APPLICATION NOTE

POWER AND CONTROL SOLUTIONS FOR FILLERS

Pharmaceutical Manufacturing (UL)

Pharmaceutical manufacturing is a cornerstone of medicine, playing a critical role in producing innovative medications that enhance public health.

As the demand for medications increases, pharmaceutical equipment manufacturers need reliable, precise, and efficient electrical components. ABB's control and protection solutions help to ensure performance when it is needed the most.

What is filling?
Filling is a vital step in pharmaceutical manufacturing that places the proper dosage of product into a capsule or vial while maintaining a sterile environment. Filling equipment design varies based on if it's intended to work with a liquid, gel, powder or solid. The product, whether liquid or powdered solid, is measured by weight or volume and dispensed into a vial or syringe and sealed or put into a capsule. The critical and life saving nature of this work demands absolute precision and quality in this process. The product can then be transferred to the next stage of packaging for distribution.

Why is power and control important for filling equipment?
Power and control are essential during the filling process to ensure consistent and reliable performance of the equipment. The filling process is highly precise, even small fluctuations in power quality can lead to variations and operational inefficiencies. Effective power management also provides safety and protection by incorporating overload and short circuit protection, which helps to prevent equipment damage and ensure consistent performance. Additionally, control systems provide enhanced operator protection by immediately shutting the equipment down in the event of an emergency or unsafe condition.

Main benefits

Continuous operation
Avoid operational disruptions and downtime with ABB circuit breakers. Equipped with advanced trip units, our breakers identify voltage irregularities and protect your production system.

Energy-efficient system
Our AF contactor coil technology boosts control panel energy efficiency, which means less dissipated heat, reduced operating costs, and better equipment performance for your pharmaceutical processes.

Compact and easy to install
Save space, reduce assembly time, and experience greater design flexibility with our narrow designs in circuit breakers, contactors, and overload relays.

Safety and protection
Our product specifications help to enhance safety and reduce hazards by using surge protective devices and monitoring relays to help provide added equipment protection.

Pharmaceutical manufacturing

Process overview

Pharmaceutical manufacturing is a precision-driven process that transforms raw materials, active pharmaceutical ingredients (APIs) and excipients, into safe, effective, and consistent dosage forms. These forms include tablets, capsules, liquids, creams, inhaled formulations, and injectables, each requiring tailored handling and formulation techniques to meet strict quality and regulatory standards.

The following illustration outlines the core stages commonly involved in pharmaceutical manufacturing, beginning with raw material preparation and concluding with final product packaging.

Process	Steps	Description
Ingredient preparation	Weighing and dispensing	APIs and excipients are weighed in a controlled environment.
Ingredient processing	Granulation	Weighed ingredients are converted from powders to granules through wet or dry granulation.
	Drying	Moisture is removed from the product.
	Milling and sieving	Particles are further reduced to ensure uniformity and flow.
	Mixing and blending	The ingredients are mixed or blended to form a homogeneous mixture.
Product formation and finishing	Tablet compression or filling	The mixture is compressed into tablets or inserted into capsules.
	Tablet coating	A coating is applied to the tablet for protection, taste masking, and/or controlled release.
	Finishing and printing	The product is polished to enhance appearance and remove residues. Branding, identification marks, and dosing information added to final product.
Packaging	Primary and secondary packaging	Finished product is placed into packaging that directly contacts the product, such as blisters, bottles, or pouches. It is then enclosed in secondary packaging, such as cartons, along with labels and inserts.

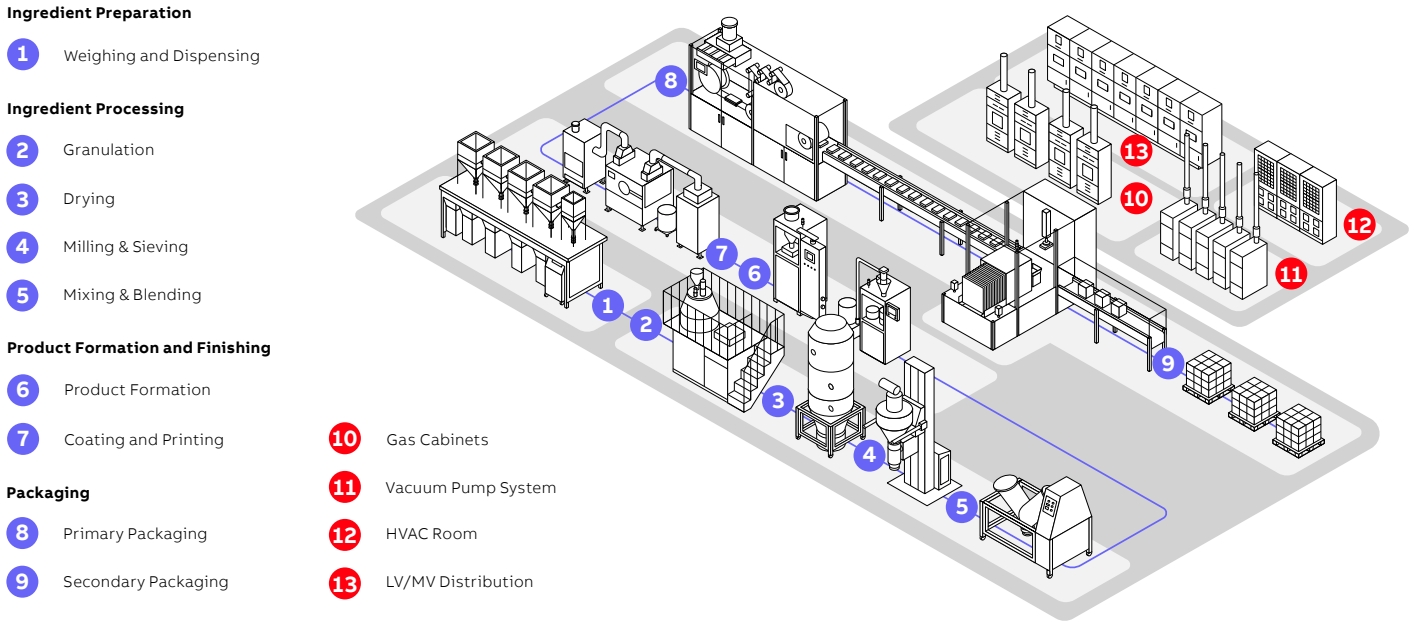


Figure 1: Layout of a generic pharmaceutical manufacturing process

Note: This diagram provides a simplified overview of pharmaceutical manufacturing and does not represent all processes or product types.

Liquid filling

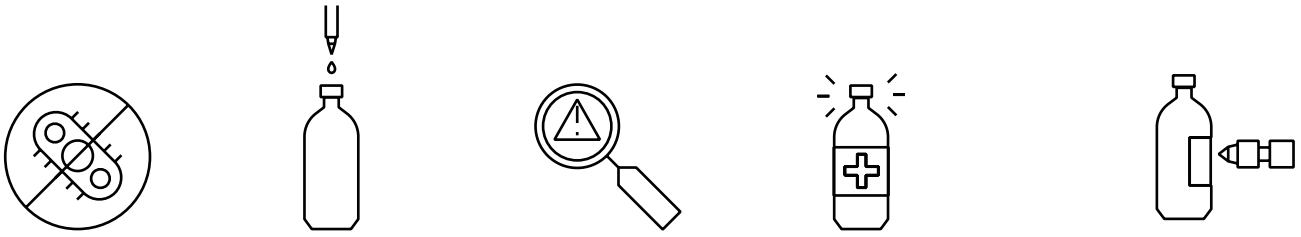
Process overview and types

The process of liquid filling begins with the cleaning and sterilization of the containers, usually vials or syringes. Each container must be free of any contaminants and completely dry to not dilute or adulterate the active product. Only after the containers are carefully prepared can the filling operation begin. The filling machines themselves range from small batch process machines to high volume production machines and can have multiple filling stations on each machine. After dispensing the liquid product into the containers, there's a verification step to check that each container has the proper fill amount. Each container is capped and sealed to maintain the sterility of the product. The sealed containers can then be labeled and printed with lot or batch numbers and expiration dates before packaging for distribution to medical providers.

Selecting an appropriate filling method depends on the physical properties of the liquid to ensure accurate and trouble-free operation. Liquid filling techniques are distinguished by their equipment components, such as the type of pump or sensor, and each offers unique advantages depending on the application (1):

- **Peristaltic pump –** Offers precise dosing and is well-suited for single-use applications.
- **Rotary valve piston pump –** Provides flexibility and accuracy, works well for both aqueous and highly viscous liquids.
- **Rolling diaphragm pump –** Ensures gentle product handling with the precision of a volumetric filling system.
- **Time-pressure system –** Features a space-saving design with minimal moving parts, ideal for high-volume filling stations.
- **Mass-flow –** Incorporates a sensor at each station for in-process control and precise filling.

Typical steps in the pharmaceutical filling process:



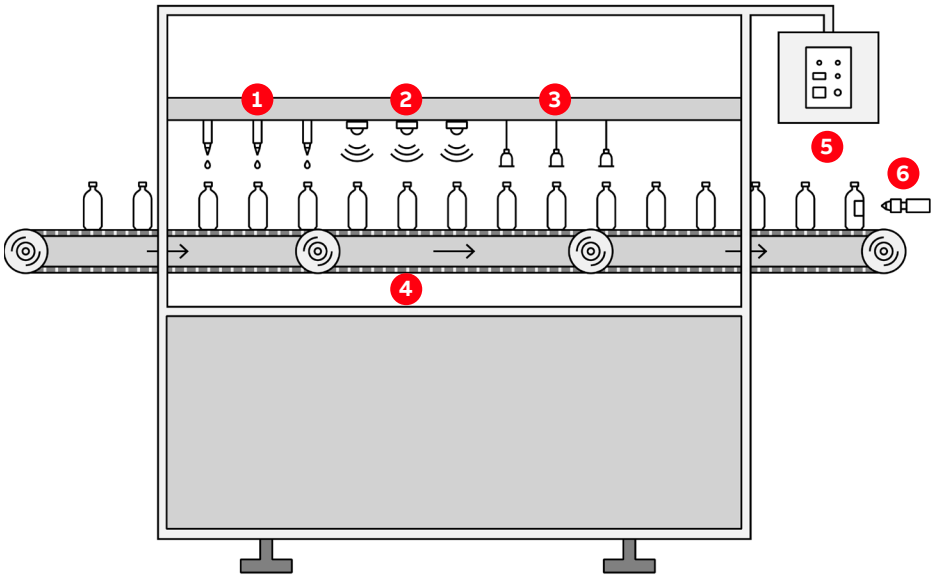
1 **Sterilization** 2 **Filling** 3 **Inspection** 4 **Capping/sealing** 5 **Printing**

Liquid filler components

A liquid filler is used to fill and seal sterilized containers such as bottles, vials, and syringes with pharmaceutical formulations all while maintaining a sterilized environment. Each component of the equipment serves its' specialized purpose to keep the filling process moving along efficiently and without interruption.

The illustration below highlights the primary components of a liquid filling machine. The conveyor belt moves containers to the next step of the operation. A pump system is selected according to the physical properties of the liquid or gel being dispensed. Optical or weigh sensors check each container to verify the proper amount of product is dispensed. The container is hermetically sealed to ensure a sterile and effective product reaches the consumer. A printing station marks each container with lot and batch numbers for traceability and expiration date for maximum efficacy.

Effective power and control systems are essential for the liquid filling machine to operate consistently and efficiently, thereby supporting the highest product quality and production volumes.



1. **Liquid filling station**
   Fills multiple containers with liquid to the proper level
2. **Verification station**
   Verify that the vials are filled with the correct amount using optical sensor or weight
3. **Capping/sealing station**
   Places a cap on the container and seals it
4. **Conveyor belt**
   Moves containers from station to station through the filling machine
5. **Control screen**
   HMI that allows the operator to control and monitor the machine
6. **Printing station**
   Prints on the container the batch or lot number using ink jet or laser printer

Figure 2: Liquid filling machine and components

Capsule filling

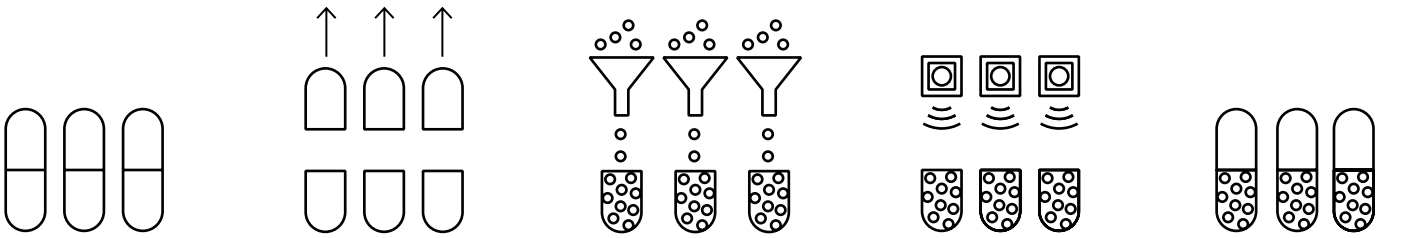
Process overview and key system components

Capsule filling machines typically use a rotary turret in various sizes to match the size of the capsule being filled. The turrets are made to be quickly replaced to allow the machine to be setup for filling a variety of different capsule sizes. The medicinal product may be a fine powder, granules, or tiny pellets (2). The machine incorporates a combination of mechanical, electrical and pneumatic systems to operate (3). These machines range in production capacity from a few hundred capsules per minute to several thousand capsules per minute.

The basic steps the machine performs are:

1. Sorting the capsule into the proper orientation to be opened.
2. Opening the capsule.
3. Filling the capsule.
4. Error checking by means of a powder level sensor.
5. Closing the capsule.

Manufacturers may vary in how they accomplish these tasks.



1 **Sorted capsules**

2 **Opening the capsules**

3 **Filling the capsules**

4 **Error checking**

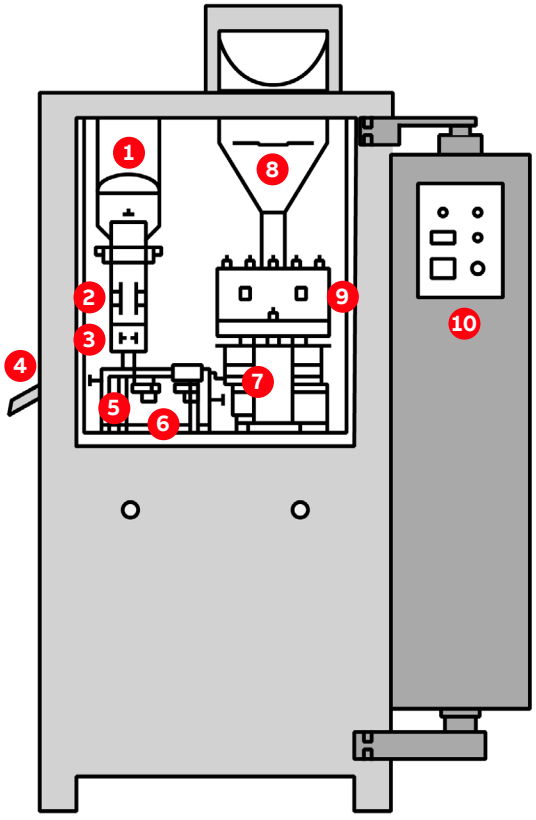
5 **Closing the capsules**

Capsule filler components

Capsule fillers are machines used to fill capsules with powder, pellets or granules containing the pharmaceutical formulation and then closes or "caps" the capsule while maintaining a sterilized environment. Each component of the system serves a specialized purpose to keep the capsule filling process moving along efficiently and without interruption.

The illustration below highlights the primary components of a capsule filling machine. The capsule hopper holds the empty capsules to be filled. The capsule feeding station aligns the capsules in the proper orientation and feeds them into the machine for the next step, where the capsule is separated into halves. At the capsule filling station, the API is put into the capsule. The closing station is where the capsule is closed or "capped", creating a finished capsule. Weigh sensors check each capsule to verify the proper amount of product is dispensed.

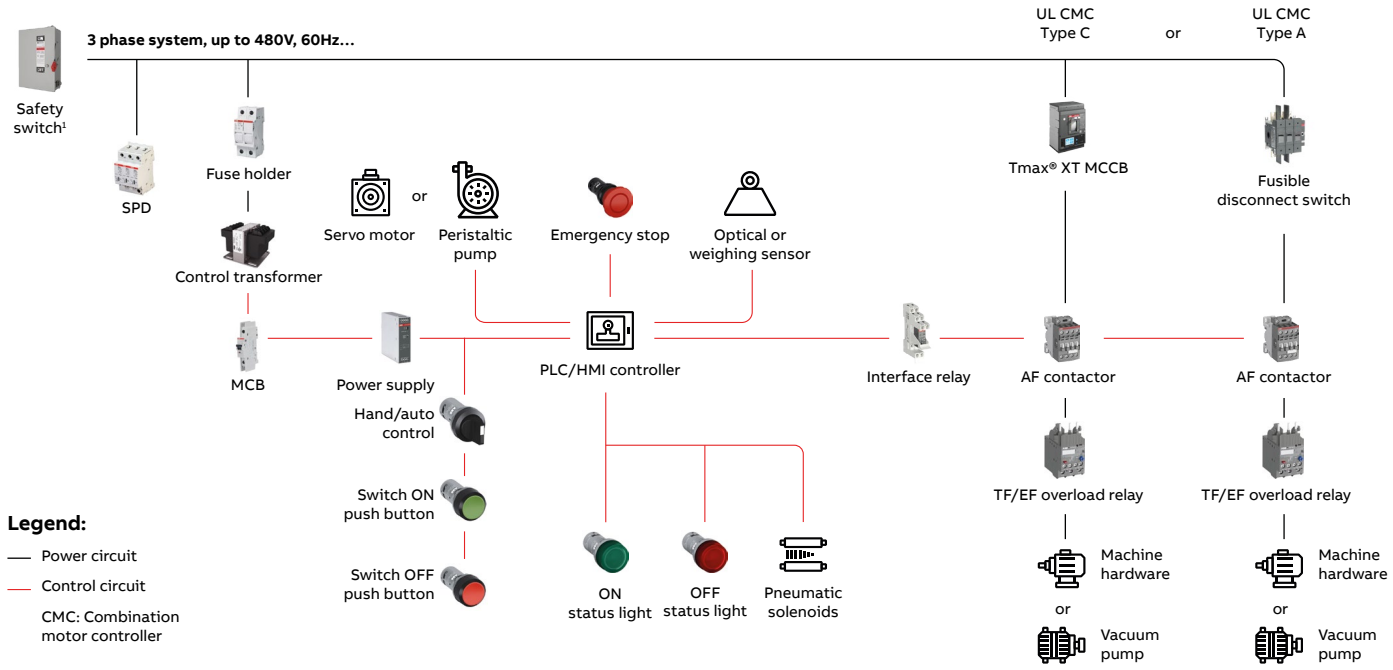
Effective power and control systems are essential for the capsule fillers to operate consistently and efficiently, thereby supporting the highest product quality and production volumes.



1. **Capsule hopper**
   Holds the empty capsules
2. **Capsule feeding station**
   Aligns and feeds empty capsules into the machine
3. **Capsule separation station**
   Separates the capsule's cap and body
4. **Capsule discharge station**
   Discharges the finished product from the machine
5. **Capsule closing station**
   Locks the capsule body and cap together
6. **Rejection station**
   Rejects unseparated capsules
7. **Filling station**
   Fills capsules with powder or pellets
8. **Material hopper**
   Holds the powder or pellets to be filled into the capsules
9. **Dosing station**
   Prepares and measures the material to be filled into the capsule
10. **Control screen**
    HMI that allows the operator to control and monitor the machine

Figure 3: Capsule filling machine and components

Power and control solutions for pharmaceutical filling equipment



Note: This configuration is for a generic system and is not representative of existing manufacturers.
¹ Use the fusible version to meet NEC code requirements.

Main components and functions

Primary functional requirements

- Fusible switches, circuit breakers, and surge protective devices, to prevent equipment damage or fires
- Safety switches for lock out tag out (LOTO) procedures to protect service personnel and emergency stops to protect machine users

Secondary optional requirements

- Power supplies to provide a stable control circuit voltage free of fluctuations and abnormalities that could lead to damage of sensitive electronic components

Power and control components and functionalities

Application	Electrical components	Functional description
Power circuit	Safety switch	Isolation, overload and short circuit protection
Power circuit	Surge protective device	Prevent damage from electrical surge
Power circuit	Fuse holder	Short circuit protection
Power circuit/Motor load	Circuit breaker	Isolation, overload and short circuit protection
Power circuit/Motor load	Fusible switch	Isolation, overload and short circuit protection
Motor load	AF contactor	Remote isolation and control
Motor load	TF/EF overload relay	Thermal and electronic overload protection
Control circuit	Miniature circuit breaker	Overload and short circuit protection
Control circuit	Control transformer	Reduces voltages from higher to lower
Control circuit	Power supply	Converts an electric input to a different current and voltage output
Control circuit	Interface relay	Isolates, connects, and ensures compatibility between components
Control circuit	Pilot devices	Provide visual status and machine control

Product offering

Tmax XT molded case circuit breakers

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AF contactors

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Safety switches

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Fusible disconnect switches

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Electronic overload relays

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Thermal overload relays

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Fuse holders

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Surge protective devices

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Control transformers

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Miniature circuit breakers

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Assorted pilot devices

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Definite purpose contactors

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Power supplies

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B series mini contactors

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Interface relays and optocouplers

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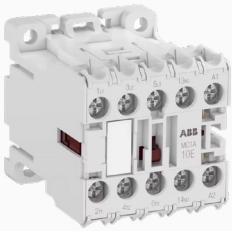
M series mini contactors



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References

(1) Syntegon. “Pharmaceutical Filling Systems.” Syntegon.com. Accessed: Oct 6, 2025. [Online]. Available: https://www.syntegon.com/solutions/pharma/filling-systems/

(2) Anxine. “High Efficient Automatic Capsule Filling Machine NJP-400C.” Anxine.com. Accessed: Oct. 6, 2025. [Online]. Available: https://www.anxine.com/capsule-filling-machine/automatic/njp-400c

(3) Comecer. “VERSALINE – Pharmaceutical Linear Fillers Solutions.” Comecer.com. Accessed: Oct. 6, 2025.[Online]. Available: https://www.comecer.com/versaline-linear-fillers-solutions/

(4) METTLER TOLEDO. “Automated Precision Weigh Modules.” MT.com. Accessed: Oct. 6, 2025. [Online]. Available: https://www.mt.com/us/en/home/products/Industrial_Weighing_Solutions/high-precision-weigh-sensors.html

(5) K. Mohanraj, A. Ramesh, K. S. Vairavel, M. S. Thoufik, R. Muthuraja, and M. M. Arshad, “Optimizing Performance in Automatic Powder Filling Systems,” in *Proc. 2024 Int. Conf. Power, Energy, Control and Transmission Systems (ICPECTS)*, Chennai, India, 2024, pp. 1–6, doi: 10.1109/ICPECTS62210.2024.10780406.

(6) B. DelSpina, Y. Zhang, and Y. Wang, “A Benchtop Robot and Automation Solution for Prefilled Syringes in Pharmaceutical Manufacturing,” in *Proc. 2021 IEEE 17th Int. Conf. Automation Science and Engineering (CASE)*, Lyon, France, 2021, pp. 228–234, doi: 10.1109/CASE49439.2021.9551535.

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