NetPod 4003 Series Instrumentation

Data Acquisition & Controls System



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Fully Synchronised Operations - Internal & Network Local Area Network Connection **Digital Anti-alias Filters** Individual ADC / Channel **Full Galvonic Isolation** Automatic Interface Card Identification **Temperature Controlled fan for Low Noise Cooling Bayonet Fitting - Self Lock Connectors** Modular Assembly - 4 Channel building blocks In-built Lightning / Surge Protection **Options for 2000V Opto-isolation** Temperature Measurement - Thermocouple / Thermistor / RTD ICP / Servo Accelerometer Interface Voltage Measurements to 500V **Current Loop measurement & Excitation** Strain Gauge Support. Analogue Output Ports Automatic card ID **Software Defined Digital Filters** 0 - 200 K Hz sample rate



Introduction

The NetPod 4003 is a new member of the Keynes Controls NetPod series of instruments have been designed from the outset to offer everything needed in a stand-alone instrument for both local and distributed measurement solutions.

The 4003 high levels of data synchronisation both among channels within an instrument and instruments across a network. The sensors inputs are securely located using self aligning bayonet connectors and offer digital filtering and high level transient/lightning protection to safeguard the instrument in the harshest of application

Features

16 individually isolated Analogue inputs - or
16 individual Analogue outputs
4 Channel Analogue Input / output building blocks
Integrated sensor excitation
Hot-swap Support
24 bit ADC Resolution per channel - Sigma Delta
Sample rate to 200 KHz/channel
lightning protection - Gas Discharge/Transorb
Option for 2000V DC Opto-isolation
Digital Anti-alias filters.
Digital Interface Options

Sensor Inputs

Thermocouples	Types B,C,J,K,R,S,T
Thermistor	
Voltage inputs from	5 V to 500V others on request
Resistance	0-600 Ohm Standard - Adjusted for other ranges on request
Current Interface	0-20 mA, 4-20, 0-60 mA loops
	including excitation
Strain Gauge	Full, ¹ / ₂ and ¹ / ₄ bridges
	120,350,500 and 1 K Ohm Gauge
ICP Accelerometer	-
Sensor Excitation	Options for +/- 12V supply

Each sensor input uses a CNT bayonet fitting self aligning be synchronised together. plug and socket to attach signal inputs to the instrument. A physical release catch needs to be operated to remove the sensor input from the device and so makes sure that the cabling remains reliably attached no matter the industrial



NetPod 4003 System

Software Support

The NetPod 4003 is supported by drivers for most modern data acquisition and SCADA software such as:

National Instruments Lab view DasyLAB Others on request

Full Software developers kit is available for the **Microsoft Windows** and **Linux/Unix** Operating Systems. Interface to any 3rd party package supporting DLL calls with only a few simple commands.

Network Data Synchronisation

The NetPod 4000 series of instruments supports network synchronised data acquisition operations in that all channels, for all instruments on a network can be synchronised together. The synchronisation ensures that all the individual analogue converters for each input channel, for all instruments set at the same sample rate operate together to make their readings at the same instance in time.

The networked synchronised readings are accurate to within a few microseconds. Different groups of instruments can be run across a network at different sample rates and yet still be synchronised together.



Timing & Synchronisation For NetPod 4000 Instruments

Each NetPod 4003 contains its' own individual real-time clock and is used to control the timing operations for the data acquisition within the instrument. The instrument clock in collaboration with the clock within the host computer forms the basis for the timing systems used to provide the synchronisation timing within the driver software.

Driver Operations

The driver software starts by sending a synchronisation packet across the network. On detecting this packet the instrument determines the time difference among its internal clock and the timing information contained within the sync pulse. Once the timing information for an instrument is determined, it is returned to the driver. See Figure 2.

The time difference for each instrument is sent back to the driver several times a second and its determinations are essential in the reconstruction of the input signal within the driver.

Figure 3 demonstrates how the synchronisation packets are sent out to multiple instruments on a network and timing information returned to the driver software running on the PC. There is a small delay between the Host PC sending the sync packet out across a network before an instrument receives the sync packet and processes it. This delay is related to the distance from the host PC and the number and different types of networks used to connect the system together. The driver effectively recreates the input signals packet by packet using the timing information received back from the instruments.

NetPod 4003 Digital Filters

The NetPod 4003 uses a 24 Bit Sigma Delta ADC converter to convert sensor input signals. The sigma delta ADC has in built digital anti-aliasing filter and these filters have sufficient roll-off to be used with any additional analogue filtering being required. All of the analogue converts within the NetPod 4003 are synchronised see Fig 5 and as such there is no phase delay between channels, no matter how many inputs are being used. A phase delay can be interpreted as a time delay between inputs and so could be misrepresented on a synchronised application.

When fitted with the NP-DSP4000-1G24 card



Figure 4 shows the Step Response for the NetPod 4000 digital filter. The filter settles to its steady state level after only 3 samples. The digital filter operations within the NetPod 4003 takes the average, of the average, of the average and presents this as the output value to be used. Apart from being a very good low pass filter, the averaging process ensures a very good signal to noise ratio for signals within the pass band of the instrument. The averaging process also removes false spikes from the input signals.

The NP-DSP4000-1G24 DSP card supports software defined digital filtering for both the low pass and high pass filters. The NP-DSP4000-1G24 has a terminal port to set locally some configuration operations. This processor card runs a real-time version of Linux and has the power and capability of running some custom programs. The custom programs are what enables the processor card to handle all the mathematic to make enable the custom defined filtering operations a reality. High Pass Filter





 δt = (Time difference) Linux Clock - Instrument Clock





Analogue Input Cards

All the analogue cards contain are supplied on the same quick mount chassis for installation and removal. The cards simply push into the rack and are secured with the mounting screws. It takes only a matter of a few seconds to insert and secure a card.

The analogue cards all support 4 input channels and containing digital anti-aliasing filters, individual ADC, signal conditioning where appropriate and options for lightning protection or opto-isolation to 2000V DC.

Analogue input support for Voltage, Thermocouple, RTD, Current loop, Piezo-electric, Resistance, Thermostor are available.

Surge/lightning Protection

Each of the input cards has the option to fit opto-isolation or Lightning/Surge protection depending on the environment into which the instrument is to operate.

Lightning/Surge protection is undertaken by Gas Discharge tube and transorbs. Any surge caused by local lightning strikes etc. is discharged to ground and so protects the instrument electronics.









Fig 9

Connectors

The interface cards use CNT bayonet fitting 7 way connectors with automatic pin alignment. The sockets can only be released by pressing the release catch making them ideal for long term stand-alone operation even under the action of high vibration.

Once the sensor input cables are terminated with the sockets they can be fastened to the instrument and removed very quickly ensuring fast upgrade and maintenance. Figures 9 and 10 show cables terminated to the instrument.

Gas Discharge Tube

Transorb

Figure 8 shows the gas discharge and transorb lightning protection fitted to an input card.

Fig 8





Fig 10

Opto-isolation

The analogue input boards are electrically in two halves but physically a single board. The two halves are electrically isolated using an opto-coupler which provides the high voltage insulation. Figures 11 & 12 show how the opto-isolation is connected to the ground plane and used within the

The input stage of the analogue card provides an individual isolated ground plane and it is to this ground plane that the input signals and screens are physically connected. No input signal passes directly into the instrument and all inputs are individually isolated.

The power supply needs to be Earthed always when utilising the gas discharge/transorb lightning protection.

NetPod 4003 - Data Acquisition & Control System

Part Number - NPAO16-1030

Analogue Output \pm 10 V Output \pm 30 mA Software Selectable

Introduction

The NPAO16-1030 card is a 4 channel high speed analogue output card for the NetPod 4003 series data acquisition instrument. The NPAO16-1030 supports 4 independently configurable analogue outputs channels each individually set for voltage or current operations by the driver software . Preset output levels, for each channel at boot up time can be defined in the driver software. Optional CNT-21 bayonet locking connectors on request.

4 x Independent Output Channels \pm 10V / \pm 30 mA User Software Selectable Output Type Maximum Isolation 2000V DC/Channel Maximum Cable Size 1.5 mm²

Power Consumption < 1 W / Channel

User Defined Initialisation Levels

Output Signal Type Identification



NPAO16-1030 Card

Operation

The analogue output card supports voltage and current output Pre-set Initialisation / Startup levels under control from the driver software. The update rate of the output signals is at the same rate as sampling rate of analogue input channels.

Installation Limitation

The NetPod 4003 supports 16 analogue output channels within a single instrument along with a single digital I/O card.

Output Signal Type Selection

The analogue output signal can be switched under software control between current and voltage without any user interaction on the card itself. The driver software must scan the network to obtain and store any new configuration details.

Test Results

The output errors shown below are worst case and are to be used as a guide only.

Load Resistance		100 Ω	300 Ω	0Ω		
Setting	100 Ω	300 Ω	0Ω	% Error Full Scale	% Error Full Scale	% Error Full Scale
-30	-30.001	-29.989	-30.007	-0.05	0.05	-0.05
0	-0.001	-0.001	-0.001	-0.05	-0.05	-0.05
30	30.002	29.989	30.008	0.05	-0.05	0.04



Each output channel can be independently configured using the driver software to give a pre-set output level on initialisation. The card has an initial zero level initialisation value held for 2 seconds after which the preset level is output. Since the output signal can be predefined then

The initial output level is zero no matter which output signal type has been chosen.

Load Circuit

The maximum load resistance that can be directly connected to the the NPAO16-1030 is 350 Ohm.

Connecting an load circuit to the NPAO16-1030



Output Connection from the NPAO16-1030

The image below shows how to connect to the NPAO16-1030 to obtain a voltage output

> +/- Output ٥V

Output Signal Type Identification

The output signal type for each channel can be identified by the driver software. Signal operational details can be accessed and processed by third party applications.

NPAO16-1030v101.pp

Technical Specifications

The following tables summarise the technical guidelines for the various input modules which can be supplied for use with the NetPod instrumentation. The specifications shown for the strain gauge interfaces are worst case and supplied units should operate above the results displayed in the table

Table 1

Specifications	High Resolution 24 Bit Card	Sample Rate	The sa are ide	imple rate for all NetPod 4003 input cards entical no matter what type or how they are
CMMR	138 dB	- All Cards	installe	ed within an instrument.
Sample Rate	0.1 - 200 KHz		0 - 200) KHz / Channel
Isolation	to 2000V _{RMS}	Note 1 (range V1)		
Dynamic Range	150 dB	Ormala Data Tan	· · · · · · · · · · · · · ·	
Signal/Noise Ratio Average:	See Note 1		NCAI NOISE LE	vei(RMS)
Gain Accuracy (Accuracy as % reading)	0.1 % or better	10 Hz 3 μ 100 Hz 7 μ 1 KHz 10	ιν 130 dB ιV μV	
Settling Time	2 ms	Note two		
Input Range: V1	± 5.0 V			
V2 V3	$\begin{array}{c} \pm 50 \text{ V} \\ \pm 500 \text{ V} \end{array}$	The pre-amp gain sett limited.	ings on all the	analogue input modules are sample rate
Resolution: V1 V2 V3	0.6 μV 6.0 μV 60.0 μV	Strain Gauge & L	.oad Cell S	pecifications
Input Offset: V1 V2	$\pm 1 \mu V/^{\circ}C$ +10 $\mu V/^{\circ}C$	Specifica	tion	High Resolution 24 Bit Card
V3	$\pm 100 \ \mu \text{V/}^{\circ}\text{C}$	Linearity	/	0.02% FS
Stability: V1	10 ppm/°C	Range		± 20,000 με
V2 V3	10 ppm/°C	Bridge Bala	ince	50% FS
Input V1		Resolutio	n	0.05 με
Impedance V2	2 MΩ	Input Nois	se	$1 \mu V_{RMS}$
V3	20 M Ω Higher input impedance option	Bridge Ty	ре	'/4, 120,350,1K Ω , For 1/2 and full bridges
Current Input	$\pm 60 \text{ mA}, 0.20 \text{ mA}$			and gauge greater that 120 Ohm gauges Gauge values same for both card types
	User Defined	Gauge Fac	ctor	0 - 10
Overload	250 V _{RMS}	Input Imped	ance	20 ΜΩ
Converter Type	Sigma Delta	Excitatio	n	2.5V
Gain (Software Selectable)	1,2,4,8,16 note 2	Output No	ise	5 μV _{RMS}
Linearity (accuracy as % of range)	0.0015 %	Thermocouples		

Resistance Measurement

 NPAl24- RES83-4 cards
 Accuracy 0.05% FS

 RANGE
 Set at manufacture 0 - 600 Ohm

 Other ranges on request

Temp Drift

Digital Interface Specifications

Interface	Specification
Isolated Digital Input	1000V Standard 2500 V on request
No. Channels/Board:	8/16
Low Level (0):	0-1 V, 0-2 V
High Level (1):	4-30 V, 6-300 V
Switch Rate:	2 KHz, max
Digital Output (*)	
No Channels/Board	8/16 options
Low Level (0):	0V/ User Option
High Level (1):	5V Standard
Relay Switch Card	Any level up to 240 V
Switch Rate:	2 KHz
Drive Current	20 mA/Channel

25-50 ppm/Deg C

Sensor	Sensor Accuracy / Deg C	
Fe-Con (J)	Class 1 -40 to + 750 Class 1 -40 to + 750	±1.5 ± 2.5
Cu-Con (T)	Class 1 -40 to + 750 Class 2 -40 to + 750 Class 3 -200 to + 40	$\pm 0.5 \\ \pm 1.0 \\ \pm 2.5$
BiCr-Ni (K)	Class 1 -40 to + 1000 Class 1 -40 to + 1200	±1.5 ± 2.5
NrCrSi-NiSi (N)	Class 3 -200 to + 40	± 2.5
NiCr-Con (E)	Class 1 -40 to + 800 Class 2 -40 to + 900 Class 3 -200 to + 40	$\pm 0.5 \\ \pm 2.5 \\ \pm 2.5$
Pt10Rh-Pt (S)	Class 1 0 to + 1600 Class 1 -40 to + 1600	±1.0 ± 1.5
Pt6Rh (B)	Class 2 600 to 1700 Class 3 -200 to + 40	$ \pm 2.5 \pm 2.5$

Analogue Output Modules

Resolution	16 bit
Output	+/- 10V or +/- 30mA
Accuracy	0.05 % FS
Isolation	1500V

Other options available on request

NetPod 4003 General Application



System Operation

The diagram above demonstrates a typical NetPod 4003 application mixing analogue inputs and output signals. The advanced timing system that runs the NetPod 4003 systems across a network and through network switches and Hubs requires the analogue output channels to be used independently to the analogue inputs and mounted in their own instrument.

Installing the analogue outputs in their own instrument reduces the chance that the outputs will be wired incorrectly.

Enhanced Synchronisation

Improved synchronisation can be obtained by connection to the world time clock via an Internet link.

Output Control Systems

Each of the outputs can be individually configured in level and is operated independently



1. V1H1 1 : S (+) 2 : S (-) 3 : V (+8.3 ma Const I_c 4 : GND (COM) 5 : N/A





GPS Data Timing Synchronisation



NetPod 4003 4 Wire Resistance Card Pin-outs

Free issue driver software SDK for Microsoft Windows & Unix Operating Systems



Linux & Unix Driver Software Options



Example Application





mmm

Bridge Structural Monitoring

One main feature of the NetPod 4003 series instruments are its ability to synchronise with other instruments on a network. For a bridge monitoring application the instruments can be connected to sensors mounted on the main structural members for example using strain gauges. Simple analysis of the results will show the bending of structural members under various loads. Combining the results from all the instruments will enable a full structural understanding of the relationships to be obtained.

The true direction of motion of the top if the pylon can only be made using a synchronised measurement so the vector magnitude for the displacement can be calculated.

The NetPod 4003 instruments can be connected onto industry standard Ethernet network. So long as the instruments are connected to the same network string as the host data analysis PC they can be used over long distances. The only limitation on the systems deployment is that the timing pulses sent out by the driver is received, processed and returned to the host PC with the minimum delay

Enhanced Synchronisation

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Part Numbers - The following table lists the part numbers used by the NetPod 4000 and interface

	4003 Series Instruments		
NP-DSP4000-1G24	DSP Processor Card - 1 G Hz Processor Software Defined Digital Filters - SSD Buffer	NP-SF4000-100T-24 NP4203BF-V110 NPCAB-4003	DSP Card Motherboard + microprocessor controlled fan unit Enclosure
NP4809-JIO NP4810-JIO NP4811-RLY NP4812-TRC NP4818-DO-8 NP4808-JIO-8 NPSYS-4003-16	Digital I/O Modules Standard for each instrument 8 digital input channels - 2 KV isolation - ID memory 16 digital Input channel - 1 KV isolation 8 input, Jumper Select TTL/24 Dig Input 8 relay switch cards 8 digital output channels - 2 KV isolation - memory ID 8 TTL output channel card Complete 24 bit fully populated analogue system. Any analogue input combination	NPGPSU-01 NPFAN-01 NPRCK-013 NPAI24-V1HI-4 NPAI24-V2HI-4 NPAI24-V2HI-4 NPAI24-SC1-4 NPAI24-SC1-4 NPAI24-SC3-4 NPAI24-SC3-4 NPAI24-SC3-4 NPAI24-SC3-4	Power Supply module Fan 84 HP X 6U Plug In Module Frame 24 Bit ADC Analogue Input Modules Standard for all instruments 4 Channel ± 5V. 24 bit ADC board. 4 Channel ± 50V. 24 bit ADC board 4 Channel ± 500V. 24 bit ADC board 4 Channel of 24 bit Current loop .4-20mA, 0-60 mA 4 Channel of 24 bit Current loput 5A 4 Channel of 24 bit Warnet Input 5A 4 Channel of 24 bit Warnet Input 5A 4 Channel of 24 bit full bridge strain gauge card 4 Channel of 24 bit full bridge strain gauge card 4 Channel of 24 bit full bridge strain gauge - No Excitation
NPDKIT03 NPDRIVER NP-DLABV23 NP-OPCSerV104 NP-NICVIv103 NPCitectV101	Software Software developers tool kit Multi-user, Multi instrument driver DASYLab Multi-instrument driver OPC Server Package National Instruments Labview Driver Citect Driver	NPAI24-TC-B-4 NPAI24-TC-C-4 NPAI24-TC-E-4 NPAI24-TC-K-4 NPAI24-TC-N-4 NPAI24-TC-R-4 NPAI24-TC-S-4 NPAI24-TC-T-4 NPAI24-RT1-4 NPAI24-RE83-4-X	4 Channel of 24 bit thermocouple type B 4 Channel of 24 bit thermocouple type C 4 Channel of 24 bit thermocouple type E 4 Channel of 24 bit thermocouple type K 4 Channel of 24 bit thermocouple type N 4 Channel of 24 bit thermocouple type R 4 Channel of 24 bit thermocouple type S 4 Channel of 24 bit thermocouple type T 4 Channel of 24 bit RTD - Type A & B 4 Channel resistance measurement card - 8.3 mA excitation X = range
	Copyright Keynes Controls [©] 2010-2011	NPAO16-1030	4 Channel 16 bit Analogue output card +/- 10V, +/- 30 mA



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