Outdoor Display Primer

How to select the best notebook display for your mobile application

by Geoff Walker

Are you in the market for a standard notebook that you can use both indoors and outdoors? If so, you're in a very small minority of notebook buyers. The low demand for outdoor-readable notebooks results in a very limited number of products on the market. Nevertheless, there are some available, and this article will help you make an educated selection.

Notebook vendors use two different LCD technologies to achieve outdoor readability – anti-reflective (AR) treated transmissive, and transflective. Understanding the strengths and weaknesses of these two technologies is important when selecting an outdoor-readable notebook. Screens in these two technologies are available in two different resolutions, which also has an effect on outdoor readability.

Transmissive Technology

Transmissive technology achieves outdoor readability by applying an anti-reflective (AR) treatment to the screen so that the amount of ambient (outdoor) light that's reflected doesn't overwhelm the backlight, thus allowing the image on the screen to be seen. Indoors, the AR treatment has no effect, so the screen looks the same as any other notebook screen, with full brightness and color saturation.

Table 1: Screen readability for AR-treated transmissive versus transflective notebook LCDs under varying lighting conditions

Light Condition	Transmissive	Transflective
Total darkness	Excellent	Very Good
Normal indoor light	Excellent	Good
Heavy overcast outdoors	Very Good	Poor
Shaded bright outdoors	Good	Fair
Direct sunlight	Fair	Good

Table 2: Notebooks under 11 pounds with outdoor-readable screens

Vendor	Model	Ruggedness	Weight	LCD Size	Resolution	LCD Type
Amrel	Rocky Matrix (1)	Rugged	10.8 lbs.	13.3 in.	XGA	Transmissive
				12.1 in.	SVXGA	Transmissive
Getac	W130 (3)	Rugged	5.9 lbs.	12.1 in.	SVGA	Transmissive
				12.1 in.	XGA	Transflective
Itronix	GoBook	Rugged	7.5 lbs.	12.1 in.	SVGA	Transmissive
Itronix	GoBook II (1)	Rugged	7.9 lbs.	12.1 in.	XGA	Transmissive
				12.1 in.	SVGA	Transflective
Itronix	GoBook MAX	Ultra-rugged	6.2 lbs.	10.4 in.	SVGA	Transmissive
				10.4 in.	SVGA	Transflective
Motorola	ML800	Rugged	5.5 lbs.	10.4 in.	SVGA	Transflective
Motorola	ML850	Rugged	6.2 lbs.	12.1 in.	SVGA	Transflective
Motorola	ML900	Rugged	9.0 lbs.	12.1 in.	SVGA (4)	Transflective
NEC	Versa E120 DayLite	Commercial	3.1 lbs.	10.4 in.	XGA	Transflective
Panasonic	Toughbook 18 (TPC)	Semi-rugged	4.5 lbs.	10.4 in.	XGA	Transmissive
Panasonic	Toughbook 28 (1)	Semi-rugged	9.0 lbs.	13.3 in.	XGA	Transmissive
				12.1 in.	SVGA	Transmissive
Panasonic	Toughbook 29	Semi-rugged	7.9 lbs.	13.3 in.	XGA	Transmissive
				12.1 in.	SVGA	Transflective
Panasonic	Toughbook 34	Semi-rugged	3.8 lbs.	08.4 in.	SVGA	Transmissive
				08.4 in.	SVGA	Transflective
Panasonic	Toughbook 73 (2)	Commercial	5.5	13.3	XGA	Transmissive

Note (1): These models were reviewed in Issue #48 of Pen Computing
Note (2): This model was reviewed in Issue #50 of Pen Computing
Note (3): This model was reviewed in Issue #51 of Pen Computing
Note (4): The 12.1" transflective XGA on Motorola's ML900 datasheet is an error (it's really SVGA)

The brighter the outdoor light, the worse an AR-treated transmissive screen looks. In direct sunlight, it can be quite difficult to read. High-contrast images, such as black text on a white background, are still relatively easy to read, but images containing a range of subtle tones (such as photographs) are very difficult to see clearly in direct sunlight. As the outdoor light gets brighter, the AR treatment sometimes causes a color shift. This makes applications that require accurate color reproduction more difficult to use outdoors on an AR-treated transmissive screen.

Effective use of an AR-treated transmissive screen outdoors requires finding a way to shade the screen from direct sunlight. In any kind of shade, even the shade from your own body, the screen is very readable. The worst condition for an AR-coated transmissive screen is full sunlight when there's no way to shade the screen. In heavy overcast, early morning or late afternoon, an AR-coated transmissive screen is much more readable than a transflective screen.

Transflective Technology

Transflective technology achieves outdoor readability by compromising both indoor and outdoor readability. A transflective LCD transmits only a portion of the light from the backlight, which makes the screen appear dimmer and lower-contrast indoors than a transmissive screen. Viewed side-by-side indoors, you'll always prefer a transmissive screen over a transflective screen.

A transflective LCD reflects only a portion of the ambient outdoor light that hits it. The brighter the outdoor light, the better the screen looks (because more light is reflected). As the light becomes brighter, colors become more clearly distinguishable and more saturated – although they never look as good as on a transmissive screen indoors. A transflective screen looks best outdoors with direct sunlight on the screen. However, because the screen is acting like a partial mirror, if you position the screen so that it reflects the image of the sun directly into your eyes, the glare is blinding. You must position the screen at just the right angle so that it receives direct sunlight without reflecting the image of the sun. This limits the usefulness of a transflective screen to some extent.

The worst conditions for a transflective screen are outdoors in heavy overcast, early in the morning, or late in the afternoon. The ambient light in these conditions is bright enough so that the backlight has little or no effect, but not bright enough for good reflection from the screen. You'll have to strain to read a transflective screen in these conditions.

Table 1 summarizes the effect of LCD technology on screen readability in various lighting conditions.

Resolution

Outdoor-readable notebook screens are available today in two resolutions – XGA (1024 x 768) and SVGA (800 x 600). Sizes range from 8.4" to 13.3". For AR-treated transmissive screens, the resolution does not affect outdoor readability at all. But with transflective screens, outdoor readability is significantly affected by resolution. In general, higher resolution screens are less readable (less bright) outdoors than lower resolution screens. This is due to the way a transflective screen is constructed (higher resolutions have a smaller aperture ratio, which allows less light to be reflected outdoors). Because of this, there are very few XGA

transflective LCDs on the market, which means that most transflective screens offered in notebooks today are SVGA rather than XGA (see Table 2).

However, there is another very important aspect of resolution that must be considered – usability. The standard for Windows applications today is XGA. While most applications will work on an SVGA screen, horizontal scrolling may be required – which is a significant nuisance. This is especially apparent when viewing web pages, many of which are designed for XGA. Also, with an SVGA screen, viewing multiple large windows is impractical – there just aren't enough pixels. SVGA in notebooks is very close to end-of-life. DisplaySearch, a market research firm, predicts that SVGA's market share in notebooks will drop to zero at the end of 2003. Buying a notebook today with an SVGA screen represents a definite risk – it's not future-proof.

Decoding the Datasheets

Unfortunately, there is no standard vocabulary to describe the outdoor readability of a TFT LCD notebook screen, so comparing product specifications can be difficult. However, if you don't see any of the following terms, you can be reasonably sure that a particular screen is not usable outdoors: sunlight-readable, daylight-readable, outdoor-readable, anti-reflective, anti-glare, high-brightness, transflective, illuminated reflective, Alpha-Star or ColorVue (the last two are vendor trademark names for outdoor readability).

Most notebook vendors use "sunlight-readable" to describe transflective screens, since they look better as the sun gets brighter. However, NEC uses "outdoor-readable" and "illuminated reflective" to describe transflective. Most notebook vendors use either "outdoor-readable" or "daylight-readable" to describe AR-treated transmissive screens, since they look worse as the sun gets brighter. However, Amrel uses "sunlight-readable" to describe AR-treated transmissive.

Notebook vendors use "anti-reflective" (AR) and "anti-glare" (AG) interchangeably, even though technically they're slightly different. From the user's point of view, they mean the same thing – they're both a method of reducing the amount of ambient light that's reflected from the screen, which in turn makes the backlight seem brighter. This apparent increase in backlight intensity is usually what's meant when a notebook vendor uses the term "high brightness" to describe a transmissive LCD. However, in the case of transportable (non-mobile) equipment such as LCD monitors, "high brightness" really does mean increased backlight intensity, usually achieved by adding more backlight bulbs (which substantially increases power consumption).

The resolution of an outdoor-readable screen option may not be immediately apparent on some notebook datasheets. Most standard transmissive (indoor) notebook LCDs are XGA resolution, but as noted above, most transflective notebook LCDs are SVGA. You may have to look in the fine print or on a separate "Options" datasheet to learn that a notebook billed as XGA is actually SVGA when purchased with an outdoor-readable screen. Caveat emptor!

Vendor trademarks such as "ColorVue" for outdoor readability are essentially valueless, since not even the vendors who own the trademarks use them consistently. At best, when they're present they're an indication of some form of outdoor readability. Similarly, the term "glare-free" used by some notebook vendors is essentially meaningless, since it's impossible to eliminate 100% of the glare (reflected light) from a screen. Finally, some notebook vendors characterize their transflective screens as "high contrast", which is also relatively meaningless, since all transflective TFT notebook screens have approximately the same contrast.

Make Your Selection

If your application is more indoors than outdoors, and if you can find a way to shade the screen when you're outdoors, you'll be happier with an AR-coated transmissive screen. If your application is more outdoors than indoors, and you must work a lot in direct sunlight with no shade, you'll be happier with a transflective screen. If you select a notebook with a transflective screen, SVGA will look better but an XGA screen will work better with Windows today and in the future.

Products

In today's notebook market, ruggedness and outdoor viewability go hand-in-hand. Standard commercial notebooks are typically used by knowledge workers, road warriors and corridor cruisers – all of whom work almost totally indoors. As a result, there is only one outdoor-readable notebook among the 100+ models of standard commercial (non-rugged) notebooks on the market – the NEC Versa DayLite, and it's approaching end-of-life with no replacement in sight. In contrast, rugged notebooks are frequently used outdoors, so most rugged notebooks offer at least an option for an outdoor-readable screen.

Table 2 lists all the notebooks the author could find that offer outdoor-readable screens and weigh less than 11 pounds. (Eleven pounds is an arbitrary cutoff point that eliminates notebooks aimed mostly at the military market.) Of the 14 notebooks in Table 2, all but two are rugged (see Table 3 for a definition of the ruggedness levels used in Table 2).

Table 3: Notebook ruggedness levels used in Table 2

Characteristic	Commercial	Durable Commercial	Semi-Rugged	Rugged	Ultra-Rugged
No ruggedization of any kind	X				
Shock-mounted hard disk		X	X	X	X
Magnesium display housing		X			
Full magnesium housing		Some	X	X	X
Spill-resistant keyboard		Some	Some		
Sealed keyboard			Some	X	X
Sealed connectors and ports			X	X	X
Vibration-resistant LCD mounting			Some	X	X
Designed using MIL-STD procedures			X		
Designed and tested to MIL-STD 810F				X	X
Extreme environmental specifications					X
Ingress Protection (IP) rating	None	None	None to 52	51-54	65-67

Editor's Choice

Panasonic is the clear leader in the outdoor-readable notebook market, with five models offering seven choices of screen size and technology. In the author's opinion, the "best" notebook in Table 2 for general-purpose use is the Panasonic Toughbook 37. Its "durable commercial" design is rugged enough for most uses, so it doesn't incur the higher cost of a semi-rugged or fully rugged design. It has a touchscreen, the largest available outdoor-readable XGA screen (13.3") and a very competitive weight (5.5 pounds). The technology used to achieve outdoor readability is AR-treated transmissive, which is more suitable for general use than transflective. Finally, the Toughbook 73's main specifications are very attractive: Intel Pentium M at 1.4 GHz, integrated Centrino WiFi wireless, 256 MB DRAM expandable to 1 GB, 40 or 60 GB hard disk, removable DVD/CD-RW, ATI Mobility RADEON 7500 video with 64 MB of VRAM, 3.5 to 5.5 hours of battery life and a 3-year warranty. The only downside is the cost – street prices found on the web for the Panasonic Toughbook 73 in January 2004 ranged from $2,900 to $3,700 (MSRP is $4,400). If you want a state-of-the art notebook with an outdoor-readable screen, the Panasonic Toughbook 37 is the clear winner.

–Geoff Walker

Table 4: Vendor Websites

Vendor	URL
Amrel	http://www.amrel.com/asi_intromatrix.html
Getac	http://www.getac.com/product/W130/W130Home.htm
Itronix	http://www.itronix.com/products/notebooks.asp
Motorola	http://ruggedpower.motorola.com/
NEC	http://www.necsolutions-am.com/mobilesolutions/products/Versa/E120_DayLite
Panasonic	http://www.panasonic.com/computer/toughbook/tb_models.asp