10. IPS/PLS TFT panel with high brightness and all-round viewing angle

In OR and on ICU/IMC a special emphasis needs to be placed on optimal image representation. On the one hand, users often cannot position themselves in an optimal angle to the screen, which creates the demand for an all-round viewing angle (horizontal 178° and vertical 178°). In particular, the often high mounting on the ceiling supply units requires an optimal display even at viewing angles from below. In addition to the actual viewing angle, colour shifting also plays an important role, since e.g. various shade of red may signal different disease states, which is for example used in endoscopy. Here, only panels based on IPS (LG) and PLS technology (Samsung) achieve acceptable representations over a wide viewing angle. Panels with TN or MVA technology show significant weaknesses even at otherwise good viewing angles.

11. ULV processors

The completely enclosed design requires the power consumption of the units to be kept as low as possible in order to achieve a long service life. Therefore, it is strongly recommended to use power-saving ULV processors, because the processor is the component with the largest power consumption. From a manufacturer's point of view, it is imperative to request a thermal design power (TDP) of <= 15 W. The Core i5 and i5 mobile and desktop processors are more powerful, but have a TDP of at least 35 W and are, therefore, unsuitable for fully enclosed devices.
A maximum internal temperature of <50°C (preferably <45°C) is required for continuous operation in real conditions of use to ensure a long service life in 24/7 operation. Indoor temperatures above 60°C are not permitted.
The power consumption of the device should be measured as part of the evaluation and should be an important criterion in the evaluation.
Attention: The previous 4th and 5th generations of the i3-/i5/i7 processors with a similarly low power consumption are significantly less efficient, similarly to various Atom processors. On the other hand, the announced 7th generation has hardly any advantages because of the TICK/TOCK strategy from Intel.

Comments: While an i3 processor of the same series is significantly less powerful than the corresponding i5, the power difference to the i7 (with a high surcharge!) is rather moderate.

Guiding principle: As a statement about the service life of electronic components in connection with their temperature, the following mnemotechnic verse can be used: The expected lifetime is halved for every 10 K temperature increase.

12. mSATA instead of SSD

The SSD as a direct successor to the hard drive is connected via cables to the classic SATA interfaces. Alternatively, the use of newer mSATA modules may be preferred, which are assembled without error-prone cable connections directly via an mSATA slot.

13. Screen-off button

In intensive care units, the PCs are often used in continuous operation. A separate switch-off facility for backlighting not only avoids disturbing patients at night but also prolongs the life of the device and protects the environment.

14. Long-term availability of components

The devices are to be used over a long period and, if necessary re-buys or repairs with replacement of components within this period will be required. It is, therefore, necessary that the individual components satisfy the requirement for long-term availability (> = 7 years). This is particularly true for the motherboard, to ensure image stability.

15. Internal power supply

An internal medical power supply with wide range input (AC/DC or, if desired, DC/DC) is required, since external power supplies require additional mounting solutions and cables and the hygienic situation could deteriorate or increased cleaning effort will be required.

16. Standardised VESA 100 Recording

An integrated VESA-100 standard mounting interface simplifies installation and allows for the use of standard accessories.

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Important Features of Panel-PC for OR and ICU/IMC

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16 Important Features of Panel-PC for OR and ICU/IMC

1. Completely enclosed housing without ventilation holes

The devices regularly undergo wet disinfection in the hygienically critical areas. To prevent the penetration of germs and liquids during disinfection, a completely enclosed construction without vents is strongly recommended.

2. Fanless design

Cooling with fans is reasonable only when large amounts of air can be moved outwards from the inside, since air itself has a poor thermal conductivity coefficient. In this respect, the absence of ventilation openings in the housing also makes the use of internal fans almost ineffective. However, when noise (e.g. in the case of installation near the head of the patient in the ICU/IMC) and the need for maintenance (a rotating part with higher probability of failure) are taken into consideration, the elimination of rotating internal fans is strongly advised. In the sterile area above the operating table, devices with fans can interfere with the functioning of the germ-reducing laminar flow ceilings.

3. Metal housing

Points 1 and 2 inevitably lead to the sole use of metal enclosures. Among metals, aluminum offers the best ratio for price-to-weight thermal conductivity and is, therefore, also widely used for such applications in the industry.
Inexpensive housing made of plastic materials is not suitable for physical reasons, since the thermal conductivity of these materials suggests that they should rather be used as heat insulators.

Metals	Thermal conductivity λ in W/(m · K)
Silver	429
Copper, pure	401
Copper, merchandise	240...380 [8]
Copper alloys (Sn, Zn, Ni, Pb)	30...110 [9]
Gold, pure	314
Aluminum (99.5%)	236
Aluminum alloys	75...235 [10]

Due to the energy conservation rate, the use of plastic housing leads inevitably to higher internal temperatures and thus (also inevitably!) to higher failure rates.

Plastics	Thermal conductivity λ in W/(m · K)
Polyethylene terephthalate (PET)	0.24 [12]
Compact polyurethane (PUR)	0.245 [13]
Polyimides (PI)	0.37...0.52 [12]
Polyetherimide (PEI)	0.24 [13]
Polytetrafluoroethylene (PTFE)	0.25 [12]
Polyvinyl chloride (PVC)	0.17 [12]
Polyamides (nylon, perlon)	0.25...0.35 [12]
Polypropylene (PP)	0.23 [12]
Polycarbonate	0.20 [12]
Epoxy resin (EP)	0.20 [12]
Polymethyl methacrylate (PMMA, Plexiglas)	0.19 [12]
Polyethylene (PE)	0.33...0.57 [12]
Polystyrene (PS)	0.17 [12]
Polysiloxanes (silicone)	0.2...0.3

Moreover plastics tend to fade and become brittle, especially when exposed to chemicals (disinfectants).

4. Weight

The only practical disadvantage of metal housing is the high specific weight of the material. It is therefore advisable to set a weight limit, as mounting solutions are always designed for a maximum load. Overload eventually leads to manifestations of fatigue and increases the risk of fracture. Many systems are designed for a maximum of 12 kg. Since, in addition to the weight of the device, keyboard solutions or the necessity of supporting the operator on the device must also be considered, the weight of the terminal is recommended to be limited to a maximum of 8–10 kg. The permissible weight for the mounting solution is also usually stated on the mounting plate, which is why any leverage effects that may occur must be considered.

5. Protective glass made of aluminosilicate glass

In the standard DIN EN 60601-1, the requirement for high impact resistance is established for the entire device, which is why the sensitive TFT modules must be protected from external effects by means of pre-installed glass panes. It is recommended to use modern aluminosilicate glass which has a fivefold higher impact and scratch resistance than regular soda-lime glass (float glass). These glass grades have been specially developed for touch screen applications and have a better chemical conductivity and better suitability, especially for touch systems, due to their different chemical composition. Due to the more modern production process, the glass panes are extremely flat and distortion free. Touch performance is further improved.

Popular brand names of such modern glass types extensively used in mobile telephones and tablet PCs, are: **Gorilla-Glass** (Corning: http://www.corninggorillaglass.com), **Xensation** (Schott: http://www.schott.com/xensation/german/products/xcover/keybenefit.html) and **Dragontrail** (Aashi: http://dragontrail.agc.com/en/#top) among others. The reduced weight due to the thinner design of the protective glass pane with improved properties (0.5–1 mm instead of 3–4 mm) offers additional advantages.

6. Anti-reflection coating

Operating theatres and intensive care units often use very strong sources of light. Improved readability thus requires an antireflection coating (AR). This should not only be well-coated, but also very hard (scratch-resistant) and exposable (constantly disinfected) in order to ensure a long service life. For touch applications, an oleophobic coating is strongly recommended, which is highly water-repellent and effectively reduces fingerprints etc. on the glass. This is often called Anti-Fingerprint (AF) coating. For industrial applications, anti-glare (AG) surface treatments are often used which achieve a matte finish by etching, but this is accompanied by a reduced quality of the display. It is not recommended for display of images and video, but rather for use in operator terminals.

7. Protective glass made of antibacterial glass (NEW)

New on the market is a genuinely antibacterial glass (AntiMicrobial = AM) manufactured by the American manufacturer Corning. During the hardening process silver ions (Ag +), which have been shown to have a strong antibacterial effect, are introduced directly into the glass. In contrast to all previously known coatings, this one is not subsequently applied, but is firmly bonded and thus becomes a property of the glass itself. Thus the threat to the operator resulting from "tapping" the disinfecting layer and creating a reduction in effectiveness is excluded. It has even undergone FDA approval. Only available with AG and only up to the size of 21.5".

8. Antibacterial paint and all-glass protective glass panel

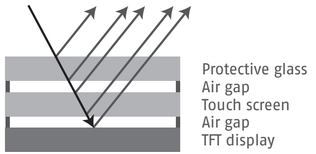
CTo reduce the germ load, it may also be necessary to use antibacterial coating for the housing. Furthermore, antibacterial glass is also useful since, for example, cross-contamination can be hazardous, especially when using touch-screen operation. Glass types in which the material itself is inherently antibacterial are recommended, since coatings are naturally tapped or scratched and lose their effect. A complete front panel is recommended to be created as an all-glass front with no mounted frames in order to avoid crevices in which germs could accumulate. All housing sides should, for hygienic reasons, be as smooth as possible and have as few textured/jagged edges as possible.

9. Bonding the protective screen

However, the air gap between the panel and the protective screen leads to significant loss of quality due to the additional reflections on the separating surface facing the pane, in particular from lateral viewing angles. With the modern technology of bonding, and the full-surface bonding of the protective screen to the panel, this problem can be solved.

- Better readability without higher power consumption: By gluing the glass panes, the refraction of light is reduced and the contrast is increased; the brilliance increases considerably, especially from lateral viewing angles
- No condensation or misting: By avoiding an air gap between the glass panes, no moisture can penetrate and settle
- No contamination: By avoiding an air gap between the glass panes, no dust and dirt particles can penetrate
- High vibration and shock resistance: A bonded display is more stable and more resistant to mechanical loads.
- Improved heat dissipation (up to a factor of 8): By closing the insulating air gap between the glass panes heat can be dissipated through the front panel to the outside
- Due to the smaller distance display to the front, the unsightly tunnel effect is avoided and an outstanding visual impression is made possible.
- The complete bonding makes it possible to abandon mounting solutions for the display module and thus makes lighter and thinner devices possible
- The fully automated optical bonding achieves manually unachievable tolerances in the orientation of the display to the edge (e.g., 0.025 mm).

Reflection caused by light refraction at each air gap



Reflection minimised by removing the air gaps with optical bonding