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# Continuously Variable Drive (ICVD<sup>®</sup>)

## Innovation for Manufacturers of Self-propelled Farm and Construction Machinery

*GKN Walterscheid GmbH collaborated with SAUER BIBUS GmbH on developing a continuously variable, hydrostatic drive for self-propelled agricultural and construction machinery. The ICVD<sup>®</sup> (Integrated Continuously Variable Drive) makes it possible to drive through the entire speed range without interrupting the tractive force. Following exhaustive testing with partners in the construction and farm machinery industry, the drive is now proving successful in the marketplace. The first CLAAS telescopic loader with ICVD<sup>®</sup> was presented at Agritechnica 2005.*

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### Keywords

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Self-propelled agricultural and construction machinery, such as wheeled and telescopic loaders, have not only to be capable of generating high tractive force, but also of covering relatively long distances at the highest possible speed in certain applications.

Conventionally, both functions were realized via hydrostatic drives with manual gearboxes - with a first gear for high tractive power and speeds up to 20 km/h, and a second gear for higher speeds up to 40 km/h. The machine had to be at a standstill to switch between gears, making the procedure both inconvenient and time-consuming. The demands of today's agricultural and construction industries in relation to the variability of a drive and operating convenience have grown substantially in the meantime: continuous variability is called for, and different hydrostatic drive concepts have come increasingly close to providing it in recent years. The solutions so far available in the marketplace for self-propelled agricultural and construction machinery can be roughly divided into three categories:

- 1) Power-shift transmissions with variable hydraulic motors
- 2) Summation gearboxes with variable hydraulic motors
- 3) Gearboxes switchable at a standstill with variable hydraulic motors

The ICVD is a symbiosis of these drive concepts, combining their advantages, but without having to accept the drawbacks of the individual solutions. For instance, while a power-shift transmission with variable hydraulic motor can certainly be switched while in motion, the gear-change process is clearly perceptible as a brief power interruption. On the other hand, the combination of variable hydraulic motors with summation gearboxes is an attempt to compensate for the conventional, small conversion range of the motor ( $\alpha < 32^\circ$ ) by means of a gearbox with a large transmission range – a common compromise, but one that has the disadvantage of not being able to realise all the required parameters, e.g. as regards tractive power and maximum speed.

### Continuously variable: optimised efficiency due to large-angle technology

A new feature of the ICVD concept is the use of a hydraulic motor based on large-angle technology. It enables angular movement of the motor by up to  $45^\circ$ , instead of the customary maximum of  $32^\circ$ . This increases the hydrostatic conversion range and substantially improves the efficiency, making this technology a real alternative to the previous concepts.

The innovative concept of the ICVD offers numerous advantages:

- Large, continuously variable conversion range
- Automatic adaptation of the power requirement
- Tractive force generation independently of the rpm speed
- Simple reversal of direction and torque
- Flexible arrangement of the drive elements

With the ICVD, manufacturers of agricultural and construction machinery or municipal vehicles can realise equipment with combined higher maximum speed and high tractive force. At the same time, the optimised efficiency cuts fuel consumption - a factor of increasing importance for manufacturers and users alike. In addition, the drive gene-



Fig. 1: Hydrostatic drive: compact assembly

rates significantly less noise than previous technologies. Users will find that the ICVD is more economical and more environmentally friendly to operate than a conventional drive.

### Modular structure for all applications

The ICVD consists of a control unit, the gearbox (mechanical output) and the hydraulic motor (hydraulic input). This compact assembly is universally adaptable in the vehicle, directly on the axle or on the vehicle frame. The ICVD comes in five output classes with different torques, allowing manufacturers to equip their entire machine portfolio. The performance parameters specified by the customer - tractive force, output power, speed - are decisive for the choice of the version, which is then custom-designed on the basis of the vehicle-specific parameters. The special feature is that the entire product line has a modular structure, making it possible to realise individualised customer solutions, on the one hand, while common parts standardised according to the modular-design principle are available, on the other. These parts include core elements, such as the control unit, the swivel yoke and the drive, as well as blanks for the internal components, such as gear wheels and shafts. This not only reduces the production cost of the ICVD, and thus the purchase price for the customer, but also offers advantages in terms of spare-part and repair services.

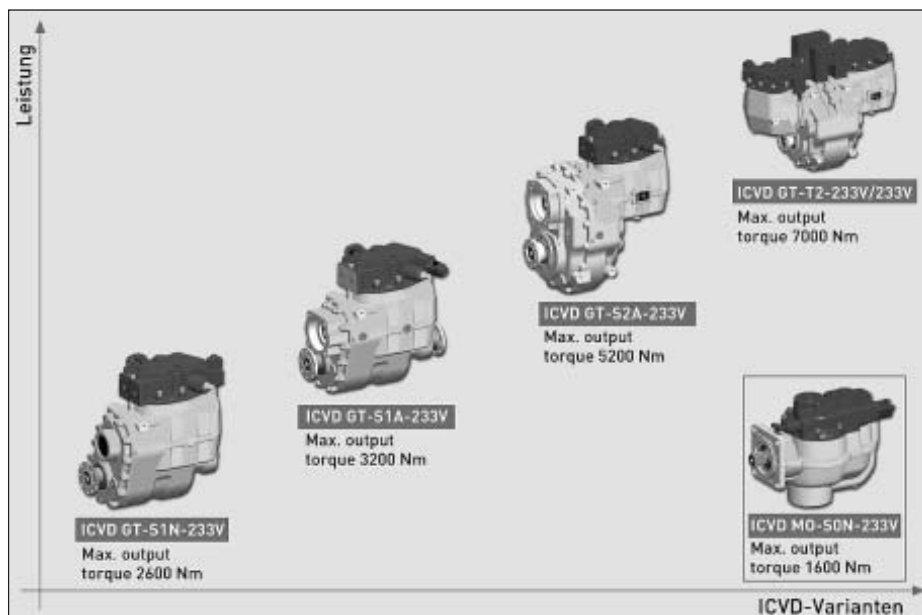


Fig. 2: Five ICVD power-classes allow manufacturers to equip their entire portfolio

### Successful on the market following exhaustive testing

Well-known specialists collaborated on developing the new hydrostatic drive: the control system was devised by SAUER BIBUS, while the mechanical elements were created by engineers at Walterscheid. Since they proved successful in the engineering work, the two companies will also continue to exploit the existing synergistic effects in future when realising the individual requirements

of the equipment manufacturers.

Following exhaustive test phases, the ICVD is now being used by several equipment manufacturers. For instance, KRAMER uses the new hydrostatic drive in its wheeled loaders, and CLAAS presented the first telescopic loader with ICVD at Agritechnica 2005. There are plans to expand the applications to include self-propelled agricultural machinery, such as combine harvesters, choppers, beet lifters, etc. and other construction machinery.