

Switched Reluctance Drives®



‘A Complete Drive Solution’



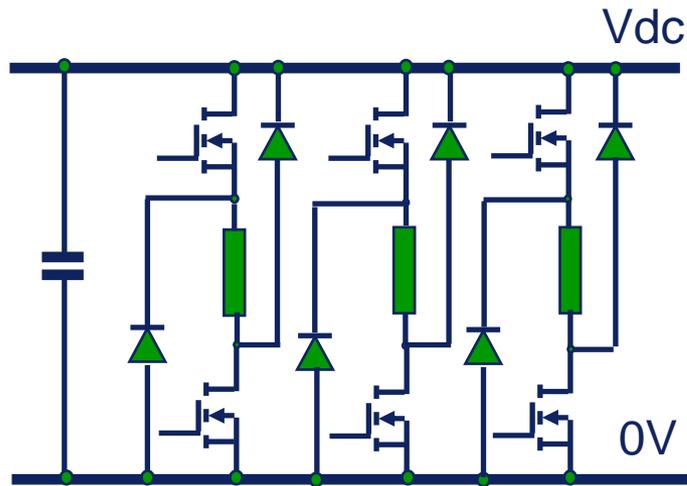
SR Drives®: Principles of operation

- “Variable Reluctance” motor – related to stepper motor but with significant differences in design and control
- Self-synchronous: phases are switched on & off depending on measured rotor angle, hence *switched* reluctance motor
- Torque is produced as a result of changing electrical inductance with respect to rotor angle
- Energising phases over rising inductance region (poles approaching each other) yields *motoring* torque
- Energising phases over falling inductance region (poles being separated) yields *braking* torque

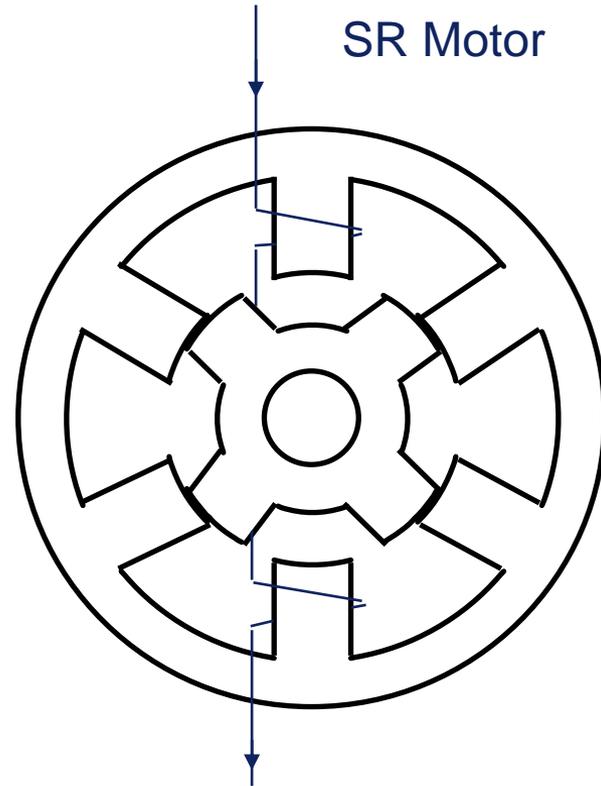


SR Drives[®]: Typical drive configuration

Power Switching Converter



SR Motor



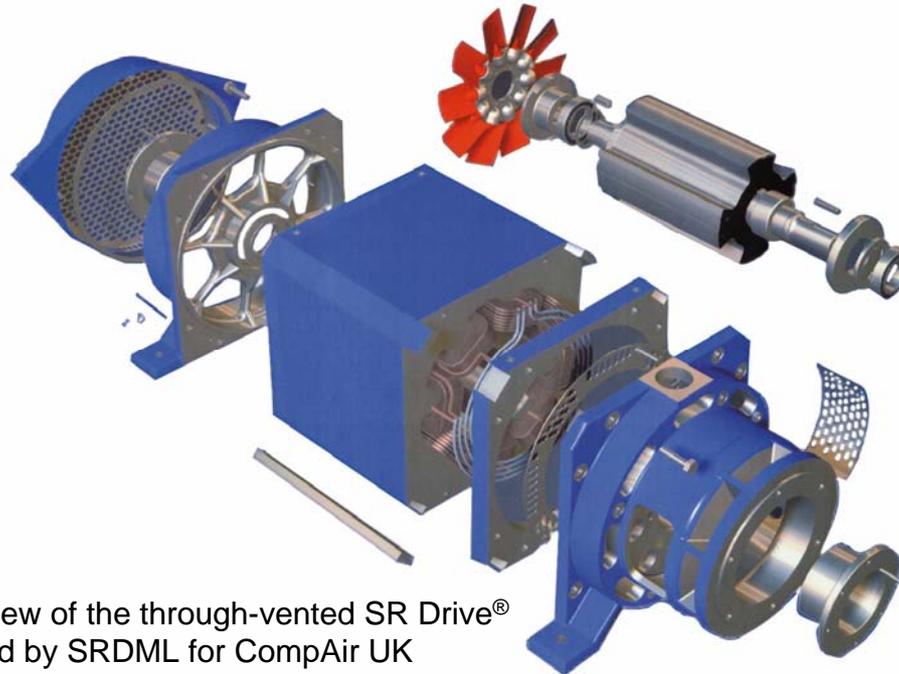
SR Drives®: Key advantages

- **Reliable:** A simple, robust, fundamentally reliable technology
- **Easy to install:** Matched motor and drive designs facilitate fast installation and set-up
- **Efficient:** Energy efficient over a wide range of outputs
- **Compact:** Flexible form-factor provides a compact solution for both motors and drives
- **High performance:** many aspects exceed those of alternative drive technologies
- **Proven:** A technology embraced by many users for over 20 years



SR Drives®: Motor construction

- Robust and straightforward laminated steel construction with independently wound stator coils
- Well suited to operation in harsh environments



An exploded view of the through-vented SR Drive® motor produced by SRDML for CompAir UK



SR Drives®: Rotor

- Simple and robust laminated steel construction: no brushes, no windings, no rotor bars (or “squirrel cage”), no magnets
- Well suited to high speed, high vibration, high temperature, harsh environments etc.
- Low mechanical inertia: well suited to applications demanding rapid acceleration
- Low rotor losses reduce shaft temperature, prolong bearing life



The simple SR Drive® rotor has many advantages over conventional types which utilise magnets or conductors



SR Drives[®]: The stator

- No magnets: simple laminated iron construction
- Simple windings: singly-pitched coils embrace only one stator pole
- No overlap between coils of successive phases: significantly reduced risk of inter-phase short circuit failures
- Compact and short coil overhangs make efficient use of active coil area



Compact end-windings permit construction of high-performance motors with unusually flat aspect ratios.



SR Drives®: Power electronic converter

- Low frequency switching minimises switching losses and reduces the number and rating of the output devices for a given motor power
- Output device configuration does not permit the the risk of 'shoot-through' faults inherent on other types of drive
- Inherently stable control including high torque conditions
- Utilises standard switching devices i.e. IGBT's



CompAir UK utilise SR Drives® in their ranges of direct-drive, high efficiency air-compressors



SR Drives[®]: Operational reliability

- Enhanced bearing life: low rotor losses = cooler shaft
- Simple stator windings: no 'overlaps' between phases
- Electronics topology eliminates inverter shoot-through fault
- Low switching frequency: lower power losses without compromise to motor performance
- Low susceptibility to insulation failures due to partial discharge caused by high dv/dt
- Motor phases are independent: motor can continue to run in the event of a phase failure



LeTourneau Inc's L-1350 electric-wheel loader is the first machine of its type to be fitted with SR Drive[®] systems. Four compact 300kW motors provide independent traction for each wheel.



SR Drives[®]: Installation and maintenance

- Matched motor and drive designs take the guesswork out of installation and guarantee system performance
- Straightforward set-up parameters (like simple DC drive) permit easy on-site optimisation of drive performance
- Comprehensive diagnostics for continual monitoring of both drive system and process



Three 150kW SR Drives[®] underground at Maltby Colliery



SR Drives®: High energy efficiency

- Low electronics switching frequency compared to PWM AC drive systems greatly reduces converter switching losses
- Absence of rotor windings or “squirrel cage” greatly reduces rotor losses
- High efficiency over a wide range of speed and torque
- Motor and converter are designed together: true system efficiency is specified from mains input to shaft output
- All motor current harmonics are torque-productive
- No spin losses due to permanent magnets
- Low motor losses allow low speed operation at full rated torque without additional cooling

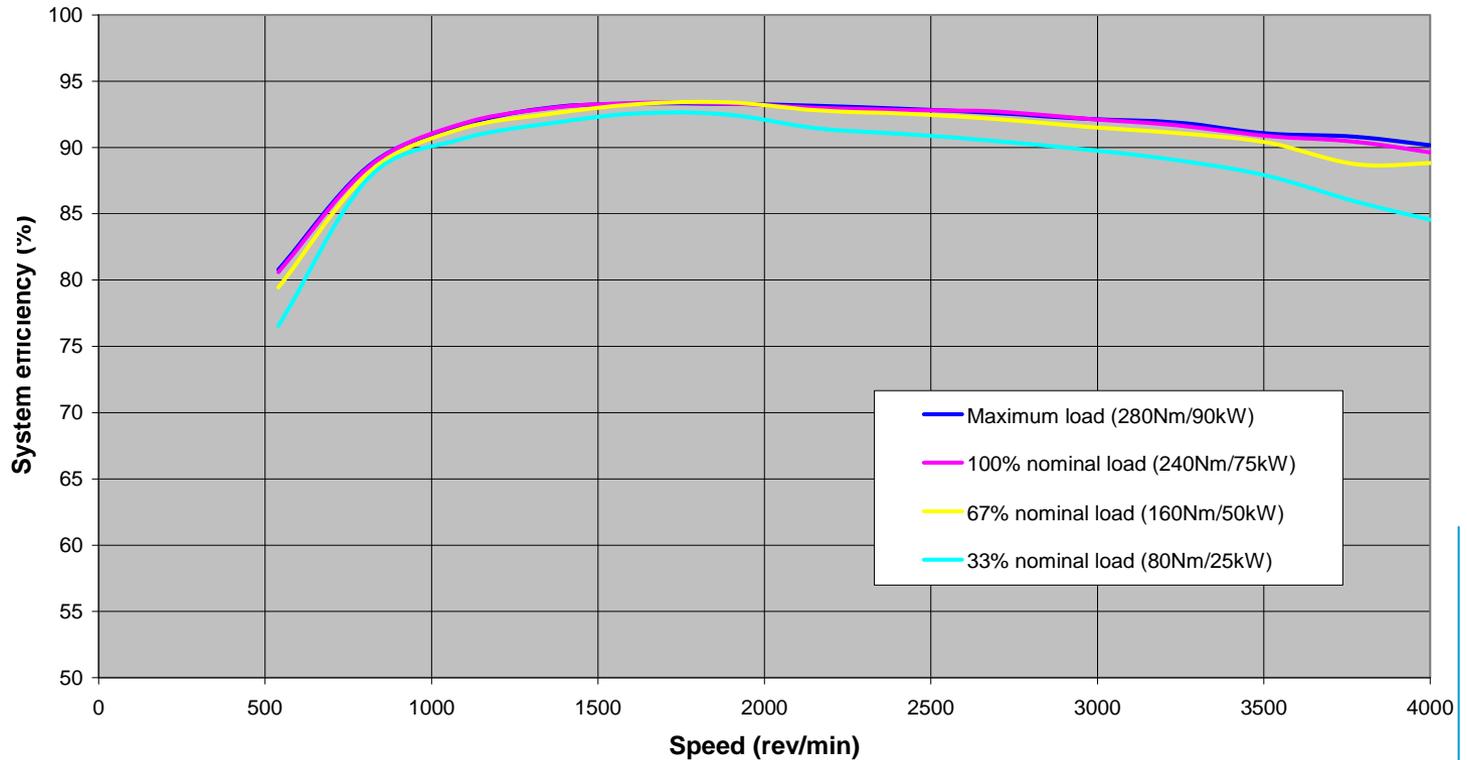


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SR Drives®: Remarkably constant efficiency under varying load: e.g. IEC D250 motor (90kW rating)

Drive system comprising motor type 03-00017 operated with controller 02-00017
Measured system efficiency plotted vs. speed at 380V AC
SR Drives Manufacturing Ltd

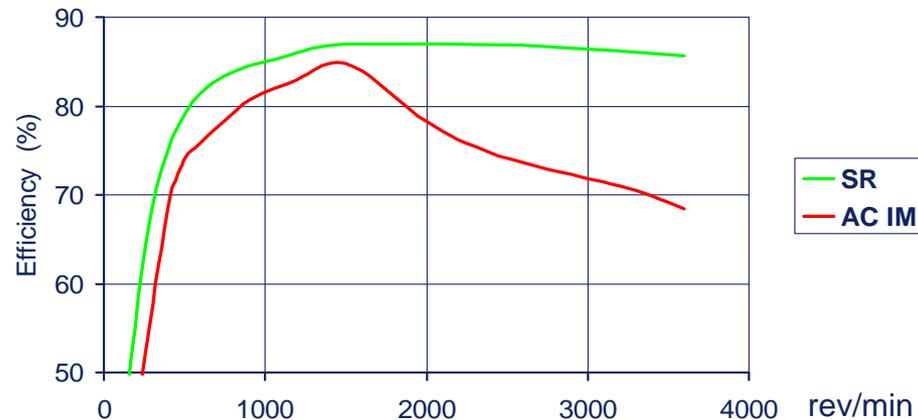


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Efficiency comparison: SR Drive[®] vs. induction motor + inverter

- Comparison for SR Drive[®] and vector AC system with same motor frames (TEFV/132) and same power devices (50A IGBT)
- Both machines running at rated torque up to 1500rpm and thereafter at 7.5kW constant power
- SR Drive[®] efficiency is substantially flat over most of the working speed and torque range



SR Drives[®]: A compact solution

- Short end windings allow for compact motor designs making best use of available space
- Flexible form factor is well suited to integration within customer equipment
- Lower semiconductor power device ratings within the converter permit compact drive designs
- Lower switching losses within power devices minimises cooling requirements



Compact end-windings permit construction of high-performance motors with unusually flat aspect ratios.



Food processor: SR and conventional solutions compared



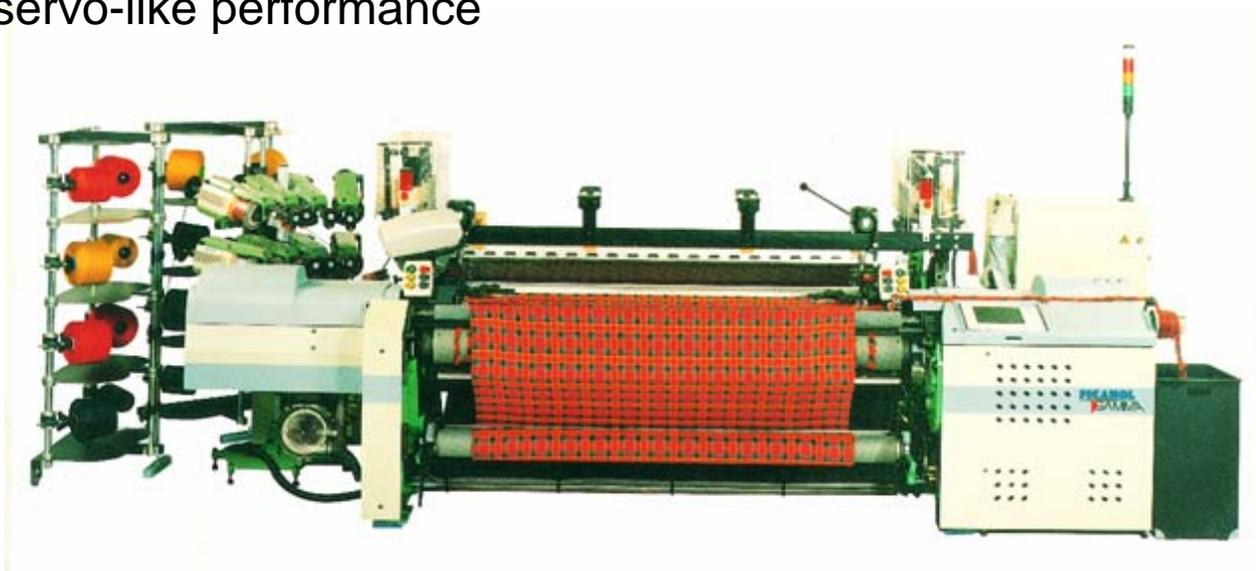
SR Drives[®]: Torque-speed performance

- High speed direct drive is possible: scope to eliminate mechanical speed changing arrangements
- Wide constant power speed range achievable without the penalties of reduced efficiency or disproportionate increases in electronics cost
- Stable torque control at all speeds including stall conditions
- Capable of operation under constant torque and constant speed control
- Very high overload torque permissible: up to 10 times rated torque if required
- Negligible rotor losses under stall conditions



SR Drives®: Rapid dynamic response

- The inherently high torque / inertia ratio for the motor permits rapid dynamic response if required
- Direct torque control with wide torque bandwidth permits servo-like performance



Picanol, a world leader in the design and manufacture of weaving machines, incorporates SR Drive® technology in its latest hi-tech looms. SR Drives® provide exceptionally high peak torque and controllability for main-shaft and high-bandwidth servo drives



SR Drives[®]: Electromagnetic compatibility

- Radio frequency emissions from the drive are lower than those from a VFD due to reduced switching frequencies
- Proven compatibility with North American and European regulations for both emissions and immunity



The performance advantages of SR Drive[®] technology over conventional drives offers a rapid route to compliance/conformity



SR Drives®: A proven technology

- Over 3,000,000 SR Drives® in service since 1983
- Applications range from fractional HP units in domestic goods to flameproof mining drives of >500kW
- Some 5,000 standard industrial TEFV machines installed since 1983



Maytag's Neptune washing machine
utilises SR Drives® technology



SR Drives®: Company capabilities

- All aspects of electrical, electromagnetic and mechanical design including microelectronics and software
- Our own dedicated manufacturing capability for both drives and motors in the UK
- Customer support and backup direct from our own engineering team or appointed service agencies



SR Drives Ltd. headquarters in
Harrogate, UK



SR Drives®: A Complete drive solution

- SR Drives® offer a complete Turnkey service for the development, manufacture and support of bespoke drive systems to suit customer requirements



Consumer to industrial in all shapes and sizes: A selection of switched reluctance motors developed by SR Drives®

