WHITE PAPER

ECDIS Hardware and the Integrated Bridge

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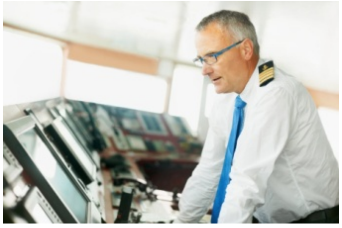
Overview



The International Maritime Organization's (IMO) mandate for a Electronic Chart Display and Information System (ECDIS) has established a new navigational paradigm, combining into a single display and control system all the modern navigational aids that large ships currently possess. ECDIS is such a revolutionary marine technology that the UK Hydrographic Office notes:

> *It is important to recognise that the transition from paper to electronic navigation is a fundamental change in the way ship navigation will be conducted, not simply a case of fitting another piece of hardware to ensure compliance with a carriage requirement.* [i]

While monolithic ECDIS solutions are available and may seem the most effective means of outfitting a bridge, the more effective technological approach is to treat ECDIS as the foundation of a fully integrated, modular bridge. That means building a system with modularized components that serve more than a single role, across multiple subsystems.

Technological Context of the ECDIS Transition

For the last two decades, even before the IMO began mandating the shift to ECDIS, modern technology has been driving a rapid evolution in bridge layout and design. Systems consolidation and redundancy are the currently operative concepts. Bridge crews today enjoy more control and navigational awareness than ever before, and ECDIS is now emerging as the end-point around which all this change is focused.

Certified ECDIS systems must conform to a broad collection of strict IMO regulations that will create a navigational system standardized across every ship and fleet. These regulations cover everything from the frequency of electronic chart updates to the color calibration of the display hardware.

What an Integrated Bridge Entails

For even the most basic ECDIS solutions, the integration of RS-232, -422, and -485, NMEA 0183, NMEA 2000 (N2K), Ethernet, and other signaling standards/protocols may all be involved. Integrating the bridge is clearly not a trivial task, so using highly interoperable, modularized components wherever one can is a priority, even though in some instances—as with the calibration of displays for high color precision—modularization is an extremely difficult criterion to meet.

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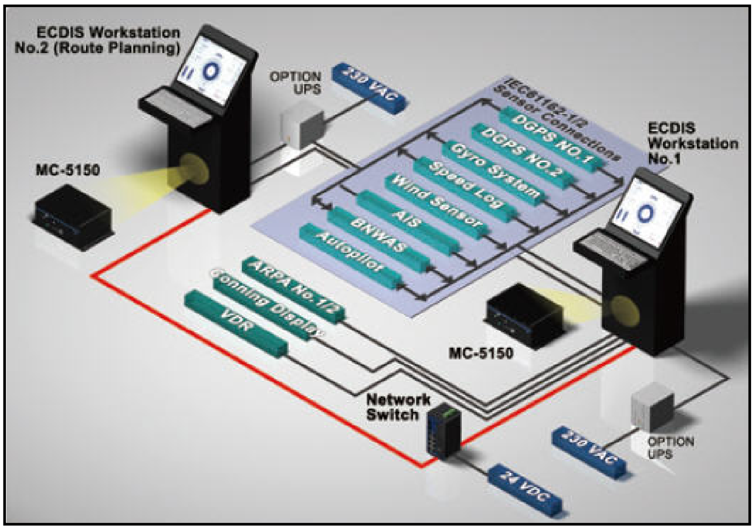
The American Practical Navigator, 2002 (2004) ("Bowditch") notes:

> *An Integrated Bridge System (IBS) is a combination of equipment and software which uses interconnected controls and displays to present a comprehensive suite of navigational information to the mariner…. [It] is designed to centralize the functions of monitoring collision and grounding risks, and to automate navigation and ship control. Control and display of component systems are not simply interconnected, but often share a proprietary language or code.*[ii]

According to Bowditch, an integrated ECDIS equipped bridge will, at the minimum, have two ECDIS stations, two radar/ARPA stations, a conning display, DGPS, speed measurement, an auto-pilot/gyrocompass, a VDR, and GMDSS.[iii]



What ECDIS Integrates

Many of these systems will require further redundancy. In addition, the bridge may further integrate communications, fire control, machinery control, status alarms, and cargo/loading controls,[iv] while ECDIS itself must integrate radar, AIS, wind, electronic navigation charts (ENC) and an ENC database, GPS, gyrocompass, echosounder, and the VDR.[v] Thus, depending on the ship, the burden of integration may be quite heavy, and the allure of purchasing a monolithic ECDIS solution may be strong.

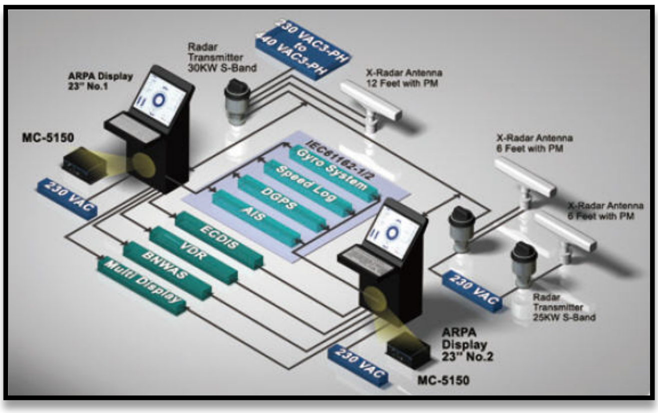
Technical Standards and Technical Capabilities

A modularized ECDIS design, however, offers substantial benefits that both system integrators and end users will appreciate. First, modularized components may be engineered to much higher standards of durability and efficiency. High quality industrial components cut maintenance and repair costs by significantly increasing MTBF, and further allow for easier hardware upgrades or more rapid repairs by simplifying replacement procedures. Second, the physical specifications for modularized components may be more carefully controlled than is the case for monolithic systems. High IP ratings, for instance, bring unquestionable benefits to any system, as do design features like thermal optimization and corrosion resistance, fanless cooling, heat and cold tolerance, or high vibration and shock tolerance.

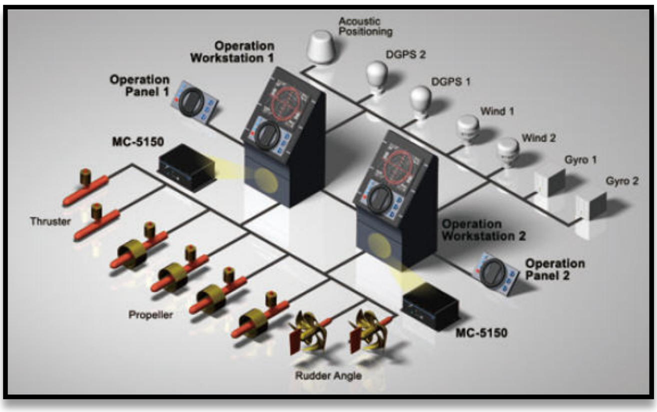
Of course, all shipboard systems must meet the basic marine specification IEC 60945; but to guarantee reliability and durability that should be considered only a modest minimum, not the ultimate standard.

The Value of Modularization: Bridge Processing Hubs

Over the next few years and up to 2018, commercial maritime fleets the world over are going to be upgrading and retrofitting every oceangoing vessel with ECDIS technology. This period will be an excellent opportunity for these same fleets to undergo complete bridge integration. Suppliers will be asked to create a central computing hub which will handle all of the processing for the entire ship; this will involve the interlinking of multiple interfaces running a wide variety of protocols, and computer redundancy for emergency operations should the main computing platform suffer a catastrophic failure. Ideally, the computers used to form the computing hub will come already engineered and assembled with serial, NMEA, and digital I/O interfaces. Multiple display outputs will also be necessary, so that redundant radar, conning, and ECDIS displays may also be easily supported, and since these graphics-heavy applications will be the vessel's primary nav systems, reliable, high performance processors will also be necessary. Only computers engineered with these specifications as standard features will be suitably called modular platforms.



A Fully Redundant Radar System



A Fully Redundant DPGS System

The Value of Modularization: Bridge Displays

For the displays, however, something more is needed. The easy part is the size: 19 inch screens are required for radar service, and an IP rating of 22 for protected or indoor marine devices (IEC 60945). For ECDIS, however, there are strict color calibration requirements that must be met, and this process presents several distinct challenges. First is the nature of the process, itself. Calibration is often done after the display leaves the manufacturer, on a system-by-system basis; this is because, since chipsets vary from computer to computer, a display must be calibrated in a different fashion for each processing hub it is paired with. Thus, calibration is be a time-consuming and resource-intensive task. There is a means of streamlining this process: manufacturers that invest in the correct tools and procedures may subject the displays to extensive in-house testing and calibration to create a universal calibration file—called an RGB file—for each display they create. This single RGB file will contain within it all of the calibration parameters required for every existing chipset.

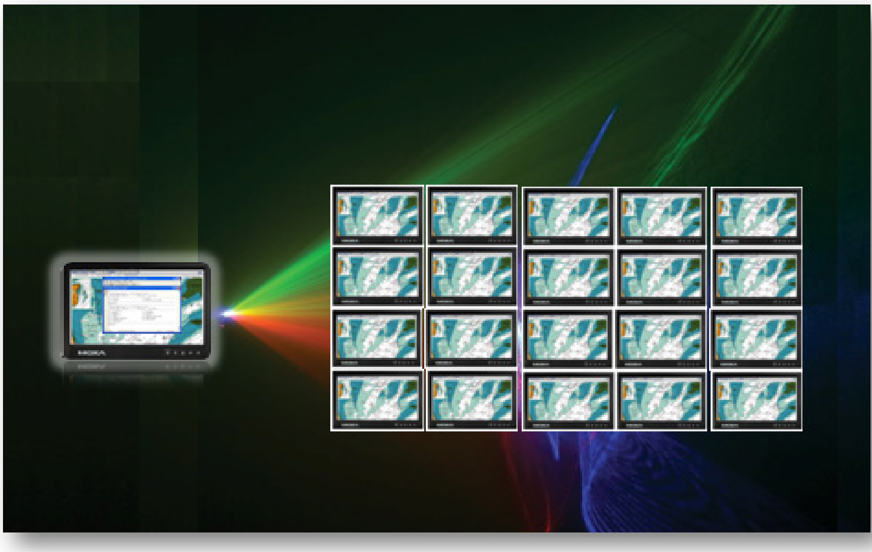
To generate this RGB file means a lot of painstaking engineering must take place even before the display is sold. To properly calibrate an ECDIS display for color accuracy, a very specific, scientifically precise control environment must be constructed, as defined by the International Hydrographic Organization (IHO) in its March 2010 publication, ***S-52 – Specifications for Chart Content and Display Aspects of ECDIS***.

In accordance with the ***S-52*** document, the colorimeter and optometer to be used in the process must meet a predetermined accuracy, and every aspect of the testing environment—from light absorbers, near-absolute darkness, and operator eyesight to the apparatus distance from the screen, device burn-in (48 hours), and initial set-up of black and white levels—must be carefully reproduced.[vi] Once the testing environment has been established (which can be a long process in itself), operators can expect the actual calibration procedure to take somewhere between 30 to 50 minutes before it is completed.

Performing this procedure for the customer before the sale is, of course, quite time consuming, especially since—in order to achieve a universal modularity—it must be done across all major video chipsets. However, the benefits the effort delivers to the customer are huge: where a typical ECDIS display must be hand-calibrated by specialists called in for this single task (or worse, be coordinated to the manufacturer on a case-by-case basis there), this universal RGB file allows ship technicians to bypass the initial calibration process entirely, effectively making each display a drop-in replacement for whichever role it needs to fulfill on the bridge, whether for ECDIS, conning, radar, or any other purpose.

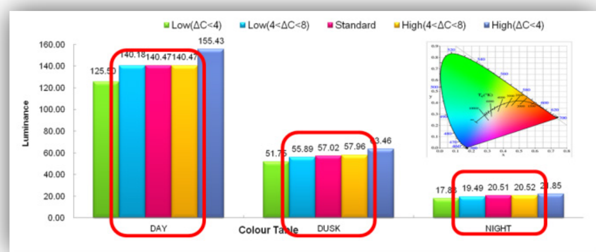
Further, the value of this method is not only at the initial installation and configuration stage, but continues as the monitor's color profile begins to shift with age. For displays that are roughly the same age, recalibration need not be something undertaken on device-by-device basis. Instead, after recalibrating a display to adjust a color profile that has shifted beyond the acceptable parameters, the RGB file may be downloaded from the display and then re-used in its sister devices. Again, device modularity becomes a key time- and money-saving virtue, and with the calibration process taking around half-an-hour per display, the savings are considerable when servicing a large number of displays.

Color calibration done in the traditional way involves an independent calibration for each monitor involved. This can quickly add up to many hours or days of work, across even small fleets. A universal RGB file can change that.

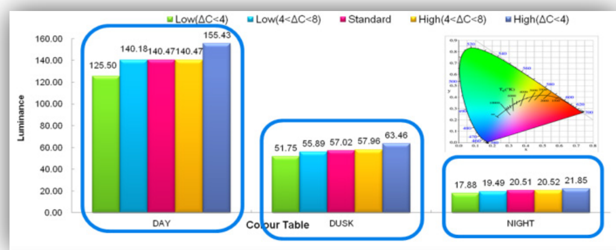


On appropriately engineered monitors, a new RGB file may be first created on a representative panel and then used to reset other displays from the same manufacturing run.

Moreover, devices manufactured to truly industrial specifications will surpass the basic ECDIS requirements for color variation, significantly increasing both the time needed before the device must undergo a recalibration as well as their overall MTBF. ECDIS requires that for any single display the color deviation (ΔC) from the benchmark CIE color table be no greater than 8 units of differentiation; yet devices engineered to the more exacting standard of 4 units provide a dramatically increased performance, all around: more consistent color rendering, at greater luminance variation, for a longer period of usage before shifts in color accuracy due to age or hardware decay force a recalibration.



*The International Hydrographic Office's **S-52 color variation tolerances** for displays are only calibrated to 8△C units or under.*



Big improvements in performance and device durability may be obtained by engineering displays to within 4△C units.

While ECDIS represents the culmination of several decades of consensus, there is clearly a lot of room for innovation and careful design to offer significant value to the customer. The three facets of industrial-grade durability and design, innovative display technology, and integrated device modularization offer substantial savings for both system integrators and end users alike. By using innovative methods to achieve a universal color calibration file and NMEA integration, device interoperability for both computing hub and displays is significantly increased, streamlining and facilitating the integration and maintenance of system components. Similarly, by enforcing a more exacting standard for color calibration and device durability the overall mean time before failure for both the computing hub and displays is increased significantly. The value these engineering achievements offer ECDIS manufacturers and integrators (as well as ship owners and operators) is certain and undeniable.

As 2013 dawns, the ECDIS transition for established fleets is kicking into high gear. Going forward, all new ships will leave the docks with the latest, most integrated bridges, with ECDIS navigation stations at their core. Older vessels, however, will need more carefully tailored solutions, that will be designed to fit their own needs and bridge space, rather than the other way around. This will require more flexible, easily deployed systems than what is offered by monolithic ECDIS solutions. With our innovative approach to ECDIS display calibration and the integration of our widely used NMEA interfaces into an industrial-grade computing hub, Moxa offers ECDIS designers and maritime system integrators an excellent foundation upon which any number of systems may be assembled, in whatever variety required, on a case-by-case basis. As ECDIS moves from the future into the present, Moxa devices—durable, dependable, capable, and convenient—represent an excellent first step towards the next generation of integrated bridges and ECDIS navigation.

For further information on how Moxa's marine technology can better integrate your bridge and aid in ECDIS deployment, visit our website at www.moxa.com.

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Credits/Sources

[i] *10 Steps to ECDIS Mandation*, Admiralty Charts and Publications, The UK Hydrographic Office, Somerset, England, 2011, pg. 4. < http://www.ukho.gov.uk/ProductsandServices/ElectronicCharts/Documents/10_steps.pdf> Website last accessed January, 2013

[ii] National Imagery and Mapping Agency, "Integrated Bridge Systems" in *The American Practical Navigator*, 2002 Bicentennial (2004) Edition, Bethesda, Maryland, U.S.A.: Ch. 14, Sec. 14, pg. 207 <http://en.wikisource.org/wiki/The_American_Practical_Navigator/Chapter_14#1400._The_Importance_of_Electronic_Charts> Website last accessed January, 2013

[iii] Ibid.

[iv] Ibid. pg. 208

[v] Ibid.

[vi] *S-52 – SPECIFICATIONS FOR CHART CONTENT AND DISPLAY ASPECTS OF ECDIS*, 6th Ed, 2010, International Hydrographic Organization, International Hydrographic Bureau, Monaco: Section B.2.1, ppg 60-61; http://www.iho.int/iho_pubs/standard/S-52/S-52_e6.0_EN.pdf