



# Comparison of MECHATROLINK-III and EtherCAT

**MECHATROLINK  
Members  
Association  
2012.7**

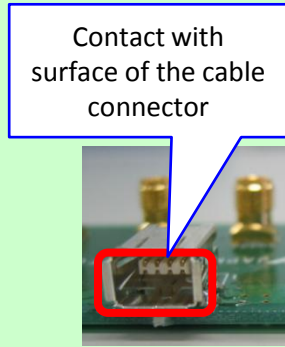
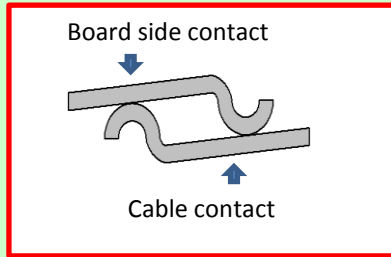
# Comparison

	MECHATROLINK-III	EtherCAT
Open network	Yes	Yes
Baud rate	100Mbps	100Mbps
Number of slaves	62	65535
Transmission cycle time	31.25us ~ 8ms	31.25us ~
Cable length between nodes	100m	100m
Control mode	Position, Speed, Torque	Position, Speed, Torque
Topology	Cascade, Star	Cascade, Star, Branch, Ring, Line, LVDS
Connector	Industrial mini I/O(IMI) or RJ45	RJ45
H/W	ASIC, FPGA	Master : ASIC or Software Slave : ASIC, FPGA
Profile	MECHATROLINK	CAN, SERCOS
Communication method	Command / Response	Packet
Retry function	YES	NO
Synchronization	by ASIC	by software, FPGA, or PHY layer microcode
Message	YES	YES
Hot-plug	YES	YES
Certification system	Master and Slave	Slave

## MECHATROLINK-III



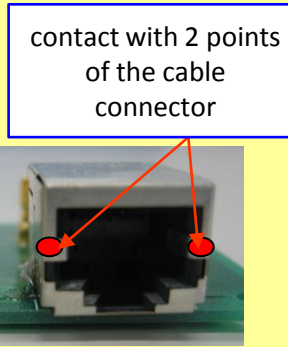
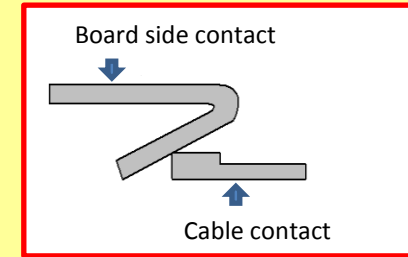
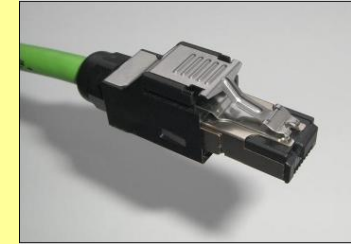
### IMI connector



- Industrial mini IO connector is strong against noise, vibration and twisting force.
- The shield is all-enclosing. · More reliable.
- Appropriate for a small machines.

## EtherCAT

### RJ-45 connector



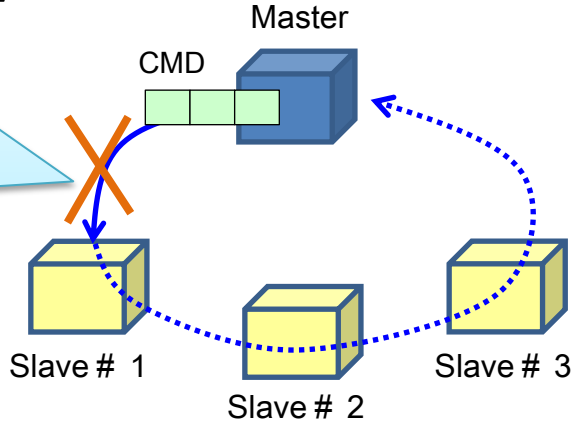
- RJ45 for EtherCAT is not robust against noise, vibration and twisting force.
- The shield is partially covered.
- It is inappropriate for a small machines as the connector is big.

# Retry function : (1)

## EtherCAT

All slaves can not receive command data if the packet is broken here.

It means there are nothing to receive for slaves in that cycle.

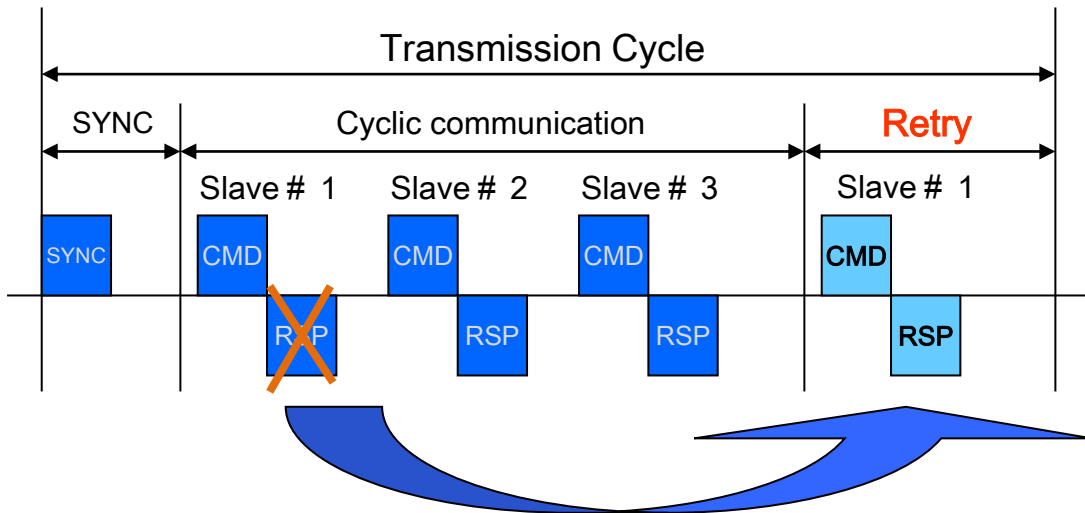


**No RETRY function within a cycle time**

If the communication error occurs, all data(for all slaves) are eliminated and slaves wait for the next cycle.

⇒ Motion will be incorrect for the missed cycle.

## MECHATROLINK-III



If a communication error is detected,

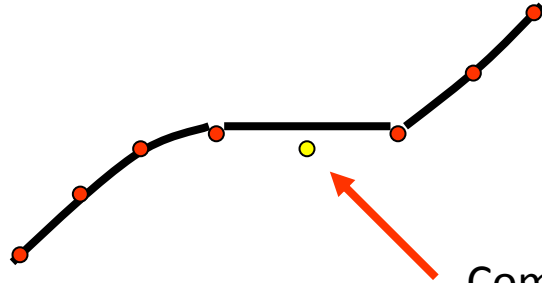
**The master asic sends the command to the slave again in the same cycle.**

**The CPU is not involved in the retransmission.**

⇒ Improve the robustness to the noise

# Retry function : (2) In case of the motion application

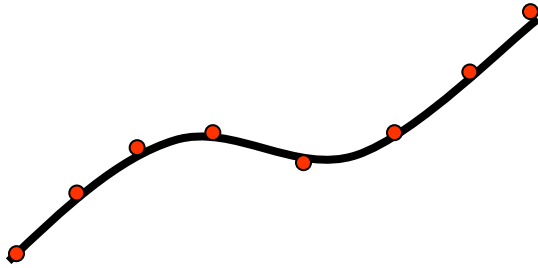
EtherCAT



The path is **incorrect !!!**

Command position ignored due to communication error.

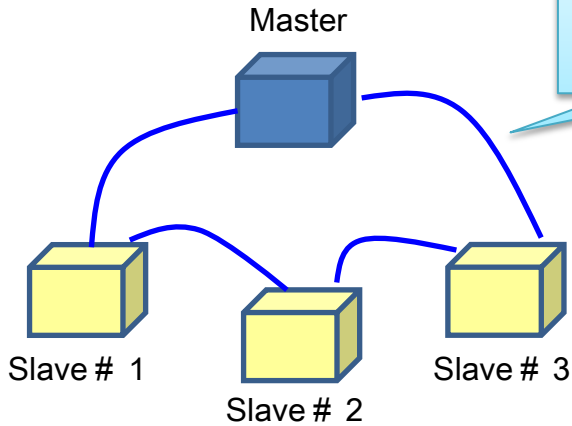
MECHATROLINK-III



The path is **correct !!!**

# Retry function : (3) Cost

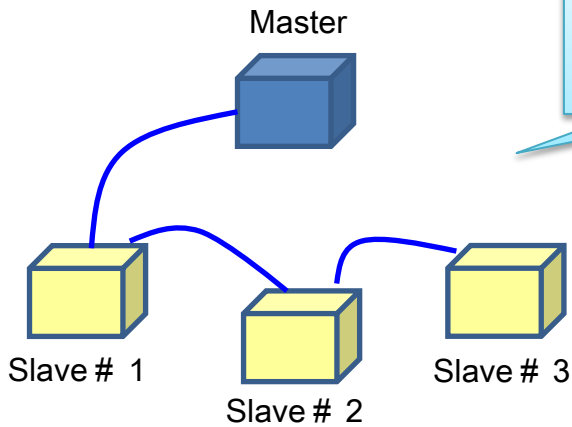
## EtherCAT



Adding the cable for improving the reliability

⇒ "High cost" for the reliability

## MECHATROLINK-III



Just set the retry function for the reliability

⇒ "No cost" for the high reliability

# Command profile

## EtherCAT

- Using CAN base profile as a standard
- PDO mapping must be configured by the user for many commands to run the motor.
- Each procedure to run the motor for Servo A and Servo B is not always the same because each vendor's servo specification is not same.
- The EtherCAT Master must provide vendor specific support servo.

## MECHATROLINK-III

- In MECHATROLINK-III, commands for each slave type is defined.
  - Standard Servo Profile
  - Standard I/O Profile
  - etc.
- Motor commands are clearly defined. (SV\_ON command -> POSING command, etc)
- Same procedures (Command sequences) for all slaves

Profile type

Profile Lvop	Profile group	Profile spec
00	Reserved	Reserved
01	E-11 compatible	E-11 compatible
02 to 0F	Reserved	Reserved
10	Servo profile	Std Servo profile
11 to 1F		High res servo profile
		Multi axes profile
20		Std Inverter profile
11 to 2F	Inverter profile	:
30		Std I/O profile
31 to 3F	I/O profile	:
40 to 7F	non	non
80 to FF	System reserved (Safety, etc)	System reserved (Safety, etc)

Command table

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
00	IMP	POS	POS	TRUN	COMP	HAL	HAL									
10																
20	POS	POS	POS	STOP	STOP	STOP										
30	STOP	STOP	STOP	STOP	STOP	STOP										
40	STOP	STOP	STOP	STOP	STOP	STOP										
50																
60																
70																
80																
90																
A0																
B0																
C0																
D0																
E0																
F0																

Common commands: 00-09, 0A-0B, 0C-0D, 0E-0F

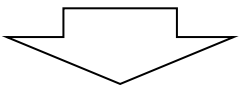
Profile specific commands: 10-1F, 20-2F, 30-3F, 40-4F, 50-5F, 60-6F, 70-7F, 80-8F, 90-9F, A0-AF, B0-BF, C0-CF, D0-DF, E0-EF, F0-FF

Vendor specific commands: 10-1F, 20-2F, 30-3F, 40-4F, 50-5F, 60-6F, 70-7F, 80-8F, 90-9F, A0-AF, B0-BF, C0-CF, D0-DF, E0-EF, F0-FF

# Master development

## EtherCAT

① Motion control : by software  
 ② Communication : by software  
**All done by software**



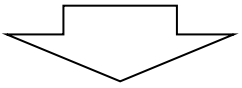
**Strong CPU power is required**



- All of Motion and communication must be implemented by software.
- Real-time OS must be used for high performance.
- License for protocol stack very expensive.

## MECHATROLINK-III

① Motion control : by software  
 ② Communication : by ASIC  
**CPU**



**Hitachi SH-4(200MHz) CPU is enough**



- ASIC performs all communication control.
- PCI card and API available for RTX, Intime, Linux, Windows
- Not necessary to use RT-OS for simple motion application



## EtherCAT

- Only for slaves
- Test items : "Protocol Test", and Physical layer test (Indicator and Labeling)
- Test specification changes each year
  - Vendors and users need to update their products to match the new test specification.
- No conformance test is provided for the motion profile.

## MECHATROLINK-III

- For Master and slaves
- Test items : "Protocol Test" for the motion profile, "Indicator", "Noise immunity test", and "Conformance Test for Ethernet". Error situation tests are also included.
- Test specification is stable.

# Reliability : Noise Immunity Test

Following 2 tests were done for an implementation of MECHATROLINK-III and EtherCAT.

## Test 1

Observe noise amplitude range with no data loss during injecting noise.

Result

The MECHATROLINK-III implementation with one retry has twice the noise amplitude range with no data loss compared to the EtherCAT implementation.

## Test 2

Observe 2 axis circular interpolation during injecting fast transient burst noise.

Result

MECHATROLINK-III : **No Error**  
EtherCAT : **Error occurred**

MECHATROLINK-III is more reliable network than EtherCAT.

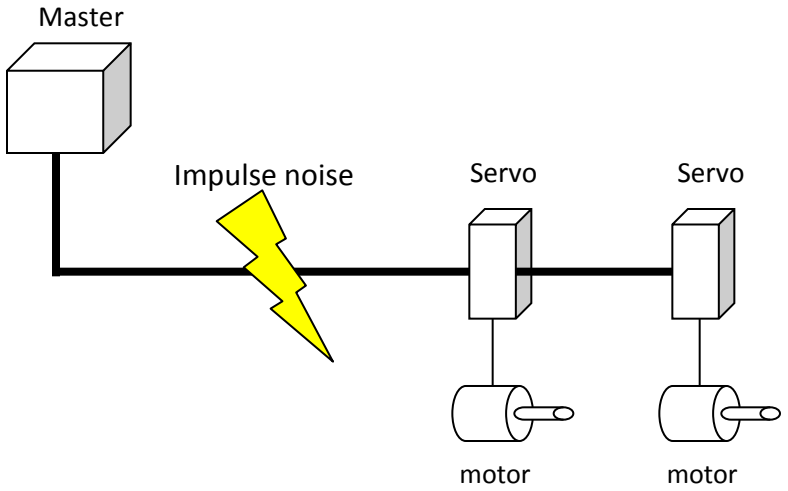
# Test 1

## 1. Contents

Observe noise amplitude range with no data loss during injecting the impulse noise.

## 2. Conditon

- Cycle time 250usec, 32-byte data size
- Inject the noise between -3000V to +3000V



### <MECHATROLINK-III>

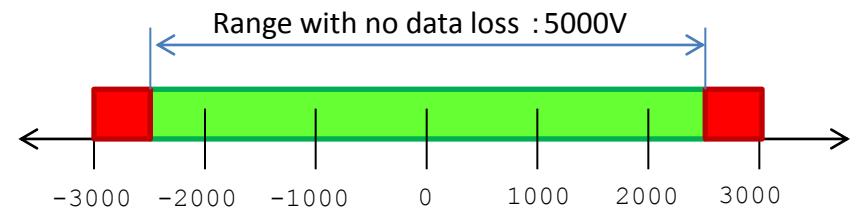
- Data size : 32 byte
- Retry : 1 time

### <EtherCAT>

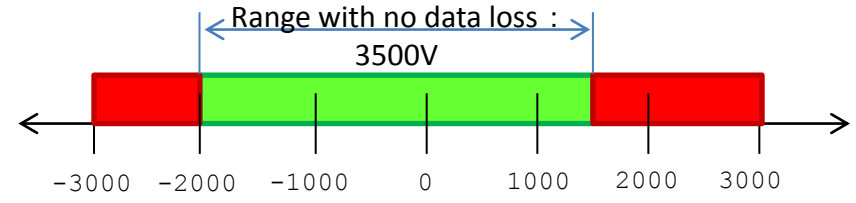
- Data size : 32 byte

## 3. Result

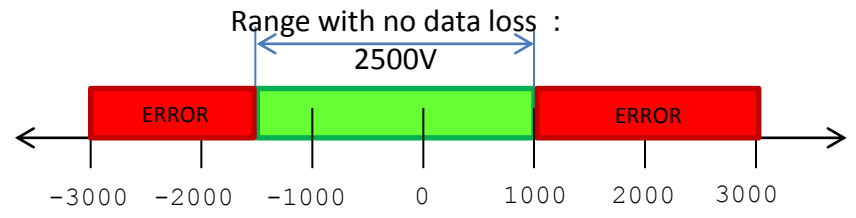
<MECHATROLINK-III> Implementation with 1retry



<MECHATROLINK-III> Implementation with no retry



<EtherCAT> Implementation



**MECHATROLINK-III implementation has twice the noise amplitude range with no data loss compared to EtherCAT implementation.**

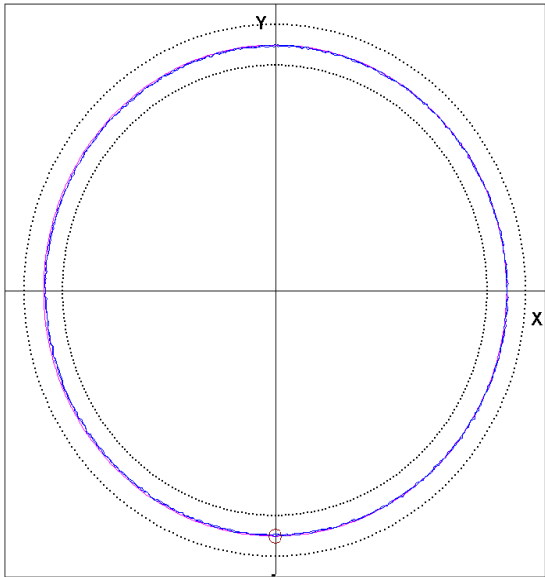
# Test 2

## 1. Condition

- 2 axis circular interpolation, radius 2500mm, 30000 pulse / sec
- Transmission cycle 250usec
- Radiation noise to network cable 1500V

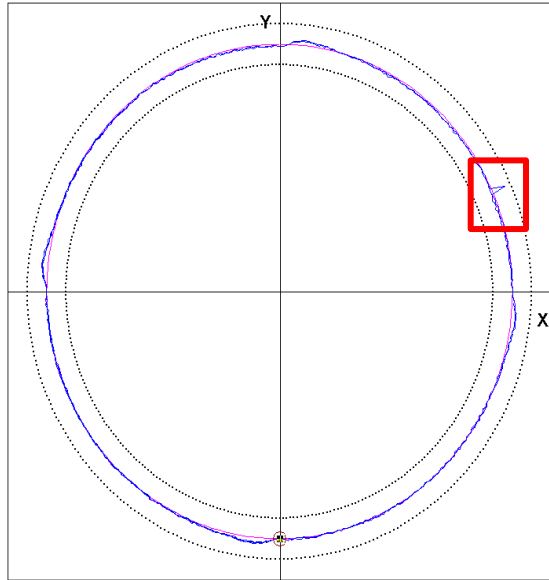
## 2. Result

MECHATROLINK-III



**No error**

EtherCAT



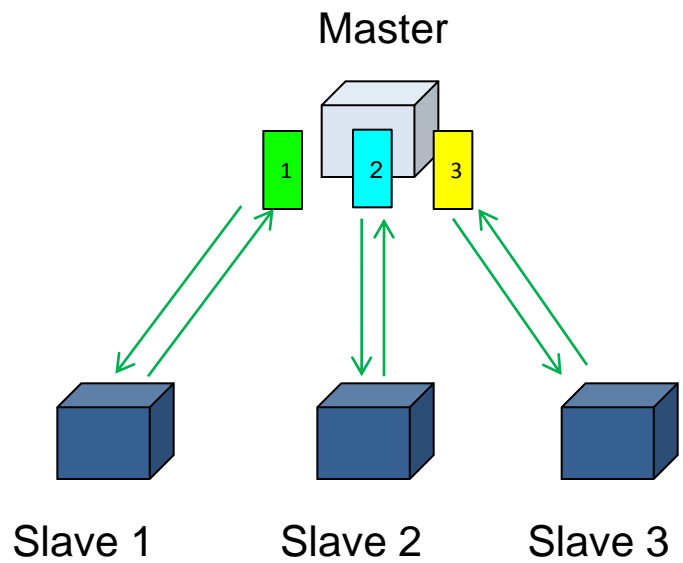
**Error occurred**



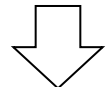
Position error  $\pm 10$  pulse  
Radius 2500mm  
30000 pulse/sec

# Communication method

## MECHATROLINK

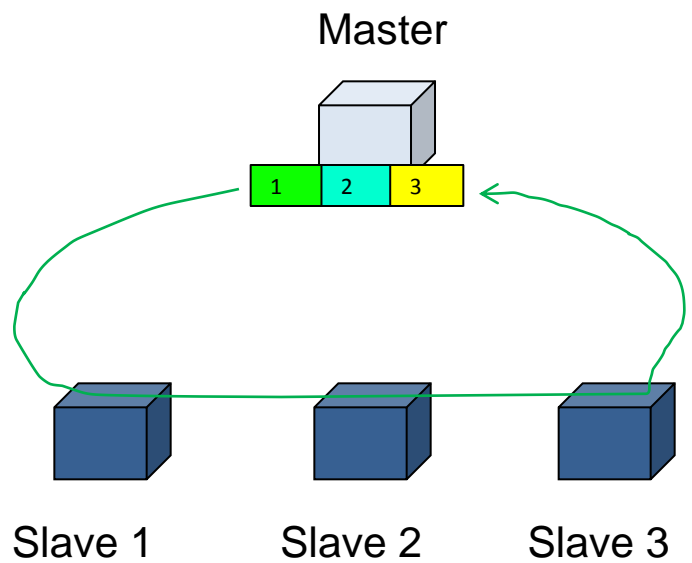


Individual packet to each slave

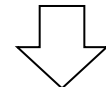


When data packet is corrupted by noise, MECHATROLINK-III retry function sends the command again. Therefore, there is no problem.

## EtherCAT



One packet to all slaves



When data packet is corrupted by noise, **Multiple slaves do not receive commands in that cycle.**