VACON® NX
AC DRIVES

RESOLVER OPTION BOARD OPT-BC
USER MANUAL

VACON®
DRIVEN BY DRIVES

NOTE! You can download the English and French product manuals with applicable safety, warning and caution information from www.vacon.com/downloads.
REMARQUE Vous pouvez télécharger les versions anglaise et française des manuels produit contenant l'ensemble des informations de sécurité, avertissements et mises en garde applicables sur le site www.vacon.com/downloads.

Table of contents

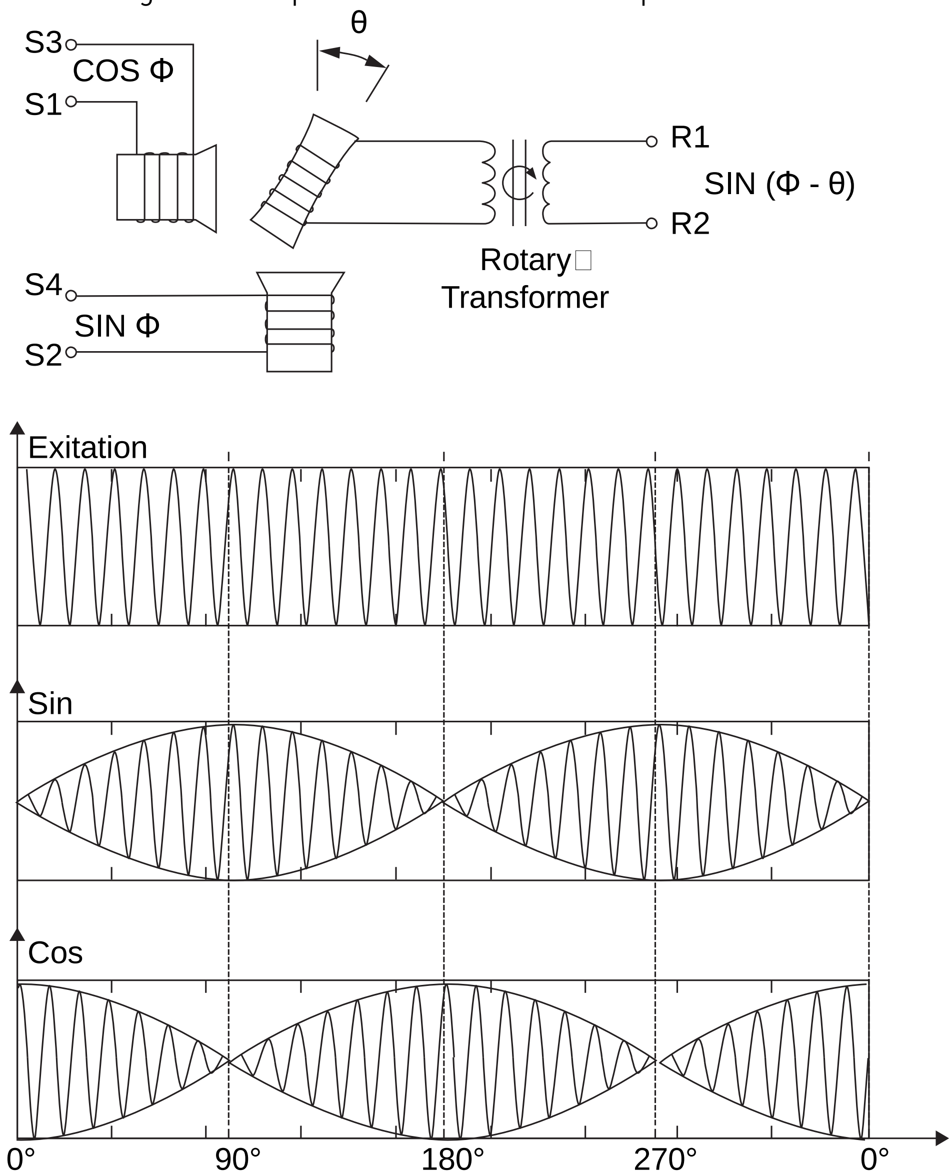
Document code: DPD01362A
Date: 28.10.2013

1. RESOLVER OPTION BOARD OPT-BC

This manual is valid for board versions VB00339i or later. The Resolver option board OPT-BC provides the user with an interface to use resolvers as feedback device to Vacon NXP Drive. The interface provides speed and position data. The OPT-BC includes also encoder simulation output (HTL -level) and secondary encoder input (HTL-level).

1.1 Resolver basics

A resolver is a rotary transformer where the magnitude of the energy through the resolver windings varies sinusoidal as the shaft rotates. A resolver contains one primary winding and two secondary windings, the SIN and COS windings.
Primary winding is in the rotor of the resolver and secondary windings are in the stator. Secondary windings are mechanically displaced 90 degrees from each other.
The primary winding is excited by an AC voltage called the reference voltage (Vr). The induced voltages in the SIN and COS Windings are equal to the value of the Reference Voltage multiplied by the SIN or COS of the angle of the input shaft from a fixed zero point.



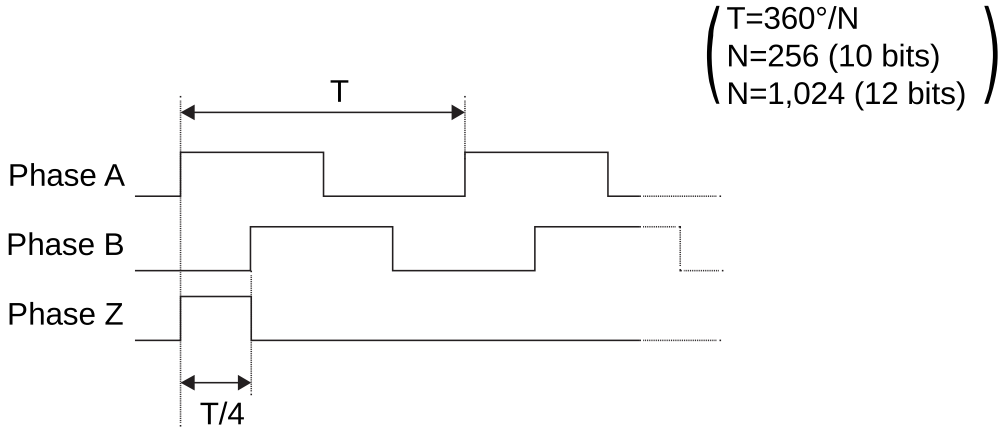
Resolver signals

Why resolvers?

When a Motion control application exists in a hot, humid, dusty, oily, or mechanically demanding environment, a resolver-based system is the preferred choice.

1.2 Resolver to digital conversion basics

The OPT-BC board sends the Excitation signal to the resolver, and resolver sends sin and cos signals back to the board. In the OPT-BC board, sin and cos signals are converted to incremental encoder pulses by the ASIC circuitry (see picture 1).
The incremental pulses are used for calculating rotation speed in the NXP control card. The conversion from resolver sin/cos signals to digital pulses is called RTD (Resolver To Digital conversion).



Picture 1 Simulated encoder signals from RTD ASIC

1.3 Compatible resolver types

Resolver Output voltage:	$1{,}8V_{rms} – 4{,}0V_{rms}$
Resolver Input voltage:	$1.3V_{rms} – 7.5V_{rms}$
Number of poles:	2, 4, 6 … 20 (System software version V182 or later)

Note
If the number of poles of the resolver is not 2, then the resolver can only work with a motor that has the same number of poles (e.g. a 6 pole resolver with a 6 pole motor). Maximum tracking rates assume that resolver has 2 poles.

1.4 Resolver board features

Resolution in panel	10bit	12bit	14bit	16bit
Encoder Simulation Output Resolution	10bit	12bit	14bit	14bit
Encoder Simulation Pulses / rev	256	1024	4096	4096
Converter's position accuracy*	+/- 4 LSB	+/- 4 LSB	+/- 4 LSB	+/- 16 LSB
Converter's velocity accuracy*	+/- 4 LSB	+/- 4 LSB	+/- 4 LSB	+/- 4 LSB
Excitation frequency	2-20kHz (adjustable with 1kHz steps)			
Transformation Ratio	The output voltage of the resolver has to be between 1,8V_{rms} and 4V_{rms}. Input voltage can be adjusted between 1.3V_{rms} and 7.5V_{rms}.			
Slots	C			
Encoder Simulation Output	A,B, Z (max. pulse frequency 150kHz)			

*tested in zero acceleration
Note: by selecting 16bit mode, you can improve only position accuracy. Velocity accuracy remains the same (14bit).

Encoder Simulation Pulses per Revolution and Maximum tracking rate depend on the number of resolver poles.
Simulated Pulses / rev = 2^R · Resolver_Poles / 8
R = Encoder simulation output resolution
Maximum tracking rate = (150 KHz / (Simulated Pulses / rev)) * 60 rpm = X rpm (X is maximum motor rpm).

2. CONFIGURATION

2.1 Board parameters and monitoring values

Monitor Menu

Number	Monitor	Unit	Description
7.3.2.1	Resolver Freq	Hz	Resolver Frequency
7.3.2.2	Resolver Speed	RPM	Resolver Speed
7.3.2.3	Sim. Pulses/rev	-	Simulated pulsed / revolution
7.3.2.4	Encoder 2 Freq	Hz	Encoder Frequency from secondary encoder
7.3.2.5	Encoder 2 Speed	RPM	Encoder Speed from secondary encoder

Parameters menu

Number	Parameter	Min	Max	Default	Description
7.3.1.1	Invert Direction	0	1	0	0 = No 1 =Yes
7.3.1.2	Reading Rate	0	4	1	0 = No 1 = 1 ms 2 = 5 ms 3 = 10 ms 4 = 50 ms

7.3.1.3	Exciting freq	0	19	0	0 = 10 kHz 1 = 20 kHz 2 = 1 kHz 3 = 2 kHz 4 = 3 kHz 5 = 4 kHz 6 = 5 kHz 7 = 6 kHz 8 = 7 kHz 9 = 8 kHz 10 = 9 kHz 11 = 11 kHz 12 = 12 kHz 13 = 13 kHz 14 = 14 kHz 15 = 15 kHz 16 = 16 kHz 17 = 17 kHz 18 = 18 kHz 19 = 19 kHz
7.3.1.4	Resolution	0	3	1	0 = 10 bit 1 = 12 bit 2 = 14 bit 3 = 16 bit
7.3.1.5	Resolver poles	0	9	0	0 = 2 pole 1 = 4 pole 2 = 6 pole 3 = 8 pole 4 = 10 pole 5 = 12 pole 6 = 14 pole 7 = 16 pole 8 = 18 pole 9 = 20 pole
7.3.1.6	Enc 2 Pulse/Rev	0	65535	1024	

7.3.2.3 Simulated pulses / rev is calculated on the basis of resolution bits(R) and resolver poles. The formula used is:

Simulated Pulses/rev = 2^R * Resolver poles / 8

.

Example:

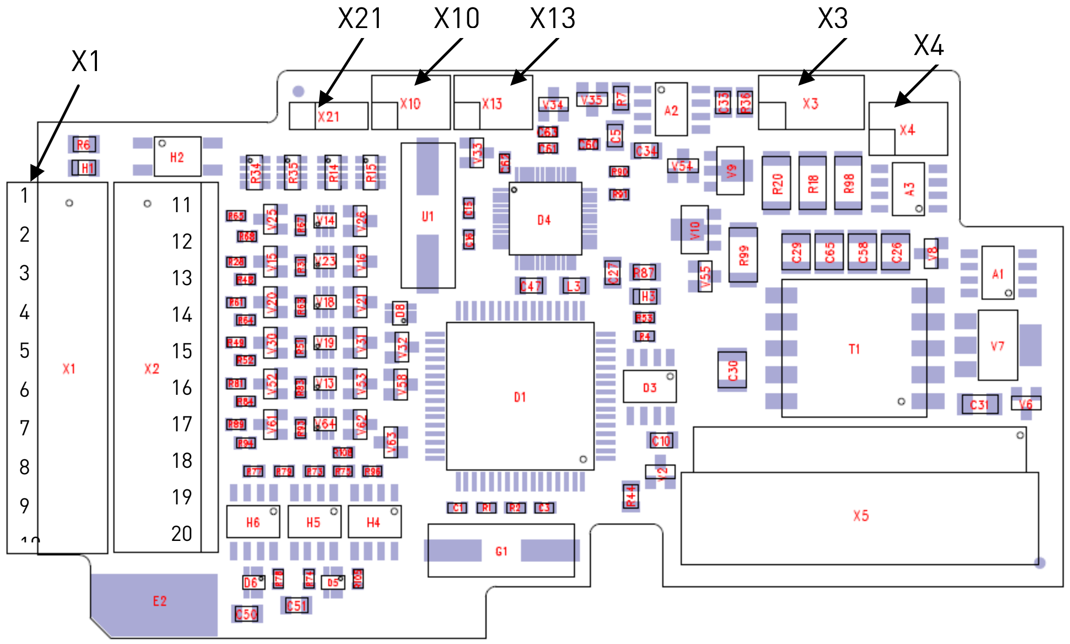
Resolution bits = 12

Resolver poles = 2

Simulated Pulses/rev = 2^12 * 2 / 8 = 1024

The absolute position value is from 0 to 4095 (2^12=4096).

2.2 Connectors and jumpers



Picture 2 Connector and pin header placement in OPT Board. Pin number 1 is marked with a small square on the X3, X4, X10, X13 and X21.

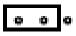
2.2.1 Terminal data for X1 and X2 connectors

PIN	Name	Description	Input/Output	Signal type
1	S4	SIN	Input	User specific
2	S2	SIN\		User specific
3	S1	COS	Input	User specific
4	S3	COS\		
5	R1	Excitation HI	Input	User specific
6	R2	Excitation LO		
7	Frz+	Freeze signal HTL+	Input	+/- 24V HTL
8	Frz-	Freeze signal HTL-		
9	ENC2_C+	Encoder input channel C	Input	+/- 24V HTL
10	ENC2_C-	Encoder input channel C\		
11	A	Encoder Simulation Output A	Output	+/- 24V HTL
12	A\	Encoder Simulation Output A\		
13	B	Encoder Simulation Output B	Output	+/- 24V HTL
14	B\	Encoder Simulation Output B\		
15	C	Encoder Simulation Output C	Output (please see description below)	+/- 24V HTL
16	C\	Encoder Simulation Output C\		
17	ENC2_A+	Encoder input channel A	Input	+/- 24V HTL
18	ENC2_A-	Encoder input channel A\		
19	ENC2_B+	Encoder input channel B	Input	+/- 24V HTL
20	ENC2_B-	Encoder input channel B\		

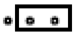
Encoder Simulation Output C depends from X21 (C-Pulse source selection). Encoder Simulation Output C is one of following:

- Incremental C-pulse (Zero pulse) to control board
- Freeze signal from FRZ input. In this case pin mapping is: 15=7, 16=8.

2.2.2 X21 (C-Pulse source selection)



Incremental C-pulse (Zero pulse) to control board (Default setting). This signal is constructed from the signals that are received from the resolver attached to the option board.



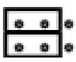
C-pulse is External. Read from FRZ input. This feature can be used with special applications for marking position data. Not supported in Standard NXP applications.

2.2.3 X10 and X13 (Gain selection)

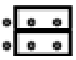
SIN and COS feedback signals from the resolver should be in the range of 1,8 – 4V_{rms} (between SINHI - SINLO and COSHI - COSLO). To scale the input signals to an acceptable level we can select ½, 1/3 or ¼ attenuation for the input lines. Following equation can be used to calculate output signal level. Transformation for the corresponding resolver is told in resolver datasheets.

EXC_OUT = excitation output voltage
SIN Feedback voltage = EXC_OUT * Transformation ratio

1/4 gain for SIN / COS feedback signals from 3,25 V_{rms} to 4V_{rms}



1/3 gain for SIN / COS feedback signals from 2,4 V_{rms} to 3,24V_{rms}



1/2 gain for SIN / COS feedback signals from 1,8 V_{rms} to 2,39V_{rms}

X13 sets SIN attenuation and X10 sets COS attenuation. SIN and COS input pairs should all have the same attenuation to keep signals symmetrical.

For example, a resolver that is rated for 5.6V_{rms} excitation and has a transformation ratio of 0.485 gives output voltage of 2.72V_{rms}. Excitation voltage and corresponding settings are selected from the table 1 in chapter 2.2.4. In this case exact match is found. Resolver output voltage of 2.72V V_{rms} fits to the signal range of 1/3 attenuation.

2.2.4 X3 and X4 Excitation Voltage Control

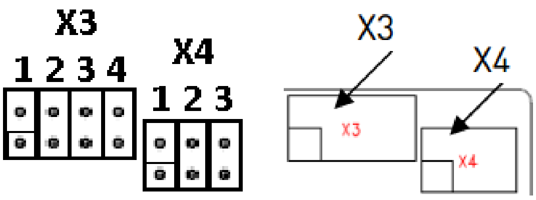
Resolver option board has an amplifier for adjusting excitation voltage. Jumpers X3-1-4 and X4-1-3 set the amplifier gain and consequently the excitation voltage. Excitation voltage can be set in the range of $1.3V_{rms}$ to $7.5V_{rms}$. To get the best possible accuracy, excitation voltage should be selected to be as high as the used resolver allows AND so that the output voltage fits to the given range.

Excitation frequency is set from the control panel and it should be set prior to connecting the resolver to the option board.

To set the excitation voltage accurately, measure the excitation voltage when resolver is connected. Notice that measurement device must be capable of measuring high frequency RMS voltage.

Typical excitation voltage for each jumper setting can be checked from the table, usable values are highlighted.

EXC_OUT = target excitation output voltage. This is specified in resolver datasheets (Excitation Voltage)



Now, set the calculated gain with X3 and X4 jumpers. Jumper settings for the desired gain can be found from table. All jumpers attached gives minimum gain and all jumpers open gives maximum gain. Maximum output voltage is limited to the boards internal voltages and is approximately $7,5V_{rms}$. Recommended voltage range is highlighted with blue.

X = Jumper installed

X3-1	X3-2	X3-3	X3-4	X4-1	X4-2	X4-3	EXC_OUT [Vrms] Typical
X	X	X	X	X	X	X	1,27
	X	X	X	X	X	X	1,34
X		X	X	X	X	X	1,43
		X	X	X	X	X	1,50
X	X		X	X	X	X	1,55
	X		X	X	X	X	1,62
X			X	X	X	X	1,71
			X	X	X	X	1,78
X	X	X		X	X	X	1,87
	X	X		X	X	X	1,94
X		X		X	X	X	2,02
		X		X	X	X	2,10
X	X			X	X	X	2,15
	X			X	X	X	2,22
X				X	X	X	2,30
				X	X	X	2,38
X	X	X	X		X	X	2,43
	X	X	X		x	X	2,50
X		X	X		X	X	2,58
		X	X		X	X	2,66
X	X		X		x	X	2,71
	X		X		X	X	2,78

X			X		X	X	2,86
			X		X	X	2,94
X	X	X			X	X	3,03
	X	X			X	X	3,10
X		X			X	X	3,18
		X			X	X	3,25
X	X				X	X	3,31
	X				X	X	3,38
X					X	X	3,46
					X	X	3,53
X	X	X	X	X		X	3,56
	X	X	X	X		X	3,64
X		X	X	X		X	3,72
		X	X	X		X	3,79
X	X		X	X		X	3,84
	X		X	X		X	3,92
X			X	X		X	4,00
			X	X		X	4,07
X	X	X		X		X	4,16
	X	X		X		X	4,23
X		X		X		X	4,31
		X		X		X	4,39
X	X			X		X	4,44
	X			X		X	4,51
X				X		X	4,59
				X		X	4,67
X	X	X	X			X	4,72
	X	X	X			X	4,79
X		X	X			X	4,87
		X	X			X	4,95
X	X		X			X	5,00
	X		X			X	5,07
X			X			X	5,15
			X			X	5,23
X	X	X				X	5,32
	X	X				X	5,39
X		X				X	5,47
		X				X	5,54
X	X					X	5,60
	X					X	5,67
X						X	5,75
						X	5,82
X	X	X	X	X	X		5,85
	X	X	X	X	X		5,93
X		X	X	X	X		6,01
		X	X	X	X		6,08
X	X		X	X	X		6,13
	X		X	X	X		6,21
X			X	X	X		6,29
			X	X	X		6,36
X	X	X		X	X		6,45
	X	X		X	X		6,52
X		X		X	X		6,61
		X		X	X		6,68
X	X			X	X		6,73
	X			X	X		6,80
X				X	X		6,89
				X	X		6,96

X	X	X	X		X		7,01
	X	X	X		X		7,08
X		X	X		X		7,17
		X	X		X		7,24
X	X		X		X		7,29
	X		X		X		7,36
X			X		X		7,45
			X		X		7,52

Table 1 Excitation voltage selection

2.2.5 Configuration example

Example Resolver Datasheet

Input Voltage (rms)	6.1 V @ 10 kHz
Transformation Ratio (+-5%)	0.485
Output Voltage	2.96V

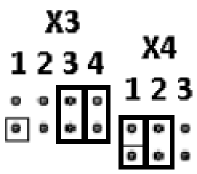
Step 1:

Check resolvers input voltage and select corresponding configuration for jumpers X3 and X4 from the table1.

->6,1 V (Use smaller Voltage from the table if exact match is not found = 6,08V)

X3-1	X3-2	X3-3	X3-4	X4-1	X4-2	X4-3	EXC_OUT [Vrms] Typical
		X	X	X	X		6,08

Set jumpers to X3-3, X3-4, X4-1 and X4-2:



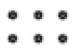
Step 2:

Find resolver output voltage from the datasheet or calculate it.

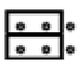
Output voltage = input voltage · transformation ratio.

Output Voltage = 6.08 · 0,485

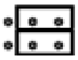
Output Voltage = 2,95 Vrms



1/4 gain for SIN / COS feedback signals from 3,25 V_{rms} to 4V_{rms}



1/3 gain for SIN / COS feedback signals from 2,4 V_{rms} to 3,24V_{rms}



1/2 gain for SIN / COS feedback signals from
1,8 V_{rms} to 2,39V_{rms}

If Output voltage is higher than 4V_{rms} -> Lower the excitation voltage.

->Use 1/3 gain

Step 3:

Configure board using the control panel. (Software configuration)

7.3.1.1 Invert Direction ->This parameter can be used for inverting rotation direction

7.3.1.2 Reading Rate -> Default 1ms. In noisy environments this parameter can be used to filter disturbances. Set first to 5ms if the shaft is not running smoothly.

7.3.1.3 Exciting freq -> Select the Exciting frequency as told in specification

->In this example 10kHz

7.3.1.4 Resolution ->Default 12bit ->In slow Speed applications high Resolution can be used.

Planned Max Speed in Example is 1500rpm

Select highest possible accuracy ->16 bit

(16bit) = 7500rpm · 2 / Resolver_Poles

7.3.1.5 Resolver poles = 2 poles

3. INSTALLATION

WARNING!	*Internal components and circuit boards are at high potential when the frequency converter is connected to the power source. This voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.*

3.1 Installing the option board

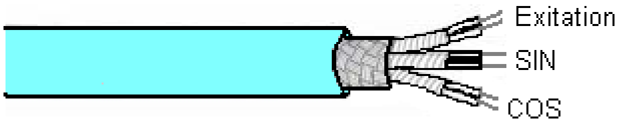
Following installation guidelines should be followed carefully to get the best performance of the system. Improper installation of the system might cause to disturbances which may in RTD conversion generate extra encoder pulses or jitter to the pulse lengths.

Since the board supports large variation of resolvers, the used resolver should always be verified before installation.

The option board OPT-BC can only be used with Vacon **NXP** drives.

The option board OPT-BC can be connected to **slot C**.
Disconnect the drive from the mains before starting the installation.

A	Vacon NXP frequency converter	
B	Remove the cable cover.	
C	Open the cover of the control unit.	

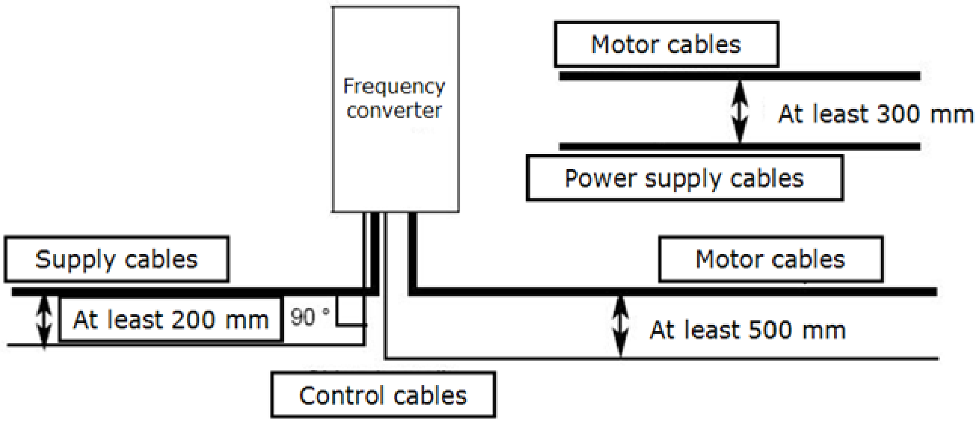
D	Install the option board in slot C on the control board of the frequency converter. Make sure that the grounding plate fits tightly in the clamp. Strip the cable at such distance from the terminal that you can fix it to the frame with the grounding clamp. **Note!** Vacon recommends to use always shielded twisted pair cables with resolvers. Use cables that are recommended for encoder and resolver feedback. Do not mix signals in twisted pairs.  Always make earthing contact throughout the full circumference of the cable (**360°**) Only remove the resolver cable's outer insulation where required. The cable is weakened where the shield is removed.  **Note!** Usually the cable shield is earthed only to the drive. Usually earthing in the engine end of the cable is not made.
E	Make a sufficiently wide opening for your cable by cutting the grid as wide as necessary. 
F	Close the cover of the control unit and the cable cover. 

3.2 Installing the resolver

Connect the resolver after setting the jumpers. Use cable clamp in the lower part of the NXP drive to connect cable shield. Strip the cable so that the shield is exposed only from the part that is fitted to the clamp.

3.3 Additional cabling instructions

The resolver and other control cables should not be in parallel with power cables (supply and motor cable).



The feedback signals might also suffer from the noise coming from motor and supply cables. Use shielded symmetrical motor cables. It is recommended to connect the motor cable shield with 360° emc bushing. The motor and supply cables should not be in parallel with resolver signal cable.

4. DIAGNOSTICS AND TROUBLESHOOTING

The panel shows in the G7.3 that board is OPT-BC. Monitor values from 7.3.2 shows:

7.3.2.1 Resolver Freq (Hz)
7.3.2.2 Resolver Speed (Rpm)
7.3.2.3 Sim. Pulses/rev
7.3.2.4 Encoder 2 Freq
7.3.2.5 Encoder 2 Speed

Parameter values from panel index 7.3.1

7.3.1.1 Invert direction
7.3.1.2 Reading rate
7.3.1.3 Exciting freq (10 / 20 kHz)
7.3.1.4 Resolution bits(10 / 12 bits)
7.3.1.5 Resolver Poles
7.3.1.6 Enc 2 Pulse / Rev

7.3.2.3 Simulated pulses / rev is calculated on the basis of resolution bits(R) and resolver poles. The formula used is *Simulated Pulses/rev =* 2^R ** Resolver poles / 8*.
Example:
Resolution bits = 12
Resolver poles = 2
Simulated Pulses/rev = 2^12 * 2 / 8 = 1024

Lower resolution is used in high speed applications. In 10bit mode the resolver sends 256 pulses / revolution and in 12 bit mode 1024 pulses / revolution, if resolver's poles = 2 .

The absolute position value is from 0 to 4095 (2^12=4096).

4.1 LED indicators

There are two LED indicators in the option board:

Yellow LED: The Processor LED (The status of the processor)

LED is:	Meaning:
OFF	Option board not activated
Blinking	Run State

Red LED: The R/D converter LED (The status of the R/D converter)

LED is:	Meaning:
OFF	OK
ON	Fault

Fault conditions:

- Abnormal sensor Error

- Abnormal R/D conversion

Only way to reset the red LED, is to recalculate jumper settings and do a power up cycle.

Find your nearest Vacon office
on the Internet at:

www.vacon.com

Manual authoring:
documentation@vacon.com

Vacon Plc.
Runsorintie 7
65380 Vaasa
Finland

Document ID:
DPD01362A
Rev. A