User’s manual
Edition 06/2017
Release A

Extended KAS PipeNetwork template with two AKD drives

General information

Record of Document Revisions

Revision	*Description*
A 06/2017	First version

Trademarks
KAS and AKD PDMM are registered trademarks of Kollmorgen.

Notes
For better readability of the code, all variables have a prefix of lower case letter. The definition is as following.

Prefix	Size	Description
i	Unknown	Input
o	Unknown	Output
b	1 Bit	Bool
by	8 Bit	Byte
w	16 Bit	Integer (INT)
dw	32 Bit	Double integer (DINT)
	Unknown	Variable struct

Abbreviations

AKD	Advance Kollmorgen Drive
PDMM	Programmable Drive Multi axis Master
KAS	Kollmorgen Automation Software

Contents

Introduction

The KAS extended template shows the use of different basic functionality, when using the pipe network motion engine. It's based on the standard two axis pipe network example and includes some of the most common use cases. It covers the following topics

- PipeNetwork motion blocs (Master, Gear, Comparator, Cam, Phaser, Converter, Axis)
- Programming languages (SFC, LD, ST)
- Subprograms (Functions, UDFB)
- Control Panel
- Variable structures
- Defines

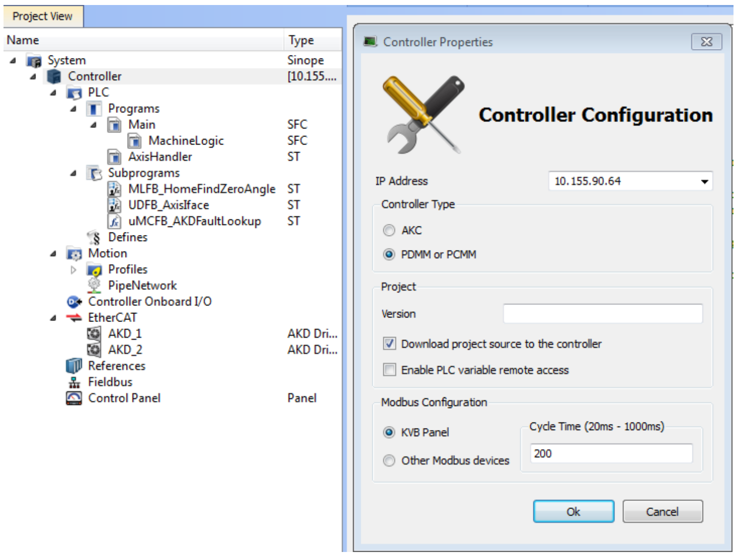
For each of this topic there is a short help in this manual. More information can be found in the KAS help or on the Kollmorgen developer network webpage.

⚠	**Never use the KAS-Project „KAS_BasicPipeNet2Axis_060_en.kas“ unchanged in an application. The application is intended as an example on how two AKD's can be integrated into a KAS-Project. This project example must always be changed according to the real application.**
⚠	**KOLLMORGEN cannot be held liable for any damage caused by the use of the KAS-Project „ KAS_BasicPipeNet2Axis_060_en.kas“ or any parts of it.**

Using the Template

After opening, the template needs to be adapted to the test environment.

Enter the IP-address of the connected PDMM/PCMM hardware or connect to the simulator. To open the *Controller Properties* use a right click on *Controller* in the *Project View*.


Project View

Name	Type
System	Sinope
Controller	[10.155....
PLC	
Programs	
Main	SFC
MachineLogic	SFC
AxisHandler	ST
Subprograms	
MLFB_HomeFindZeroAngle	ST
UDFB_AxisIface	ST
uMCFB_AKDFaultLookup	ST
Defines	
Motion	
Profiles	
PipeNetwork	
Controller Onboard I/O	
EtherCAT	
AKD_1	AKD Dri...
AKD_2	AKD Dri...
References	
Fieldbus	
Control Panel	Panel

Controller Properties

Controller Configuration

IP Address: 10.155.90.64

Controller Type: AKC [✓ PDMM or PCMM]

Project

Version:

[✓] Download project source to the controller

[ ] Enable PLC variable remote access

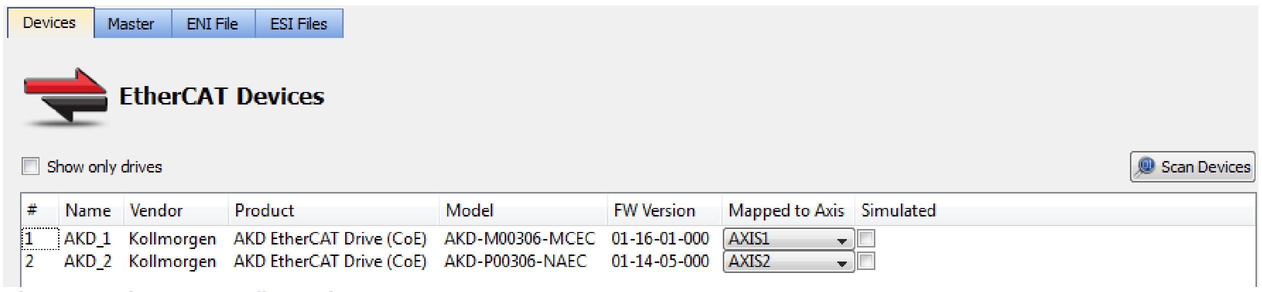
Modbus Configuration: [✓ KVB Panel] Other Modbus devices

Cycle Time (20ms - 1000ms): 200

Figure 1 Controller configuraion

Scan the EtherCat network for connected drives by opening the EtherCAT editor and hit *Scan Devices*. Map the two pipe network axis to AKD drives.

The example can run with no axis mapping. In this case use the simulator or the oscilloscope to supervise the motion.



#	Name	Vendor	Product	Model	FW Version	Mapped to Axis	Simulated
1	AKD_1	Kollmorgen	AKD EtherCAT Drive (CoE)	AKD-M00306-MCEC	01-16-01-000	AXIS1	☐
2	AKD_2	Kollmorgen	AKD EtherCAT Drive (CoE)	AKD-P00306-NAEC	01-14-05-000	AXIS2	☐

Figure 2 EtherCat configuration

⚠	**Mapping a pipe network axis to an AKD drive will end up in real life motion. Make sure the axis is setup properly and is able to move with no restrictions. All safety measures need to be operating!**

After these steps are done the software can be downloaded to the controller and started.

PipeNetwork

The pipe network setup is extended to give an idea on what can be done with the different motion blocks. Not all pipe network motion blocs are used in this example.

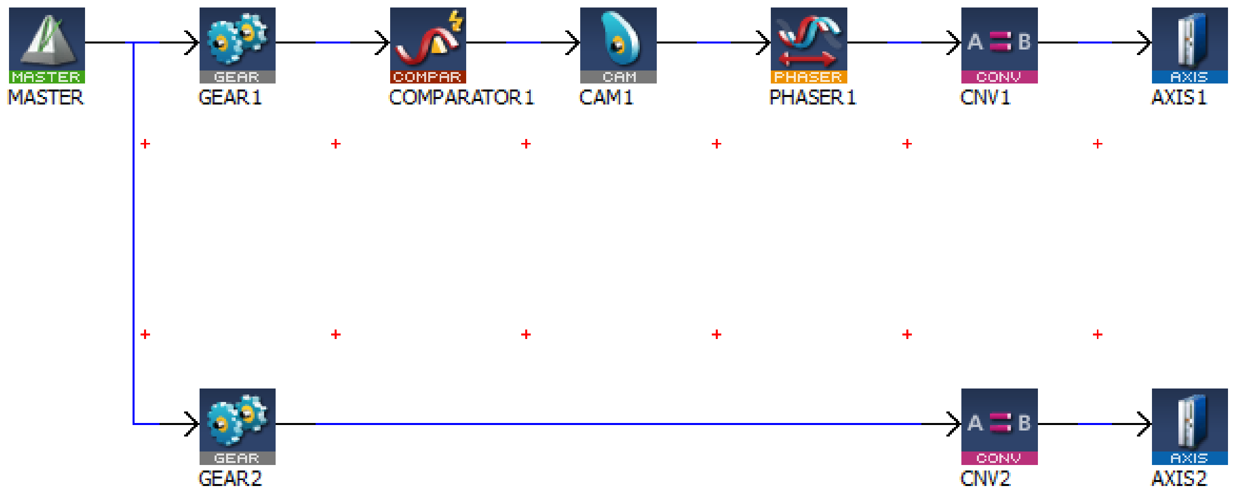


Figure 3 PipeNetwork

Master

The master bloc is used as a virtual master axis for the machine. Its output is calculated every motion cycle. The position is scaled in 360 per revolution, which can be interpreted as 360 degrees being one machine cycle, or one product.

Gear

The gear block is used as a multiplier of axis cycle versus machine cycles. The default ratio is set to one, so the axis is doing the same number of cycle as the virtual master. The ratio and offset slops are set to 100°/sec. This allows changing of ratio or slope with smooth ramping.

Comparator

The comparator block is used to detect the zero crossing of the virtual axis position. This flag is needed to perform actions at a defined pipe position. With cams for example this allows the switching of profiles at identical positions on old and new profile.

Cam

The cam block is used to perform a cam following, intermittent motion. The used profile is waiting for 90°, accelerating for 90°, running on constant speed for 90° and then decelerating for the last 90° to a full stop again. The total slave move distance is also 360°, corresponding with one full revolution.

Phaser

The phaser block is used to shift the axis position. The phaser has a slop of 100°/sec and a modulo of 360°. This allows the user to shift the position of the cam stop position around the axis position.

Converter

The converter block is used to prepare the pipe values to be sent to the axis as position values.

Axis

The axis block is setup to interpreted 360° as one full revolution, with modulo.

Programming language

The three programming language used, all have different advantage. There is no right or wrong in using one over the other.

SFC

Sequential function chart is a programming tool to adapt flow chart. The template uses this for the *Main* routine and its child *MachineLogic*.

In the main routine the motion engine is started and the stop function is performed.

In the machine logic all motion commands are sequenced. This includes waiting for the user to enable to drives. There are two modes in which the drive can be enabled.
In manual mode the drives are just powered and any manual mode motion can be performed.
In automatic mode the axis are first homed and synchronized before any automatic motion can be performed. In the example this includes a home move for axis one if not done before and a synchronization move. Axis two immediately performs a synchronization move. Only after these moves are completed the automatic mode is started.
The machine logic is only executed if the main logic is in the state *Running*.

FFLD

Free form ladder diagram is a graphical programming tool making input and output connection easily visible. The template uses this in the actual mode inside the SFC to allow input changes form the control panel take place.

ST

Structured text is a text only programming tool allowing compact code for even complex algorithm. The template uses this in the subprograms, to allow a short straight forward programming, for parts which won't be touched by a user too much.

Subprograms

The subprograms are used to define reusable code. This code is not executed by default, but needs to be called in the program. There are two different types: functions and user defined functions (UDFB). While a function can be called right away and has no storage, UDFB's are instantiated in the variable list, have internal memory, and can be executed over multiple cycles.

MLFB_HomeFindZeroAngle

A Kollmorgen predefined UDFB which is used in the project. There is a help about this block available in the KAS help. Hit F1 on the function in the libraries or search the name in the help.

UDFB_AxisIface

A template specific UDFB programmed to ease the axis handling. This block can be reused for each axis and just needs to be controlled according to the actual axis needs.

Input:

iAxisName	DINT	Axis name in the pipe network
iAxisCmd	tAxisCmd	Axis command values, see defines for bit usage

Output:

oAxisIface	tAxisIface	Actual axis state data, see defines for bit usage

The code reads back actual value of the axis including position, speed, torque, alarm codes and status. It allows the execution of fault reset, home moves and synchronization to pipe position. ***RESET***, ***HOME***, ***DOSYNC*** is raising edge triggered

uMCFB_AKDFaultLookup

A Kollmorgen predefined function which is used in the project. This module returns the full AKD specific alarm code.

Control panel

The extended control panel includes status information from the axis and control for the additional commands.

Kollmorgen Automation Suite

Control Panel

Figure 4 Control Panel

Machine state

Chooses the axis mode. If set to ***off*** the axes are not powered, in ***manual mode*** all manual mode function can be used, in ***auto mode*** all automatic mode functions can be used. If switched to auto mode the axis are first moving to the pipe position before going into auto mode. This can lead to movement, even with no auto mode function motion active!

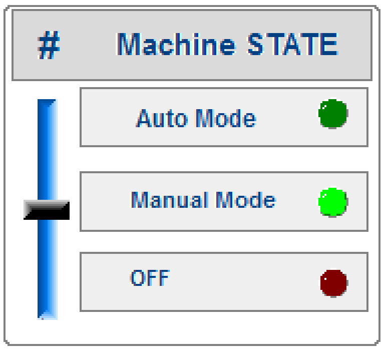


Figure 5 Machine state

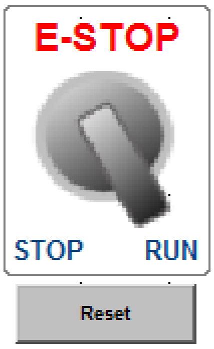


Figure 6 E-Stop

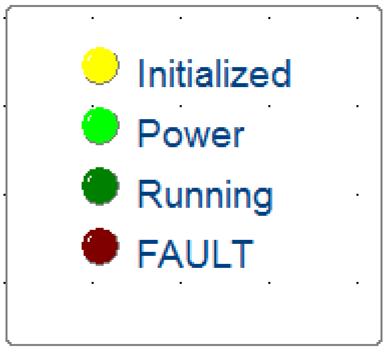


Figure 7 Led indication

E-Stop

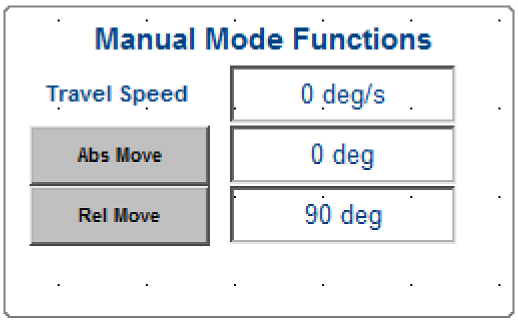
If ***E-Stop*** is set to stop all motion halts, the drives are disabled and the mode is switched back to off. To enable any mode the e-stop has first to be switched back to run. With ***Reset*** drive faults can reset.

LED indication

If ***Initialised*** is lit, the pipe motion engine is ready.
If ***Power*** is lit, the drives are powered.
If ***Running*** is lit, the axes are moving in automatic mode according to the virtual master.
If ***FAULT*** is lit, the e-stop is switched or any axis has a drive fault.

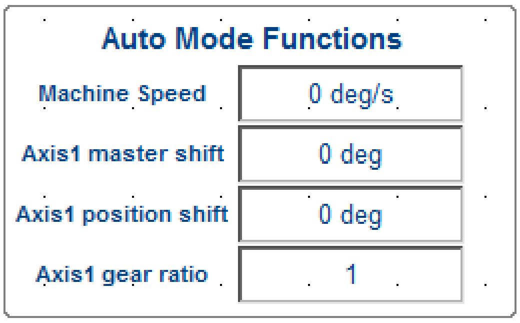
Manual mode function

In manual mode the master can be moved at a fixed speed by setting ***Travel Speed*** to any value.
With ***Abs Move*** the master can be moved to a fix position.
With ***Rel Move*** the master can be moved by a fix distance.


Manual Mode Functions

Travel Speed	0 deg/s
Abs Move	0 deg
Rel Move	90 deg

Figure 8 Manual mode function


Auto Mode Functions

Machine Speed	0 deg/s
Axis1 master shift	0 deg
Axis1 position shift	0 deg
Axis1 gear ratio	1

Figure 9 Automatic mode function

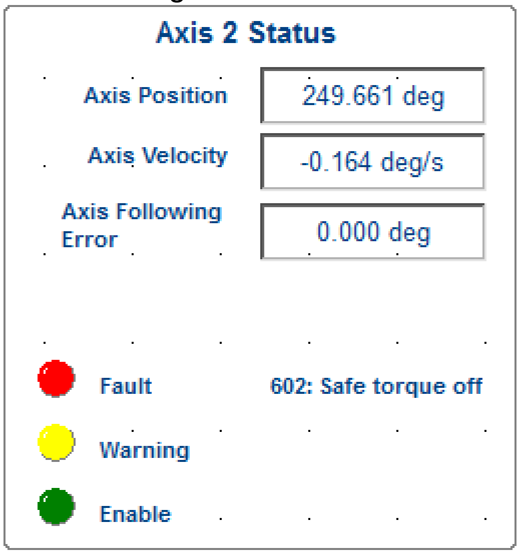
Automatic mode function

In automatic mode the master can be moved at a fixed speed by setting ***Machine Speed*** to any value.
With ***Axis1 master shift*** the *GEAR1* gets an offset. This leads to a delay on the axis position. With this function the timing of the virtual master and axis can be adjusted.

With ***Axis1 position shift*** the *PHASER1* gets an offset. This is leading to a position shift on the axis. With this function the cam can moved on the mechanical position.
With ***Axis1 gear ratio*** the *GEAR1* multiplier is adjusted. With this the axis can be speeded up or down in relation to the virtual master.

Axis status

The axis status values are updated as soon as the pipe motion engine is running. ***Axis Position*** is scaled in degrees, ***Axis Velocity*** in degrees per second. The ***Axis Home Offset*** allows a shift between the virtual master zero position and the axis zero position, at the homing procedure. The ***Axis Following Error*** is the actual following error in degrees. With the ***Fault*** LED any drive fault is indicated, right next to the text the actual fault text is displayed. The ***Warning*** LED indicates any drive warning and the ***Enabled*** LED indicates if the axis is powered.


Axis 2 Status

Axis Position: 249.661 deg
Axis Velocity: -0.164 deg/s
Axis Following Error: 0.000 deg

● Fault 602: Safe torque off
● Warning
● Enable

Figure 10 Axis status

Variable structures (structs)

In the dictionary all variable are defined. This goes from global, retain (stored value over power down) to local variable. It is also possible to define variable structures for variables at any level. The example uses two user defined variable structs.

tAxisCmd

dwAxisCmd
Axis command word as double integer, bit coded by defines.
lrHomeOffset
Home offset used in the homing routine as long real in axis unit.

tAxisIface

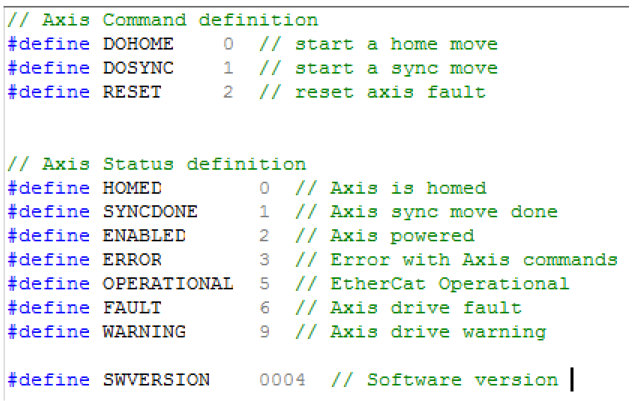
dwAxisState

Axis status word as double integer, bit coded by defines.
lrActPos
Actual axis position as long real, read by *MLAxisReadActPos*.
lrActVel
Actual axis speed as long real, read with *MLAxisReadVel* and low pass filtered by the last 20 values with *avarageL*.
lrActTorque
Actual axis torque as long real, read with *MLAxisReadTq*.
lrFollowingError
Actual axis following error as long real, read with *MLAxisReadFEUU*.
strFaultText
Actual axis fault text as string, read from the function *uMCFB_AKDFaultLookup* with the fault number from PDO 0x2001.

Defines

The defines allows the definition of constants which can be used at any position in the programming. In the template all bit access in the axis command and status word are done via a keyword from defines. This way a change in bit order or function extension can be achieved with changes at only one place.

As a screen shot, an example of how a bit access works, in the double integer *.dwAxisCmd* a reset can be performed if bit *RESET* is set to true. Defines lists *RESET* with the value two. So if bit two in *dwAxisCmd* is true a reset is performed. (Which will lead to *dwAxisState* bit three (*ERROR)* be set to false.)

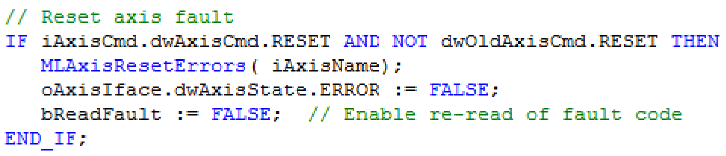


```
// Axis Command definition
#define DOHOME     0  // start a home move
#define DOSYNC     1  // start a sync move
#define RESET      2  // reset axis fault


// Axis Status definition
#define HOMED         0  // Axis is homed
#define SYNCDONE      1  // Axis sync move done
#define ENABLED       2  // Axis powered
#define ERROR         3  // Error with Axis commands
#define OPERATIONAL   5  // EtherCat Operational
#define FAULT         6  // Axis drive fault
#define WARNING       9  // Axis drive warning

#define SWVERSION     0004  // Software version
```

Figure 11 Defines



```
// Reset axis fault
IF iAxisCmd.dwAxisCmd.RESET AND NOT dwOldAxisCmd.RESET THEN
   MLAxisResetErrors( iAxisName);
   oAxisIface.dwAxisState.ERROR := FALSE;
   bReadFault := FALSE;  // Enable re-read of fault code
END_IF;
```

Figure 12 Use of defines in program

About KOLLMORGEN
Kollmorgen is a leading provider of motion systems and components for machine builders. Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions that are unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

For assistance with your application needs, visit www.kollmorgen.com or contact us at:

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