Toshiba's Innovative T300MV – Medium Voltage Drive

Affordable high performance in a small footprint

TOSHIBA
Motors & Drives

BUILT4XTREMES

1) Starting at the input side, the Toshiba T300MV drive has a wireway that allows cable entry from top or bottom.

2) Power is fed through a patented visible blade, bolted pressure switch. In the open position, "OPEN" flags are visible and the switch blades touch grounding pads to confirm that it is safe to access the incoming compartment. The switch feeds a fused Toshiba vacuum contactor.

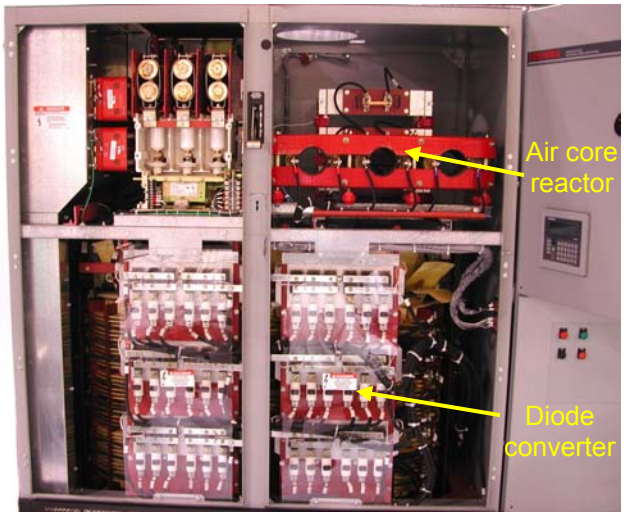

Fig. 1 – Incoming, transformer behind diode converter section of 1750HP, 4160V drive.

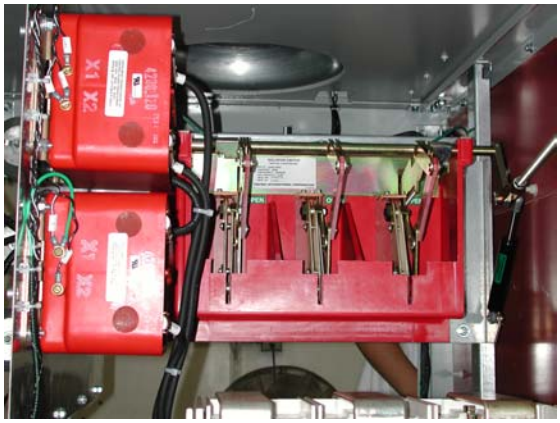

Fig. 2 – Visible blade bolted pressure switch

3) The contactor feeds an integral 24 pulse transformer with 635V secondaries. This configuration provides IEEE 519-1992 compliance at the input of the drive.

4) The transformer feeds series connected 2200V PIV rated diodes that provide two levels of DC bus voltage. An air core reactor controls the charging rate of the DC capacitors. A second vacuum contactor bypasses the air core reactor when the DC bus has charged.

5) Diodes are individually fused using blown fuse indicators. The drive electronics sense DC ripple if one of the fuses blows and shuts the drive down. Indicators are only used to assist finding the blown fuse.

6) The 2 level DC voltage is fed to the inverter section of the drive. The inverter consists of self contained, power modules – one per phase. Each power module houses the control boards, 3300V IGBTs and the DC bus capacitor.

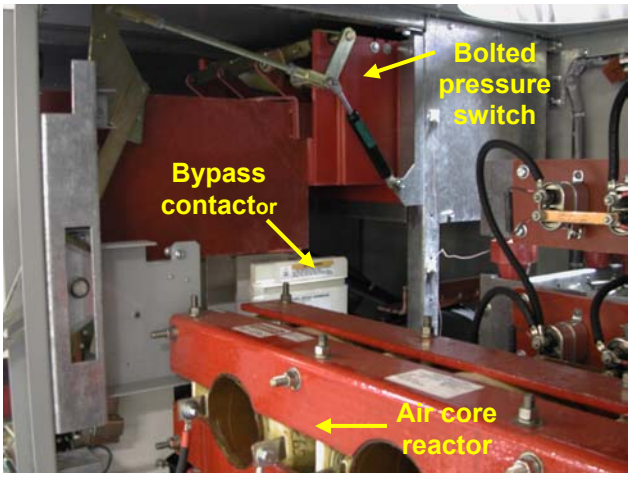

Fig. 3 – View of side of incoming switch, bypass contactor and air core (soft charge) reactor

7) The inverter cell modules are designed to be easily withdrawn. The heat sink for the IGBTs uses field proven, sealed, heat pipe technology. Oil filled capacitors are used instead of electrolytic because they provide longer life. All components are fully accessible once the cell is withdrawn or removed. Once the cell is withdrawn, the sliding rail locks in place.

Fig. 4 – Rail lock button

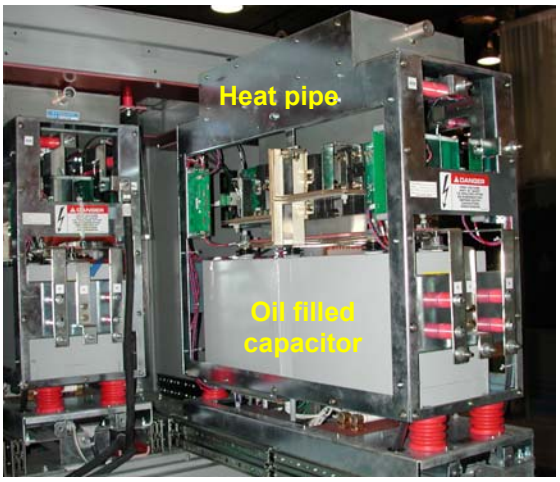

Fig. 5 – Easily racked out inverter module

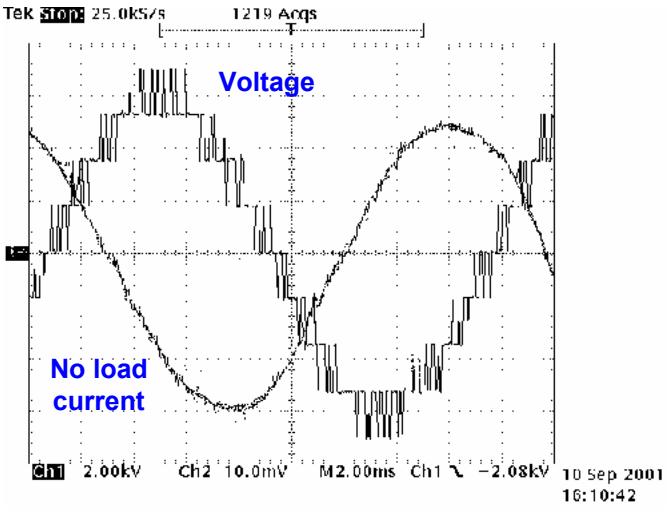

Fig. 6 – Output voltage and no load current waveforms

8) The Toshiba T300MV utilizes 5 level, NPC (Neutral Point Clamp) technology utilizing highly reliable 3300V IGBTs in the inverter section. This provides a low stress output waveform with minimal neutral point shift enabling use of existing motors.

Note in fig. 6 that even no load current is very sinusoidal.

9) Voltage between the positive or negative bus and common is 1950V. The IGBTs are rated at 3300V which provides a voltage margin ratio of 3300 ÷ 1950V = 169%. Voltage margin on a 2400V drive increases to 293%.

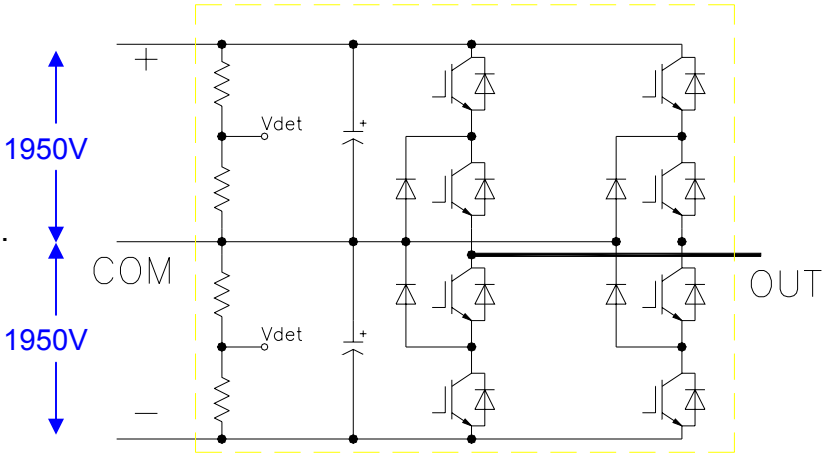

Fig. 7 – One phase of inverter section

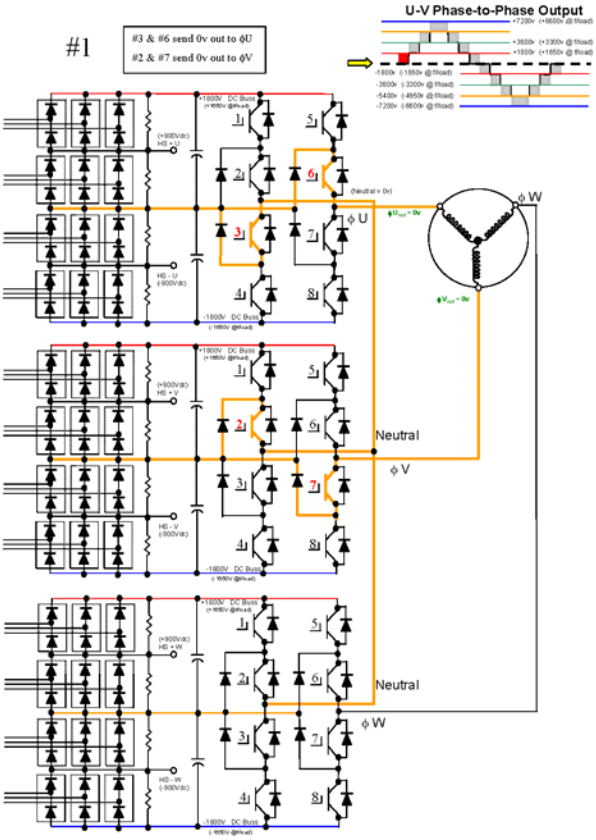

Fig. 8 – First of 16 switching states of the NPC topology

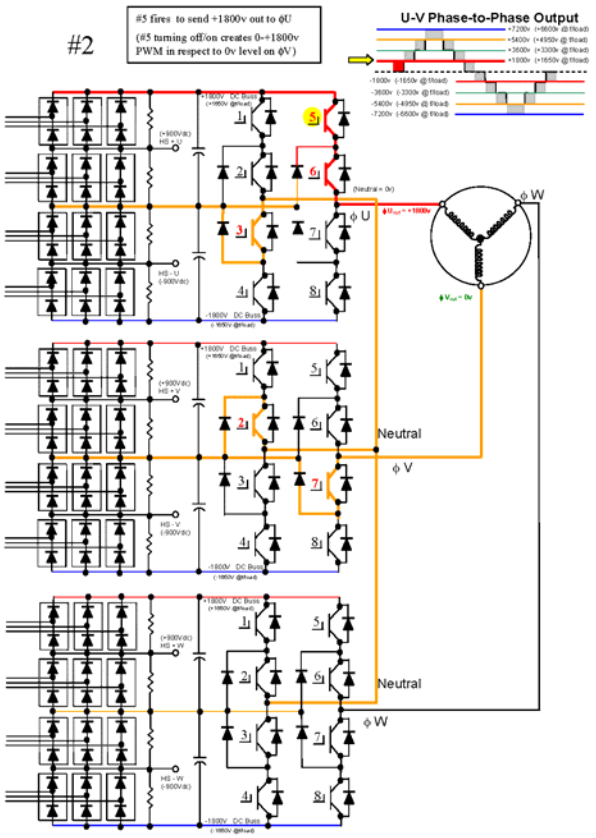

Fig. 9 – Second switching state

10) Switching is accomplished with only one IGBT cycling on and off at any given time. In fig. 8, IGBTs 3 & 6 of U phase and IGBTs 2 & 7 of V phase are on. No voltage is developed between the U & V phases (this is referred to as level 1). In fig. 9, IGBT 5 toggles off and on to provide a PWM regulated level 2 voltage between phases U & V. All steps have just one IGBT per pair toggling on and off for each voltage level. This switching technique combined with the switching speed of IGBTs provides an extremely realistic sign wave so high torque with virtually no cogging is realized even at very low shaft speeds. (The drive can be configured in sensorless or closed loop vector modes.)

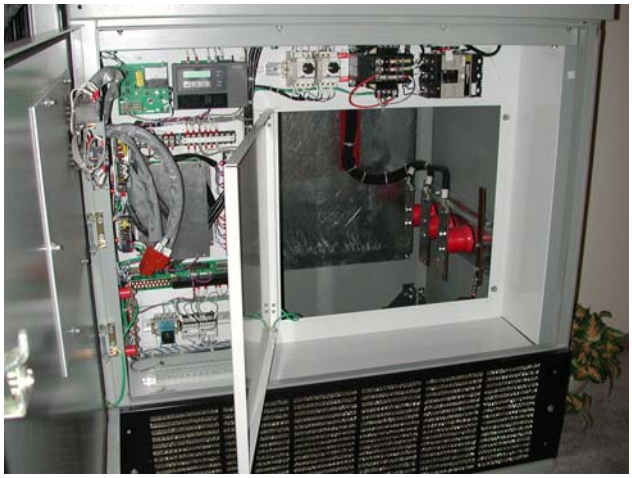

Fig. 10 – Access door to motor lead connection bus

11) A door located inside the bottom, low voltage compartment provides easy access to the motor cable terminal busses. Cables can be fed either out the bottom or the top.

12) The 24 pulse input transformer includes a dedicated auxiliary 5KVA, 460V three phase winding that is used to power the cooling fans for the drive.

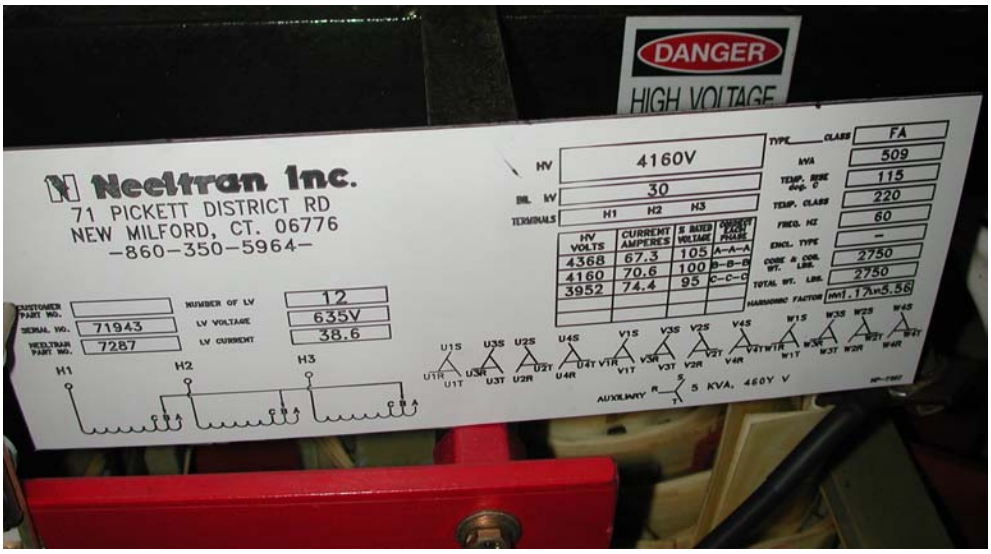

Fig. 11 – Typical transformer nameplate. (In this case a 450HP, 4160V drive)

Fig. 12 – Front view of a 1750HP, 4160V drive with inverter section door open. Note roof mounted fans. There is room for a second set of fans.

13) Cooling for the drive is provided by roof mounted 3 phase fans that evacuate air out of the enclosure by blowing air out the roof. These fans are powered by a dedicated 460V, 5KVA winding on the internally mounted 24 pulse input transformer. A redundant fan option includes a PLC that includes a testing function, automatically switches to the alternate fan if one fails and alternates between fans once a week.

14) The Toshiba T300MV drive is very compact. Dimensions for drives c/w built in transformer are as follows:

2300V Drives		4160V Drives	
Rating Range (HP)	**Width (Inches)**	**Rating Range (HP)**	**Width (Inches)**
Up to 500	74	450 – 900	74
600 – 1000	122	900 – 1750	122
1250 – 1750	174	2000 – 3200	174
2000 – 2500	220	3300 – 4500	220

Summary

1) The Toshiba T300MV drive is **motor and electrical system friendly**:
   - Input harmonics are below the requirements of IEEE 519 – 1992.
   - The output waveform will not stress standard motor insulation either phase to phase or phase to ground (or neutral).
   - The output waveform will not cause additional motor heating therefore the motor does not need to be re-rated or modified for variable torque applications. (Constant torque applications may need additional motor cooling considerations.)
2) The T300MV is **reliable** by design with features including:
   - 2200V PIV rated diodes rectifying 635VAC
   - 3300V PIV rated IGBTs stressed to a maximum of only 1950V
   - Sealed heat pipe cooling technology
   - Oil filled rather than less expensive electrolytic capacitors
   - Copper wound transformer with 220^{0}C insulation operated at a max. of 115^{O}C rise
   - Fan power provided by dedicated auxiliary transformer winding
   - A redundant fan option is available
3) **Maintaining the drive is easy** with full access available to all electronic components.
4) The T300MV has a **very compact** footprint making installation easier and less costly.
5) The T300MV has a **high performance** microprocessor – the same processor used in systems drives for applications such as steel rolling mills. This means smooth performance down to very low speeds, high torque capability and 0.01% speed regulation if closed loop vector control is invoked.
6) As a bonus, innovative design, not only provides high performance and high reliability it helps to reduce costs making the T300MV an **extremely affordable** drive.