F-93 | Keywords | Y3 | Equipment or Facility | Z4 | Power | E29 | electrical machinery

TMEIC Corporation

High-voltage IGBT inverter

Features

- A product lineup of Diode Front End (DFE) models (Type D) and Active Front End (AFE) models (Type P)
- High Efficiency
  - Reduced harmonic losses in the motor due to almost sinusoidal output current.
  - No transformer on output side and no loss due to not require output transformer.
  - Multi-level PWM control reduces IGBT switching losses.
- High reliability
  - Latest IGBTs for MV converter main circuit makes improvement of the reliability.
  - Improved control reliability by using a reduced number of components.
  - Highly reliable control is possible by Ride- through operation, even if sudden momentary power failure.
  - Active power control makes it possible to minimize the reactive power of the entire system (Type-P).
- Low impact on the power system, high power factor makes it friendly to power supply and motors
  - Reduced harmonic currents without harmonic filter by multiplexing the input transformer.
  - Leading/Lagging reactive power is controlled by Static Var Compensation, that reactive power can quickly and stability minimized (Type P).
- Easy maintenance
  - Film capacitors are used for DC smoothing.
    Maintenance and replacement is not necessary,which significantly reduces the life cycle cost.
- Energy saving
  - In variable torque load applications such as fans, pumps or blowers,
    variable speed operation of inverters achieves significant energy saving effect.
  - The power regeneration function allows rotational energy to be returned to the power source (Type-P).

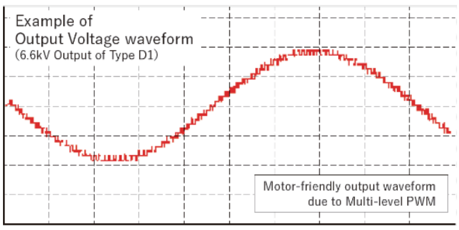
Overview & Principles

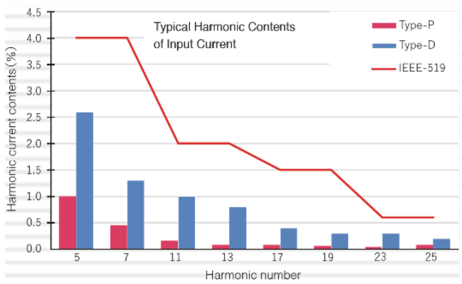
- High-voltage IGBTs ensure highly efficient variable speed operation

TMdrive-MVe3 uses latest IGBTs for MV inverters, reduces switching losses in the main circuit semiconductor by unique multi-level PWM control, and reduces harmonic losses in primary winding of VFD input transformer by lowering harmonic currents on power supply, resulting in a highly efficient variable speed drive system.
Furthermore, compared to previous drive systems that require harmonic filters and phase advance capacitor, no losses are incurred by these devices, contributing to improved overall facility equipment efficiency.

- TMdrive-MVe3 can feed standard type existing medium-voltage motors

Multi-level PWM control of TMdrive-MVe3 provides an almost sinusoidal current waveform by using staircase output voltage that also approximates to a sinusoidal waveform. In addition, TMEIC's unique switching shift control, in which the on/off timing of the IGBT does not overlap with the line-to-line output voltage, reduces switching surges to a minimum, enabling energy-saving drive of existing motors without capacity reduction.





- Integrated multiplexing input transformer can reduce input current harmonics

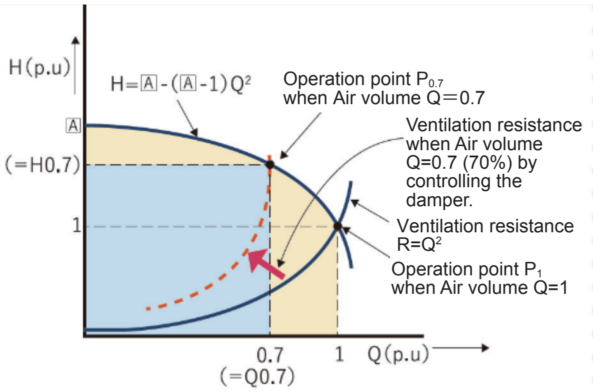
TMdrive-MVe3 is “low in harmonic current = friendly for power supply” converter by using integrated multiplexing input transformer. Harmonic currents to power supply are greatly reduced and meet “Technical Guidelines for Harmonic Suppression Measures” (JEAG 9702-2013) and “IEEE standard 519 (Recommended Practice and Requirements for Harmonic Control in Electric Power Systems)”.
In Japan, TMdrive-MVe3 can applicable for special measures associated with further expansions and upgrades.

- Speed control by VFD can provides significant energy savings and CO2 emission reductions

In variable torque load applications such as fans, pumps or blowers, variable speed operation of inverters achieves significant energy saving effect as compared to the constant speed operation using a commercial power supply (50 Hz or 60 Hz).
When motor speed control is used in an applications such as a fans, pumps or blowers
Air volume (flow) ∝ Speed
Required power ∝ $(\text{Speed})^3$. For example, when 80% air volume (flow) is required, significant power saving can be achieved by performing the speed control：Required power = $(80\%)^3$ ≒ 50%

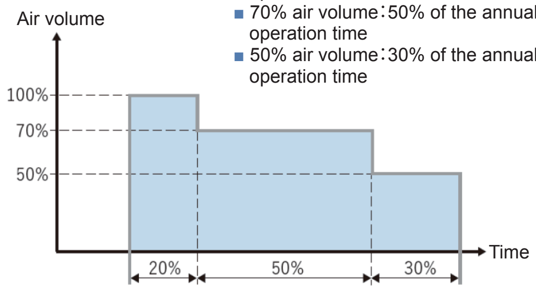
Energy-Saving Effects & Special Remarks

Example of Power saving with speed control / CO2 emission reduction.

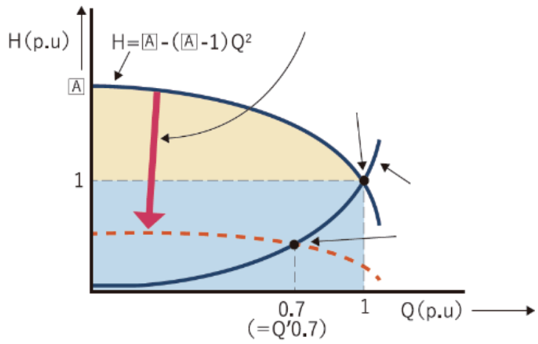


Air pressure H, Air volume Q and shaft power P with damper control

Motor efficiency=96.5%
TMdrive-MVe3 efficiency=97% (including transformer)
Fan shaft power at rated air volume：1,100kW
Fan characteristics ....H (when Q=0)=1.4p.u
Annual operation time 8,000h
Fan operation pattern ......■ 100% air volume：20% of the annual operation time
■ 70% air volume：50% of the annual operation time
■ 50% air volume：30% of the annual operation time



In the operating conditions of right side figure pattern, power consumption for damper control (at the rated motor speed) are described as follows
When the motor efficiency is ηM, the input power P_{I1} when Q = 1 and the input power $P_{I0.7}$ when Q = 0.7 (0.5 case is same) are as follows: $P_{I1} = P_1 / \eta M$ (kW), $P_{I0.7} = P_{0.7} / \eta M$ (kW)
P_{100} = 1,100/0.965 = 1,140 kW
P_{70} = 1,100 x 0.7 x (1.4−0.4×0.7×0.7) / 0.965 = 961 kW
P_{50} = 1,100 x 0.5 x (1.4−0.4×0.5×0.5) / 0.965 = 741kW
Electric power = 1,140 x 8,000 x 0.2 + 961 x 8,000 x 0.5 + 741 x 8,000 x 0.3 = 7,446,400 kWh/year

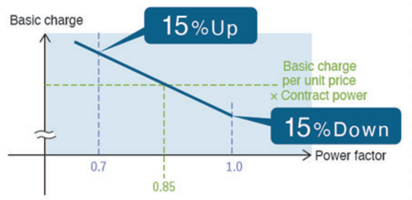


Wind pressure H, air volume Q and power P with inverter control

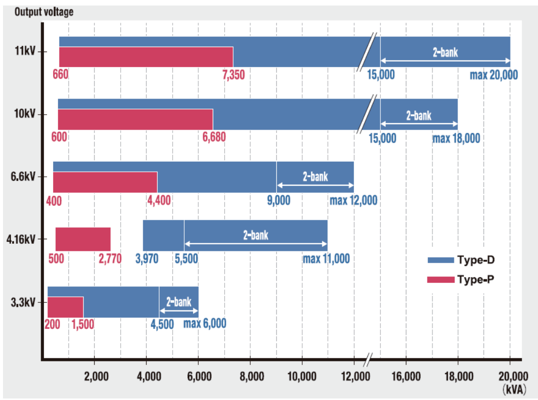
In the operating conditions of right side figure pattern, power consumption for speed control of inverter are described as follows
The input P_{I1} required when Q = 1 is the same as that of the damper control.
$P_{I1} = P_1 / \eta M$ (kW)
On the other hand, when the 70% air volume = $Q'_{0.7}$, the operation point is $P'_{0.7}$ (0.5 case is same).
The shaft power $P'_{0.7}$ required in this case is as follows: $P'_{0.7} = P_1 \times Q'_{0.7} \times H' = P_1 \times Q'^3_{0.7}$. Consequently, the input $P'_{I0.7}$ required in this case when the inverter efficiency is ηINV is as follows: $P'_{I0.7} = P'_{0.7} / \eta M / \eta INV = P_1 \times 0.7^3 / \eta M / \eta INV$
P'_{100} = 1,100 / 0.965 / 0.97 = 1,176 kW
P'_{70} = 1,100 × 0.73 / 0.965 / 0.97 = 403 kW
P'_{50} = 1,100 × 0.53 / 0.965 / 0.97 = 147 kW
Electric power = 1,176 x 8,000 x 0.2 + 403 x 8,000 x 0.5 + 147 x 8,000 x 0.3 = 3,846,400 kWh/year

Difference between the damper control and the speed control
■ Power saving amount:
7,446,400 kWh − 3,846,400 kWh = 3,600,000 kWh/year
■ Power cost saving:
When the electric power unit price is 0.1dollars / kWh,
3,600,000kWh×0.1(dollars) / kWh=360,000dollars / year
■ CO2 reduction:
When the CO2 emission factor is 0.000451t-CO2 / kWh
3,600,000kWh×0.000451t-CO2 / kWh=1,624ton

Furthermore,
Preferential electric power charge are applied possibility (P.F. > 0.85).
Basic charge = Basic price per unit price × Contract power × (1.85 – P.F.)
(The above is example in Japan. Price system is depended on the country.)



Product lineup



Track Record or Implementation Plans

Worldwide total: 9,632 sets (of which 4,517 sets are regenerative Type-P) 17,751 MVA (1,693 sets in Japan)
As of April 2024, including the number of orders received.

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