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Application Information

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SERCOS Basics:

A SERCOS ring consists of a single master and 1 or more slaves daisy-chained together using fibre-optic cable. During initialisation the ring passes through several 'communication phases' before entering the final cyclic deterministic phase in which motion control is possible. In the final phase, the master transmits control information and the slaves transmit status feedback information every cycle time.

## **Trio BASIC SERCOS Support:**

TrioBASIC includes a 'SERCOS' keyword which is of the following format :

### **Function Definitions:**

#### **Sercos Function 0 – SERCOS( 0, slot , ram/reg, address)**

Read Sercos ASIC memory. This low-level function will return the value at the given RAM location (RAM/reg flag=0) or register (RAM/reg flag = 1) in the Sercos ASIC memory.

#### **Sercos Function 1 – SERCOS( 0, slot , ram/reg, address, value)**

Write Sercos ASIC memory. This low-level function will write to the required Sercos ASIC RAM location or register.

#### **Sercos Function 2 – SERCOS( 2, slot [, intensity [, baudrate [,period]]])**

Initialisation command. This function resets the Sercos ASIC register configuration to the default values. Phase 0 is set. The optional "intensity" parameter sets the light transmission intensity from the SERCOS daughter board and should be in the range of 1..6 (default is 3). The optional baudrate should be set to 2,4,8 or 16 for the baudrate in MBAUD ( default is 16). The optional period parameter is the SERCOS ring cycle time for the cyclic phases ( phases 3 & 4 ) in usec ( default is 1000usec). The available values are 8000,4000,2000,500, and 250usec.

#### **Sercos Function 3 – SERCOS( 3, slot, slave addr, axis[,slave drive type])**

Used to link a SERCOS drive to an axis of the Motion Coordinator. The command associates an axis number to a particular slave (drive) on the sercos network connected to the controller via the daughterboard in the given slot number. The user's BASIC program can confirm the existence of these slaves on the network at startup. Therefore if any slaves are not found there must be an error on the network. The configuration stored by the controller is reset (all recorded definitions removed) when the command is called with the slave address and axis both equal to zero (since this is not a valid slave address). The optional final parameter identifies the slave drive type :

0	Generic Drive
1	Sanyo-Denki
2	Yaskawa + Trio P730
3	Indramat/Rexroth
4	PacSci
5	Kollmorgen

#### **Sercos Function 4 – SERCOS( 4, slot , slave address, parameter ID [, parameter size[, element type [ , list length offset]]])**

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Read parameter command. Parameter size values include 2 (default) for a 2 byte parameter, 4 for a 4 byte parameter, 6 for a list of parameter Ids, and 7 for an ASCII string. Element type refers to the SERCOS definition of the element types in the data block, namely :

1	ID Number
2	Name
3	Attribute
4	Units
5	Minimum Input Value
6	Maximum Input Value
7	Operational Data

This is an optional parameter, where number 7 (operational data) is the default.

The list length offset parameter is used to compensate for different interpretations of the list length indicators. Some drives give the list length as the number of 2-byte parameters in the list (this is the functions default - in which case the parameter can be omitted). However, other drives appear to include the size of the list length indicator (2 words) in the overall length value. To allow for the latter case, an offset of -2 should be used. Note that this function will return 2 & 4 byte parameters, but print lists.

**Sercos Function 5 – SERCOS( 5, slot , slave address, parameter ID, parameter size, parameter value [ , parameter value ...])**

Write parameter command. Parameter size values are as for function 4. There must be between one and 7 parameter values (>1 is used for list parameters.)

**Sercos Function 6 – SERCOS( 6, slot , slave address, parameter ID [, time-out,[command type]])**

Run sercos procedure command. This function will run the procedure command given by Parameter ID, and return 1 if the command runs successful, -1 if the command ran and failed, or 0 if there was a comms timeout error. The default time allowed for a command to complete is 10 seconds, since some commands can take a long time to execute on the drive. If this time is exceeded the function will return a -2.

There is an optional time out (in msec) parameter, which can be passed to this function if a value other than the default is required.

The second optional parameter is a command type – which defines whether the command should be run, cancelled, or run and cancelled. The latter is the default. The values used are:

-1	Run & cancel command (default value)
0	Cancel command
1	Run command

**Sercos Function 7 – SERCOS(7 , slot , slave address)**

Used in Phase 1: Returns 1 if drive is detected, 0 if no drive detected.

**Sercos Function 8 – SERCOS(8 , slot , required parameter)**

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Print required network parameter. This function will print the required network parameter, where the possible 'required parameter' values are

0: to print a semi-colon delimited list of 'slave Id, axis number' duples for the registered network configuration (as defined using function 3). Used in Phase 1: Returns 1 if drive is detected, 0 if no drive detected.

1: to print the baud rate (either 2, 4, 6, or 8), and

2: to print the intensity (a number between 0 and 6).

**Sercos Function 10 – SERCOS(10,<slot>)**

Function checks whether the fibre optic loop is closed in phase 0. Return value is 1 if network is closed, -1 if it is open, and -2 if there is excessive distortion on the network.

## ***SERCOS Ring Commissioning:***

MotionPerfect2 now contains (version 2.1.4.3 & above ) support for commissioning SERCOS rings. Please see 'MotionPerfect SERCOS Support' below. This tool simplifies the creation of a TrioBASIC startup program which initialises the SERCOS ring following power-on.

The startup program will consist of TrioBASIC SERCOS statements which initialise the ring following power-on, and configure the ring in the deterministic cyclic phase. The startup program will bring the ring through the following phases:

1. Phase 0 - check the ring is closed. This ensures all slaves are powered on and repeating the network messages.
2. Phase 1 - check all expected drives are responding. This section ensures that the drives identified during commissioning are in the ring and responding to messages from the master.
3. Phase 2 – Send timing & setup information to each slave. Clear any startup errors ( if possible ). Ensure each slave executes and passes the phase change function.
4. Phase 3 - Ensure each slave executes and passes the phase change function.
5. Phase 4 – the motion control phase.

## ***SERCOS Debugging***

1. Network Open/distorted

Check the master and all slaves are powered-on, the ring is correctly connected in a daisy-chain, with the fibre-optic cables connected from the transmit of one node to the receive of the next. Check slave is not in test mode.

Check the intensity levels of each slave – perhaps the intensity is too low (ring open) or too high (ring messages distorted).

The ring-open error LED will be illuminated on the slave which is not receiving a signal.

2. Drive not responding ( in Phase 1 )

Is the drive powered-on ?

Has the drives address switches been set correctly.

Is the drives baud rate switches set correctly.

Is the drives (and that of the neighbouring drives) intensity level set correctly.

3. Drive not responding ( in Phase 3 )

Most probably the drives timing information is incorrect. Also, an intensity level problem might not reveal itself until this cyclic data transmission phase.

## ***SERCOS Cycle Times***

The following SERCOS cycle times are available for CP3 and 4:

SERCOS Cycle Time (usec)	Notes
2000	
1000	Default value.
500	
250	

The `sercos(2,<>)` statement has an optional fifth parameter which is used to define the SERCOS cycle time, and must be used if any value other than the default is required for the ring.

## ***SERCOS Slave Operation Modes***

The Trio Master supports the Velocity & Position modes of operation, using standard or application telegrams.

## ***SERCOS Slave Drives Startup & Datum Programs***

The Trio SERCOS master has been tested with the drives from a range of manufacturers. Observations and the startup programs used for a selection of these drives have been reproduced below.

### ***Kollmorgen - Startup***

Drive: ServoStar 600™  
Control Mode: velocity

Observations :

Drive failed if attempted to communicate too quickly after changing SERCOS ring communication phase – hence use of delays in startup program.

Drive failed if ran the C1D reset function when there were no errors to clear.

Drive raised error (F29) if enabled via SERCOS before drives hardware enable switch set to on. Ensure drives hardware enable switch set to off before power on drive.

Startup Program:

```
' *****  
' Kollmorgen Setup
```

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```

TABLE(0, 124, 47, 45, 92 , 124, 47, 45, 92 )

'Program Constants

comms=5 'channel for progress information

'Telegram Type Enum
standard = 0
application = 1
'Drive Mode Enum
velocity=0
position=1
torque=2

'Controller Configuration
nslot=0
mdt_tx_time = 500

'Drive Configuration
ndrive1=1 ' Kollmorgen
drivelaxis=5
ndrive1mode=standard
drivelmode=velocity

'Program Data
nindex=0
numdrives=0

' *****
' Phase 0
SERCOS(2,nslot,3,4)
SERCOS(3,nslot,0,0)

IF SERCOS(10,nslot)<>1 THEN
    PRINT #comms,"Network open or messages distorted"
    STOP
ENDIF

' *****
' Phase 1
SERCOS_PHASE=1

'Check slave
IF SERCOS(7,nslot,ndrive1)=1 THEN
    numdrives=numdrives+1
    SERCOS(3,nslot,ndrive1,drivelaxis,4)
ELSE
    PRINT #comms,"Failed to find drive ", ndrive1
ENDIF

' *****
' Phase 2
SERCOS_PHASE=2
PRINT #comms,"Entered CP2"
GOSUB pause

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```

```

' *****
' Slave 1 - Kollmorgen
IF ndrivel>0 THEN
    index = index + 1

    'Clear any startup errors
    PRINT #comms, "Drive",ndrivel,"Check status "

    'If there is a comms fault (probably due to resetting the SERCOS
    'master), then attempt to clear.
    VR(0) = SERCOS(4,nslot,ndrivel,11)
    PRINT #comms, "Drive",ndrivel,"C1D (IDN 11)",HEX(VR(0))

    VR(1) = SERCOS(4,nslot,ndrivel,14) AND $F8
    PRINT #comms, "Drive",ndrivel,"Interface Status (IDN 14)",HEX(VR(1))

    VR(2) = SERCOS(4,nslot,ndrivel,129)
    PRINT #comms, "Drive",ndrivel,"Manufacturer C1D (IDN 129)",HEX(VR(2))

    IF VR(0)>0 OR VR(1)>0 OR VR(2) THEN
        PRINT #comms, "Drive",ndrivel,"procedure command 99"
        SERCOS(6,nslot,ndrivel,99)
        PRINT #comms, "Drive",ndrivel,"Executed IDN 99 - pause before continuing"
        GOSUB pause

    ENDIF

    PRINT #comms, "Drive",ndrivel,"CP2 Initialisation"
    SERCOS(5,nslot,ndrivel,1,2,1000)'ID1 NC Cycle Time
    SERCOS(5,nslot,ndrivel,2,2,1000)'ID2 SERCOS Cycle Time
    SERCOS(5,nslot,ndrivel,6,2,50*index)'ID6 AT Tx Start Time
    'NB we hard code these in the drive ...
    SERCOS(5,nslot,ndrivel,7,2,700)' ID7 fb acquisition start time
    SERCOS(5,nslot,ndrivel,8,2,800)' ID8 Command Valid Time
    SERCOS(5,nslot,ndrivel,9,2,8*index-7)' ID9 Initial Address in MDT
    SERCOS(5,nslot,ndrivel,10,2,8*numdrives)'ID10 Length of MDT
    SERCOS(5,nslot,ndrivel,89,2,mdt_tx_time)'ID89 MDT tx Start Time

    IF drivemode = torque THEN
        IF driveltmode=standard THEN
            SERCOS(5,nslot,ndrivel,15,2,1)'ID15 Telegram Type - torque CMD
            SERCOS(5,nslot,ndrivel,32,2,1)'ID32 Primary Mode of op (torque)
        ELSE
            SERCOS(5,nslot,ndrivel,15,2,7)'ID15 Telegram Type - VEL CMD/POS fb
            SERCOS(5,nslot,ndrivel,32,2,1)'ID32 Primary Mode of op (torque)
            'SERCOS(5,nslot,ndrivel,16,6,51) 'position fb
            SERCOS(5,nslot,ndrivel,16,6,84) 'torque fb
            SERCOS(5,nslot,ndrivel,24,6,80) 'torque cmd
        ENDIF
    ENDIF

    IF drivemode = velocity THEN
        IF driveltmode=standard THEN
            SERCOS(5,nslot,ndrivel,15,2,3)'ID15 Telegram Type - VEL CMD/POS fb
            SERCOS(5,nslot,ndrivel,32,2,2)'ID32 Primary Mode of op (VELOCITY)
        ELSE

```

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```

        SERCOS(5,nslot,ndrive1,15,2,7)'ID15 Telegram Type - VEL CMD/POS fb
        SERCOS(5,nslot,ndrive1,32,2,2)'ID32 Primary Mode of op (VELOCITY)
        SERCOS(5,nslot,ndrive1,16,6,51) 'position fb
        SERCOS(5,nslot,ndrive1,24,6,36) 'velocity cmd
    ENDIF
ENDIF

IF drive1mode = position THEN
    IF driveltmode=standard THEN
        SERCOS(5,nslot,ndrive1,15,2,4)'ID15 Telegram type - POS CMD/POS FB)
        SERCOS(5,nslot,ndrive1,32,2,3)'ID32 Primary Mode of op (POSITION)
    ELSE
        SERCOS(5,nslot,ndrive1,15,2,7)'ID15 Telegram Type - VEL CMD/POS FB)
        SERCOS(5,nslot,ndrive1,32,2,3)'ID32 Primary Mode of op (POSITION)
        SERCOS(5,nslot,ndrive1,16,6,51) 'position fb
        SERCOS(5,nslot,ndrive1,24,6,47) 'position cmd
    ENDIF
ENDIF

'Configure RTS Bit 1
SERCOS(5,nslot,ndrive1,305,2,130)

ENDIF

'*****
' Pre Phase Change Checks

IF ndrive1>0 THEN
    PRINT #comms, "Drive",ndrive1,"Procedure Command 127"
    IF SERCOS(6,nslot,ndrive1,127)<>1 THEN
        PRINT #comms, "Drive 1 Failed Phase 2-3 Transition Check"
        STOP
    ENDIF
ENDIF

'*****
' Phase 3
SERCOS_PHASE SLOT(nslot)=3
PRINT #comms, "Entered CP3"

FOR nrepeat=0 TO 1
    GOSUB pause
NEXT nrepeat

IF ndrive1>0 THEN
    PRINT #comms, "Drive",ndrive1,"Procedure Command 128"
    IF SERCOS(6,nslot,ndrive1,128)<>1 THEN
        PRINT #comms, "Drive 1 Failed Phase 3-4 Transition Check"
        STOP
    ENDIF
ENDIF

'*****
' Phase 4
SERCOS_PHASE SLOT(nslot)=4
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```

```

PRINT #comms, "Entered CP4"
GOSUB pause

IF ndrivel>0 THEN
  IF drivemode=velocity THEN
    ATYPE AXIS(drivelaxis)=16 'velocity
  ENDIF
  IF drivemode = position THEN
    ATYPE AXIS(drivelaxis)=17'position
  ENDIF
  IF drivemode = torque THEN
    ATYPE AXIS(drivelaxis)=16'velocity
  ENDIF
ENDIF

PRINT #comms, "Initialisation Succesfully completed"

IF ndrivel>0 THEN

  PRINT #comms, "Kollmorgen Information"
  PRINT #comms, "Version (IDN 30)",SERCOS(4,nslot,ndrivel,30,7)
  PRINT #comms, "Controller Type (IDN 140)",SERCOS(4,nslot,ndrivel,140,7)
  PRINT #comms, "Motor Type (IDN 141)",SERCOS(4,nslot,ndrivel,141,7)
  PRINT #comms, "Application Type (IDN 142)",SERCOS(4,nslot,ndrivel,142,7)
  PRINT #comms, "System Interface Version (IDN 143)","";
  PRINT #comms, SERCOS(4,nslot,ndrivel,143,7)

ENDIF

STOP

' *****
' Handlers
pause:

PRINT #comms,"Please Wait"
FOR ncount = 0 TO 5
  FOR nindex= 0 TO 7
    PRINT #comms,CHR(TABLE(nindex));CHR(13);
    WA(100)
  NEXT nindex
NEXT ncount

RETURN

```

## Sanyodenki - Startup

Drive: PVSercos™  
Control Mode: velocity

```
*****
'SanyoDenki
'
' Drive Tuning
' p_gain = 6000
' all other gains = 0
' units = 8000
' speed = 10
' accel=dece=100
' fe_limit = 2.5

*****
'Phase 0
SERCOS_PHASE SLOT(0)=0
SERCOS(2,0,3,4)' Intensity=3, Baudrate=4Mhz

IF SERCOS(10, 0) < 0 THEN
    PRINT "SERCOS loop open or distorted"
    STOP
ENDIF

*****
' Phase 1
SERCOS_PHASE SLOT(0) = 1

IF SERCOS(7, 0, 1) < 0 THEN
    PRINT "Drive 1 not detected"
    STOP
ENDIF

SERCOS(3,0,1,5,1)' Set drive 1 as axis 5

*****
' Phase 2
SERCOS_PHASE SLOT(0) = 2

SERCOS(6,0,1,99)' Clear Errors on drive 1

SERCOS(5,0,1,1,2,1000)'ID1 NC Cycle Time
SERCOS(5,0,1,2,2,1000)'ID2 SERCOS Cycle Time
SERCOS(5,0,1,6,2,50*1)'ID6 AT Transmission Start Time
SERCOS(5,0,1,7,2,700)' ID7 feedback acquisition start time
SERCOS(5,0,1,8,2,800)' ID8 Command Valid Time
SERCOS(5,0,1,9,2,8*1-7)' ID9 Initial Address in MDT
SERCOS(5,0,1,10,2,8*1)'ID10 Length of MDT
SERCOS(5,0,1,89,2,500)'ID89 MDT Transmit Starting Time
SERCOS(5,0,1,32,2,2)' ID32 Primary Mode of Operation - vel control mode
SERCOS(5,0,1,15,2,3)' ID15 Telegram Type Parameter - vel cmd:pos fb

SERCOS(5,0,1,33025,2,6)' ID33025 Hold Direction Limits OFF

*****

IF SERCOS(6, 0, 1, 127) <> 1 THEN
    PRINT "Drive 1 Failed Phase 2-3 Transition Check"
```

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```

        STOP
    ENDIF

    *****
    ' Phase 3
    SERCOS_PHASE SLOT(0) = 3

    ' Speed loop gains for Sanyo drive:

    SERCOS(5,0,1,100,2,150)
    SERCOS(5,0,1,101,2,300)

    IF SERCOS(6, 0, 1, 128) <> 1 THEN
        PRINT "Drive 1 Failed Phase 3-4 Transition Check"
        STOP
    ENDIF

    *****
    ' Phase 4
    SERCOS_PHASE SLOT(0) = 4

    ATYPE AXIS(5) = 16

    PRINT "Program completed successfully"

```

## ***Sanyodenki – Datum Routine***

Drive: PVSercos™

Description: The following program illustrates how to datum a SERCOS axis to the motor Z-mark, using the drives own homing routine. It is also possible to datum to a homing switch, or the master can control the homing procedure (see the drive 'Installation and Operation' manual for details.)

```

nslot=0
ndrive1=1
naxis=6

    *****
    'Datum sequence

    BASE(naxis)

    SERVO=OFF

    'Run homing procedure command
    SERCOS(6,nslot,ndrive1,148,8000,1)

    'wait for procedure command change, bit 5 in IDN135.

    'Cancel homing procedure command
    SERCOS(6,nslot,ndrive1,148,8000,-1)

    SERVO=ON

```

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## Yaskawa & Trio P730 Interface - Startup

Drive: SGDHTM™

Control Mode : velocity. The SGDHTM 04AE with ver 0D214 operated in velocity or speed mode. SGDHTM 01BE with ver 0900E operated only in velocity mode (went out with overspeed error (E51) when attempted to operate in position mode.)

```
*****
'Sigma II Initialisation
'
' Drive is configured in velocity mode, using
' standard telegrams, and uses Trio Masters default
' telegram tx times.

nslot = 0 ' Board is in slot 0
ndrive1 = 1 ' Slave drive address is 1
nw_speed = 16 ' Network baud rate is 16MHz
nw_period = 1000 ' SERCOS cycle time is 1000usec
drivelaxis = 5 ' Use axis 5 as the remote axis.
comms=5 'Write Trio progress and user messages to channel 5.
numdrives=1 'there is only 1 drive in the ring.

*****
'Phase 0 - ensure ring closed.

SERCOS(2,nslot,3,nw_speed, nw_period)
SERCOS(3,nslot,0,0) 'Initialise config

IF SERCOS(10,nslot)<0 THEN
    PRINT#comms, "SERCOS loop open or distorted"
    STOP
ENDIF

*****
' Phase 1 - check drive online

SERCOS_PHASE SLOT(nslot)=1

IF SERCOS(7,nslot,ndrive1)<0 THEN
    PRINT#comms, "Drive 1 not detected"
    STOP
ENDIF

'Register Yaskawa Drive.
SERCOS(3,nslot,ndrive1,drivelaxis,2)

*****
' PHASE 2 - configure drive

SERCOS_PHASE SLOT(nslot)=2

    ' Slave Drive 1
    index = 1

    'Clear any startup errors
    SERCOS(6,nslot,ndrive1,99)

    'Check drive in correct control mode.
    VR(0) = SERCOS(4,nslot,ndrive1,32768,2)
```

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```

IF (VR(0)<>0 AND VR(0)<>$90) THEN
  PRINT #comms, "Error - drive not in correct mode - set Pn0000 to 0"
  PRINT #comms, "& cycle power to drive. "
  STOP
ENDIF

'Configure drive
SERCOS(5,nslot,ndrive1,1,2,nw_period)'ID1 NC Cycle Time
SERCOS(5,nslot,ndrive1,2,2,nw_period)'ID2 SERCOS Cycle Time
SERCOS(5,nslot,ndrive1,6,2,50*index)'ID6 AT Tx Start Time
'NB we hard code these in the drive ...
'SERCOS(5,nslot,ndrive1,7,2,700)' ID7 fb acquisition start time
'SERCOS(5,nslot,ndrive1,8,2,800)' ID8 Command Valid Time
SERCOS(5,nslot,ndrive1,9,2,8*index-7)' ID9 Initial Address in MDT
SERCOS(5,nslot,ndrive1,10,2,8*numdrives)'ID10 Length of MDT
SERCOS(5,nslot,ndrive1,89,2,500)'ID89 MDT tx Start Time

SERCOS(5,nslot,ndrive1,15,2,3)'ID15 Telegram Type - VEL CMD/POS fb
SERCOS(5,nslot,ndrive1,32,2,2)'ID32 Primary Mode of op (VELOCITY)

'*****
' Pre Phase Change Checks

IF SERCOS(6,nslot,ndrive1,127)<>1 THEN
  PRINT #comms, "Drive 1 Failed Phase 2-3 Transition Check"
  STOP
ENDIF

'*****
' Phase 3
SERCOS_PHASE SLOT(nslot)=3

IF SERCOS(6,nslot,ndrive1,128)<>1 THEN
  PRINT #comms, "Drive 1 Failed Phase 3-4 Transition Check"
  STOP
ENDIF

'*****
' Phase 4
SERCOS_PHASE SLOT(nslot)=4

ATYPE AXIS(drive1axis)=16 'velocity
PRINT #comms, "Sercos network successfully initialised"

```

## ***Yaskawa & Trio P730 Interface – Datum Routine***

Drive: SGDHTM™

Description: The following program illustrates how to datum a SERCOS axis to the motor Z-mark.

```

nslot=0
ndrive1=2
drive_axis=5

old_speed=10
datum_speed=1

```

```

'*****
' Probe Initialisation
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```

BASE(drive_axis)

'0=origin(z)mark, 1=ext1, 2=ext2, 3=ext3
trig_mode=0

'Set Drive RTS Bit 1 to trigger on IDN130.
SERCOS(5,nslot,ndrive1,305,2,401)

'Set active high edge.
SERCOS(5,nslot,ndrive1,169,2,1)

'Set probe trigger input.
SERCOS(5,0,ndrive1,49252,2,trig_mode)

'Now IDN401 = 1 after probe triggered, & IDN130 contains
'encoder value.

'*****
'Datum sequence

'Enable probe
SERCOS(5,nslot,ndrive1,405,2,1)

old_speed = SPEED
SPEED = datum_speed

FORWARD
WHILE NOT MARK
WEND
CANCEL
WAIT IDLE
'move to datum
MOVE(((SERCOS(4,nslot,ndrive1,130,4) AND $ffff)-ENCODER)/8192)
WAIT IDLE
WA(300)
SPEED =old_speed

'Disable probe
SERCOS(5,nslot,ndrive1,405,2,0)

```