

Drive & Control profile

Key Considerations for Cleanroom Conveyors



Cleanroom specialists can help develop an optimum approach for cleanroom conveying—including appropriate specifications—as well as for other aspects of clean manufacturing processes.

The case for modular conveyors

Cleanroom production lies at the heart of many of the world's leading industries. These include pharmaceutical, medical, semiconductor—and, if current events are any guide, solar power, now just beginning to emerge as a worldwide technological mainstay. The clean industrial environment can encompass the entire assembly/manufacturing process, leaving only packing and shipping to be done in a

non-cleanroom area, or the manufacturer can isolate only certain facets of the process as a cleanroom environment. Increasingly, the trend has been toward the latter approach, due to cost savings and flexibility—a solar panel manufacturer, for example, may have production processes with cleanroom requirements ranging anywhere from Class 1 to Class 100,000. The simplest way to do this is

Cleanroom-rated Aluminum Framing for Conveyor Enclosures

Bosch Rexroth offers a series of modular aluminum framing components designed for cleanroom applications and other contaminant-sensitive environments. As an alternative to welded steel components, the modular aluminum cleanroom profile product line saves time and money in configuration. The system uses easy-to-assemble, bolt-together construction for maximum configurability.

Independently cleanroom-tested by the Fraunhofer Institute for Production Technology and Automation, this series includes smooth surfaced aluminum extrusions and aluminum cover strips that eliminate particle traps and minimize outgassing in cleanroom structures. Additionally, a wide range of accessories designed to ensure maximum air flow with minimum turbulence lets users build numerous cleanroom components such as conveyor enclosures.

to take a modular approach, in which each manufacturing step requiring a clean environment is treated as a self-contained process. Each process station can then be operated within the appropriate cleanroom specifications. In solar panel assembly, for example, wafer production, cell production, and module

approach helps manufacturers employ rapid and proactive methods to meet the demands of new developments.

Along with flexibility, modular conveyors can help manufacturers achieve the goal of cost savings through isolation of specific processes within cleanroom

and sealed blister packaging. Depyrogenation of pharmaceutical glassware (e.g., vials, ampuls) is made more efficient through the use of a conveyor within a clean-environment tunnel. The use of separate cleanroom areas within the same plant can also help prevent cross-contamination between pharmaceutical products and batches. The medical supply industry has applied similar, process-based cleanroom techniques to ensure sterile bandages, syringes, gauzes, razors, chemistry analysis kits, and surgical instruments. In the semiconductor industry, 300 mm wafer fabrication has been isolated in environments so clean that even stray ions—as well as dust and organisms—must be prevented from contact with the wafer. The key in all these cases is that stringent cleanroom specifications

Table 1. Typical Solar Process Cleanroom Requirements (U.S. classifications)

Process	Typical Class Requirement Ranges
Wafer Production	Class 1 to 1,000
Cell Production	1,000 to 10,000
Module Production	1,000 to 10,000

production all have different cleanroom requirements (Table 1). These requirements further vary within each production area, depending on the process.

conditions. In the pharmaceutical industry, these processes can include ovens for dehydration of pharmaceutical solutions, pill compression, bottle filling,

The most logical approach to handling product within a clean modular-type assembly process is to use modular conveyors. Modular conveyors are commonly used in conjunction with standard cleanroom components, such as HEPA filters, cool zone sterilization, and hermetically sealed entry/exit gates to minimize the risk of product exposure to the environment outside each module. Modular conveyors, which are made from bolt-together components and aluminum framing, provide a high level of flexibility. In industries where production needs can suddenly change, or where sudden innovation is common (e.g., the solar industry), the modular



The modular approach to cleanroom conveying offers numerous advantages for manufacturers such as increased flexibility, reduced costs, and the ability to take a more proactive approach to changes in technology or levels of demand.

need only be applied to the operations that need them—not to the entire manufacturing process.

The same concepts are taking hold in the emerging solar industry, where U.S. production is apparently ready for an enormous leap forward in response to demand. In Europe, where demand is already climbing and the solar industry is more established, modular conveyors are already commonly used in the production of wafer-based and thin modules. The use of a modular conveyor makes it easier to reconfigure the production process in response to (or anticipation of) future demands. Demand for solar power components in the U.S. is likely to increase soon—and so is the use of modular cleanroom conveyors.

What modular conveyors should do

The most critical requirement for a modular conveyor in a cleanroom environment is, of course, its specification. Conveyors rated to class 100,000 are readily available, but for processes requiring true contamination control, class 100,000 is well out of range. Indeed, a truly sensitive process will require a vastly stricter specification (down to class 1 in some cases, such as semiconductor manufacture), while other processes in the same facility require only class 100 or 1000. This wide range of cleanroom requirements can present a challenge in terms of conveyor system planning and layout. In addition to contaminants, a modular cleanroom conveyor must



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also protect materials from damage caused during the manufacturing process itself—including, potentially, the conveyor itself.

Modular conveyors should also be truly modular in design: Pre-assembled, and available in

a wide variety of section lengths and widths appropriate to the application. Some applications require materials to travel several inches, while others require materials to be conveyed several feet, or even farther. Conveyor width is also crucial, especially



In the solar industry, production methods for processes such as stringing and lay up, vary greatly from one solar panel manufacturer to the next. As a result, solar industry requirements often generate a variety of custom conveying/material handling requirements.



Beyond the conveyor itself, all potential sources of environmental contaminants should be considered.

in the solar industry. Conveyors must be able to accommodate a wide variety of size requirements, ranging from wafers the size of a CD-ROM to frameless, thin film panels that average 1100mm x 1300mm in size.

What to look for—and avoid—in specifying a cleanroom conveyor

Both European and United States regulators have applied considerable resources to answering the question “What is ‘clean’?” The spectrum of U.S. cleanroom classes for typical manufacturing applications runs from class 100,000 (an environment with $\leq 100,000$ particles of 0.5 micrometers in diameter per cubic foot) to class 1 (≤ 1 particle of 0.5 μm /cubic foot). The European system is similar but is based on particle concentrations per cubic meter—ISO 9 is the least stringent standard and ISO 1 is the cleanest.

For some applications, a class 100,000 environment is clean enough. But most cleanroom processes require lower levels of contaminants than this—some solar manufacturing processes, for example, require less than a class 10,000 environment, and semi wafer production can have a class 1 to 100 requirement. The cleanroom rating of the conveyor should be at least as strict as any of the environments with which it interacts—and in many industries, that means class 10,000 or cleaner. Another aspect of conveyor specification to consider is technological changes that may require an upgrade in clean environment rating. In these cases it may be advisable to “err on the side of caution” and specify a higher cleanliness class.

On the other hand, overspecification can be wasteful and lead to unnecessary

complications in a manufacturing process. Few industries require exceptionally clean conveying (e.g., class 1)—hard disk, computer chip, and semiconductor manufacturing are the exceptions. In some cases, a 100,000 clean rating will be appropriate. If a class 100 level conveyor is selected for a class 100,000 application, the result will be an unnecessary investment in technological features that are rarely if ever used, and which might slow down manufacturing processes (e.g., by requiring thermal sterilization between steps). The best approach is to consider not only current cleanroom requirements, but possible changes in the future. Will processes change? Is technology likely to advance? Will production demand increase? The answers to these questions will help determine clean specification decisions for modular conveyors both now and in the future.

Specification can also be complicated by the nature of the industry. In the semiconductor and computer hardware industries, processes have become fairly well established through decades of manufacturing experience. There is a “book” to consult when designing and implementing conveying solutions. In the solar industry, however, processes are still evolving. The production methods, for processes such as stringing and lay up, vary greatly from one solar panel manufacturer to the next. As a result, solar industry requirements tend to generate a variety of custom

conveying/material handling requirements. The same plant may have twin-rail, single-chain, and contact-free magnetic conveying systems in close proximity—different solutions for different processes. The expected increase in demand for solar energy is likely to increase the level of standardization, but for now, designers should be prepared for customization requirements.

Finally, maintenance and upkeep must be kept in mind. Cleanroom conveyors must be readily accessible for cleaning, sanitation, maintenance, repair and other requirements. Maximizing accessibility helps reduce downtime and improve efficiency.

Thinking beyond the conveyor

A crucial area to remember in evaluating cleanroom conveyors is that the conveyor is only as clean as the environment in which it is operating. A conveyor rated to class 1,000 will only perform at that level if its environment remains class 1,000 rated as well. All potential sources of environmental contaminants should be considered along with the conveyor itself.

With this in mind, consultation with a cleanroom specialist is

highly recommended. A number of firms provide consulting, design, planning, and installation (including modular systems) dedicated to cleanroom solutions. These specialists can help develop an optimum approach for cleanroom conveying—including appropriate specifications—as well as for other aspects of clean manufacturing processes.

Major advantages for clean manufacturing

The modular approach to cleanroom conveying offers numerous advantages for manufacturers. It can increase flexibility, reduce costs, and allow a more proactive approach to changes in technology or levels of demand. It should also be remembered that clean manufacturing can be an important facet of lean manufacturing. The right choice of conveyor(s) can reduce wasted material, improve efficiency and increase productivity. Best of all, modular cleanroom conveying can better position manufacturers for future developments. As products continue to shrink in size—as is the case in many high-tech industries—the need for clean manufacturing solutions will continue to grow.

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