Next generation control system using the EtherCAT technology

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Good points of EtherCAT

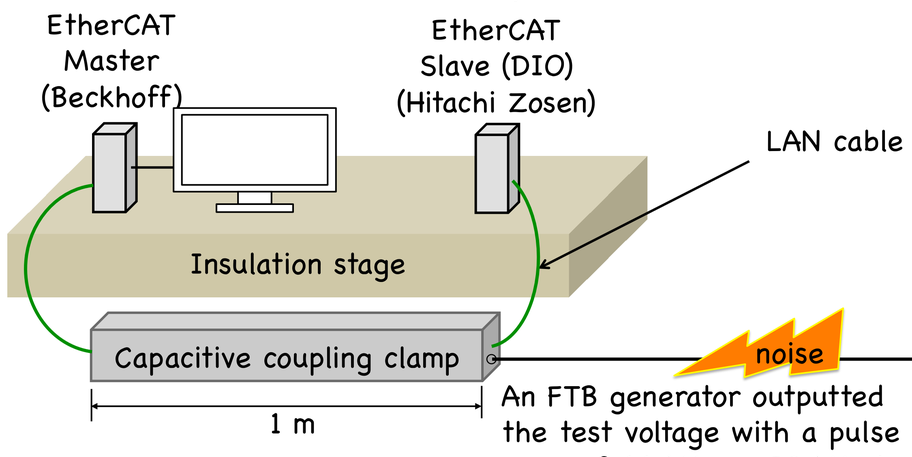
- The market is large.
  - EtherCAT is being introduced in industry (semiconductor and automobile facilities). Toyota motor decided to adopt.
  - many choices of commercial products.
  - Stable supply of commercial products is attractive for long-term operation and maintenance.
- The cyclic data transfer time is less than 1 msec.
  - EtherCAT is suitable for a fast control and a feedback system.
- EtherCAT can reduce wiring.
  - EtherCAT slaves can be installed near control component.
  - This leads to shortening of working time.

Toward the SPring-8 upgrade, we adopted EtherCAT as a network fieldbus.

Electrical noise immunity of LAN cables

In accelerator and synchrotron radiation facilities, slaves may be installed in places with high electrical noise levels.

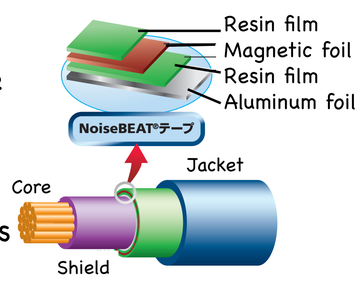
it is necessary to pay attention to the effect of electrical noise on LAN cables. Therefore, we conducted the electrical fast transient/burst immunity (FTB) test.



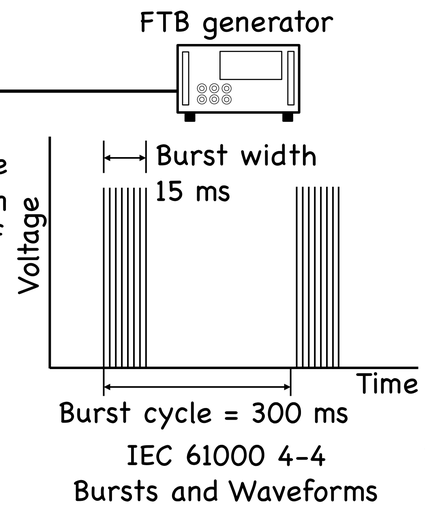
Test cables : a length of 10 m.
- ✓ CAT5e UTP
- ✓ CAT5e STP
- ✓ CAT7
- ✓ CAT5e using NoiseBEAT tape

Test time : 60 sec each.

NoiseBEAT was developed by NTT AT.
It is employed special magnetic alloy films to provide reliable EMI noise reduction.



An FTB generator outputted the test voltage with a pulse wave of 66 kHz or 30 kHz in a burst form with a cycle of 300 ms.



IEC 61000 4-4
Bursts and Waveforms

Results

CAT5e UTP had the lowest noise immunity.
For STP and CAT7, the error rate gradually increased with the test voltage.
The error rate for CAT5e using NoiseBEAT tape suddenly increased at the test voltage of +4.5 kV at 30 kHz.

It is reasonable to use CAT5e UTP in the locations with a good electrical noise environment.
It will be better to use CAT5e STP and CAT7 in the locations with a poor electrical noise environment.

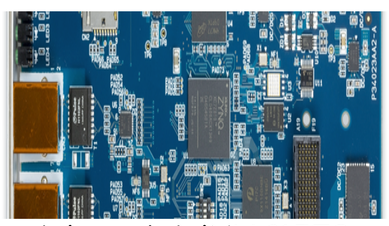
The error rate of the FTB test

Noise frequency	Test voltage	CAT5e UTP	CAT5e STP	CAT7	CAT5e NoiseBEAT
66 kHz	+0.5 kV	0.0%	0.0%	0.0%	0.0%
	+1.0 kV	59.1%	--	--	--
	+1.5 kV	93.1%	0.0%	0.0%	0.0%
30 KHz	+2.5 kV	38.3%	0.06%	0.0%	0.0%
	+3.5 kV	--	1.5%	0.5%	0.0%
	+4.5 kV	--	2.4%	1.3%	90.9%

There was no difference upon changing the polarity of the test voltage.

Application

EtherCAT master



Advanet AdXMC1573

A master protocol stack :
Acontis Technologies EC-Master supporting Class A

For now,
AdXMC1573 is used in all EtherCAT systems.

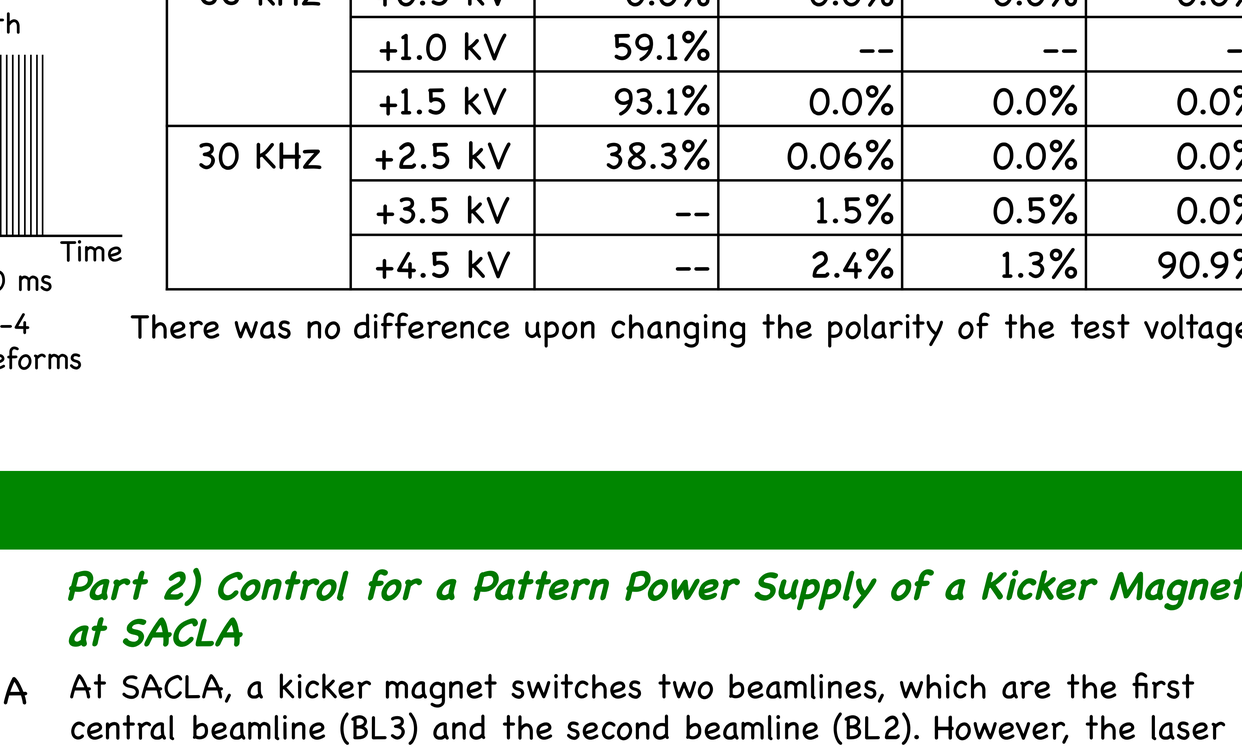
Part 1) Cavity Tuner Control for LLRF System At SPring-8 Storage Ring

See also TUPHA081

EtherCAT slaves:
ADC … Sinfonia (AI0816)
ADC sampling is performed in synchronization with a distributed clock (set to 1 ms) of EtherCAT.
Encoder DIO … CEC (ECAT-S-DIO)
Motor controller … Melec (F3200/EC)

Part 2) Control for a Pattern Power Supply of a Kicker Magnet at SACLA

At SACLA, a kicker magnet switches two beamlines, which are the first central beamline (BL3) and the second beamline (BL2). However, the laser intensity of BL2 was limited compared with that of BL3. To solve the problem, a kicker magnet and a high-precision pattern power supply were developed. And the beam switching system will drive the electron beam to the SPring-8 storage ring.



To adjust the magnetic field of the kicker magnet, a graphical user interface can change the current value of the flat top of the reference trapezoidal pattern.

EtherCAT slave: YOKOGAWA (FA-M3)
Supporting dynamic PDO, where a user can define the exchange data structure of the PDO.