



Electrical Ride-Through ERT-400

Raptor Lift Solutions was given access to the Toshiba International Corporations (TIC) motor test facility in Houston from January 24th - 28th, 2020. Potential clients were invited to 2-hour sessions on January 27th and 28th where they were witness to our primary demonstrations:

- 3-phase power loss for 5 seconds
- Single-phase power loss for 20 seconds

Additional tests were completed on January 28th which would also be representative of common field events:

- Single-phase power loss for 30 seconds
- Three-phase reclosure, 2 seconds off/2 seconds on
- Single-phase reclosure, 2 seconds off/2 seconds on

The test was designed to prove the ERT-400 can safely support the minimum voltage requirements to a VSD to maintain an ESP's operation through power disturbances caused by weather, an overloaded grid, sags, etc. The test also highlighted various factors that affect the duration of ride-through events, such as AC input voltage and low voltage "trip" points of VSDs. All tests were carried out safely and without incident.

Test Set Up

Drive

- 3-phase Plus Pack Series Toshiba Drive
- 460V/60Hz drive input, 200HP, 240A FLA
- Integrated output PWM filter

Drive Load

- A motor dyno set to adjust load to the drive
- Drive can be loaded to maximum capacity using the motor dyno set

Power Input Connection

- 3-phase input voltage 460V/480V and 60Hz
- 3-phase input lines connected through contractors which can be controlled using a timer relay to simulate power outages of different durations
- For single-phase faults, only one input line is fed through the contractor in order to simulate single-phase loss

Electrical Ride-Through (ERT) Unit

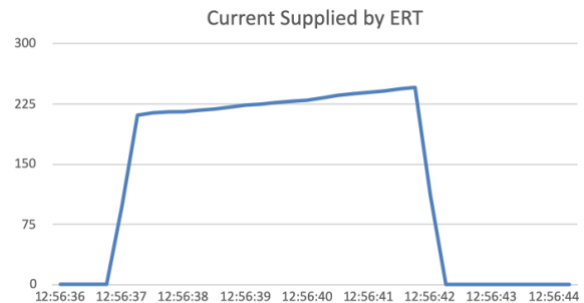
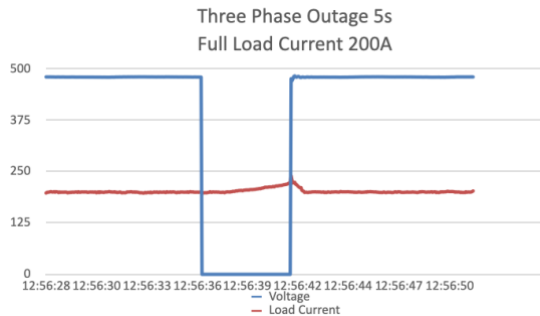
- ERT manages all power connection controls using a PLC
- The pre-charge circuit is integrated within ERT
- The ERT is connect to the drive DC bus using a DC disconnect

Test Measurement Instrumentation

- Input voltages to VSD
- Output current of VSD
- Output current of ERT

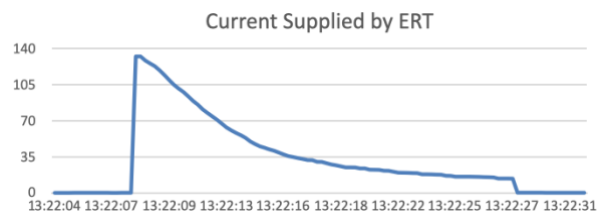
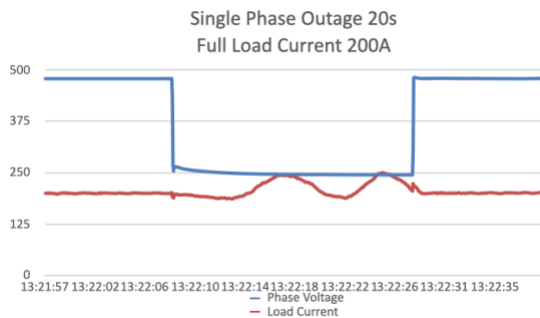
Test 1: Three-Phase Power Loss

- 3-phase fault was created by using contractors on all three input phases
- The VSD continued to operate during the 3-phase loss for 5 seconds at 200A
- The VSD continued to operate after the 3-phase re-engaged and the ERT disconnected
- A complete 3-phase loss is the most extreme form of power disruption, however still a possibility



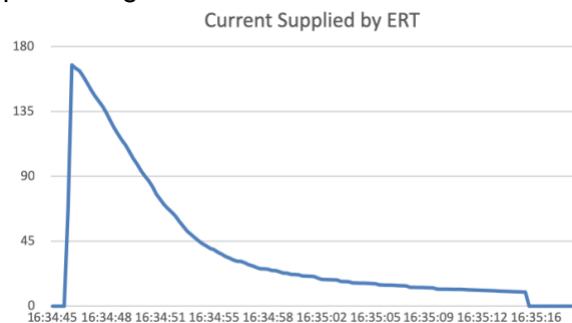
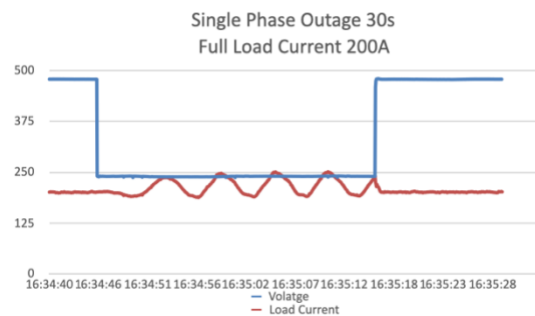
Test 2: Single-Phase Loss

- Single-phase loss was created by using a contactor on one input phase while keeping the remaining two phases connected
- The test demonstrated the VSD maintained operation during a single-phase loss for 20 seconds
- The VSD continued to operate after the lost phase re-engaged and the ERT disconnected
- A complete single-phase loss is the most common form of power sag



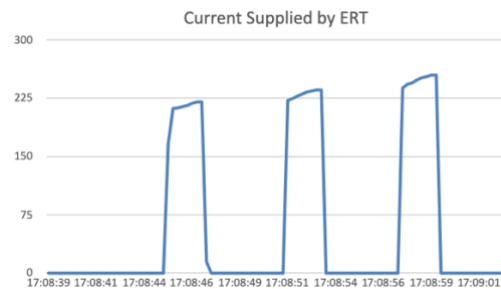
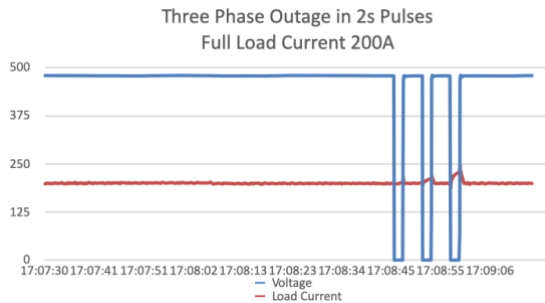
Test 3: Single-Phase Loss

- Single-phase loss was created by using a contactor on one input phase while keeping the remaining two phases connected
- The test demonstrated the VSD maintained operation during a single-phase loss for 30 seconds
- The VSD continued to operate after the lost phase re-engaged and the ERT disconnected
- A complete single-phase loss is the most common form of power sag



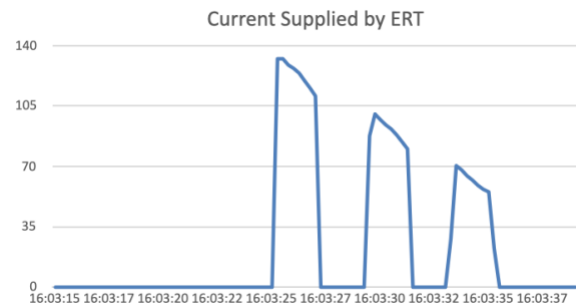
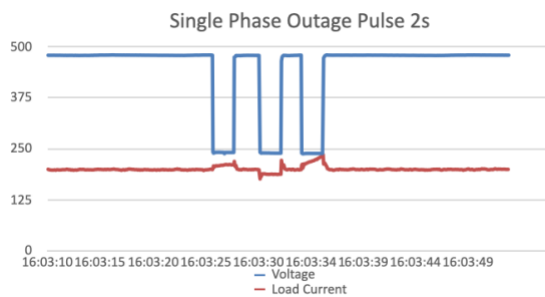
Test 4: Three-Phase Reclosure Event

- 3-phase fault was created by using contractors on all three input phases
- The VSD continued to operate during the 3-phase loss for 2 seconds off/2 seconds on $\times 3$ at 200A
- The VSD continued to operate after the 3-phase re-engaged and the ERT disconnected
- A complete 3-phase loss is the most extreme form of power disruption, however still a possibility



Test 5: Single-Phase Reclosure Event

- Single-phase loss was created by using a contactor on one input phase while keeping the remaining two phases connected
- The VSD continued to operate during the single-phase loss for 2 seconds off/2 seconds on $\times 3$ at 200A
- The VSD continued to operate after the lost phase re-engaged and the ERT disconnected



Conclusion

The ERT-400 performed as expected, demonstrating its ability to effectively manage several different types of potential power disturbances. ERT-300, ERT-400, and ERT-500 are commercially available and sized for drive applications up to 300A, 400A, and 800A, respectively. The voltage drop in the ERT storage modules during the tests was between 100VDC to 150VDC depending on the type of faults, leaving between 528V and 578V available in the storage modules, representing 3-5 seconds of additional ride-through capability.