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Intelligent Motion Control Solutions

Motion Control Overview

Motion Control Solutions

Advantech intelligent motion control product division provides solutions to OEM machine makers and system integrators. The core technologies are based on state-of-art DSP/FPGA/SoC processors, Advantech's own softmotion kernel for trajectory and control, EtherCAT motion bus, and configuration utilities. With our softmotion kernel, users can leverage the new, high performance computing hardware and latest application functions supported in the kernel, to enhance machine features and performance. With the support of EtherCAT open standard protocol, users can leverage high speed cycle times for high performance synchronous motion control, and the Ethernet cable connection saves wiring costs.

Motion Control Technology

There are three basic types of motion control system: point-to-point, contouring, and synchronization.

Point-to-Point (PTP) motion

Point-to-point (PTP) movement is the most basic form of motion control. The principle function of the PTP is to position the tool from one point to another within the coordinate system. It is used when precise start and stop position is important, but the path is irrelevant. Velocity, time, and acceleration can be defined for point-to-point moves, allowing the controller to construct either a T or an S-curve move profile.

Contouring (continuous trajectory)

To achieve contoured motion, a series of points is provided during programming, and the motion controller extrapolates a smooth line or curve from these points. Unlike point-to-point motion, contouring guarantees that the system passes through each point, using either linear or circular interpolation. Between the points, linear or circular interpolation is performed, leading to a contour described by a succession of linear segments. In a contoured move, a time to complete the move is specified, but the actual move profile is determined by the motion controller.
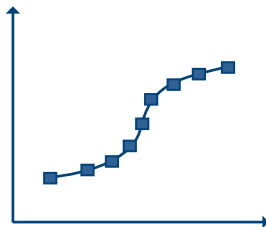
Synchronization

All synchronization controllers follow the master/slave principle. Where the master can freely move with any motion profile under control of any speed curve and one or several slaves exactly follow the master motion in terms of position and speed. The control is based on incremental position feedback by means of encoders on both sides. Many applications just use a measuring wheel with encoder instead of a master drive. It is possible to preset every speed or gear ratio by means of adjustable impulse scaling factors.
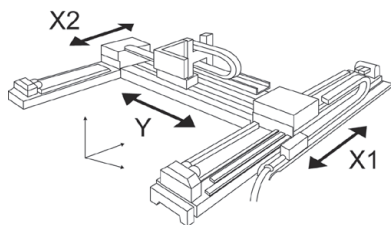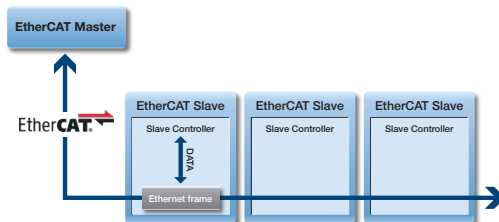
EtherCAT

EtherCAT (Ethernet Control Automation Technology) is a high-performance, Ethernet-based fieldbus industrial network system. The protocol is standardized in IEC 61158 and applies to automation applications that need faster and more efficient communications. Short data update times with precise synchronization make EtherCAT suitable for real-time requirements in automation technology.

Functional principle

In EtherCAT network, the Master sends Ethernet frames through all of the slave nodes. The Standard Ethernet packet or frame is no longer received, interpreted, and copied as process data at every node. Instead, slave devices read the data addressed to them and input data are also inserted in the same time while the telegram passes through the device, processing data "on the fly". Typically the entire network can be addressed with just one frame.

Data exchanges are cyclically updated between EtherCAT Masters and Slaves.

Topology

EtherCAT supports a variety of network topologies, including line, tree, ring, and star. Inexpensive industrial Ethernet cable can be used between two nodes up to 100m apart in 100BASE-TX mode. EtherCAT makes a pure bus or line topology with hundreds of nodes possible without limitations. Up to 65,535 devices can be connected to EtherCAT.

Synchronization

Distributed clocks (DC) mechanism provides highly precise time synchronization between slaves in an EtherCAT network, which is equivalent to the IEEE 1588 Precision Time Protocol standard. By using distributed clocks, EtherCAT is able to synchronize the time in all local bus devices within a very narrow tolerance range. All EtherCAT slaves are provided with an internal clock (system time/local time). One EtherCAT slave is used as a reference clock, distributes its clock cyclically and synchronize between slaves in DC mode by internal clocks in hardware. Therefore, EtherCAT can guarantee the time jitter is less than 1us.
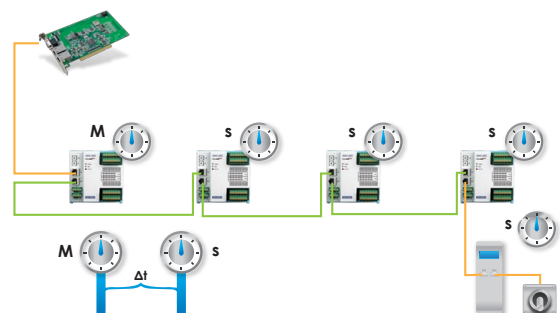
PC-based Motion Controllers

The MAS controller which is a PC-based programmable motion controller provides a variety of tools to shorten development times such as MotionNavi software environment, flowchat-based programing and .Net HMI. For centralized motion control, MAS solutions provide a 4/8-axis controller and offer PTP, interpolation, and trajectory motion functions. MAS controller also supports EtherCAT distributed solutions which can connect up to 32 EtherCAT motors and 1024 byte I/O processing to reduce wiring time and maintenance cost. Furthermore, MAS controller has a built-in powerful Softmotion kernel which is dedicated to motion control and allows customers to focus on their own machine development.
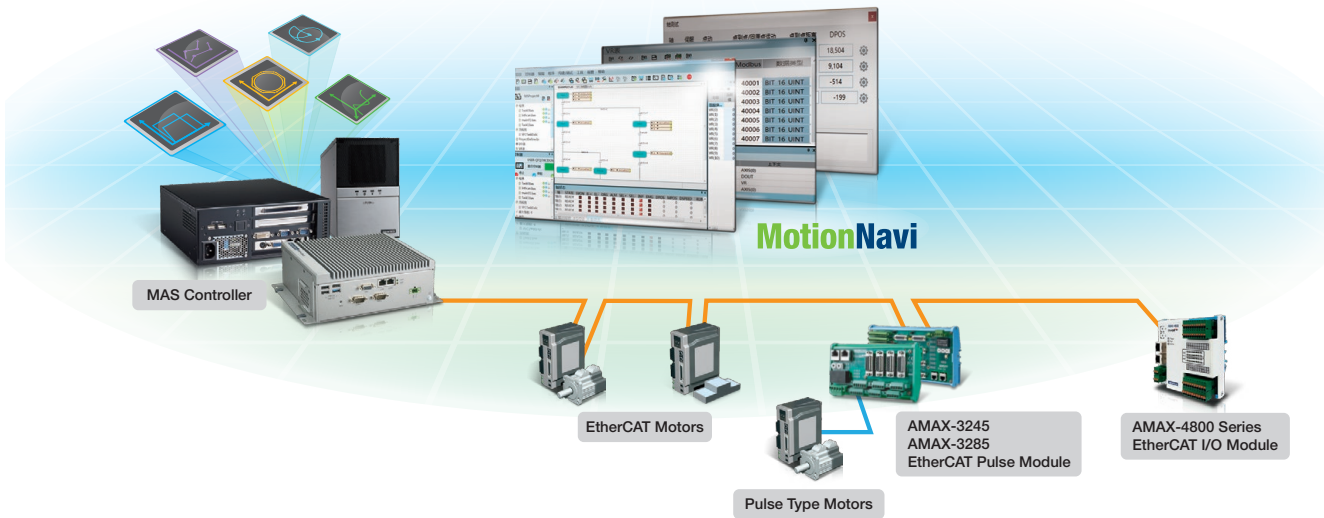
Open platform multi-axis controller
- Seamlessly integrated motion control, machine vision, I/O
- Open standard interface for communication, database

One programming tool - MotionNavi
- Easy to program with BASIC language to shorten learning curve
- Extensive debugging tools for machine control applications
- Faster to learn, program and service

Real-time SoftMotion kernel
- Max 6 axes interpolation, trjectory planning and tracking
- Rich motion functionalities for XYZ tables, SCADA control

MotionNavi

MAS Controller

EtherCAT Motors

Pulse Type Motors

AMAX-3245
AMAX-3285
EtherCAT Pulse Module

AMAX-4800 Series
EtherCAT I/O Module

Standalone Motion Controllers

The AMAX-3110 is a 6 axes pulse train standalone motion controller with compact design to save panel space. It is based on ARM processor that makes it ideal for real time motion and I/O control and has built-in Softmotion kernel which provides 2-6 linear interpolation, 3D circular interpolation and various application focus motion functions such as position compare trigger and latch in. The AMAX-3110 solutions also provides ARES developer software which supports ARES BASIC programing to shorten the development time.
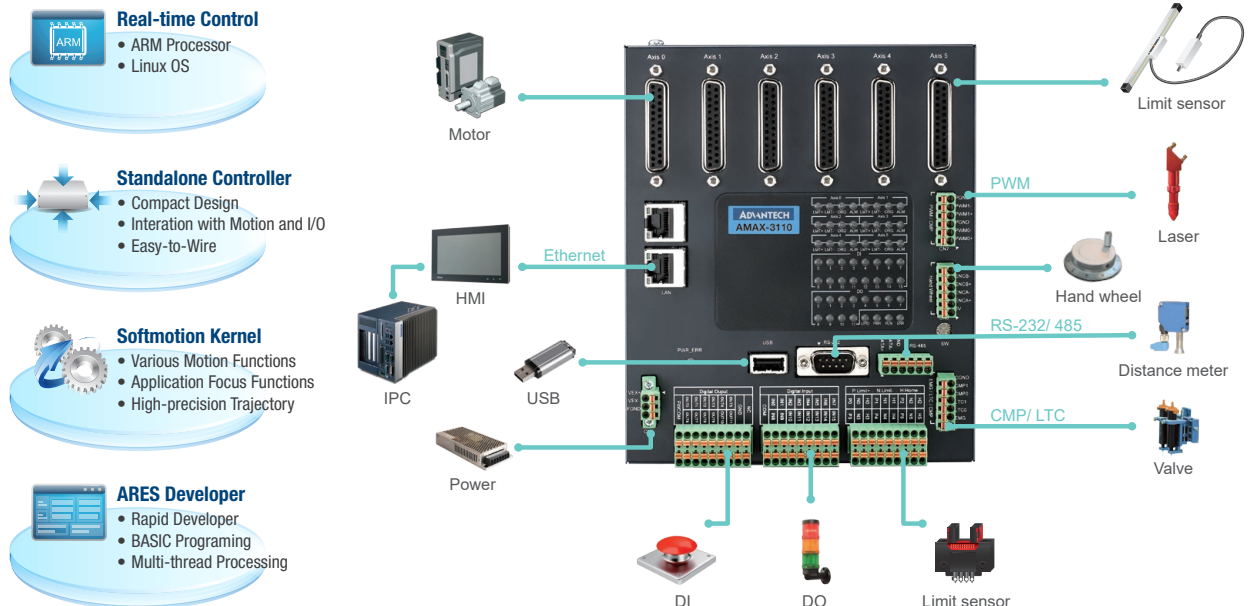
Real-time Control
- ARM Processor
- Linux OS

Standalone Controller
- Compact Design
- Interation with Motion and I/O
- Easy-to-Wire

Softmotion Kernel
- Various Motion Functions
- Application Focus Functions
- High-precision Trajectory

ARES Developer
- Rapid Developer
- BASIC Programing
- Multi-thread Processing

Motor

HMI

IPC

USB

Power

Ethernet

PWM

RS-232/ 485

CMP/ LTC

Limit sensor

Laser

Hand wheel

Distance meter

Valve

DI

DO

Limit sensor

SoftMotion Introduction

Advantech's SoftMotion Introduction

SoftMotion is Advantech's important core technology in the equipment automation field. Compared to ASIC motion control solutions, Advantech's Machine Automation Team independently developed its own SoftMotion control technology and uses the FPGA (Field Programmable Gate Array) and DSP (Digital Signal Processing) as the core-computing hardware platform. Because of SoftMotion excludes the inherent limitations of ASIC specifications, Advantech is able to offer the expertise of professional motion control for our customers and provides custom firmware to optimize device control as well as to minimize the need for additional programming. Through SoftMotion technology enhancements, Advantech offers critical technologies in EMA (Electronic Machine Automation) and TMA (Traditional Machine Automation) fields. Meanwhile, based on the three motion control architectures (centralized, distributed and embedded), Advantech's comprehensive product offering helps our customers to continuously progress their technologies to create win-win opportunities.

SoftMotion Function Table

Item		Description	☞ PCI-1240U	☞ PCI-1245L	☞ PCI-1245E ☞ PCI-1285E	☞ PCI-1245V ☞ PCI-1285V	☞ PCI-1245 ☞ PCI-1265 ☞ PCI-1285	☞ PCI-1203 (6/10/16/32 axis)	☞ PCIE-1203-64AE (64axis)	☞ PCIE-1203L-64AE (64axis)
Motion Control Function	Single-Axis Motion	JOG Move	✓	✓	✓	✓	✓	✓	✓	✓
		MPG	✓	✓	✓	✓	✓	-	✓	-
		T&S-curve speed profile	✓	✓	✓	✓	✓	✓	✓	✓
		Programmable acc. and dec.	✓	✓	✓	✓	✓	✓	✓	✓
		Point to point motion	✓	✓	✓	✓	✓	✓	✓	✓
		Position / Speed Override	✓	✓	✓	✓	✓	✓	✓	✓
		Velocity motion	✓	✓	✓	✓	✓	✓	✓	✓
		Backlash compensation	-	✓	✓	✓	✓	✓	✓	✓
		Superimposed move	-	-	-	-	✓	✓	✓	-
		Stop	✓	✓	✓	✓	✓	✓	✓	✓
	Multi-Axis Motion (Group)	up to 4 groups	1 Group	1 Group	2 / 4 Group	2 / 4 Group	2 / 3 / 4 Group	6 Group	6 Group	6 Group
		Line	2/3 axis	2 axis	2 axis	2/3 axis	2/3 axis	2/3 axis	2/3 axis	2/3 axis
		2-axes Circular	✓	-	-	✓	✓	✓	✓	-
		Speed Override	-	-	-	✓	✓	✓	✓	-
		Helical	-	-	-	-	✓	✓	✓	-
		Pause & Resume	-	-	✓	✓	✓	✓	✓	-
	Home	16 home mode	✓	✓	✓	✓	✓	✓	✓	✓
	Motion Trajectory Planning	Table	✓	-	3 tables (10K poins)/ 4 tables (7K poins)	3 tables (10K poins)/ 4 tables (7K poins)	3 tables (10K poins)/ 3 tables (10K poins)/ 4 tables (7K poins)	6 tables, size: 7k points	6 tables, size: 7k points	-
		Start / End motion list	✓	-	✓	✓	✓	✓	✓	-
		line trajectory: up to 8 axes	2/3-axis Line	-	2-axis Line/Direct	2/3-axisLine, 2~8 axis Direct	2/3-axis Line, 2~8 axis Direct	2/3-axis Line, 1~8 axis Direct	2/3-axis Line, 1~8 axis Direct	-
		Add arc trajectory (2/3-axis)	✓	-	-	✓	✓	✓	✓	-
		Add Dwell	-	-	✓	✓	✓	✓	✓	-
		Start/Sop/Repeat	✓	-	✓	✓	✓	✓	✓	-
		Auto Blending	-	-	-	-	✓	✓	✓	-
Application Function	Gantry	Master & Slave Synchronized motion	-	-	-	-	✓	✓	✓	-
	Speed Forward	Master & Slave Synchronized motion	-	-	-	-	✓	✓	✓	-
	Tangential Following		-	-	-	-	✓	✓	✓	-
	E-Gear		-	-	✓	✓	✓	✓	✓	-
	E-CAM		-	-	-	-	✓	✓	✓	-
	Error check	Error status, Watchdog	✓	✓	✓	✓	✓	✓	✓	✓
	Position Window trigger	Position window output	-	-	-	-	✓	✓	✓	-
	Position Latch	Position Latch Information	-	-	-	✓	✓	✓	✓	-
	Multi-axis Simultaneous Start / Stop	Simultaneously Start/Stop	-	✓	-	-	✓	✓	✓	✓
	PT/PVT	Position/Velocity/ Time Planning	-	-	-	-	-	✓	✓	-
	Torque Limit	Position/Torque Limit	-	-	-	-	-	✓	✓	-
Interrupt	Axis Interrupt	Axis Stop	✓	✓	✓	✓	✓	✓	✓	✓
		Axis Compare	✓	-	-	-	✓	-	-	-
		Axis Error	-	✓	✓	✓	✓	✓	✓	✓
		Axis Latch	-	-	-	-	✓	✓	✓	-
		Axis VH Start	-	✓	✓	✓	✓	✓	✓	✓
		Axis VH Stop	-	✓	✓	✓	✓	✓	✓	✓
	Group Interrupt	Group Stop	✓	✓	✓	✓	✓	✓	✓	✓
		Group VH Start	-	✓	✓	✓	✓	✓	✓	✓
		Group VH Stop	-	✓	✓	✓	✓	✓	✓	✓
Trigger Function	Single Compare	Up to 8 channels	✓ (2 Channel)	-	-	4 / 8 Channel	4 / 6 / 8 Channel	-	2 Channel	-
	Table Compare	Up to 2 channels	✓	-	-	-	✓	-	✓	-
	Linear Compare	(Table size: 100K points)	✓	-	-	✓	✓	-	✓	-
Device DIO	DAQ	DIO	-	-	-	-	8DI, 8DO (PCI-1265)	8DI, 4DO	4DI, 2DO	-
Device AI	DAQ	AI	-	-	-	-	2 AI (PCI-1265)	-	-	-

PCI/PCIE Motion Cards

Centralized Motion Control Solutions

Category	Motion Control				
Bus	PCI				
Model	☞ PCI-1240U	☞ PCI-1245L	☞ PCI-1245E ☞ PCI-1285E	☞ PCI-1245V ☞ PCI-1285V	☞ PCI-1245 ☞ PCI-1265 ☞ PCI-1285
Axis — Number of Axis	4	4	4/8	4/8	4/6/8
Linear Interpolation	✓	✓	✓	✓	✓
2/3-axis Circle Interpolation	✓	-	-	✓	✓
Advanced Functions — Encoder Channels	4	4	4/8	4/8	4/6/8
Limit Switch Input Channels	8	8	8/16	8/16	8/12/16
Home Input Channels	4	4	4/8	4/8	4/6/8
Emergency Stop Input Channels	1	1	1	1	1
Slow Down Limit Switches	8	8	8/16	8/16	8/12/16
General Purpose DI Channels	12	16	16/32	16/32	16/32/32
Servo On Output Channels	4	4	4/8	4/8	4/6/8
General Purpose DO Channels	16	16	16/32	16/32	16/32/32
Analog Input Channels	-	-	-	-	2 (PCI-1265 only)
BoardID Switch	✓	✓	✓	✓	✓
Position Compare	✓	-	-	✓	✓
Position Latch	-	-	-	✓	✓
Dimensions (mm)	175 x 100	175 x 100	175 x 100	175 x 100	175 x 100

Category	Latch & Trigger		Encoder	
Bus	PCI			ISA
Model	☞ PCI-1274-12AE	☞ PCI-1274-16AE	☞ PCI-1784U	☞ PCL-833
Axis — Number of Axis	4	1	-	-
Linear Interpolation	✓	-	-	-
2/3-axis Circle Interpolation	-	-	-	-
Advanced Functions — Encoder Channels	4	1	4	3
Limit Switch Input Channels	8	8	-	-
Home Input Channels	4	4	-	-
Emergency Stop Input Channels	1	1	-	-
Slow Down Limit Switches	8	8	-	-
General Purpose DI Channels	4	-	4	2
Servo On Output Channels	4	-	-	-
General Purpose DO Channels	4	-	4	-
Analog Input Channels	-	-	-	-
BoardID Switch	✓	✓	✓	-
Position Compare	12	16	-	-
Position Latch	12	16	-	-
Dimensions (mm)	175 x 100	175 x 100	185 x 100	185 x 100

PCI/PCIE Motion Cards

EtherCAT Master Control Card

Model	☞ PCI-1203	☞ PCIE-1203L	☞ PCIE-1203
Axis	6/10/16/32	64	64
Advanced Functions — General Purpose DI Channels	8	-	4
General Purpose DO Channels	4	-	2
Encoder In	-	-	2
MPG	-	-	1
Compare Trigger	-	-	2
Position Latch	-	-	2
Remote Motion	32 Servo Drive Max.	64 Servo Drive Max.	64 Servo Drive Max.
Remote I/O	1024-CH DI and 1024-CH DO 128-CH AI and 128-CH AO	1024-CH DI and 1024-CH DO 128-CH AI and 128-CH AO	1024-CH DI and 1024-CH DO 128-CH AI and 128-CH AO
Dimensions (L x H)	175 x 100 mm		
Connectors	2 x RJ45, D-sub 15	2 x RJ45	2 x RJ45, D-sub 26

Motion Controllers

Embedded Machine Automation Solution

Model Name		☞ MVP-3245	☞ AMAX-3110
Hardware	CPU	Intel Celeron J1900 @ 1.99 GHz	ARM-based
	Memory	4GB DDR3	4G DDR3
	Storage	mSATA 32GB	eMMC 8GB
Communication	Ethernet	2	1
	USB	4 x USB 2.0, 1 x USB 3.0	1
	Serial	2 x RS-232/422/485	1 x RS-232, 1 x RS-485
Motion	Axes	4	6
	Pulse Input	CW/CCW, AB Phase	CW/CCW, AB Phase
	Pulse Output	CW/CCW, Pulse/Dir	CW/CCW, Pulse/Dir, AB Phase
	Hand Wheel	1	1
	PWM	-	2
	Compare Trigger	4	2
	Position Latch	4	2
General I/O	Digital DI	16	16
	Digital DO	16	12
Other	Input Voltage	DC 24V	DC 24V
	Library	Visual.Net, BCB, LabVIEW	ARES Command
	Dimensions (W x H x D)	250 x 160 x 85 mm	148 x 180 x 22 mm

Terminal Boards and Cables

Motion Card
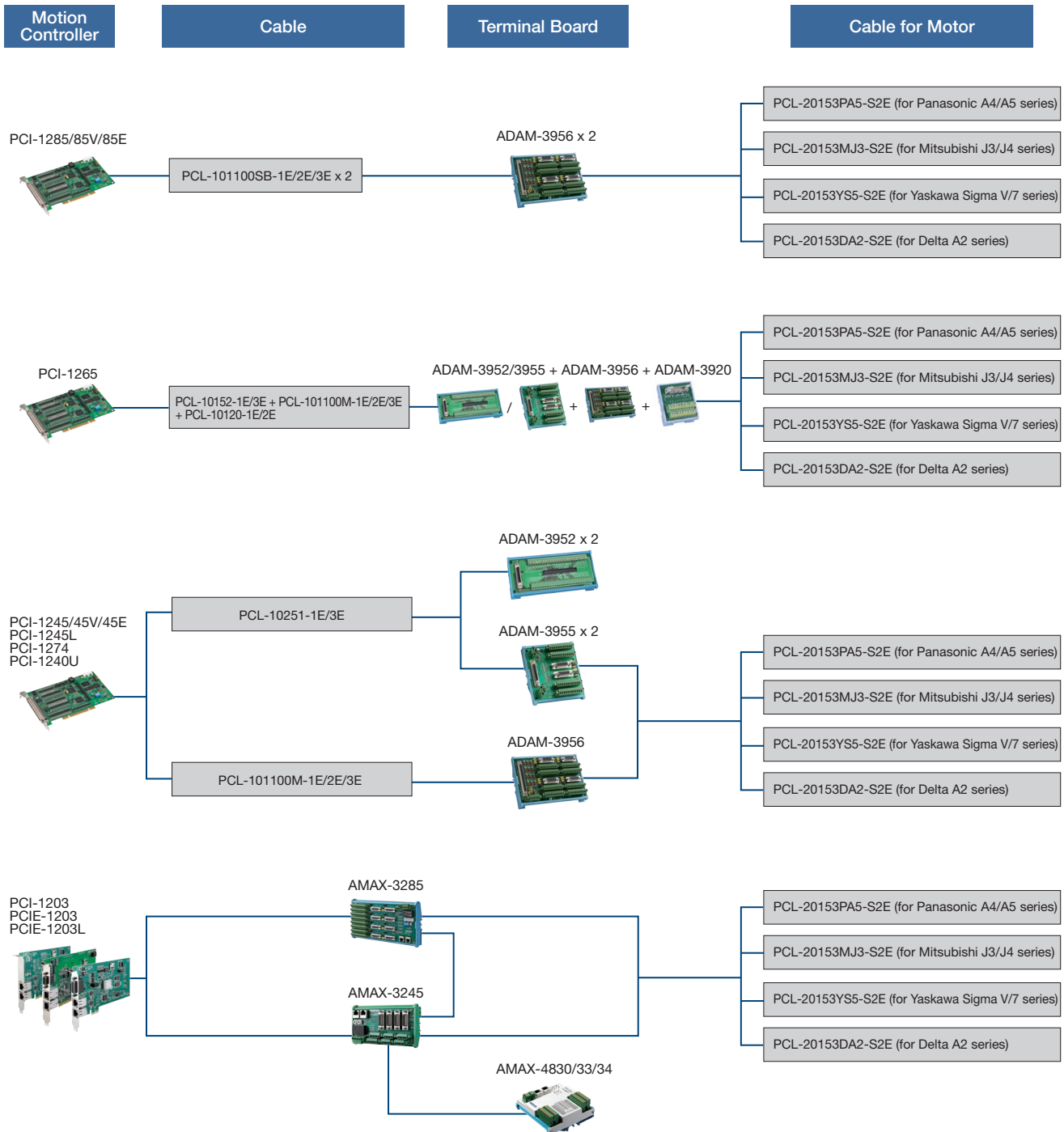
Motion Controller	Cable	Terminal Board	Cable for Motor

PCI-1285/85V/85E

PCL-101100SB-1E/2E/3E x 2

ADAM-3956 x 2

- PCL-20153PA5-S2E (for Panasonic A4/A5 series)
- PCL-20153MJ3-S2E (for Mitsubishi J3/J4 series)
- PCL-20153YS5-S2E (for Yaskawa Sigma V/7 series)
- PCL-20153DA2-S2E (for Delta A2 series)

PCI-1265

PCL-10152-1E/3E + PCL-101100M-1E/2E/3E + PCL-10120-1E/2E

ADAM-3952/3955 + ADAM-3956 + ADAM-3920

- PCL-20153PA5-S2E (for Panasonic A4/A5 series)
- PCL-20153MJ3-S2E (for Mitsubishi J3/J4 series)
- PCL-20153YS5-S2E (for Yaskawa Sigma V/7 series)
- PCL-20153DA2-S2E (for Delta A2 series)

PCI-1245/45V/45E
PCI-1245L
PCI-1274
PCI-1240U

PCL-10251-1E/3E

ADAM-3952 x 2

ADAM-3955 x 2

ADAM-3956

PCL-101100M-1E/2E/3E

- PCL-20153PA5-S2E (for Panasonic A4/A5 series)
- PCL-20153MJ3-S2E (for Mitsubishi J3/J4 series)
- PCL-20153YS5-S2E (for Yaskawa Sigma V/7 series)
- PCL-20153DA2-S2E (for Delta A2 series)

PCI-1203
PCIE-1203
PCIE-1203L

AMAX-3285

AMAX-3245

AMAX-4830/33/34

- PCL-20153PA5-S2E (for Panasonic A4/A5 series)
- PCL-20153MJ3-S2E (for Mitsubishi J3/J4 series)
- PCL-20153YS5-S2E (for Yaskawa Sigma V/7 series)
- PCL-20153DA2-S2E (for Delta A2 series)

Terminal Boards and Cables

Motion Controller

Motion Controller	Cable	Terminal Board		Cable for Motor

MVP-3245

ADAM-3937

DIO — PCL-10137-1E/2E/3E

ADAM-3952 x 2

PCL-10251-1E/2E/3E

ADAM-3955 x 2

PCL-20153PA5-S2E (for Panasonic A4/A5 series)

PCL-20153MJ3-S2E (for Mitsubishi J3/J4 series)

PCL-20153YS5-S2E (for Yaskawa Sigma V/7 series)

ADAM-3956

PCL-101100M-1E/2E/3E

PCL-20153DA2-S2E (for Delta A2 series)

AMAX-3110

PCL-30153PA5-S2E (for Panasonic A4/A5 series)

PCL-30153MJ3-S2E (for Mitsubishi J3/J4 series)

PCL-30153YS5-S2E (for Yaskawa Sigma V/7 series)

PCL-30153DA2-S2E (for Delta A2 series)