A Curtiss-Wright Company

Penny & Giles Controls Limited
Engineering Department
15 Airfield Road
Christchurch
Dorset

Tel: (+44) (0) 1202 409409
Fax: (+44) (0) 1202 409410

SRH520CN
Issue 6

CANopen Technical Information

Penny and Giles

Prepared by: ……
D Searle

Approved by: ……
J Witts

Guarantee

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Revision History

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Revision	Description	Date
1	Initial draft	05/05/2010
3	Page 1 – Title PGS CANopen ISSUE 3 CANopen TECHNICAL INFORMATION DEVICE PROFILE FOR PENNY AND GILES ENCODERS WAS – SRH501 CANopen PROFILE PGS CANopen ISSUE 1 TECHNICAL INFORMATION Please keep for further use!	16/06/2010
4	New Product Code – SRH520CN Modifications to reflect code changes implemented to ensure CANOpen compliance.	22/11/2011
5	New functionality of TPDO Transmission Types added. New Object Dictionary Entries 0x1010 – ‘Save’ and 0x1011 – ‘Restore’ added. Minor spelling mistakes corrected. Position formula corrected.	23/02/2012
6	‘And directional mode (clockwise/counter clockwise)’ Removed from Introduction. Change Note: C10788/3	05/04/12

TABLE OF CONTENTS

1. REFERENCES

|1|: ISO 11898: Road Vehicles Interchange of Digital Information – Controller Area Network (CAN) for high-speed Communication, November 1993.

|2|: Robert Bosch GmbH, CAN Specification 2.0 Part A and B, September 1991.

|3|: CIA Draft Standard DS 301.

|4|: CIA Draft Standard DS 406.

2. DEFINITIONS, ACRYOMS AND ABBREVIATIONS

ASCII
American Standard Code for Information Interchange.

CAL
CAN Application Layer
The application layer for CAN-based networks as specified by CiA in Draft Standard 201 … 207.

CAN
Controller Area Network
Data link layer protocol for serial communication as specified in ISO 11898.

CiA
CAN in Automation international manufacturer and user organisation e.V.: non-profit association for Controller Area Network (CAN).

COB
Communication Object
(CAN Message) A unit of transportation in a CAN Network. Data must be sent across a Network inside a COB.

COB-ID
COB-Identifier
Identifies a COB uniquely in a Network.

EDS-File
Electronic Data Sheet File
The Electronic Data Sheet File is an ASCII file containing a description of a devices communication functionality and object dictionary.

NMT
Network Management
One of the service elements of the application in the CAN Reference Model. It performs initialisation, configuration and error handling in a CAN network.

PDO
Process Data Object
Object for data exchange between several devices.

SDO
Service Data Object
Peer to peer communication with access to the Object Dictionary of a device.

3. INTRODUCTION

The CAN-Bus-Interface is defined by the international norm ISO/DIS 11898 and specifies the two lowest layers of the ISO/DIS CAN Reference Model.

The CANopen Communication Profile (CIA standard DS 301) is a subset of CAN Application Layer (CAL) and describes, how the services are used by devices. The CANopen Profile allows the definition of device profiles for decentralised I/O.

The encoders with CANopen-protocol support the Device Profile for Encoder (CIA Draft Standard Proposal 406, Version 2.0).

The communication functionality and objects, which are used in the encoder profile, are described in an EDS-File (Electronic Data Sheet).

When using a CANopen Configuration Tool, the user can read the objects of the encoder (SDOs) and program the functionality.

The SRH520CN Absolute Rotary Encoder is a “Class 1” encoder.

Baud rate and Node-ID must be specified at time of order. These settings are marked on the enclosure. The baud rate and node-id are fixed and cannot be changed. The direction mode can be changed via the CAN bus.

4. SRH520CN OPERATION

4.1. Power On

After power on and finishing the initialisation, the encoder goes to the Pre-Operational state.

4.2. NMT Module Control

The table below shows NMT states and the communication the SRH520CN can perform in each state.

	Initialising	Pre-Operational	Operational	Stopped
Boot-Up	YES			
SDO		YES	YES	
Emergency		YES	YES	
SYNC		YES	YES	
Heartbeat		YES	YES	YES
PDO			YES	

Transition between the states is controlled by NMT Module Control Message. The structure of this message is shown below.

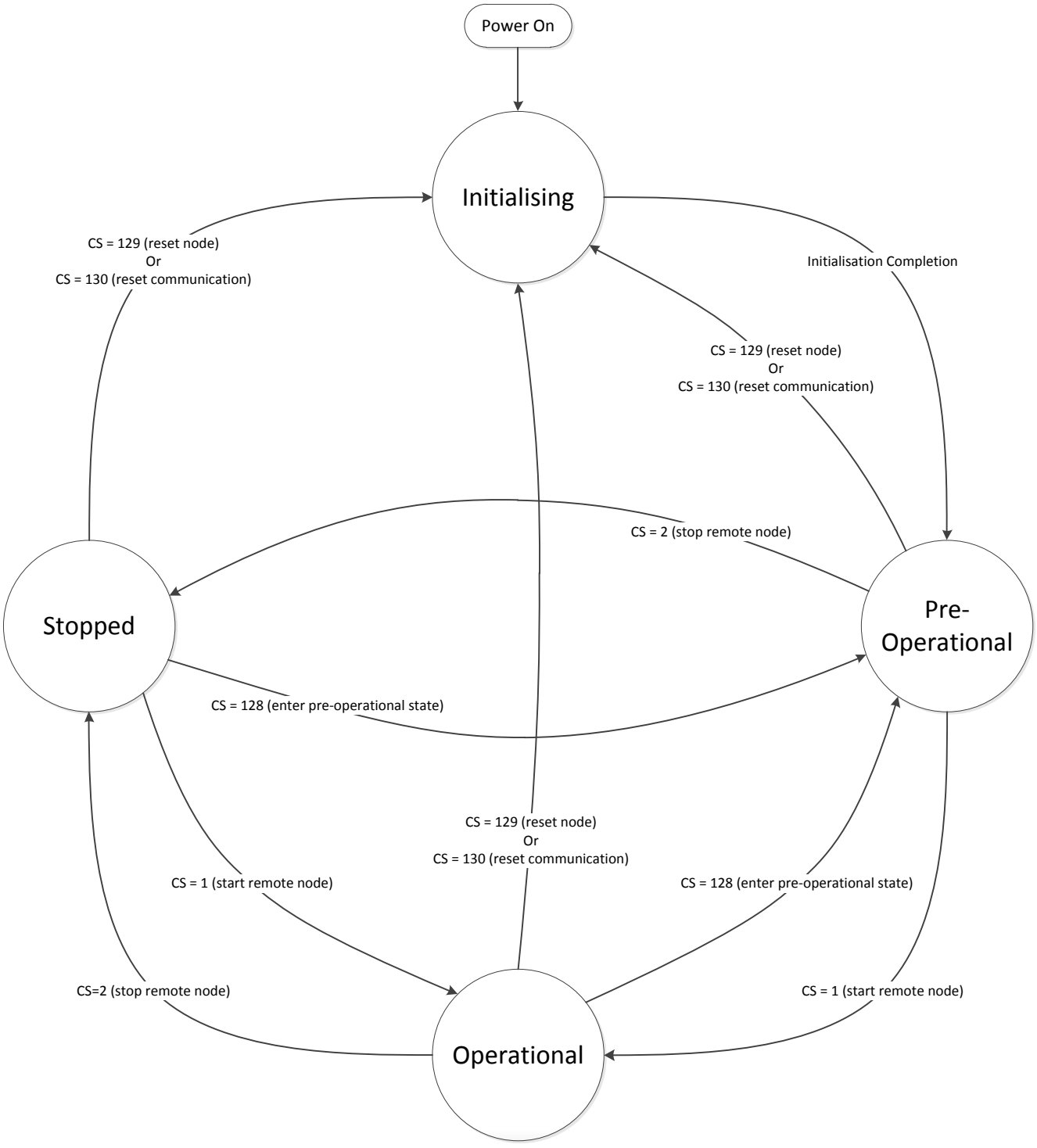
COB-ID	Byte 0	Byte 1
0x000	CS	Node-ID

If Node-ID = 0 then all nodes on the network are addressed.

CS is the command specifier with the follow options:

Command Specifier	NMT Service
1	Start Remote Node
2	Stop Remote Node
128	Enter Pre-operational state
129	Reset Node
130	Reset Communication

The state diagram below shows how the SRH520CN transitions between states in response to a NMT Module Control Message.



4.3. Enabling Transmission of Position Value

By default PDO 1 transmits the position value asynchronously (default of 10mS period) but can be changed. If no changes are made to PDO 1 settings the device will start transmitting position value entering the Operational state.

To start the device transmitting the position value (assuming device is set to factory defaults) simply send the following NMT Control Message to enter Operation state:

COB-ID	Byte 0	Byte 1
0x000	0x01	Node-ID or 0x00 (all nodes)

4.4. Heartbeat Message

The Heartbeat Message is transmitted at a rate define in object 1017h. By default this is 100mS.

The current CANopen state of the SRH520CN is also contained in the Heartbeat Message as shown below.

COB-ID	Byte 0
0x700 + Node-ID	State

Where state can be any of the following:

State	Meaning
0	Initialising
4	Stopped
5	Operational
127	Pre-Operational

4.5. Enabling / Disabling PDO's

There are two PDO's implemented in the SRH520CN, TPDO 1 and TPDO 2.

4.5.1. TPDO 1 (asynchronous)

TPDO 1's COB-ID is found in object 1800h, 01h. The value of this is 180h + Node ID.

Bit 31 of this object is used to enable or disable the TPDO 1 where clearing the bit enables the PDO and setting the bit disables the PDO.

NOTE: Transmission type of TPDO 1 can be changed to cyclic using object 1800h, 02h Transmission Type.

4.5.2. TPDO 2 (cyclic)

TPDO 2's COB-ID is found in object 1801h, 01h. The value of this is 280h + Node ID.

Bit 31 of this object is used to enable or disable the TPDO 2 where clearing the bit enables the PDO and setting the bit disables the PDO.

NOTE: Transmission type of TPDO 2 can be changed to asynchronous using object 1801h, 02h Transmission Type.

5. Data Types

The following data types are used in the SRH520CN object dictionary:

Standard Data Type	Description	Stored in Index
U8	8-bit unsigned integer	0005h
U16	16-bit unsigned integer	0006h
U32	32-bit unsigned integer	0007h
VISIBLE_STRING	A text string containing printable ASCII characters	0009h

A read of these objects will return their data size, as a U8, in bytes with the exception of VISIBLE_STRING which returns 0. They are all read-only. See table below.

Object Index Read	Returned value
0005h (U8)	1
0006h (U16)	2
0007h (U32)	4
0009h (VISIBLE_STRING)	0

6. OBJECT DICTIONARY

This section describes the object dictionary entries that are implemented.

6.1. DS301 Objects

6.1.1. Object 1000h: Device Type

This object describes the type of device and its functionality.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1000h	00h	Device Type	U32	RO	00010196h

Structure:

MSByte	LSByte
Additional Information	Device Profile Number

The Device Profile Number contains 0196h (196h = 406) showing the device uses Device Profile DS 406.

The Additional Information contains 0001h showing the device is an Absolute single-turn rotary encoder.

6.1.2. Object 1001h: Error Register

This object is an error register for the device.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1001h	00h	Error Register	U8	RO	-

Structure:

Bits	Meaning
7 - 1	Not implemented
0	Generic Error (Encoder Error) 0 = No Error 1 = Error

Bit 0 is used to flag an error with the SRH520CN device. All other error bits are not implemented and should be ignored.

6.1.3. Object 1005h: COB-ID SYNC

This object defines the COB-ID of the Synchronisation Object (SYNC).

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1005h	00h	COB-ID SYNC	U32	RW	80h

Structure:

Bits	Meaning
31	Do not care
30	0, Device does not generate SYNC message
29	0, 11-bit ID (CAN 2.0A)
28 – 11	0
10 – 0	11-bit SYNC-COB-IDENTIFIER

The default identifier at bits 10 – 0 is 80h. If a SYNC-telegram with the identifier, defined in this object is received by the device, the position value of the encoder is transmitted by the 2nd Transmit PDO (object 1801h).

6.1.4. Object 1008h: Manufacturer Device Name

This object contains the manufacturer device name and is returned as a VISIBLE_STRING.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1008h	00h	Manufacturer Device Name	VISIBLE_STRING	CONST	“Penny & Giles SRH520CN”

6.1.5. Object 1009h: Manufacturer Hardware Version

This object contains the manufacturer hardware version and is returned as a VISIBLE_STRING.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1009h	00h	Manufacturer Hardware Version	VISIBLE_STRING	CONST	-

6.1.6. Object 100Ah: Manufacturer Software Version

This object contains the manufacturer software version and is returned as a VISIBLE_STRING.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
100Ah	00h	Manufacturer Software Version	VISIBLE_STRING	CONST	-

6.1.1. Object 1010h: Store Parameters

This object supports the saving of parameters in non volatile memory.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1010h	00h	Largest Sub-index Supported	U8	RO	1
	01h	Save All Parameters	U32	RW	00000001h

Writing the correct save code signature (below) to object 1010h, 01h will save all RW parameters in the object dictionary to non volatile memory.

Signature ISO 8859 (“ASCII”) hex – ‘save’.

MSB			LSB
65h	76h	61h	73h
e	v	a	s

6.1.2. Object 1011h: Restore Default Parameters

This object supports the restoring of parameters to their default value.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1011h	00h	Largest Sub-index Supported	U8	RO	1
	01h	Restore All Default Parameters	U32	RW	00000001h

Writing the correct restore code signature (below) to object 1011h, 01h will restore all parameters in the object dictionary to their default value.

Signature ISO 8859 (“ASCII”) hex – ‘load’.

MSB			LSB
64h	61h	6Fh	6Ch
d	a	o	l

6.1.3. Object 1017h: Producer Heartbeat Time

This object defines the cyclic time of the devices heartbeat message. If 0 the heartbeat is not transmitted.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1017h	00h	Producer Heartbeat Time	U16	RW	0064h

The default value of 64h (64h = 100) gives a default Producer Heartbeat Time of 100mS.

NOTE: Concession from DS 301:
The device accepts values written to this object entry in multiples of 1mS. However, the device rounds up the value written to the nearest multiple of 10mS. This will be reflected when reading this object.

6.1.4. Object 1018h: Identity Object

This object contains general information about the device.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1018h	00h	Number of entries	U8	RO	2
	01h	Vendor ID	U32	RO	217
	04h	Serial Number	U32	RO	-

Vendor ID, 217, is specified as Curtis-Wright Antriebstechnik and is registered with CiA.

Optional sub-index 02h Product Code and 03h Revision Number have not been implemented.

However, Product Code is included in Manufacture Device Name and can be accessed via object 1008h, and Manufacture Hardware Version and Manufacture Software Version can be access via objects 1009h and 100Ah respectively.

6.2. DS406 – Process Data Predefined Communication Objects

6.2.1. Object 1800h: TPDO 1 Communication Parameter

PDO 1 transmits the position value of the encoder.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1800h	00h	Highest sub-index supported	U8	RO	5
	01h	COB-ID	U32	RW	180h + NODE-ID
	02h	Transmission Type	U8	RW	FEh
	05h	Event Timer	U16	RW	000Ah

This PDO is enabled / disabled by clearing / setting (respectively) bit 31 of the COB-ID.

COB-ID Structure:

Bits	Meaning
31	0, PDO exists / is valid 1, PDO does not exist / is not valid
30	1, no RTR allowed on this PDO
29	0, 11-bit ID (CAN 2.0A)
28 – 11	0
10 – 0	11-bit COB-IDENTIFIER

The Transmission Type at object 1800h, 02h is by default asynchronous (FEh) but can be changed to cyclic by setting Transmission Type to 01h – FDh.

With the Transmission Type set to asynchronous the position value is transmitted at a rate specified by the Event Timer at object 1800h, 05h. If the Event Timer is 0 this PDO is not transmitted.

The Event Timer by default is 000Ah (000Ah = 10) giving a default transmission rate of 10mS.

The Event Timer is hard-wired to object 6200h (Cyclic Timer) meaning a write to this Event Timer will also update objects 6200h to the written value.

With the Transmission Type set to cyclic the position value is transmitted on receipt of a sync telegram with a value matching that of object 1005h (COB-ID SYNC). The COB-ID SYNC value by default is 80h.

6.2.2. Object 1801h: TPDO 2 Communication Parameter

PDO 2 transmits the position value of the encoder.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1801h	00h	Highest sub-index supported	U8	RO	5
	01h	COB-ID	U32	RW	280h + NODE-ID
	02h	Transmission Type	U8	RW	01h
	05h	Event Timer	U16	RW	000Ah

This PDO is enabled / disabled by clearing / setting (respectively) bit 31 of the COB-ID.

COB-ID Structure:

Bits	Meaning
31	0, PDO exists / is valid 1, PDO does not exist / is not valid
30	1, no RTR allowed on this PDO
29	0, 11-bit ID (CAN 2.0A)
28 – 11	0
10 – 0	11-bit COB-IDENTIFIER

The Transmission Type at object 1801h, 02h is by default cyclic (01h) but can be changed to asynchronous by setting Transmission Type to FEh.

With the Transmission Type set to cyclic the position value is transmitted on receipt of a sync telegram with a value matching that of object 1005h (COB-ID SYNC). The COB-ID SYNC value by default is 80h.

With the Transmission Type set to asynchronous the position value is transmitted at a rate specified by the Event Timer at object 1801h, 05h. If the Event Timer is 0 this PDO is not transmitted.

The Event Timer by default is 000Ah (000Ah = 10) giving a default transmission rate of 10mS.

6.2.3. Object 1A00h: TPDO 1 Mapping Parameter

This object describes the mapping parameter for TPDO 1. It contains a single entry mapping the position value.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1A00h	00h	Highest sub-index supported	U8	CONST	1
	01h	PDO Mapping Entry	U32	CONST	60040020h

Structure:

Byte 3	Byte 2	Byte 1	Byte 0
Index		Sub-index	Size in bits

The Index 6004h and sub-index 00h specifies the position value object, its size is 32 bits (32 = 20h).

6.2.4. Object 1A01h: TPDO 2 Mapping Parameter

This object describes the mapping parameter for TPDO 2 and is identical to TPDO1. It contains a single entry mapping the position value.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
1A01h	00h	Highest sub-index supported	U8	CONST	1
	01h	PDO Mapping Entry	U32	CONST	60040020h

Structure:

Byte 3	Byte 2	Byte 1	Byte 0
Index		Sub-index	Size in bits

The Index 6004h and sub-index 00h specifies the position value object, its size is 32 bits (32 = 20h).

DS406 – Encoder Parameter Application Objects

6.2.5. Object 6000h: Operating Parameters

This object defines the operating parameters of the device. Code sequence is implemented to allow direction change from clockwise to counter-clockwise. All other parameters have not been implemented and should be ignored.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6000h	00h	Operating Parameters	U32	RW	-

Structure:

Bits	Meaning
31 - 1	Not implemented
0	Code Sequence 0 = Clockwise 1 = Counter-Clockwise

Clockwise means the position value increase when the shaft is rotated clockwise as seen from the point of view of the shaft.

Counter-Clockwise means the position value increases when the shaft is rotated counter-clockwise as seen from the point of view of the shaft.

The default value for direction is selectable when ordering an SRH520CN but can be changed by writing to this object entry.

6.2.6. Object 6004h: Position Value

This object is the absolute position value of the encoder and is outputted in communication objects 1800h and 1801h (TPDO 1 and TPDO 2 respectively).

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6004h	00h	Position Value	U32	RO	-

The SRH520CN output is 14 bits giving 16384 steps. This gives a position value range of 0 – 16383.

See Calculating Position in Degrees for information on how to use this object in conjunction with object 6501h (Single-Turn Resolution) and object 6502h (Number of Distinguishable Revolutions) to calculate the absolute position in degrees.

6.2.7. Object 6200h: Cyclic Timer

This object indicates the transmission period for TPDO 1.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6200h	00h	Cyclic Timer	U16	RW	000Ah

The Cyclic Timer by default is 000Ah (000Ah = 10) giving a default transmission rate of 10mS.

The Cyclic Timer is hard-wired to object 1800h, 05h (TPDO 1 Communication Parameter) meaning a write to this Cyclic Timer will also update objects 1800h, 05h to the written value.

6.3. DS406 – Encoder Diagnostic Application Objects

6.3.1. Object 6500h: Operating Status

This object is a read only copy of the Operating Parameters (6000h).

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6500h	00h	Operating Status	U32	RO	-

See object 6000h for structure definition.

6.3.2. Object 6501h: Single-Turn Resolution

This object provides the number of measuring steps per revolution that are output for position value.

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6501h	00h	Single-Turn Resolution	U32	RO	16384

See Calculating Position in Degrees for information on how to use this object in conjunction with object 6004h (Position Value) and object 6502h (Number of Distinguishable Revolutions) to calculate the absolute position in degrees.

6.3.3. Object 6502h: Number of Distinguishable Revolutions

This object provides the number of distinguishable revolutions that the encoder may output.

The Number of Distinguishable Revolutions and the Single-Turn Resolution (6501h) gives the measuring range of the device according to the formula below:

Measuring Range = Number of Distinguishable Revolutions * Single-Turn Resolution

For the SRH520CN this is:

16384 = 1 * 16384

Object Description:

Index	Sub-Index	Name	Data Type	Access	Default Value
6502h	00h	Number of Distinguishable Revolutions	U16	RO	1

See Calculating Position in Degrees for information on how to use this object in conjunction with object 6004h (Position Value) and object 6501h (Single-Turn Resolution) to calculate the absolute position in degrees.

7. CALCULATING POSITION IN DEGREES

The absolute position in degrees can be calculated from the following three objects:

Position Value (6004h)
Single-Turn Resolution (6501h)
Number of Distinguishable Revolutions (6502h)

Using the formula below:

*Angle in degrees = 360 / Single-Turn Resolution * Number of Distinguishable Revolutions * Position Value*

For the SRH520CN the Single-Turn Resolution is fixed at 16384 and the Number of Distinguishable Revolutions is fixed at 1.

Therefore the following simplified formula can be used:

*Angle in degrees = 360 / 16384 * Position Value*