Tech Note #58   Rev 2

Title: Replacing a SAC-SW drive with a SACS2D drive

Created: Nov 24, 2015   Revised: Jan. 15, 2016

ORMEC's S2D Drive series is the latest servo drive family. It adds support for Safety Interlocks, more control power voltage options, 24v I/O power output and a new power section, improving efficiencies in many cases.

The S2D drives can be used as replacements for SAC-SW drive. This is especially useful when upgrading your system or when replacing a failed older-series drive.   This Tech Note provides documentation on the compatibility issues for using an S2D replacement for a SAC-SW drive.

At the end is a Checklist to help evaluate the replacement.

Drive Family Overview Comparison:

Feature	SW Servodrive	SM Servodrive	SD Servodrive	S2D Servodrive
1394 Comm. Speed	200 Mbit/sec maximum	400 Mbit/sec maximum	1394a or 1394b with 800 Mbit/sec maximum	1394a or 1394b with 800 Mbit/sec maximum
I/O Connectors	Pluggable terminal block	Pluggable header	Pluggable terminal blocks	Pluggable terminal blocks
Field Oriented Control	No	Yes, firmware 3.0.1 or later	Yes, firmware 3.0.1 or later	Yes, firmware 3.0.1 or later
High-Speed Sensors	3 – ASEN, BSEN & CSEN	2 – ASEN & BSEN	2 – ASEN & BSEN	2 – ASEN & BSEN
High-Speed Sensor Pull-up Resistor	3 choices none (PNP), 2.38k (NPN) or 20k (NPN)	2 choices – none (PNP) or 2.7k (NPN)	2 choices – none (PNP) or 2.7k (NPN)	2 choices – none (PNP) or 2.7k (NPN)
Digital I/O (optically isolated)	2 Inputs, 6 Outputs	3 Inputs, 4 Outputs, 1 Bi-directional I/O.	3 Inputs, 4 Outputs, 1 Bi-directional I/O.	3 Inputs, 4 Outputs, 1 Bi-directional I/O.
Brake Output	OUT 6	OUT 3	OUT 3	OUT 3
Drive Ready Output		OUT 4	OUT 4	OUT 4
Hardware Travel Limits	HTLF & HTLR	IN1 & IN2	IN1 & IN2	IN1 & IN2
Encoder Reference Z Output	Z Out	OUT 5	OUT 5	OUT 5
Delay Counter Output	DELAY			OUT3
Option Module Interfaces	None	Support for Feedback and I/O Option Modules	Support for Feedback and I/O Option Modules	Support for Feedback and I/O Option Modules
Analog I/O	2 Outputs		1 Output, 1 Input	1 Output, 1 Input

Feature	SW Servodrive	SM Servodrive	SD Servodrive	S2D Servodrive
ID/Status Displays	2-digit seven segment display, 6 I/O status LED's and Bus Power LED	Single digit seven segment display and Bus Power LED	2-digit seven segment display, 11 I/O status LEDs and Bus Power LED	2-digit seven segment display, 11 I/O status LEDs and Bus Power LED
Auxiliary Encoder Input	Drive Option (/ P)	Drive Option (-P)	Drive Option (-P)	Drive Option (-P)
Delay Counter	Drive Option (/ D)			Drive Option (-D)
Yaskawa Absolute Encoder Support	Drive Option (/A)	Drive Option (/A) adds battery. Sigma II support always present on /S.	Drive Option (-B) adds battery. Sigma II support always present on -S.	Sigma II support always present on -S. Use CBL-HBAT for battery.
Resolver Feedback Option	None	Option Module SAC-SD-RES	Integral on –R version.	Integral on –R version.
Power connections	Fixed terminal block on all models.	Fixed terminal block on all models.	Fixed terminal block on all models.	Pluggable terminal blocks models 203-215, 403-405. Fixed terminal blocks all others.
Control power	120/230 VAC only	120/230 VAC only	120/230 VAC only	100-240 VAC or 24 VDC
24 VDC output power	Not available	Not available	Not available	Available when using AC control power
Regen control circuitry	Available on all models except 203 and 205.	Available on all models except 203 and 205.	Available on all models except 203 and 205.	Available on all models.
Peak current	2 times continuous rating	2 times continuous rating	2 times continuous rating	3 times continuous rating on models 203-215, 403-410. 2 times continuous rating all others.
Absolute encoder battery	Optional inside drive	Optional inside drive	Optional inside drive	External to drive, use cable part CBL-HBAT/n
Safety circuit	Not available	Not available	Not available	Available option on all models.

SW Replacement by S2D:

The S2D line of ServoWire drives has enhanced features and functionality from the SW series of drives. Review the table found at the beginning of this document for a comparison.
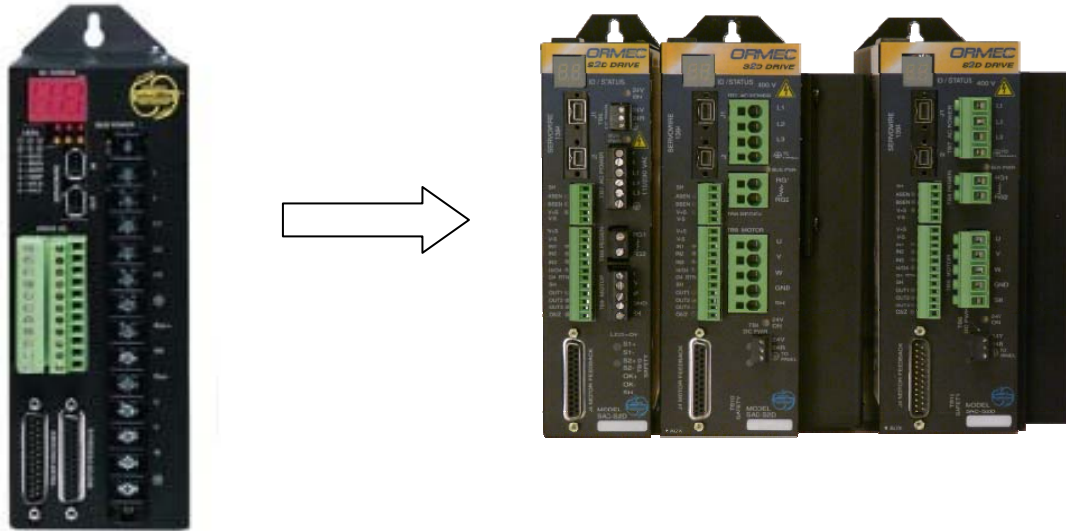
In most applications the SAC-S2D series of servodrives can be used as a substitution for the SAC-SW drives. There are some issues which prevent the SD from being a direct substitution. Considerations to review:

1. **Current capabilities.** The S2D series, models 203-215, have 3x peak capability versus 2x peak capability in the SW series. In all cases the S2D current capabilities are superior.

   While there exists an SWx220 there is no S2Dx220 drive. If replacing a SAC-SWx220 you will need to review your application to determine if a S2Dx215 or S2Dx225 is the correct replacement. The critical factors are the continuous and peak current requirements of the application. In most cases the S2Dx215 will be an acceptable replacement.

   Note: Drives used with an SMLC controller will have part numbers with an M, SAC-SWM or SAC-S2DM. Drives used with and Orion Controller do not have the M in the part number, SAC-SW or SAC-S2D.

	SW Drive			S2D Drive			
SAC-SW or SAC-SWM Drive model	**Current**		**Replace with SAC-S2D (or SAC-S2DM if SWM)**	**SMLC Systems Current**		**Orion Systems Current**	
	Cont	**Peak**		**Cont**	**Peak**	**Cont**	**Peak**
SAC-SWx203	2.4	4.8	SAC-S2Dx203	3.0	9.0	3.0	6.0
SAC-SWx205	4.2	8.4	SAC-S2Dx205	5.0	15	5.0	10
SAC-SWx210	8.4	17.2	SAC-S2Dx210	10	30	10	20
SAC-SWx217	14.2	28	SAC-S2Dx215	15	45	15	30
SAC-SWx220	17	34	SAC-S2Dx215	15	45	15	30
SAC-SWx225	25	50	SAC-S2Dx225	25	50	25	50
SAC-SWx235	35	70	SAC-S2Dx235	35	70	35	70
SAC-SWx260	60	120	SAC-S2Dx260	60	120	60	120

2. **Mounting**. The mounting hole spacings are identical in all drives. The S2D will mount using the same holes. There are minor differences in the width of the drives as shown.

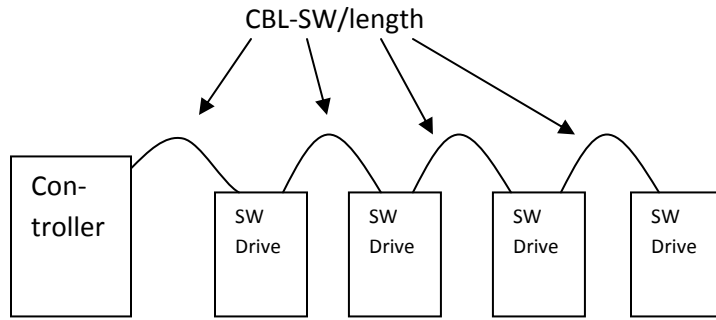| **Original model**	**Width**	**Replacement**	**Width**
SAC-SWx203	3.1"	SAC-S2Dx203	2.2"
SAC-SWx205	3.1"	SAC-S2Dx205	2.2"
SAC-SWx210	3.1"	SAC-S2Dx210	2.73"
SAC-SWx217	4.3"	SAC-S2Dx215	4.18"
SAC-SWx220	4.4"	SAC-S2Dx215	4.18"

3. **Encoder cables**. No change is required. All main feedback encoder cables which plugged into a SW drive will plug into a S2D drive and work.

4. **Motor cables**. No cable change is required. All motor cables terminate in terminal blocks in SW and will in S2D. On the smaller drives, 203-215, the terminal block changes. In most cases the change is from a single fixed terminal block to multiple pluggable terminal blocks. The wire order is the same, terminal block numbers have changed.   If ring lugs were used they will need to be removed.

5. **Servowire cables**: A change WILL be required. The SW drives use a 1394a style connector. That connector is a different shape from the 1394b connector used on the S2D drives.

The old cable was likely a 1394a to 1394a connector with ORMEC part number CBL-SW/n. There are 2 new cables to choose from, 1394a to 1394b, ORMEC part number CBL-SW-BA-n or a 1394b to 1394b cable, ORMEC part number CBL-SW-BL.
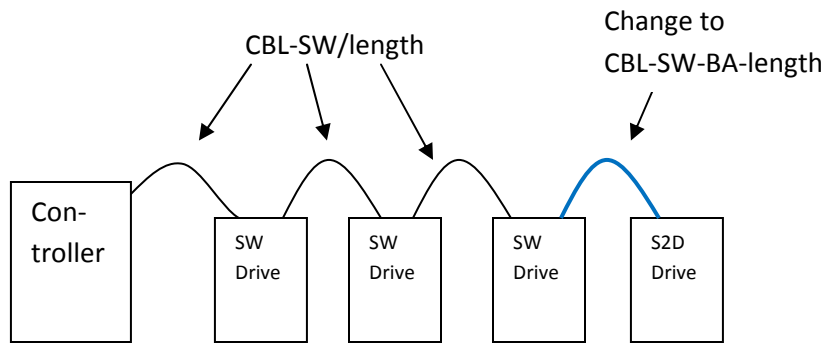
The CBL-SW-BA-n cable would be used to go from a device with a 1394a style connector (Orion controller or SW drive for example) to the S2D drive.

The CBL-SW-BL-n cable would be used to go from a device with a 1394b style connector (SMLC controller or SD or S2D drive) to the S2D drive.
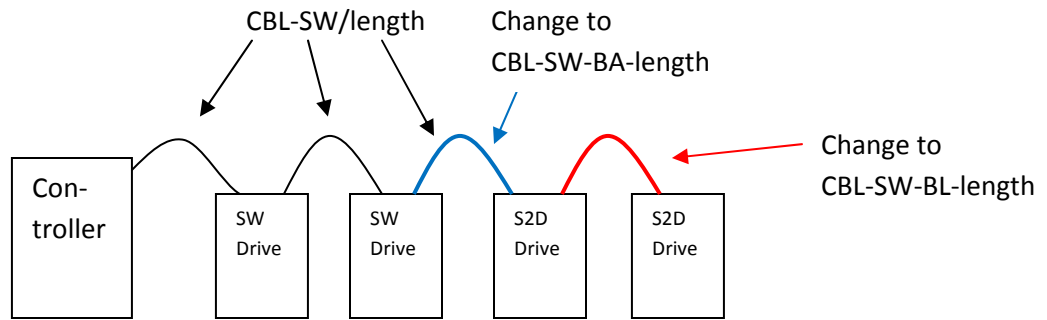
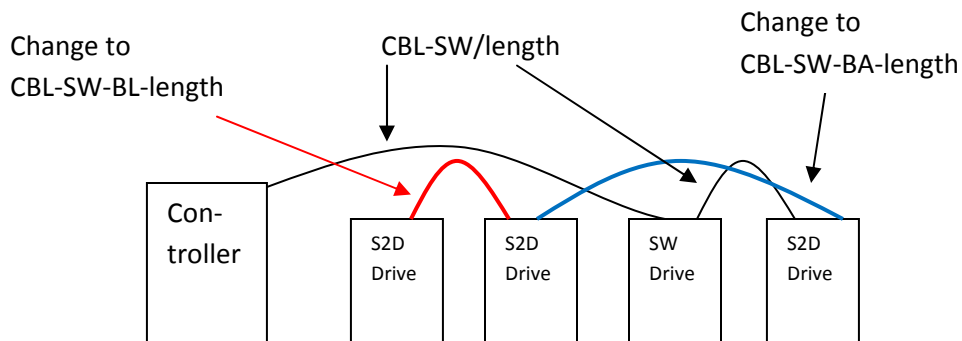Choose the correct style and number of cables for your application.

CBL-SW/length

| Con-troller | SW Drive | SW Drive | SW Drive | SW Drive |

Original communication cables

Change to CBL-SW-BA-length

CBL-SW/length

| Con-troller | SW Drive | SW Drive | SW Drive | S2D Drive |

Comm. Cables with 1 SAC-S2D drive.

CBL-SW/length

Change to CBL-SW-BA-length

Change to CBL-SW-BL-length

| Con-troller | SW Drive | SW Drive | S2D Drive | S2D Drive |

Comm cables with 2 SAC-S2D drives.

Change to CBL-SW-BL-length

CBL-SW/length

Change to CBL-SW-BA-length

| Con-troller | S2D Drive | S2D Drive | SW Drive | S2D Drive |

Always put SAC-S2D drives at end of ServoWire path.

6. **I/O wiring - digital**: Changes are required if digital I/O was used.

   The SW drives used a pair of pluggable terminal blocks with a total of 22 pins. The S2D drives use a trio of pluggable terminal blocks. Not all signals from the SW drives are available.

   Electrically the digital inputs and outputs function the same.   OUT3 and OUT4 have increased current sink capability which should not impact an application. Review the S2D drive output details with your specific application.

   The most likely mapping of SW connections to S2D connections is:

SW pin and signal, TB1a		S2D connector and pin			SW pin and signal, TB1b		S2D connector and pin	
1	AS	TB4	2		12	AOUT1	TB3	2 AOUT
2	BS	TB4	3		13	AOUT2		
3	CS				14	AGND	TB3	3 AGND
4	SH	TB4	1		15	Shield	TB5	8
5	V+	TB4	4		16	ZOUT	TB5	12
6	V+	TB5	1		17	OUT1/	TB5	9
7	V-	TB4	5		18	OUT2/	TB5	10
8	V-	TB5	2		19	OUT3/	TB5	12
9	HTLR	TB5	4		20	OUT4/	TB5	6
10	HTLF	TB5	3		21	OUT5/	TB5	12
11	DELAY				22	OUT6/		

   CSEN: The S2D drive has only 2 high speed sensors, not 3 as the SW drive did. If you are using CSEN then an application change will be needed when switching to an S2D drive.

   HTLF/HTLR: In the SW drive these overtravel inputs were dedicated inputs. In the S2D drive IN1 and IN2 can be configured to perform the same overtravel function or used as general purpose inputs.

   AOUT2: The S2D drive has only 1 analog output, as opposed to 2 of the SW drive.

   Delay: This output is not available as a hardware signal in the S2D drive. In many cases the former action initiated in hardware can now be initiated in software, eliminating the need for the hardware signal. Contact ORMEC to discuss your application.

   OUT1 – OUT6: The S2D drive does not offer 6 hardware outputs. However, there were limits on the outputs in the SW drives and in the S2D drives the existing outputs are more configurable. In addition PLS signals can be propagated in software, which was one of the primary uses of the outputs. Propagating in software will reduce the number of outputs needed. If your application uses 4 or fewer outputs then it is likely they can be arranged on the S2D. Project and programming changes will be required.

   Use of pacer PLS signals is required. If not directed to hardware signals there usually is no problem. If the PLS was configured to be output on a drive output then changes may be needed. In the SW drive pacer PLS signals mapped to OUT4 – OUT6. In the S2D drive pacer PLS signals map to OUT4-OUT5 and there is no OUT6. If pacer PLS3 is needed to drive an output it is possible in MotionBasic to swap the PLS output mappings so that pacer PLS go to OUT1-OUT3. Contact ORMEC is assistance is needed.

7. **Sensor inputs**: Changes are required in the wiring if high speed sensors are used. The primary issue is that the SW drive had 3 high speed sensors and the S2D has only 2. Functionally the remaining sensors are identical.   There is a small electrical difference. The SW drives offered a choice of 2 pull up resistors for the NPN configuration, 2.38K or

10k ohms. The S2D offers only 1 value, 2.7k ohms. If that value will not work an external resistor will be needed.

8. **I/O wiring - analog**: A change may be needed. The SW drive provided 2 analog outputs. The S2D provides only 1. If both are needed contact ORMEC for assistance.

9. **Main (motor) power input**. No cable change is required.   All main power wiring terminates in terminal blocks in SW and will in S2D. On the smaller drives, 203-215, the terminal block changes. In most cases the change is from a single fixed terminal block to multiple pluggable terminal blocks. The order is the same, terminal block numbers have changed. If ring lugs were used they will need to be removed. On larger drives, 225 – 260, the control power terminal block (r, t) changes style.

10. **Control power input**. No cable change is required.   All power wiring terminates in terminal blocks in SW and will in S2D. On the smaller drives, 203-215, the terminal block changes. In most cases the change is from a single fixed terminal block to multiple pluggable terminal blocks. The order is the same, terminal block numbers have changed. If ring lugs were used they will need to be removed. On larger drives, 225 – 260, the control power terminal block (r, t) changes style.

11. **Absolute encoder**: A minor change is required. The SW drive allowed an encoder backup battery to be installed. This option is not available on the S2D drive. Instead, the battery is external, provided in a CBL-HBAT/1 for H-Series motors. For other motors contact ORMEC for assistance.

12. **Regen support**: No change is required. The S2D drive has improved Regen support which will work correctly as a replacement for all SM drives. One improvement is that some models of the SW series did not support regen resistors, all S2D models do.

13. **Pacer option**: There is no change in pacer cable or pacer support. All pacer encoder cables used with the SW drives will work with the S2D drives.

14. **Motors supported**: Possible compatibility issue. The SW drive supported an absolute encoder version of the MAC-DE, MAC-DA, MAC-DB motor series. The S2D supports only the incremental encoder versions and does not support the absolute encoder version of these motors. Motor models with a /I are incremental and /A are absolute.

15. **Status Displays**: This has minimal changes. Both drives have 2-digit displays. The information is essentially the same though some status patterns may be slightly different. All error codes in the SW are identical in the S2D. The S2D may provide new codes or expanded information. There are differences in the status LEDs. Review the installation manuals for further details.

16. **Project Definition**. The project definition in ServoWire Pro for SMLC projects will require a change. Edit the project and select the new drive model number for each axis. If this is not done the SMLC will have a 1031 error when the axis is opened.

Compatibility issue: A ServoWire Pro configuration for an SMLC project cannot mix SWM drives with S2DM drives (or any other type). If the project has more than one SWM drive then all drives will need to be changed.

Project definition in MotionDesk for Orion systems does not require a change. The new S2D drive will function as the old SW drive did. The Orion system will allow a similarly sized drive from a different family to be used without error. However, the S2D drive will have

only 2x peak current capability, matching what was available in the SM drive. The 3x peak capability of the S2D drive is not utilized in an Orion system due to hard-coded limitations.

In Orion based systems S2D drives can be mixed with SW drives. Unlike an SMLC based system a single SW drive can be changed to an S2D drive.

17. **Motion performance and tuning**: No change in control loop settings. Motion performance should be identical. Minor improvements may occur with later versions of S2D firmware.

18. **Firmware**. The S2D drive's firmware is different than the SW drive series. All functionality of the SW is available. This merely means that when upgrading firmware you must choose a different file.

19. **Resolver motor support**: This is not an issue. The SW drives did not support motors with resolver feedback.

20. **Model Numbers**. The S2D_ drives have slightly different options than the equivalent SW_ drive. The options are defined in the corresponding Installation and Operation manual, found at Ormec.com. The differences are noted here. Contact ORMEC for assistance.

To cross SAC-SWxxx/yyyy to SAC-S2Dnnn/zzzzzzz or SAC-SWMxxx/yyyy to SAC-S2DMnnn/zzzzzzz

FIRST step – cross power level. Use this table to map the old drive power level to the new drive model power level.

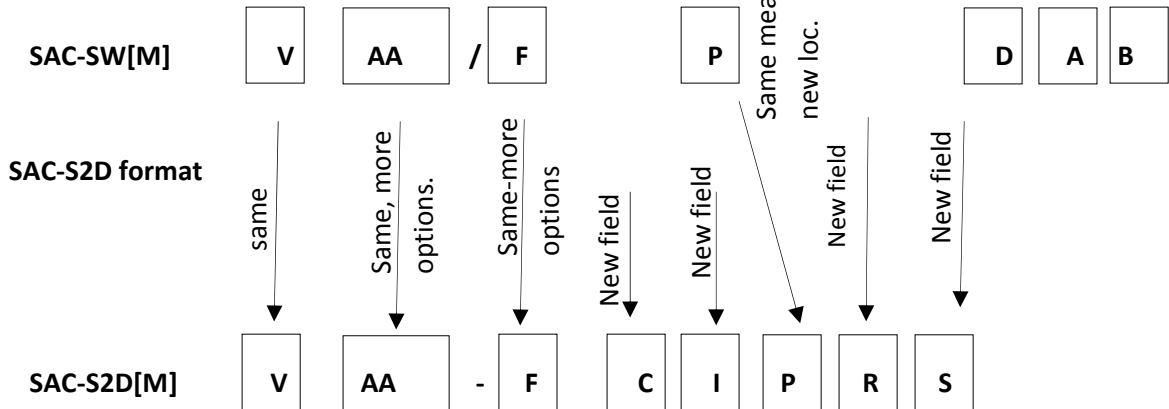| SAC-SW Drive model	Replace with SAC-S2D		SAC-SWM Drive model	Replace with SAC-S2Dm
SAC-SW203	SAC-S2D203		SAC-SWM203	SAC-S2DM203
SAC-SW205	SAC-S2D205		SAC-SWM205	SAC-S2DM205
SAC-SW210	SAC-S2D210		SAC-SWM210	SAC-S2DM210
SAC-SW217	SAC-S2D215		SAC-SWM217	SAC-S2DM215
SAC-SW220	SAC-S2D215		SAC-SWM220	SAC-S2DM215
SAC-SW225	SAC-S2D225		SAC-SWM225	SAC-S2DM225
SAC-SW235	SAC-S2D235		SAC-SWM235	SAC-S2DM235
SAC-SW260	SAC-S2D260		SAC-SWM260	SAC-S2DM260

SECOND step – cross drive options. Use the table below to map the old Options to the New Options. SW and SWM have the same options and S2D and S2DM have the same options.

Note – this is the best direct cross. If other features or variations are desired because the S2D offers more see Tech Note 57 or 58 or ask for assistance.

SAC-SW or SAC-SWM options		SAC-S2D or SAC-S2DM options on 203 & 205 power levels	SAC-S2D or SAC-S2DM options on 210, 217, 220, 225, 235, 260 power levels
Example SAC-SW203/EP		Example SAC-S2D203-SAAP00	
/E		-SAA000	-SAA0R0
/EP		-SAAP00	-SAAPR0
/EA		-SAA000 Add CBL-HBAT/1 to order	-SAA0R0 Add CBL-HBAT/1 to order
/EPA		-SAAP00 Add CBL-HBAT/1 to order	-SAAPR0 Add CBL-HBAT/1 to order
/EPDA		Seek Assistance due to D option	Seek Assistance due to D option
/EPD		Seek Assistance due to D	Seek Assistance due to D
/EDA		Seek Assistance due to D	Seek Assistance due to D
/ED		Seek Assistance due to D	Seek Assistance due to D
/EB		Seek Assistance due to B	Seek Assistance due to B
/EPB		Seek Assistance due to B	Seek Assistance due to B
/EAB		Seek Assistance due to B	Seek Assistance due to B

The full explanation of the part number cross reference is:

SAC-SW format

SAC-SW[M] | V | AA | / F | | P | | D | A | B |

(diagram annotations top to bottom: "Same meaning new loc.")

SAC-S2D format

(arrows with labels: same; Same, more options.; Same-more options; New field; New field; New field; New field)

SAC-S2D[M] | V | AA | - F | C | I | P | R | S |

Examples:

Drive	Replaced by
SAC-SW205/E	SAC-S2D205-SA0000
SAC-SW205/EP	SAC-S2D205-SA0P00
SAC-SW217/EA	SAC-S2D215-SA00R0 and CBL-HBAT/1
SAC-SWM205/E	SAC-S2DM205-SA0000
SAC-SWM235/EPA	SAC-S2DM235-SA0PR0 and CBL-HBAT/1

Definition:

V – voltage rating, 2 = 200v series, 4 = 400 v series. Same both models.

AA – Drive current rating. Same both models.

F – Feedback option. E in SW drive map to S in S2D.

B – Battery option. Not in S2D. See Absolute encoder above.

C – Control voltage option. Always AC control voltage in SW. S2D can be DC. An A in this position makes the S2D same as SW. Note, A not valid on S2D403 – S2D410 models.

I – Analog I/O option. Always in SW, option in S2D.

D – Delay counter option. Use feedback option D. Requires application review because this feature is different in S2D.

P – Pacer option. Same in both models.

R – Regen option. Same feature, more choices in S2D drives. See Regen above.

S – Safety Interface option. New feature in S2D drive.

A – Absolute encoder battery option in SW. Not in S2D drive. Order a CBL-HBAT/1 to get a battery.

B – Dynamic brake option – Requires application review.

SAC-SW Replacement Checklist

This section provides a checklist to be used in the evaluation to determine the extent a SAC-S2D drive can replace a SAC-SW drive. Complete information can be found in Technical Note 57. Item numbers reference the same numbered section in the Technical note. Be sure to use the "SW replaced by S2D" section.

Review each 'Item to check'. Check the box which applies to your situation. Checks in the OK column indicate that substitution should work fine. Checks in the 'Possible Issue Review further' column mean that conditions may apply. See the Note column or Technical Note 57 for further information and directions about the concern. Contact Ormec Support if you need additional information or help.

Model Number of SAC-SW:	_____	Axis name or number: _____

Replacement model:	_____	Motor: _____

Review based on:	☐ Schematics	☐ Program software	☐ Customer input	Date: _____

	Item to check	OK	Possible Issue Review further	Note	Review Comments
1	Current capability	☐ new drive same or higher current	☐ new drive lower current	Use chart in Tech note 57 for current ratings.	
2	Mounting width	☐ new drive same or narrower			
3	Encoder cable - motor	√ All old cables work			

	Item to check	OK	Possible Issue Review further	Note	Review Comments
4a	Motor cables – drives 203-220	☐ wire size 18 - 12 AWG	☐ wire size 10-6 AWG	See motor cable, note [1]	
4a	Motor cables – drives 225-260	√ All old cables work.			
5	ServoWire cable		√ At least 1 new cable is required	See ServoWire cable note [2]	
6	I/O wiring review				
6a	AS or BS (A and B sensors)	☐ not used	☐ in use, check pullup	AS, BS note [3]	
6b	CS (C sensor)	☐ not used	☐ Used	CS – CSEN note [4]	
6c	Overtravel limits, HTLF/HTLR	☐ not used	☐ Used	HTLF/HTLR note [5]	

[1] Motor cable: The S2D drive uses a pluggable terminal block instead of the fixed terminal block found on the SW drive. The maximum wire size is 12 AWG.   If the old wire was larger (6-10 AWG) or had a lug attached rework will be required.

[2] ServoWire cable: The S2D drive has a different ServoWire network connector. Depending on how many drives are being replaced determines which and how many cables need to change. Connection from the existing (old) connector to the S2D drive requires a CBL-SW-BA-n. Connections from a S2D to S2D require a CBL-SW-BL-n. The n represents cable length in feet and can be 3, 6, 14 or 33.

[3] AS, BS: The S2D drive sensor pullup resistor is 2.7k. The SW drive had a choice of 2.38k or 10k. Review of the configuration setting and sensor current sinking capability is recommended.

[4] CS CSEN: The S2D drive does not have a CS input. The S2D drive has only 2 sensors and not 3 like the SW. If CS is used then a change is required. A different input is required and a change to the MotionBasic program will be required.

[5] HTLF/HTLR: On the SW drive the overtravel inputs, HTLF and HTLR were dedicated inputs. On the S2D drive overtravel switches are wired to IN1 and IN2. A program configuration change is needed and there is a problem if IN1 or IN2 were used on an SW drive when HTLF or HTLR was used.

Item to check	OK	Possible Issue Review further	Note	Review Comments
6e Delay	☐ not used	☐ Used	Delay note [6]	
6f OUT1, OUT2, OUT3	☐ not used ☐ PLS used			
6g OUT4, OUT5, OUT6	☐ not used	☐ PLS used ☐ Brake used	Pacer PLS note [7]	
7 Sensor inputs. See item 6a above.				
8 AOUT	☐ not used ☐ AOUT1 only used	☐ AOUT2 used	AOUT note [8]	
9a Motor power input– drives 203-220	☐ wire size 12 AWG or	☐ wire size larger	See motor power input, note [9]	

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[6] DELAY: The S2D does not have a hardware Delay output. If it was used on the SW drive it may be possible achieve the same results in software. Contact Ormec Support for assistance.

[7] Pacer PLS: The S2D drive does not have separate outputs for pacer PLS signals. The single group of outputs are shared by the motor and pacer. Wiring changes and program changes are required. There are fewer total outputs on the S2D drive which requires additional review.

[8] AOUT: The SW drive had 2 analog outputs, AOUT1 and AOUT2. The S2D has only 1 analog output. If both were used changes are required.

[9] Motor power input: The S2D drive uses a pluggable terminal block instead of the fixed terminal block found on the SW drive. The maximum wire size is 12 AWG. If the old wire was larger (6-10 AWG) or had a lug attached rework will be required.

	Item to check	OK	Possible Issue Review further	Note	Review Comments
		smaller	than 12 AWG		
9a	Motor power input – drives 225-260	√ All old wires work.			
10	Control power input– all drives	☐ wire size 12 AWG or smaller	☐ wire size larger than 12 AWG	See control power input, note [10]	
11	Absolute encoder battery	☐ not used	☐ Used	See Technote 57 for details.	
12	Regen support	√ All old regen resistors work.		Add R option in model number 210 and larger.	
13	Pacer	☐ not used	☐ All SW pacers work with S2D.	Add P option in part number	
14	Motor	☐ incremental	☐ Absolute		
16	Project Definition	☐ used with Orion controller	☐ Used with SMLC controller	See Technote 57 for details.	

[10] Control power input: The S2D drive uses a pluggable terminal block instead of the fixed terminal block found on the SW drive. The maximum wire size is 12 AWG.   If the old wire was larger (6-10 AWG) or had a lug attached rework will be required.

Conclusions: _____

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