14 Intelligent Motion Control Solutions

Motion Control Overview

Motion Control Solutions

The Advantech intelligent motion control product division provides solutions to OEM machine makers and system integrators. The core technologies are based on state-of-the-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

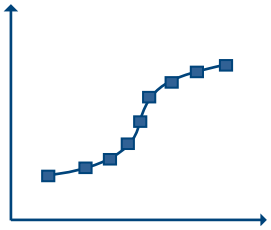
There are three basic types of motion control systems: point-to-point, contouring, and synchronization.

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.

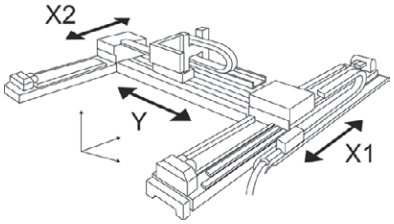
Contouring (Continuous Trajectory)

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 MDevice/SubDevice principle. Where the MDevice can freely move with any motion profile under control of any speed curve and one or several SubDevices exactly follow the MDevice 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 MDevice drive. It is possible to preset every speed or gear ratio by means of adjustable impulse scaling factors.

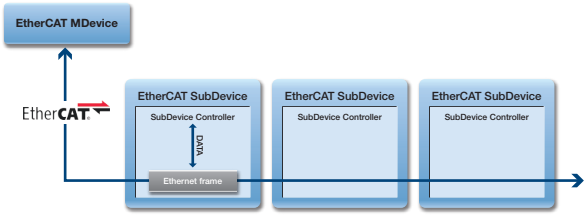


EtherCAT

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 MDevice sends Ethernet frames through all of the SubDevice nodes. The Standard Ethernet packet or frame is no longer received, interpreted, and copied as process data at every node. Instead, SubDevices 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.



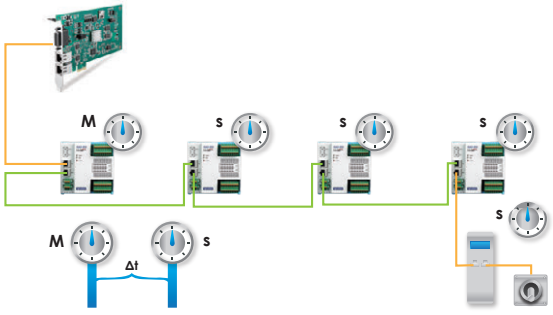
Data exchanges are cyclically updated between EtherCAT MDevices and SubDevices.

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.

Distributed Clock (DC)

Distributed clocks (DC) mechanism provides highly precise time synchronization between SubDevices 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 SubDevices are provided with an internal clock (system time/local time). One EtherCAT SubDevices is used as a reference clock, distributes its clock cyclically and synchronize between SubDevices in DC mode by internal clocks in hardware. Therefore, EtherCAT can guarantee the time jitter is less than 1us.



Arm-Based Motion Controllers

The AMAX-354/324 which is a Arm-based motion controller supports Advantech MotionNavi Designer software environment. AMAX-354/324 controller also supports EtherCAT distributed solutions which can connect up to 32 EtherCAT motors and 512 bytes I/O processing to reduce wiring time and maintenance cost. Furthermore, the AMAX-354/324 controller has a powerful built-in SoftMotion kernel dedicated to motion control and allows customers to focus on their own machine development.

Open platform multi-axis controller

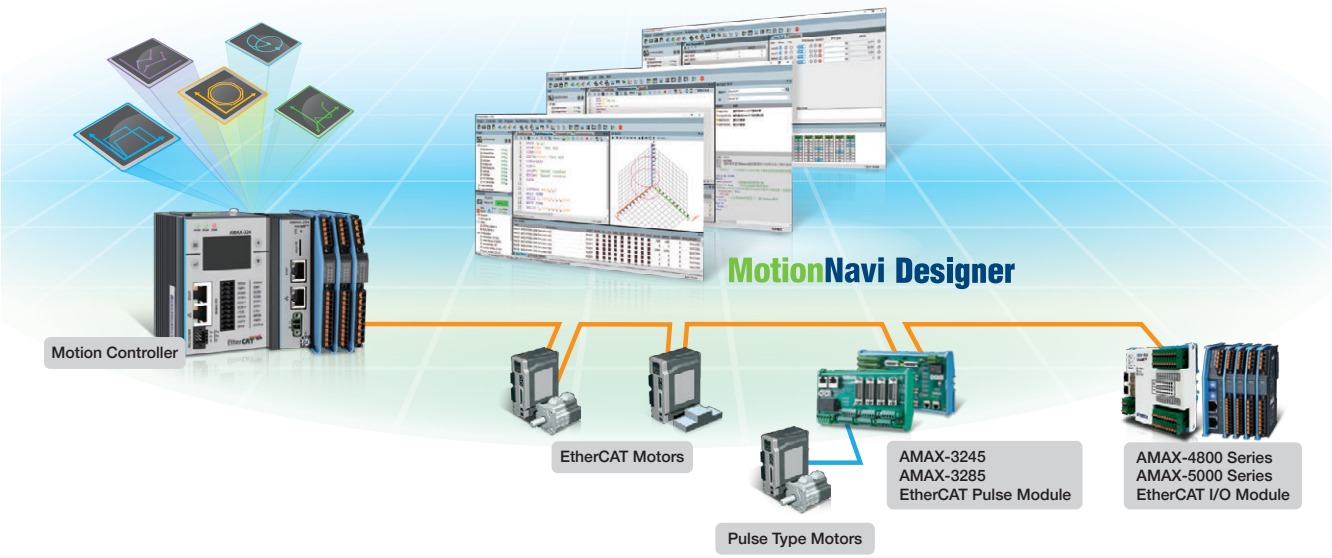
- Seamlessly integrated motion control, machine vision, I/O
- Open standard interface for communication

One programming tool - MotionNavi

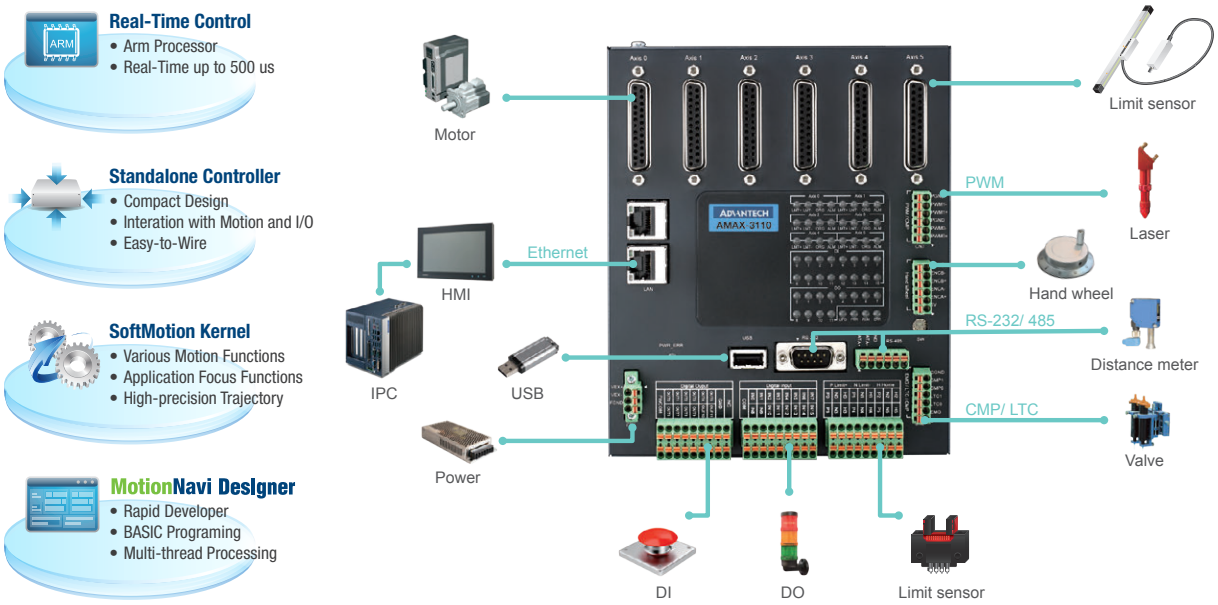
- Easy to program with BASIC language to shorten learning curve
- Extensive debugging tools for machine control applications
- Faster to learn, program, and service

Real-time SoftMotion kernel

- Max. 32 axes interpolation, trajectory planning and tracking
- Varied motion functionalities for XYZ tables, path table control



The AMAX-3110 is a 6-axis pulse train standalone motion controller with compact design to save panel space. It is based on the Arm processor, ideal for real time motion and I/O control, and a built-in SoftMotion kernel to provide 2-6 linear interpolation, 3D circular interpolation, and various application motion functions such as position compare, trigger, and latch in. The AMAX-3110 solutions also provides MotionNavi Designer, which supports the BASIC programming language to shorten the development time.



MotionNavi Designer

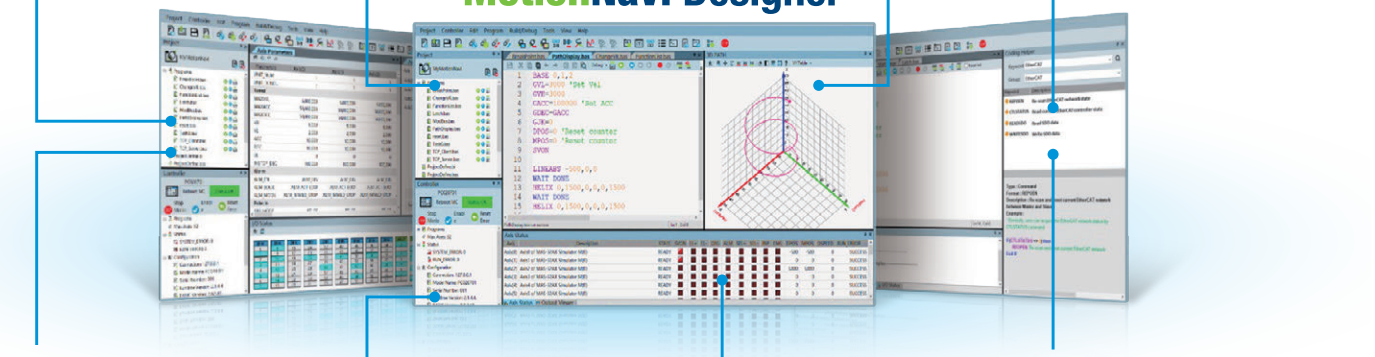
Motion Control Software

Tuning & Test Tool
Point-to-point, HOME, JOG test

Offline Simulation
Simulation without hardware installation

3D Path Display
Visualized motion trajectory by XYZ dimension

Coding Help
No need to remember all commands



Status Monitoring
Axis, I/O, system and VR (variable) status

Rapid Deployment
EtherCAT configuration tool – simple step to initialize network

BASIC Low-Code Commands
Easy-to-learn commands, helpful for developing in a short time frame

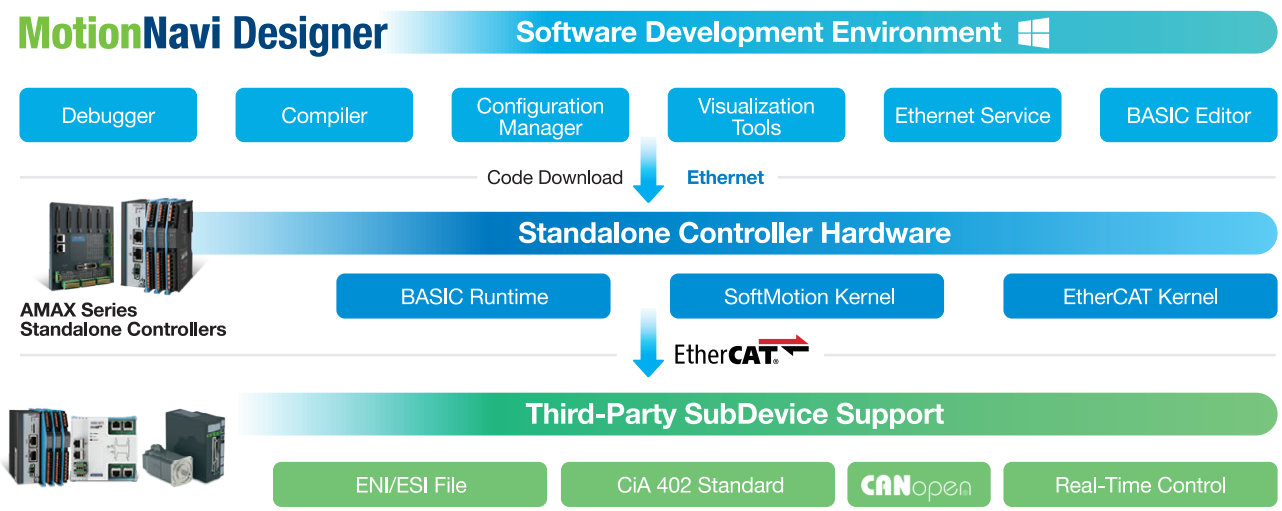
Oscilloscope
Monitor motion status in real time

Easy Development, Effortless Control Configuration

MotionNavi Designer is a low-code integrated development environment (IDE) with a visual interface for Advantech's standalone motion controllers. It's compatible with Windows OS and enables tasks like EtherCAT SubDevice configuration, network communication diagnostics, motion control testing and debugging, and trajectory analysis. It streamlines application-specific code development. After coding and debugging, the compiled code can be downloaded and executed on standalone motion controllers.

Quick Start, Flexible, and Feature-Rich Applications

MotionNavi Designer simplifies low-code development with a BASIC-like syntax, ideal for developers with basic PC experience. It supports multi-tasking with up to 20 processes on AMAX-354. Users can share data via the main program, subprograms, and variables for flexible control. The software includes tools for analyzing EtherCAT network quality, motion control, parameter tuning, and VR variables.



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 SoftMotion excludes the inherent limitations of ASIC specifications, Advantech is able to offer 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 Electronic Machine Automation (EMA) and Traditional Machine Automation (TMA) 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-1245L	PCI-1245E PCI-1285E	PCI-1245V PCI-1285V	PCI-1245 PCI-1285	PCIE-1245	PCI-1203 (6/10/16/32axis)	PCIE-1203IO-00AE (0axis)	PCIE-1203L-64AE (10/16/32/64axis)	PCIE-1203-64AE (10/16/32/64axis)
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	2 / 4 Group	2 / 4 Group	2 / 4 Group	2 Group	8 Group	–	8 Group	8 Group
		Line	2 axis	2 axis	2/3 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	–	2 tables (10K points)/ 4 tables (7K points)	2 tables (10K points)/ 4 tables (7K points)	2 tables (10K points)/ 4 tables (7K points)	2 tables (10K points)	6 tables (7k points)	–	–	6 tables (7k points)
		Start / End Motion List	–	✓	✓	✓	✓	✓	–	–	✓
		Line Trajectory: Up to 8 Axes	–	2/3-axis line, 2~4 axis direct	2/3-axis line, 2~8 axis direct	2/3-axis line, 2~8 axis direct	2/3-axis line, 2~4 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	MDevice & SubDevice Synchronized Motion	–	–	–	✓	–	✓	–	–	✓
	Speed Forward	MDevice & SubDevice 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	–	–	4 / 8 Channel	4 / 8 Channel	2 Channel	–	–	–	2 Channel
	Table Compare	Up to 2 Channels	–	–	✓	✓	✓	–	–	–	✓
	Linear Compare	(Table Size: 100K Points)	–	–	✓	✓	✓	–	–	–	✓
I/O	Remote	DI/O	–	–	–	–	–	1024/1024	1024/1024	1024/1024	1024/1024
		AI/O	–	–	–	–	–	128/128	128/128	128/128	128/128
	Device	DI/O	–	–	–	–	–	8DI, 4DO	–	–	4DI, 2DO
		AI/O	–	–	–	–	–	–	–	–	–

✓: supported, – : not supported, △ : optional

Motion Controllers

Embedded Machine Automation Solution

NEW

NEW

NEW

Model		AMAX-324	☞ AMAX-354	☞ AMAX-357
Hardware	CPU	Dual-Core Arm processor		Intel® Atom® x6413E processor
	Memory	1 GB	1 GB	4 GB DDR4 2666 MHz onboard
	Storage	8 GB emmc / 64 kb FRAM	8 GB emmc / 64 kb FRAM	64 GB eMMC onboard
Communications	Ethernet	1	1	2
	EtherCAT	1	1	1
	Serial	2 COM (RS232/RS485)	–	–
	USB	-	–	2 x USB 3.2
Pulse Control & Special I/O Function	Axes	32		
	Hand Wheel	1	–	–
	PWM		–	–
	Compare Trigger (CMP)	2	–	–
	Position Latch (LTC)	2	–	–
	TTL Differential CMP	1	–	–
	Encoder In	2	–	–
I/O	EtherCAT I/O	1024-CH DI and 1024-CH DO 128-CH AI and 128-CH AO		
Input Voltage		24 V_{DC} ± 20%		
Library		MotioNavi BASIC		MotioNavi API
Dimension (W x H x D)		70 x 70 x 100 mm	34.4 x 70 x 100 mm	65.3 x 70 x 100 mm

– : not supported

PCI/PCIE EtherCAT Motion Cards

NEW

Model		☞ PCI-1203	☞ PCIE-1203IO	☞ PCIE-1203L	☞ PCIE-1203
Axis		6/10/16/32	0	10/16/32/64	10/16/32/64
Advanced Functions	General Purpose DI Channels	8	–	–	4
	General Purpose DO Channels	4	–	–	2
	Encoder In	–	–	–	2
	MPG	–	–	–	1
	Position 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	1024-CH DI and 1024-CH DO 128-CH AI and 128-CH AO
Dimension (L x H)		175 x 100 mm			
Connectors		2 x RJ-45, D-sub 15	2 x RJ-45	2 x RJ-45	2 x RJ-45, D-sub 26

PCI/PCIE Pulse-Train Motion Cards

NEW





Category		Motion Control				
Bus Interface		PCI				PCIE
Model		PCI-1245L	PCI-1245E PCI-1285E	PCI-1245V PCI-1285V	PCI-1245 PCI-1285	PCIE-1245
Axis	Number of Axis	4	4/8	4/8	4/8	4
	Linear Interpolation	✓	✓	✓	✓	✓
	2/3-axis Circle Interpolation	–	–	✓	✓	✓
Advanced Functions	Encoder Channels	4	4/8	4/8	4/8	4
	Limit Switch Input Channels	8	8/16	8/16	8/16	8
	Home Input Channels	4	4/8	4/8	4/8	4
	Emergency Stop Input Channels	1	1	1	1	1
	General Purpose DI Channels	16	16/32	16/32	16/32	8
	Servo On Output Channels	4	4/8	4/8	4/8	4
	General Purpose DO Channels	16	16/32	16/32	16/32	8
	Analog Input Channels	–	–	–	–	–
	BoardID Switch	✓	✓	✓	✓	✓
	Position Compare	–	–	✓	✓	✓
	Position Latch	–	–	✓	✓	–
Dimension (L x H)		175 x 100 mm	175 x 100 mm	175 x 100 mm	175 x 100 mm	175 x 100 mm




Category		Latch & Trigger		Encoder	
Bus Interface		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	–	–
Dimension (L x H)		175 x 100 mm	175 x 100 mm	185 x 100 mm	185 x 100 mm

✓: supported, – : not supported, △ : optional

Terminal Boards & Cables

Motion Card	Cable	Terminal Board	Cables for Motors

PCI-1285/85V/85E

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

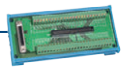
ADAM-3956 x 2

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

PCL-10251-1E/3E

ADAM-3952 x 2



ADAM-3955 x 2

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

ADAM-3956

- 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)

PCIE-1245

PCL-31068-1E/ 2E/ 3E

MTB-400

- 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)

PCI-1203
PCIE-1203
PCIE-1203L

AMAX-3245

AMAX-4800 Series

AMAX-5000 Series

- 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)