed conditionally. An extra parameter (,C) has to be added at the end of the string. If the C parameter is present, the M directive is only executed if condition 3 is 'true'. Either the C or O parameter can be specified, not both.

Note: If \*M and \*R are used for the same field, \*R has to come first.

#### **\*U-Directive**

The U-directive inserts the latest parameter saved with the \*M directive in the specified position. If a parameter terminator (comma) is required, it has to be inserted separately.

Example:

```
*U,3,GPZDA,1
```

This inserts the current saved parameter in the first position of the ZDA sentence received via channel 3.

The U-directive can also be executed conditionally. An extra parameter (,C) has to be added at the end of the string. If the C parameter is present, the M directive is only executed if condition 3 is 'true'.

#### **\*T-Directive**

The \*T directive is used for truncating sentences. A number of parameters can be disregarded using this one directive. If the original sentence has a checksum at the end, this checksum is also disregarded. Use the \*L parameter if a new checksum needs to be added to the truncated sentence.

The T-directive is useful in sentence translations and can be used instead of a number of \*R directives.

Some NMEA listeners do not recognize certain sentences if they are followed by a checksum. The \*T directive can be used to disregard the checksum.

Example:

```
*T,9,DBDBK,6
```

This truncates the \$DBK sentence after the 6<sup>th</sup> parameter, which means that the checksum is disregarded in this case.

### **\*Q-Directive**

This is a directive introduced for the conversion of relative wind angles. In the VWR and VWT sentences, the wind-angles are measured from the left of right of the bow of the vessel (0-180 L or R). In the MWV sentence, the wind-angle is 0-360, measured from the right of the bow. The Q-directive converts the latter to 0-180 L or R. Used specifically for MWV to VWR or VWT conversion.

Example:

\*Q,4,IIMWV,1

This converts the wind angle 0-360 in the MWV sentence to 0-180,L or 0-180,R.

**Note:** This directive is used together with the \*S directive for MWV to VWR sentence conversion.

### **\*C-Directive**

The C (condition) directive tests NMEA parameter values. If the condition is "true", it sets or resets one of four multiplexer output signals. The output signals can be used directly for audible alarms or to switch relays. There are many different applications. Examples: audible depth and wind-angle alarms, switching based on time found in RMC sentence (nav lights/ anchor light). This directive is only useful if the multiplexer output signals have been made available to the user. This is available as a special option.

Format:

\*C,chan#,aacc,par#,output#,on/off,cond

where:

\*C = Directive  
chan# = multiplexer channel number  
aacc = 2-letter Talker ID and 3-letter NMEA sentence ID.  
par# = parameter to be tested.  
output# = Multiplexer general purpose output number (1-4) If output# is 8, condition 3 is set (ref. to special format below) instead of a physical output signal.  
on/off = 1 for on, 0 for off  
cond = condition. Symbol, followed by value.  
Symbols available: = (equal)  
> (greater than)  
< (smaller than)

The test-symbol is directly followed by the value, e.g. >15.0

Example:

\*C,2,SDDBT,3,1,1,<3.0

This switches on output #1 when a the depth in the \$SDDBT sentence is smaller than 3.0.

### **Special format**

If par# is 0, the C-directive is used in a different way.

The mux tests for the presence of sentences with specified talker ID and sentence ID and if found, an internal condition flag is set to “true”. There are 4 condition flags. The output# field is used for the condition flag number in this special usage of the C-directive. The remaining 2 parameter fields should be set to 0.

The condition flags are used by the mux firmware for special features. Only conditions 1 and 2 are used at present:

1 – If condition 1 is “true”, the firmware generates a \*GPWPL sentence. Condition 1 should only be used in a script that looks like this:

```
*M,3,CDDSC,6
*M,3,CDDSC,7
*C,3,CDDSE,0,1,0,0
*M,3,CDDSE,4
*M,3,CDDSE,6
```

This script extracts data from the DSC and DSE sentences for the creation of a \$GPWPL sentence. The \*C directive sets the flag for creation of this sentence. It can be seen that several script lines with \*M are used in this script. The parameter values are internally stored in sequential order for to be used by the firmware code that generates \$GPWPL.

A separate document is available that describes the DSC/DSE conversion to WPL.

2 – If this condition is set to “true”, an internal condition time-out is reset. The time out is intended for the multiplexer’s GPS backup switching feature and for the conditional wipe directive.

If a certain NMEA sentence is not being received in a multi-device data stream, such as Seatalk or output of a AIS transponder, the resulting condition time-out will cause either the un-blocking of a backup port (in case the backup switching feature has been activated) or non-execution of the conditional wipe directive, if present in the active mux script..

The \*C directive has to be used in the following way:

```
*C,1,IIRMC,0,2,0,0
```

It has to correspond with the mux seatalk talker ID setting in the setup menu. A separate document is available with a detailed description of this feature.

4 – This condition can be set to ‘true’ with the special format of the \*C directive, but also with the standard format, if the output # is 8. Condition 4 applies to directives \*M and \*U. If used with the optional condition parameter specified, these directives are only executed if condition 4 is true.

8 – Condition 8, if “true” generates an empty RMB sentence with valid flag, required for Northstar auto pilot.

### **\*E-Directive**

Use this to end the filtering/editing directives.

If used on its own, as the only directive, all previous filtering/editing directives are erased from the mux memory.

### **Restrictions**

Wild card characters (?) can only be used for NMEA ID and Sentence ID if the NMEA ID and Sentence ID fields are the same in all directives, as in the example under R-directive above. If not, these fields need to be specified in full. For clarity, this is a good practice anyway.

### **Uploading the filtering / editing directives from a computer to the multiplexer**

The directives are placed in a text file (suffix .TXT), using a text editor such as standard Windows program Notepad. After you have created or edited the text file with directives, all you need to do is upload it to the multiplexer to store it in the flash memory. Make sure you have created a record with the \*E directive to mark the end of the directives. The multiplexer has to be connected to the computer via the RS232 port or USB. No special software is required for the upload. Standard Windows program Hyperterminal or any other terminal program will do the job. Configure the terminal program (assume Hyperterminal) for direct communication via COMx (the port the mux is connected to). Under *Port settings*, select the following: transmission speed 4800/9600 (has to be the same as mux setting), 8 bits, no parity and no flow control. To list directives individually, one per line, during uploading: In the *file* menu, select *properties*. Under *settings* select *Ansi terminal*, under *ASCII setup*, tick *Send line ends with line feeds*.

When you are ready to start communication with the multiplexer, press the ESC key on the computer's keyboard (**with Hyperterminal as the active foreground application**), keep ESC depressed while you switch the mux on. This tells the mux that you want it to start up in "set-up mode". A message will appear in the Hyperterminal window with instructions on how to proceed. Select the option for uploading filtering directives. To send the previously created .txt file with directives, go to the Hyperterminal Transfer menu, select "Transfer Text File", browse to find your file and press ok. The multiplexer will echo all data received from the computer, i.e. the txt-file contents appear in the Hyperterminal window as received by the mux. If errors are found, the mux will report this. Rectify and start again. After all directives have been accepted the message "Upload complete, restart mux" will appear. Switch off the multiplexer and switch it on again. From now on, the directives will take effect. Any directives upload will cancel any previously defined filtering/editing directives.

If for some reason all filtering/editing has to be cancelled, simply repeat the upload procedure with a directives file that only contains the \*E directive.

## Common problems with using Setup and uploading directives using Hyperterminal.

1. The setup menu does not appear in the Hyperterminal window when mux is switched on while ESC is depressed.  
Cause 1: Hyperterminal is not the active foreground application. The Hyperterminal window may be on the screen, but if Hyperterminal is not the application that has control over the keyboard, the ESC key is not sent to the mux. Check if the Hyperterminal title bar is greyed and if so, click on it to resolve.  
Cause 2: Wrong baudrate. The first time Setup is used, set the baudrate to 4800. If the mux baudrate is changed and setup is used again later with the Hyperterminal baudrate still set at 4800, the ESC code won't be recognised due to baudrate mismatch. Always set Hyperterminal to the current mux baudrate before attempting Setup.
2. When starting the file transfer, the error *Message format error* appears.  
Cause: Another file transfer method than *Transfer **Text** file* was selected. Always use the *Transfer Text File* option in Hyperterminal.

## **Implications on other Multiplexer features.**

### **Seatalk-NMEA conversion**

The filtering/editing feature can be used in conjunction with the Seataalk option, i.e. NMEA sentences that are the result of Seataalk-NMEA conversion can be filtered out or modified with this mechanism.

### **User-programmable compact LCD repeater**

In Brookhouse multiplexers with the programmable LCD, screen definition directives are processed before the filtering/editing stage. This means that data to be displayed is extracted from the original NMEA sentences, as received from the instruments. For example, data occurring in a certain NMEA sentence could be displayed on the LCD, while that same sentence is filtered out (deleted), so that it is not sent to the computer.

The following figure shows the sequence of the processing stages in the multiplexer.

