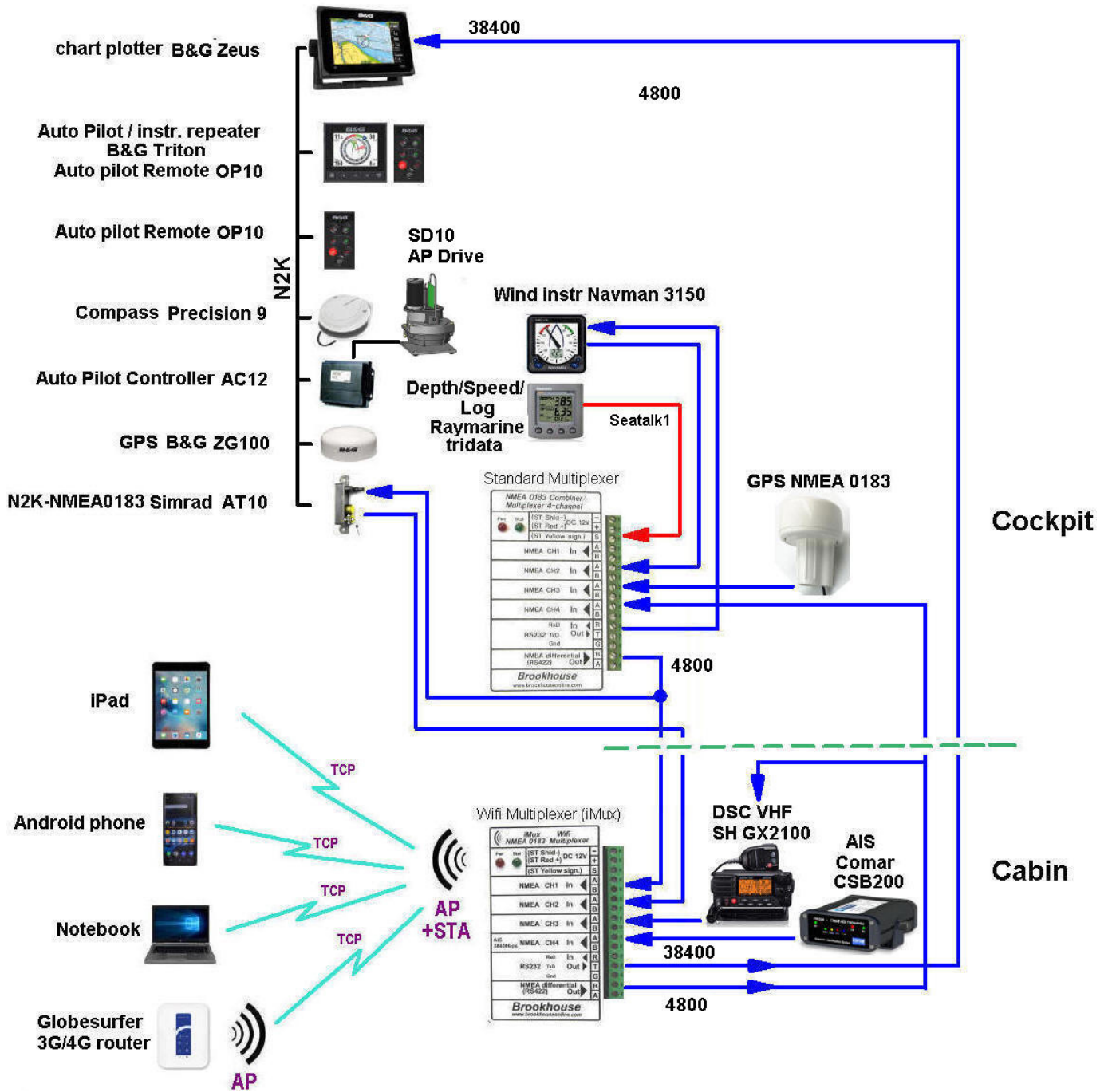


Electronics Ma Belle



Apologia

The electronics on Ma Belle consist of a mixture of NMEA 2000, NMEA 0183 and Seataalk1 instruments, all integrated using Brookhouse multiplexers and a Simrad AT10 NMEA 0183-N2K converter.

The equipment has not been inter-connected simply because "it can be done", but the design of the network is based on functional requirements defined prior to realisation. These requirements are dictated for an important part by the type of boat, the way the boat is being used, size of crew and by the cruising area:

1. 34' Sailing boat with wheel steering, sailed by skipper and 1 crew member most of the time.
2. Usually anchored for the night.
3. On longer passages steering mostly by auto pilot.
4. While cruising no shops or on-shore technical assistance readily available.

Functional requirements for electronics:

1. Chart plotter easily operable and screen well readable from behind the wheel.
2. All instrument data and AIS targets available on chart plotter screen.
3. Sailing instruments (wind, speed, depth etc.) and navigation data also viewable from cockpit seats.
4. Auto pilot easily operable from behind the wheel and also from cockpit seats.
5. Being able to switch off chart plotter to save power without losing other functionality, including steering by auto pilot and checking AIS targets.
6. Being able to use auto pilot in compass mode, track mode (to waypoint or along route) or wind angle mode.
7. Being able to use iPad as full featured chart plotter anywhere on the boat, including display of all instrument data and AIS targets independent from the chart plotter.
8. Full access to all instrument and navigation data from nav station inside cabin.
7. Sufficient back-up and redundancy if (part of) the electronics fail.

The above has been made possible by the following equipment and positioning thereof:

1. B&G Zeus chartplotter at steering position with all data sources and integrated auto pilot control screen for operating the AC12 auto pilot.
2. Auto pilot B&G remote keypad OP10 for operating the auto pilot behind the wheel while chart plotter is switched off.
3. B&G Triton instrument with OP10 remote keypad in port cockpit bulkhead for operating auto pilot and for display of navigation data while not behind the wheel.
4. Raymarine tridata (speed, log depth) instrument and Navman 3150 Wind instrument in cockpit bulkhead. Both were already installed when the boat was purchased and in good working order, so no reason to replace.
5. At chart table in cabin: Standard Horizon GX2100 VHF radio. Mounting bracket for iPad., Comar AIS transponder, Globesurfer 3G/4G router.
6. In port cupboard under stove: Precision 9 compass.
7. In port aft cabin: Simrad AC12 auto pilot controller and SD10 drive.
8. On cabin top: GPS B&G ZG100

9. On cabin top GPS NMEA 0183
10. Simrad AT10 NMEA 2000 - NMEA 0183 converter.
11. Under cockpit: Brookhouse standard NMEA 0183 multiplexer (see details below)
12. In cupboard at chart table: Brookhouse iMux (wifi) (see details below).

Technical description (connections and function)

The hybrid network consists of 2 inter-connected parts (Cockpit and Cabin) which can function together or separately and are also powered separately from the main switch panel.

The purpose of the N2K part of the network was originally the integration of the AC12 auto pilot controller, the Precision 9 compass and the B&G Triton instrument, which are a good match for the SD10 drive. No APxx head instrument is necessary in this setup. A nice feature of the B&G Zeus plotter is integral auto pilot control. The compact B&G OP10 auto pilot remotes were another reason for installing N2K. The addition of the B&G ZG100 compass seemed a logical extra step, as the boat can now be navigated and steered with N2K only if necessary. The Simrad AT10 takes care of the bi-directional connection between N2K and the 0183 network, including wifi.

There are 8 NMEA 0183 talkers, therefore two Brookhouse NMEA 0183 multiplexers are used for combining, routing, filtering and wifi transmission of NMEA 0183 data.

The sources, NMEA sentences, function and listeners are listed in the following table:

NMEA 0183 talkers

Device	NMEA sentences	Function/type of data (apart from display by instrument itself, if applicable)	Used by NMEA 0183 listeners	source baudrate
GPS	RMC, GLL, GGA, VTG, GSA, GSV	lat/long, SOG, COG, UTC, VAR, precision fix, satellite data (also backup for N2K GPS via AT10)	Simrad AT10 (for Zeus chart plotter and B&G Triton) iPad/iNavX iPad/NMEARemote Notebook/OpenCPN GX2100 DSC VHF	4800
Wind instr. Navman 3150	MWV, VPW	AWA, AWS, TWA, TWS	Simrad AT10 (for Zeus chart plotter and B&G Triton) iPad/iNavX iPad/NMEARemote Notebook/OpenCPN	4800
Raymarine ST60+ tridata (after conv to NMEA by mux)	VHW, VLW, MTW, DBT	STW for TWA and TWS calc., display on other devices.	Navman 3150 Wind Simrad AT10 (for Zeus chart plotter and B&G Triton) iPad/iNavX iPad/NMEARemote Notebook/OpenCPN	4800
Comar CSB200 AIS	VDM, VDO, RMC	AIS targets, GPS data automatic backup	Zeus chart plotter iPad/iNavX iPad/NMEARemote Notebook/OpenCPN	38400
SH GX2100 DSC VHF	DSC, DSE	position data from a DSC distress alert, position report or reply to a position request. Also converted to WPL (waypoint) by iMux	Zeus chart plotter iPad/iNavX Notebook/OpenCPN	4800
SH GX2100 DSC VHF	VDM	AIS targets. Backup for Comar	Zeus chart plotter iPad/iNavX Notebook/OpenCPN	38400
Simrad AT10 N2K-NMEA0183 converter. Sources: Precision 9 compass AC12 auto pilot controller	HDG, RSA	Compass heading. Rudder angle. (Other AT10 output filtered out)	iPad/iNavX iPad/NMEARemote Notebook/OpenCPN	4800
iPad/iNavX (Via wifi and iMux)	APB, BOD BWC, XTE, RMB, RMC GGA	Navigation data for auto pilot	Simrad AT10 (for AC12 auto pilot controller and B&G Triton)	4800

Data converted from SimNet/NMEA2000 to NMEA0183 (TX) and vice versa (RX)

NMEA0183 sentence	TX (max rate [Hz])	RX
APB	0.5	X
BWC	0.5	X
BWR		X
DBT		X
DPT	1	X
GGA		X
GLL		X
HDG	4	X
HDT	4	X
HSC	0.1	
MTW	0.2	X
MWV Relative Wind	1	X
MWV True Wind	1	X
RMA		X
RMB	0.5	X
RMC	0.5	X
RSA	3.33	
VHW	0.5	X
VTG	0.5	X
VTG	0.5	X
VLW	0.5	X
VWR		X
WPL		X
XTE		X
ZDA	0.5	X
ZTG		X

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Open cells indicates no transmission or reception.

NMEA 0183 Multiplexers

Brookhouse Standard NMEA 0183 Multiplexer (Cockpit)

Functions:

- a. NMEA 0183 conversion of Raymarine Seataalk1 protocol to NMEA 0183.
- b. Combine data from the following sources to a single data stream:
 1. Seataalk tridata.
 2. Navman wind instrument 3150
 3. GPS
 4. Nav data from iPad, output from iMux (for auto pilot track-mode steering)
- c. Output the combined data stream to:
 1. AT10 converter for entry into N2K network.
 2. Port 1 of iMux for combining with other data sources.
 3. To Navman 3150 for true wind speed / angle calculation

Brookhouse iMux - wifi NMEA 0183 multiplexer (Cabin)

Functions:

- a. Combine data from the following sources to a single data stream:
 1. Standard multiplexer (depth, speed, log, wind, GPS). (4800 baud)
 2. Output from AT10 (for heading and rudder angle). (4800 baud)
 3. DSC from VHF radio (4800 baud).
 4. AIS (38400 baud)
- b. Output the combined data stream (38400 baud) to:
 1. All wifi enabled devices.
 2. Zeus NMEA IN port mainly for AIS and DSC. (38400 baud)
- c. Output nav data from iPad and GPS data (4800 baud) to:
 1. Standard multiplexer for entry into N2K network to control autopilot from iPad for track-mode steering.
 2. DSC VHF radio.

Script iMux:

1. Test for presence of GPS (RMC) on input 1.
If found, **filter out** GPS data coming in via port 4 (AIS). If no GPS is found on input 1 (from GPS on standard mux), GPS data from AIS is let through. This effectively functions as an automatic GPS back-up switch.
2. **Filter out** NAV data from input 1. This is nav data received via wifi and sent from iMux NMEA OUT (4800) to port 4 of the standard multiplexer.
3. **Filter out** all NMEA data from AT10 (port 2) except heading and rudder angle.
4. Convert DSC-DSE sequence coming in on port 3 to waypoint (WPL) .

Setting baudrate conversion/channel block mask: **menu option 6, mask A**

This routes port 1, 3 and 4 (other than AIS) data to NMEA OUT (4800) if no data via wifi is being received.

B&G Zeus chart plotter

All data sources are N2K, except AIS and DSC, which comes in via NMEA 0183 IN (38400 baud). The NMEA 0183 data stream contains data from all instruments and NMEA 0183 GPS, so if N2K devices fail, NMEA 0183 sources can be selected in config instead.

Wifi transmission and reception

The Brookhouse iMux has been set up as an access point (AP) with NMEA 0183 server and supports station mode (STA) at the same time. Station mode is used for integration with the Globesurfer 3G router. The iMux associates with the router automatically if the router is switched on. This setup offers a high degree of flexibility: Wifi enabled devices (iPad, Notebook computer, Android phone etc.) can connect directly to the iMux or to the router to access the NMEA 0183 combined data stream. If the connection is made via the router, internet access is available without having to switch between access points. This is useful for reception of gribfiles, for weather forecasts, email, in-app purchases from nav apps, etc. Router NMEA access can be simply disabled from the iMux web interface through iPad or notebook if the router is switched off outside 3G coverage areas, to save DC power.

All communication is via TCP sessions, which is superior to UDP. TCP features error checking and retransmission to ensure no data is lost. The iMux supports 16 simultaneous TCP connections.

Navigation software running on wifi devices (in our case iNavX and OpenCPN) can send data back to the iMux for navigation purposes and to control the auto pilot for track-mode steering to a waypoint (GO TO) or along a route. Also waypoints can be transferred via this path.

Globesurfer 3G/4G router

Two main reasons for choosing the Globesurfer router were the external antenna connection and SIM card installed in a slot in the router itself. We use a high gain penta 3G marine antenna and Wilson booster to extend 3G range. The Globesurfer is feature-rich, including VOIP (voice over IP) and port forwarding.

Back-up and redundancy

If N2K fails:

The Zeus GPS and instruments source can be changed to NMEA 0183 to maintain full chart plotter functionality except auto pilot.

If Zeus fails:

Full functionality including auto pilot is still available via NMEA 0183 with iPad or Notebook as full-featured chart plotter.

If N2K GPS fails:

Zeus GPS source can be changed to NMEA 0183 or AT10.

If NMEA 0183 GPS fails, AIS GPS is enabled automatically or plug-in backup NMEA 0183 GPS can be used on input 3 of iMux.

If standard multiplexer fails, N2K network remains fully functional. Instruments data read out from head instruments, but without TWA of wind instrument.

If iMux fails, AIS can be plugged in directly to Zeus and full functionality of N2K network including AIS and instruments is maintained.