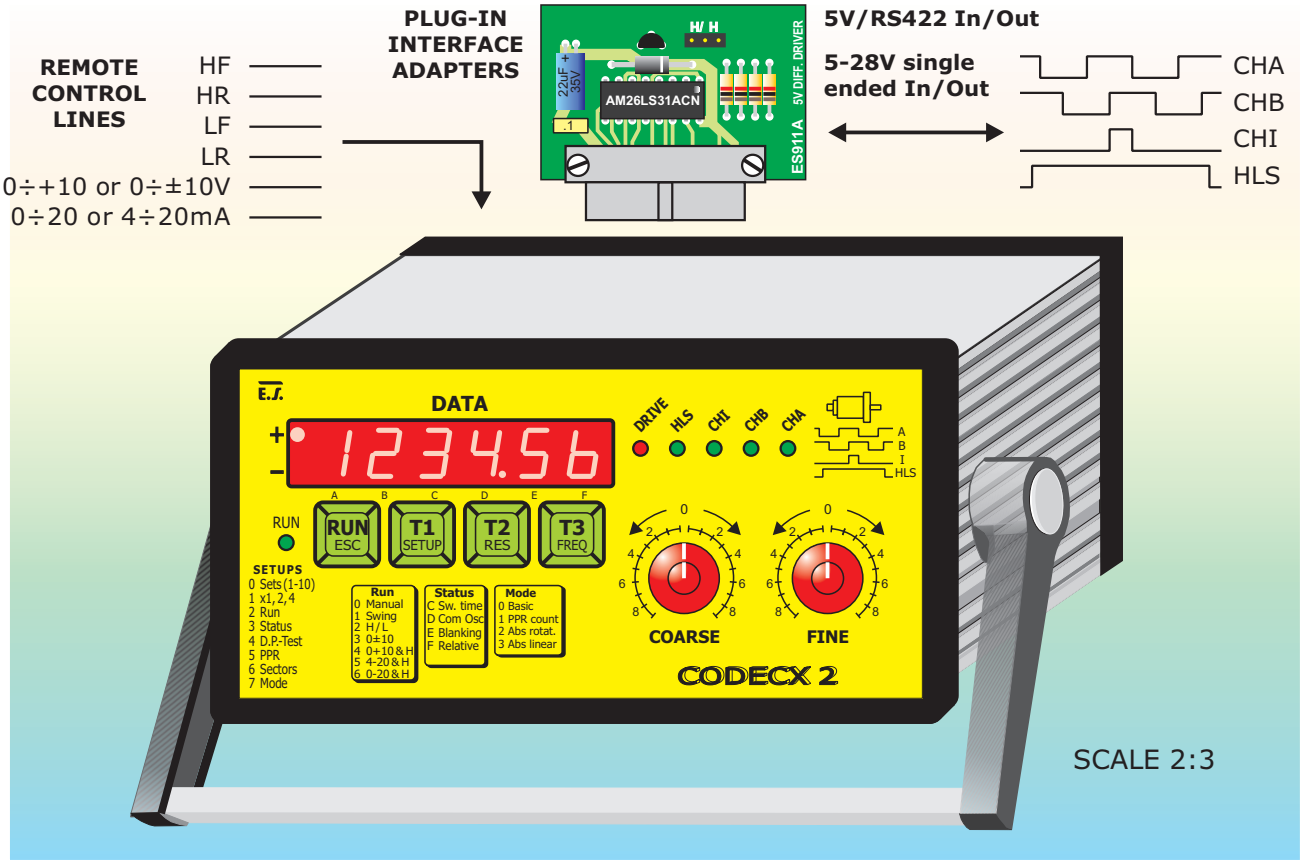
QUADRATURE ENCODER SIMULATOR

AXIS SIMULATOR PPR COUNT

CODECX 2.0

GENERATOR AND READER

UP TO 610KHz FOR LAB, PRODUCTION AND FIELD



The basic function is to manage the quadrature signals **CHA, CHB**, along with the index mark **CHI**.
Enhanced operations in Absolute Positioning mode include the signal **HLS** (Home Limit Switch) in order to determine the exact position of the home point.

Featuring:

- 10-decade-long position counter. 6-digit LED display plus sign. **Position** or **Frequency readout**.
- 340-step gear-box covering the ranges **0-80Hz**, the slowest, to **5Hz- 622Khz**, the fastest.
- 7 running mode:
  2 Local Control modes with the two knobs, for coarse and fine regulation and
  5 Remote Control modes through 0+10 or ±10V, 0÷20 or 4÷20mA analogic lines and four 24Vdc On/Off optoisolated lines: HF, LF, HR, LR (High/Low speed, Forward/ Reverse).
- **Soft** start and stop on running code 2.
- 9 configuration sets stored in eeprom. **4 -16384 PPR** rate. Basic quadrature. Pseudo-absolute position linear and rotatory. Relative positioning. PPR count. Selectable Decimal Point. Blanking capability.
- Full digital **Quadrature Active Filter**. Other than tracking the motion, the unit warns for High Frequencies , Common Mode transitions and Oscillations. Performs also the Quadrature Decoding x1, x2, x4.
- Set of plug-in **Interface Adapter** cards to be inserted on a back socket in order to determine the generator/ receiver mode and the operating voltage.
- Powered with **24Vcc/0.8A** through a 5.5/2.5mm pin Jack or screw terminals.
- **Table** top or **Panel** mount.
  Please, read MyQuadratureWorld.pdf for glossary and "how it works".

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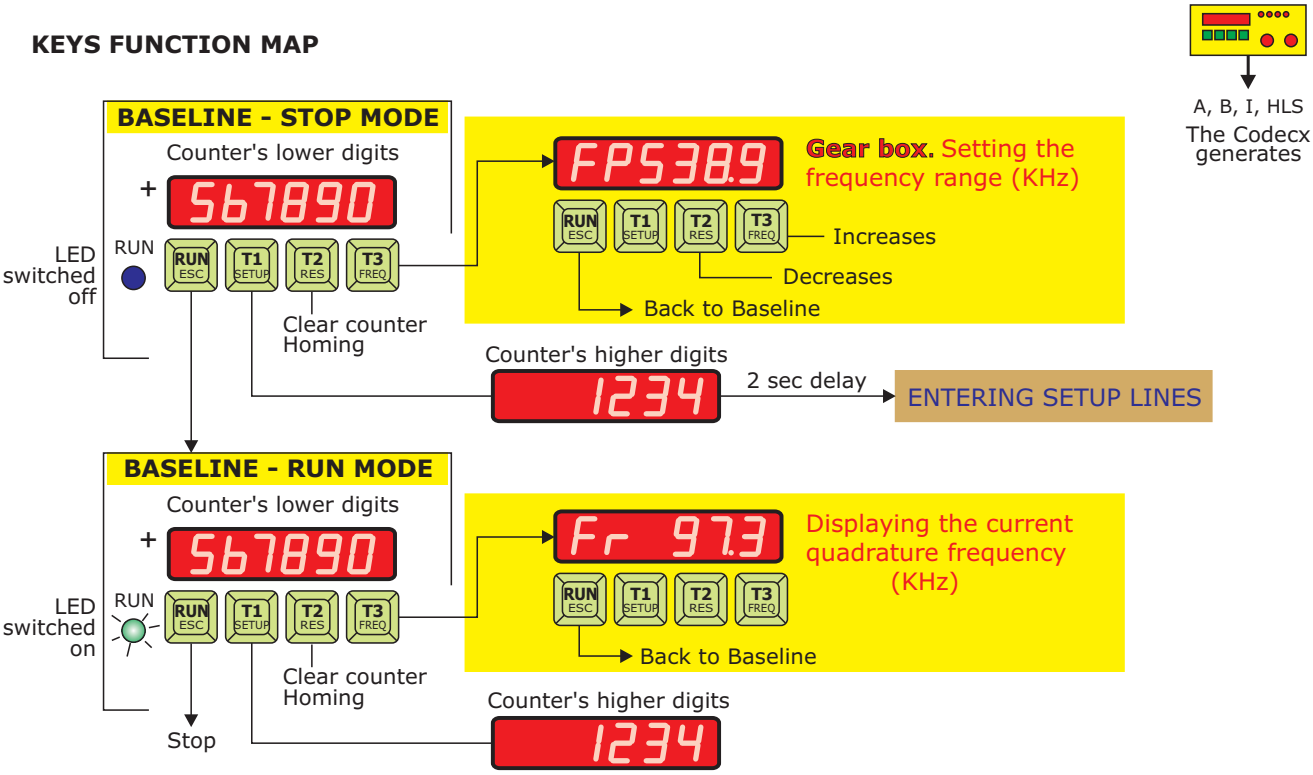
KEYS FUNCTION MAP



The assigned functions of the keys are:
From **BASELINE - STOP MODE**
- **RUN**: enabling the generator. While pressing the key, the running code being started is displayed.
- **T1**: entering the **setup lines** by holding it pressed for 2 sec. During the waiting time the 4-higher digits of the position counter are displayed.
- **T2**: clearing the counter, homing the axis and cancel the warning flags. CHA, CHB and CHI are set high. HLS goes also high when in pseudo- absolute mode.
- **T3**: selecting the frequency range. The generator run at top speed while T2 and T3 select the gear. No receiving interface card must be inserted.

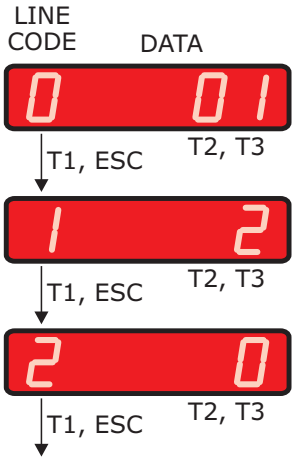
From **BASELINE - RUN MODE**
- **RUN**: stopping running.
- **T1**: temporarily display the 4-higher digits of the position counter.
- **T2**: clearing the counter, homing the axis and cancel the warning flags. CHA, CHB and CHI are set high. HLS goes also high when in pseudo- absolute mode.
- **T3**: Displaying the current quadrature frequency, in KHz (while the counter is still tracking the position).

LEDS FUNCTION

RUN - When switched off the unit is in STOP mode: the generator is inhibited. When lights, the unit is ready to receive the driving commands.
DRIVE - When switched off there are no signals for running: Either the unit is in the Stop mode or there are no driving commands. (Refer to RUN Commands on the following pages).
HLS - Simulates the Home Limit Switch. Active in pseudo-absolute mode only. Lights when the line is high at connector CN6. It lasts one complete encoder tour centered on CHI mark. (The PPR rate is programmed on line 5).
CHA, CHB and CHI - Light-up when the lines are high at connector CN6.

SETUPS

T1 key enters setups (with a waiting of 2 sec) and increases the lines. RUN key skips to baseline. The line code is on the left. T2 key decreases and T3 key increases the data if not otherwise specified. Please, see also the "Training on Codecx" chapter for further instructions.

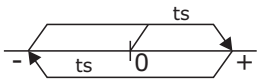


Line 0 - Sets - Allows to store up to 9 configurations. From 01 to 09. Every set includes the setup lines from 1 to 7, plus the speed.

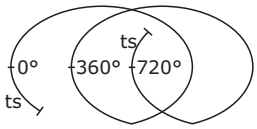
Line 1 - QD, Quadrature Decoding - Select 1, 2, 4 for the resolution multiplier.

Line 2 - Running Code - Active as generator only. Ignored when receiving.

0 - Local control with the two potentiometers on the front panel. Turn right for forward motion and left for reverse. The COARSE one weights 82% and the FINE 18% of the total. The ramp of 1 sec minimum is inherent to this code.



Linear swinging diagram



Rotatory swinging diagram

1 - Swing, local control. The bit F on line 3 should be 0.
Swinging on linear mode (line 7=0 or 3) - The Codecx simulates a back and forth motion centered at position zero. Starts and inversions are smoothed by a 320ms ramp. The inverting positions are not sharp since they are reached by a timer, with an inaccuracy of 10msec. The speed is given by the potentiometer Coarse, only on the positive half. The minimum speed is 3.4% of the maximum even if the pot is at 0. The first motion is always positive. There is a stop of a couple of seconds at every inversion, just enough to compare the position with the reader being fed. The time of the swing is set on line 3 digit C. It starts elapsing at zero crossing of the axis. The swinging frequency ranges from 1Hz, the minimum of the lowest gear, to 610KHz, the top gear. The routine is being repeated indefinitely.

Swinging on rotatory mode (line 7=2) - The Codecx starts cycling from 0°. After two revolutions applies the time and stops. Then reverses the motion until 0° and again applies the time before stopping. The routine is being repeated indefinitely.

2 - Remote control through the four on/off lines enabling local Coarse and Fine pots. The activation voltage is +24Vdc/7.5mA with respect COMI. On this particular mode a programmable up/down ramp is applied to he motion. See page 7 for details.

3 - Remote control through 0±10V. Both speed and direction are given by the voltage signal: positive is forward, negative reverse. See page 8 for details.

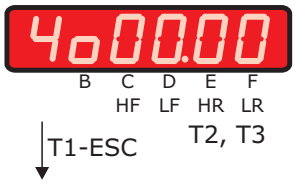
4 - Remote control through 0+10V and HF or HR. The speed is given by the voltage signal and the direction by HF or HR. See page 8 for details.

5 - Remote control through 4-20mA and HF or HR. The speed is given by the current signal and the direction by HF or HR. See page 8 for details.

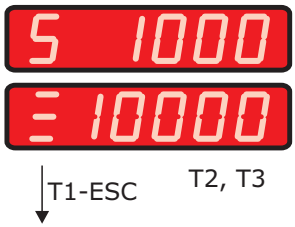
6 - Remote control through 0-20mA and HF or HR. The speed is given by the current signal and the direction by HF or HR. See page 8 for details.

Line 3 - Status - T2 is the cursor, T3 toggles data. DP indicates the selected bit.

B - Up/down slew rate ramp of running code 2. 1-9 seconds to full speed.
C - Swinging time of running code 1. 1-9 seconds.
D - Warnings C.t. and O.L. (COMmon mode transition and OSCillation).
0 The events are managed by the quadrature filter but not signaled.
1 The events are managed and signaled.
E - Blanking
0 The display is always lighted.
1 The display is blanked when running.
F - Clearing
0 The position is cleared with T2 key and with remote lines HF+HR.
1 The position is also cleared at every start from remote control mode (running codes 2 to 6), implementing the **Relative positioning**. Applies to basic quadrature generator only (line 7, mode 0).



Line 4 - D.P. and On/Off inputs test.
D.P. position is set with keys T2 and T3.
Inputs test: the digits turn to 1 when the corresponding input goes to +24V.
HF High speed forward
LF Low speed forward
HR High speed reverse
LR Low speed reverse



Line 5 - PPR setting. (Pulse Per Revolution).
Value ranges from 4 to 16384. The 5 (number of the line) switches to tree lines when the the PPR value grows to five digits.
Note:
Just keep in mind that one pulse includes 4 transitions. So, at QD=1 (line 1) the CHI LED, in the front panel, blinks every 1000 counts (if PPR where set to 1000), at QD=2 every 2000 counts, at QD=4 every 4000 counts. This may be confusing at the first sight. Suggestion is to set QD=1 when using CHI.
See also "note on quadrature frequency" page 11.

Line 6 - Number of sectors. Are the encoder tours or index marks per one full rotation. Applies to the rotatory pseudo-absolute axis only. Value range from 1 to 100. This parameter tells the uP when to produce the HLS signal. If only a single sector is programmed, the HLS signal is not released. See page 13.

Line 7 - Operating Mode

0 - CHA, CHB, CHI encoder simulator. **Basic quadrature counting mode.** CHI is ignored by the system. The endless counter reaches ±2-billion counts and circles again. The position is not saved. Relative positioning allowed. On receiving, behaves as basic quadrature readout.
1 - PPR Counting. The Codecx counts the PPR generated by its own or those received by an external encoder. Up to 2-billion-pulse capacity. See also page 14 point 6. Frequency reading and the gear-box are inhibited.
2 - Rotatory pseudo-absolute encoder simulator - Homing. Generator and receiver. CHA, CHB, CHI and HLS (Home Limit Switch) signals are involved. See notes.
3 - Linear pseudo-absolute encoder simulator - Homing. Generator and receiver. CHA, CHB, CHI and HLS signals are involved. The axis is ± 2-billion-count wide. As the limits are reached the counting stops and the sign E.4. is issued. See notes.
Notes - The position counter, the index position, the HLS status and channels' levels are saved at power off and retrieved at power on **simulating a real absolute positioning encoder.** See page 12 for waveform and speed.
- Read also "note on quadrature frequency" page 11.

GENERATOR

MODE 0		QD	RUN mode	B	C	D	E	F	TEST	PPR	SECTORS
SETUP LINES -	**1**: 1,2,4 /	**2**: 0-6 /	**3**: 1-9	1-9	0	0-1	0-1 /	**4**: D.P. Inputs/	**5**: 4-16384 /	**6**: X	/ **7**: 0
REMARKS -	The Codecx issues **CHA**, **CHB**, **CHI** although CHI is ignored by the internal counter.										
MODE 1			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1	/ **2**: 0-6 /	**3**: 1-9	1-9	0	0-1	0 /	**4**: X	Inputs/ **5**: 4-16384 /	**6**: X	/ **7**: 1
REMARKS -	The Codecx issues **CHA**, **CHB**, **CHI** and counts its own PPR.										
MODE 2			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1*	/ **2**: 0-6 /	**3**: 1-9	1-9	0	0-1	0 /	**4**: D.P. Inputs/	**5**: 4-16384 /	**6**: 1-100/	**7**: 2
REMARKS -	The Codecx issues **CHA**, **CHB**, **CHI, HLS**. When line 6=1 HLS isn't issued.										
MODE 3			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1*	/ **2**: 0-6 /	**3**: 1-9	1-9	0	0-1	0 /	**4**: D.P. Inputs/	**5**: 4-16384 /	**6**: X	/ **7**: 3
REMARKS -	The Codecx issues **CHA**, **CHB**, **CHI, HLS**.										

RECEIVER

MODE 0			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1,2,4 /	**2**: X	/ **3**:	X	X	0-1	0-1	0 /	**4**: D.P. X	/ **5**: X	/ **6**: X / **7**: 0
REMARKS -	The Codecx uses **CHA**, **CHB** only. CHI is ignored if present.										
MODE 1			digit	B	C	D	E	F			
SETUP LINES -	**1**: X	/ **2**: X	/ **3**:	X	X	0-1	0-1	0 /	**4**: D.P. X	/ **5**: X	/ **6**: X / **7**: 1
REMARKS -	The Codecx uses **CHA**, **CHB**, **CHI**.										
MODE 2			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1*	/ **2**: X	/ **3**:	X	X	0-1	0-1	0 /	**4**: D.P. X	/ **5**: 4-16384	/ **6**: 1-100/ **7**: 2
REMARKS -	The Codecx uses **CHA**, **CHB**, **CHI, HLS**.										
MODE 3			digit	B	C	D	E	F			
SETUP LINES -	**1**: 1*	/ **2**: X	/ **3**:	X	X	0-1	0-1	0 /	**4**: D.P. X	/ **5**: 4-16384	/ **6**: X / **7**: 3
REMARKS -	The Codecx uses **CHA**, **CHB**, **CHI, HLS**.										

X=don't care
* See note at PPR setting line page 5

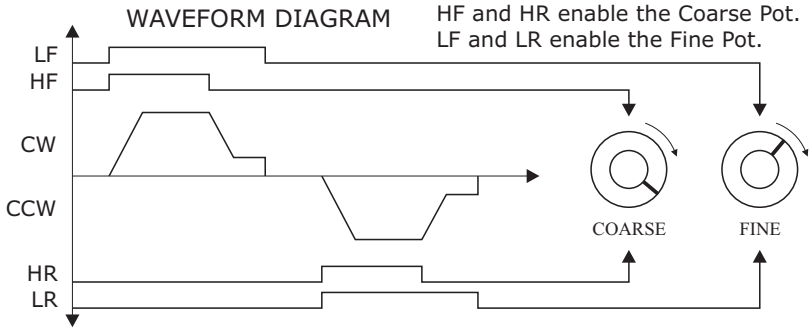
CHART OF SETTINGS FOLLOWING THE OPERATING MODE

REMOTE CONTROL CODE 2

THE CODECX GENERATES THE QUADRATURE SIGNALS DRIVEN BY THE ON/OFF LINES FOR THE DIRECTION AND THE POTENTIOMETERS ON FRONT PANEL FOR THE SPEED

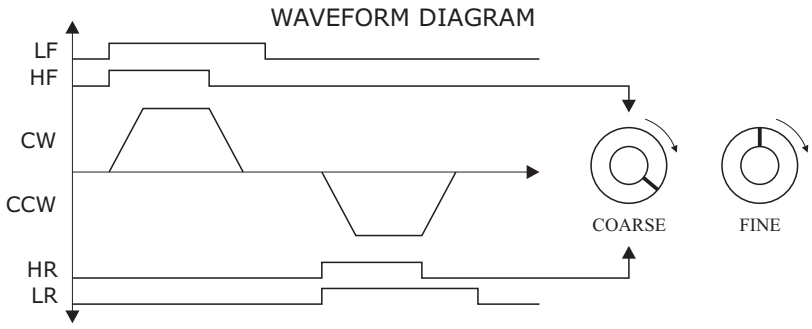
TRUTH TABLE

HF	LF	HR	LR	Functions
X	0	X	0	Stop
1	1	0	0	CW Coarse + Fine Pots
0	1	0	0	CW Fine Pot
0	0	1	1	CCW Coarse + Fine Pots
0	0	0	1	CCW Fine Pot
1	0	1	0	Clear Counter

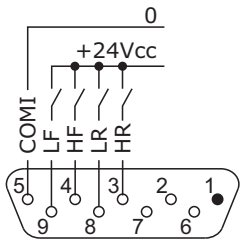


The generator applies the slope programmed on line 3 digit B, but stops abruptly when the low speed command switches off. Use the right half of the pots only.

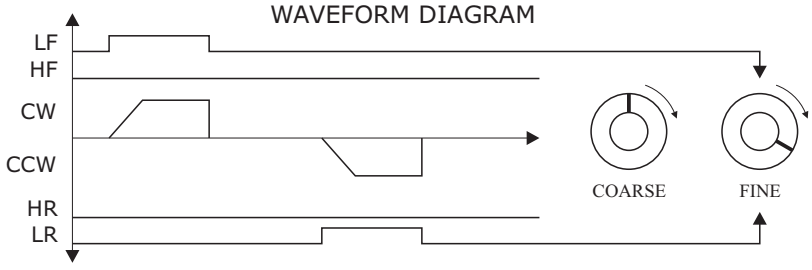
HF = High speed Forward
LF = Low speed Forward
HR = High speed Reverse
LR = Low speed Reverse



For the slope down to zero set the FINE pot at 0.



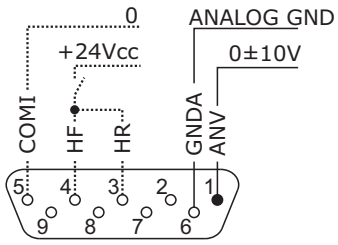
CONNECTIONS AT CN2



Using the pot FINE only for abrupt stop.

REMOTE CONTROL CODE 3

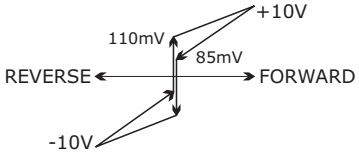
THE CODECX GENERATES THE QUADRATURE SIGNALS DRIVEN BY THE 0±10 ANALOG SIGNAL.



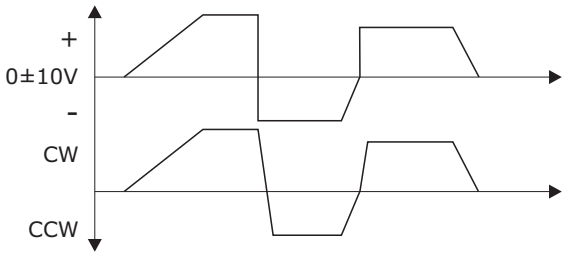
CONNECTIONS AT CN2

TRUTH TABLE

0±10V	Functions
<±85mV	No Drive
>+110mV	Forward
>-110mV	Reverse



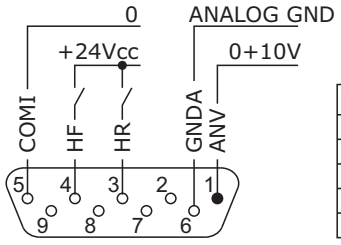
WAVEFORM DIAGRAM



- The typical drive level is 110mV and the hysteresis loop is 195mV. The input impedance is 10K. The incoming analog signal is conditioned by an 1V/msec integrator. The suggested worst case input is 15Hz, square wave, ±10V. - HF and HR both high clear the counter.

REMOTE CONTROL CODE 4

THE CODECX GENERATES THE QUADRATURE SIGNALS DRIVEN BY THE 0+10V ANALOG SIGNAL. THE DIRECTION IS DONE BY HF AND HR ON/OFF LINES.

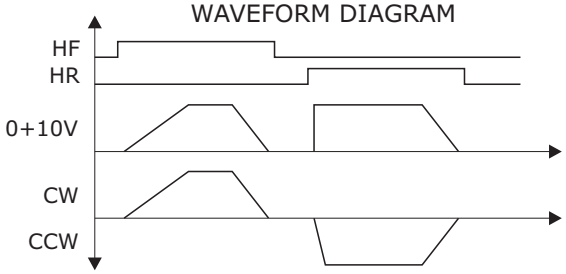


CONNECTIONS AT CN2

TRUTH TABLE

0+10V	HF	HR	Functions
X	0	0	No Drive
<+85mA	X	X	No Drive
>+110mV	1	0	Forward
>+110mV	0	1	Reverse
X	1	1	Clear Counter

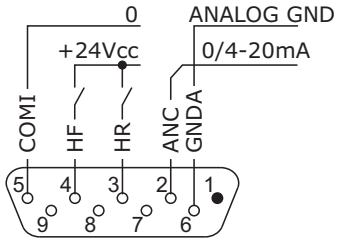
WAVEFORM DIAGRAM



Impedance, integrator and drive level (positive side only) are those described above for code 3. To **reverse the motion** switch off HF or HR lines first and wait at least 20msec before enabling the inversion.

REMOTE CONTROL CODE 5 & 6

THE CODECX GENERATES THE QUADRATURE SIGNALS DRIVEN BY 4-20mA (CODE 5) OR BY 0-20mA (CODE 6) ANALOG SIGNAL. THE DIRECTION IS DONE BY HF AND HR ON/OFF LINES.

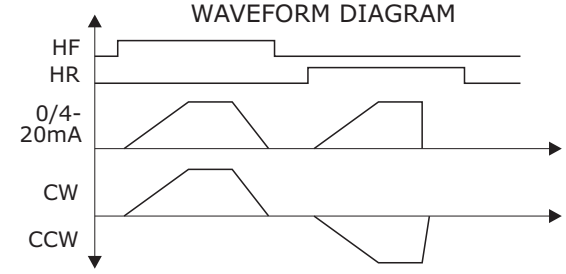


CONNECTIONS AT CN2

TRUTH TABLE

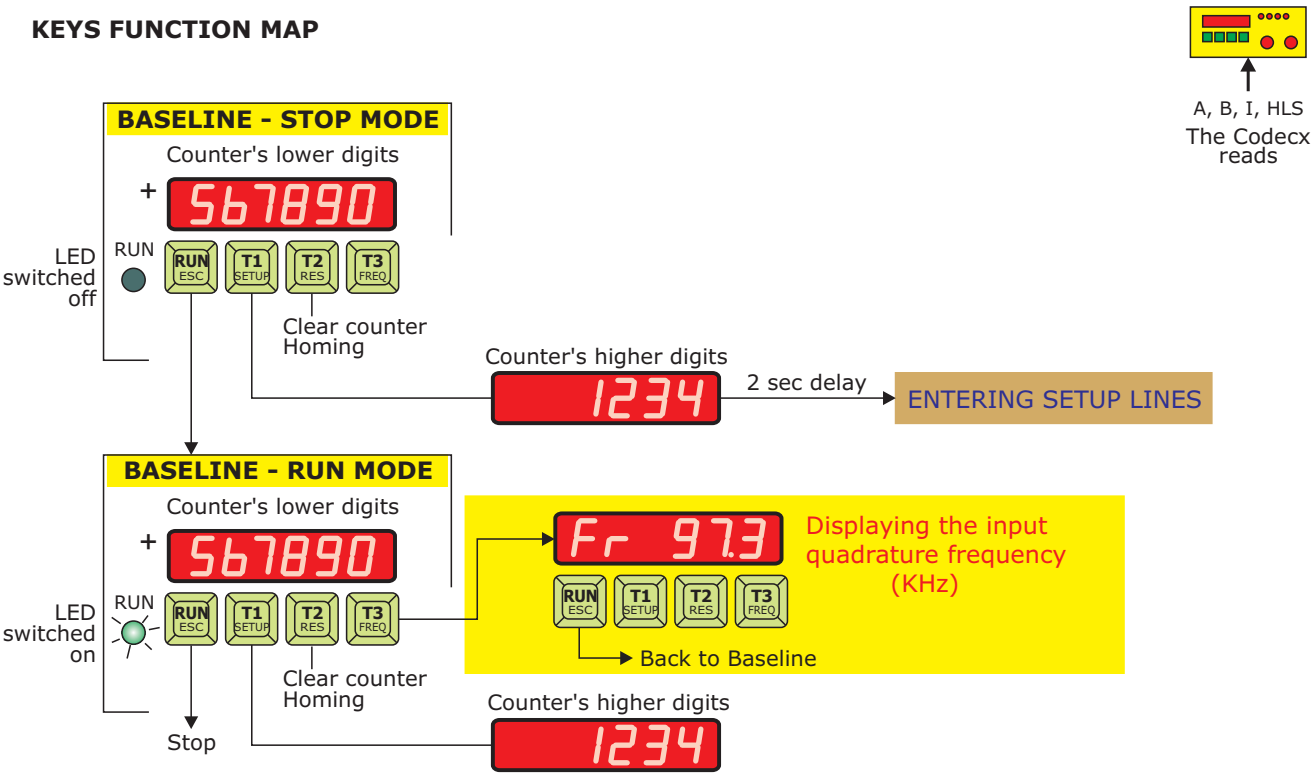
0/4-20mA	HF	HR	Functions
X	0	0	No Drive
<0.19/3.98	X	X	No Drive
>0.2/3,99	1	0	Forward
>0.2/3,99	0	1	Reverse
X	1	1	Clear Counter

WAVEFORM DIAGRAM



The impedance is 100 Ohm. The incoming analog signal is conditioned by an 1V/msec integrator. To **reverse the motion** switch off the direction line first and wait at least 20msec before enabling the inversion.

KEYS FUNCTION MAP



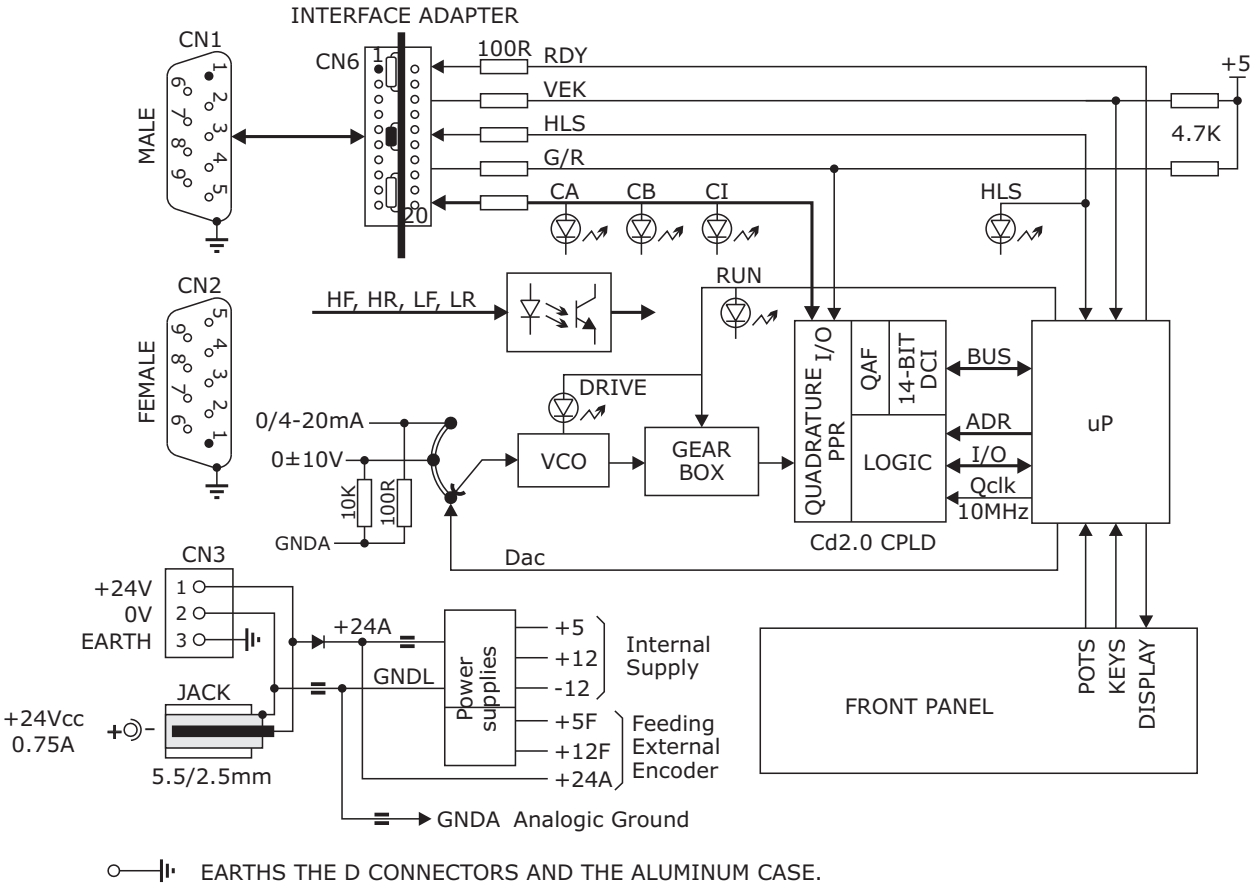
The assigned functions of the keys are:
From **BASELINE - STOP MODE**
- **RUN**: enabling receiving. While pressing the key, the word **InPut** is displayed.
- **T1**: entering the **setup lines** by holding it pressed for 2 sec.
- **T2**: clearing the counter.

From **BASELINE**, **RUN MODE**
- **RUN**: stopping receiving.
- **T1**: temporarily display the higher 4 digits of the position counter.
- **T2**: clearing the counter.
- **T3**: Displaying the incoming quadrature frequency, in KHz (while the counter is still tracking the position).

LEDS FUNCTION

RUN - When off the unit is in STOP mode: the receiver is inhibited. When on the receiver is enabled.
DRIVE - Has no function. It is always off. When receiving there are no driving commands.
CHA, CHB, CHI and HLS - Light-up when the lines at connector CN6 are high.

BLOCK DIAGRAM

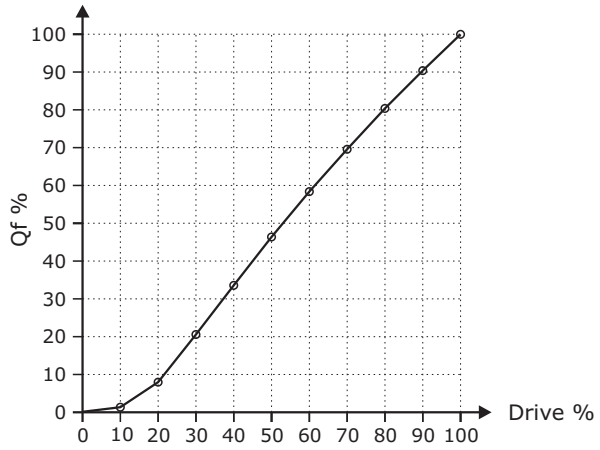


SHORT DESCRIPTION

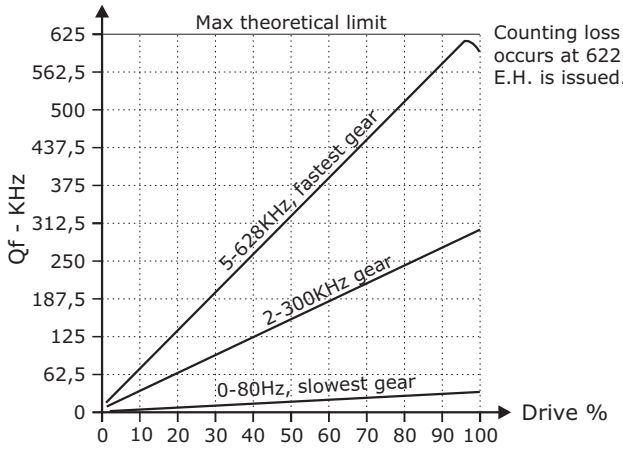
The VCO (Voltage Controlled Oscillator) feeds the Quadrature Generator through the Gear Box. The VCO is enabled when the LED RUN is on. The LED DRIVE lights (motion enabled) when LED RUN is on and the VCO input is higher than 110mV. The QAF (Quadrature Active Filter) receives CHA and CHB from the Quadrature Generator if the device operates a generator (signal G/R left open) or from the field if operates as receiver (signal G/R grounded). QAF produces the Count Enable and U/D signals to the DCI which transfers the counting to the uP. QAF takes care of the Quadrature Decoding (x1, x2, x4) and produces warnings such as E.H. (High frequency error) C. t. (Common Mode Transition) and O.L. (Oscillation).
When operating in generator mode, the motion can be activated locally by the two potentiometers (simulation of an encoder) or remotely by the control lines HF, HR, LF, LR and/or the analog voltage and current lines (simulation of an axis).
The generator/receiver mode is determined by the interface adapter inserted on CN6. ES911A, D and E live G/R open, thus, the Codecx behaves as a generator. ES911B and C ground G/R, so, the Codecx becomes a receiver. With no card inserted the Codecx is a generator for itself.
The management of the quadrature frequency of 610KHz is easy achieved with the slowest components available: the CPLD is an Altera EPM7128C84-15 compiled in Slow Slew Rate mode and the uP is an 8-bit general purpose application, both clocked at 10MHz.

GEAR-BOX - MISCELLANEOUS

The gear-box is a 340-step, mixed logic/analogic divider between the VCO and the quadrature generator. The speeds are spaced of 2-3 % approximately. The slowest reaches 80Hz, the fastest 628KHz. In the latter case the counting quadrature filter issues an E.H. error at 622KHz meaning that it is unable to manage frequencies beyond that limit. It is somehow a condition for testing the E.H. error.
- **ACCESS** - Remove any receiving interface adapter (ES911B, C), switch LED RUN off, if necessary, with key RUN and press T3. The sign FP appears, meaning that the gear-box is open. Use T2 and T3 to select the frequency range. **LEAVE** with key RUN.



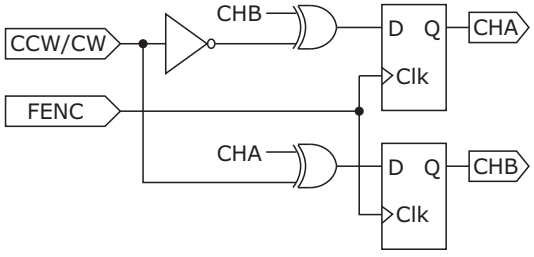
DRIVE AND Qf RELATIONSHIP



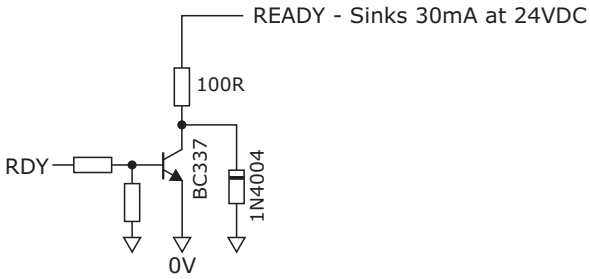
COUNTING BEHAVIOR

Note on Quadrature Frequency
When operating in pseudo-absolute mode (run mode 2 and 3 of setup line 7), the uP needs an extra time and space to map and synchronize the absolute position. For this reason the quadrature frequency, generated or received, must not exceed 1/10th of the setting of line 5. In other words, if the PPR where set to 1000, the frequency should run below 100Khz. E.I. sign is issued if the CHI's strobe are too close each other.

Qfmax - The equation Qfmax=Qclk/16 states that the maximum quadrature frequency allowed is 1/16 the clock frequency on the CPLD, in our case 10000/16=625KHz. This apply for quadrature signals exactly 90° out of phase. The real Qfmax on Codecx 2.0 is 622KHz (tested in generator run mode 3, ±10V). Since other factors may lower the limit, such as unbalance delays on transmission chain, the value of 610KHz is considered the Qfmax for this unit.



SCHEMATIC OF THE QUADRATURE GENERATOR

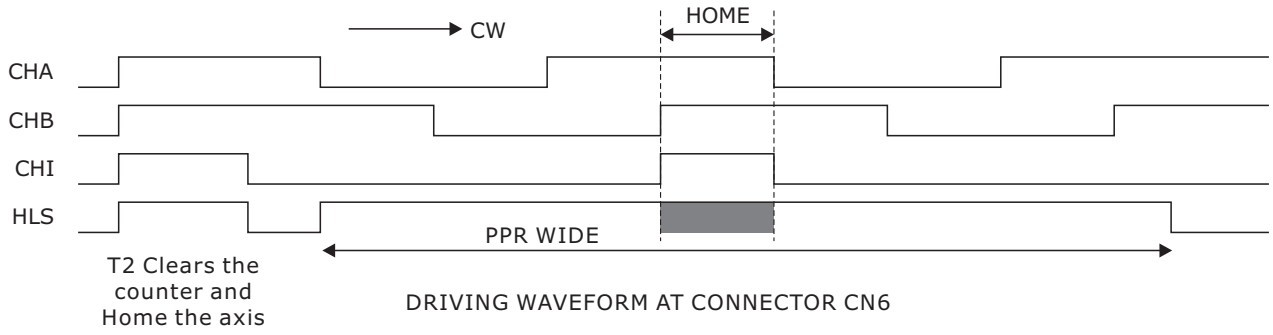


SCHEMATIC OF "READY" OUTPUT SIGNAL

MISCELLANEOUS
- The code of the unit appears for 2 sec at power up. In our case Cod 2.0
- Default data are loaded holding down T2 at power up until the end of the count down, when the display blanks for a while. See page 29 for default values chart.

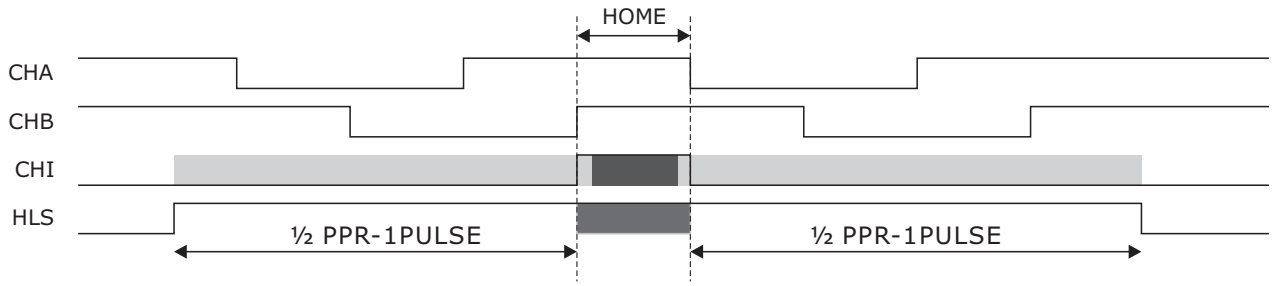
HOMING

- Generator. CHA, CHB and CHI are issued by the PLD. HLS is generated by the uP, only at pseudo-absolute mode either rotatory or linear. At reset (key T2) CHA and CHB go high (positive logic). CHI is an AND between CHA and CHB, when the PPR counter acknowledges. HLS is one-PPR wide positioned across the Home section. Generate by the uP and updated every 5msec it may fall ±5msec out of synchronism. For this reason Qf must be kept lower than PPR/10 to guarantee that HLS will overlap the Home section. (Example: For PPR=1000 the Quadrature frequency should stay lower than 100KHz. In any case, E.I. sign is issued when Qf is too high).
For complete understanding of the matter, please download the .pdf on Pseudo-Absolute encoder chapter.



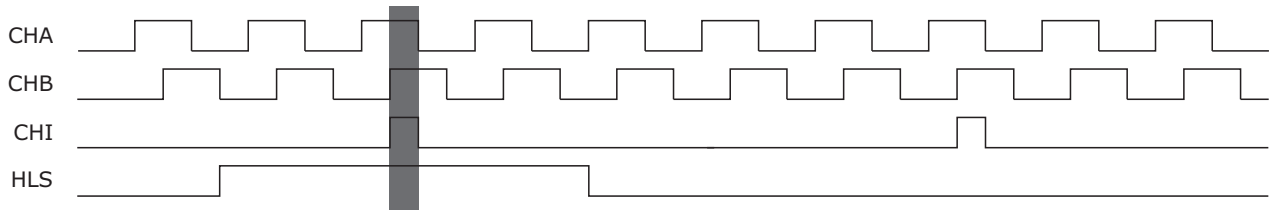
DRIVING WAVEFORM AT CONNECTOR CN6

- Receiver. To detect the homing point the four signals have to stay all stable high for at least 3 Qclk cycles. In our case 300ns. The quadrature channels (CHA and CHB) may reach 610KHz as long as the period between Indexes stays over 5ms; (One index strobe per 5msec max. For rotatory encoder that means12000RPM max). The minimum width of CHI is 3Qclk cycles, (dark grey section below), while the maximum is 3/4 of a pulse each side (light grey section). As far as HLS is concerned, it must stay high from just to cover the Home section to 1/2PPR less 1 pulse before and after across the home point.



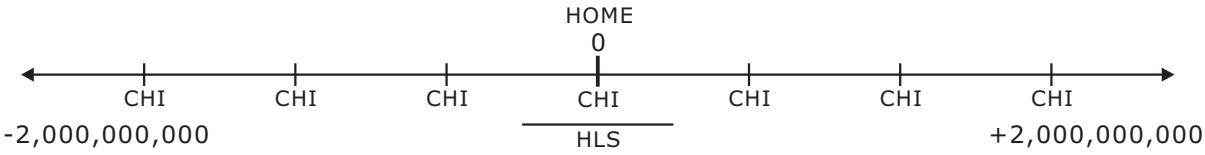
RECEIVING WAVEFORM AT CONNECTOR CN6

PPR WIDE

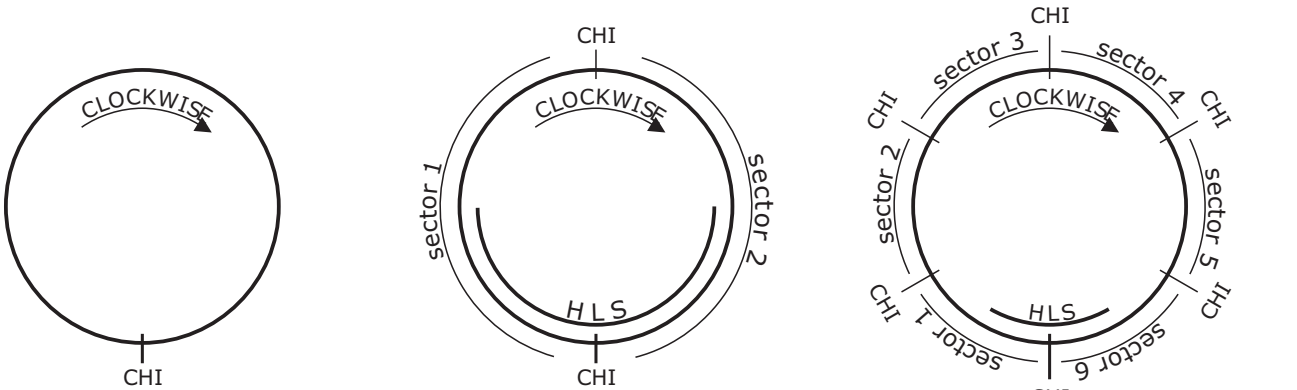


HOME

THE INDEX MARK IS ISSUED AT EVERY PPR PERIOD



LINEAR PSEUDO-ABSOLUTE AXIS
LSH is issued once, in the middle of the axis.



ROTATORY PSEUDO-ABSOLUTE AXIS
HLS is issued at every revolution

WARNINGS

The Codecx issues letters and numbers, some dotted, to indicate errors, flaws or status, as listed below.

C.t.	Common transition has occurred. Harmful, fully managed by the digital filter. The occurrence is reported if enabled on setup line 3 (*). See "Common mode" on MyQuadratureWorld.pdf
E.1.	The CHI frequency is too high. Pseudo-absolute mode only (*) (**). To overcome this problem read the "Note on quadrature frequency" page 11.
E.4.	Overstepped the limits, either positive or negative of the linear pseudo-absolute mode (*) (**).
E.E.	Error in communicating with the eeprom (*). Hardware fault.
E.H.	Error of quadrature high frequency (*) (**). See "High frequency" on MyQuadratureWorld.pdf
E.O.	Error of counter overflow. The counter is read full (3FFF). (*) (**).
FP	The gear-box for selecting Qf, the quadrature frequency range is open.
Fr	The current quadrature frequency is being displayed.
InPut	Appears when pressing RUN on receiving mode.
L.u.	Means that the external +5V power supply feeding the interface adapter ES911A is too low. The threshold is typically 4.61V.
O.L.	Oscillation has occurred. Harmful, fully managed by the digital filter. The occurrence is reported if enabled on setup line 3 (*). See "Channel oscillation" on MyQuadratureWorld.pdf
	(*) - Appears every 2 sec for a short while. Many signs may appear in sequence. Key T2 (RES) clears all.
	(**) - Fatal error, the axis' position is lost. A reset is necessary.

TRAINING ON CODECX

1) The Codecx is shipped ready to go: just plug the power, switch the LED RUN on (toggled with key RUN) and turn the knobs. Then,
   - Press T1 to see the higher digits of the counter.
   - Press T3 to see the frequency. Press RUN to return to baseline.
   - Dim the LED RUN and enter the setup lines: press and hold T1 key for 2 sec to enter line 0. Release it and press it again to enter line 1. Change the Quadrature Decoding to 2 or 4 with the buttons T2 and T3. Skip to baseline with RUN button and run.
   - Dim the LED RUN and press T3 to enter the gear-box. The left displays show FP. Change the frequency with T2 and T3. Press RUN again to return to baseline.

The shipping setup is the follow: Line 0: 01, line 1: 01, line 2: 0, line 3 1.3000, line 4: o0000, line 5: 1000, line 6: 002, line 7: 0, speed 123KHz, no interface adapter inserted.

2) Simulate an alternate motion (swing). Change only the setup line 2 to 1.
   - Return to baseline and run. Adjust the speed with the COARSE potentiometers (only on the positive half).
   - Stop running. Go to setup line 3, change the the swinging time (digit B) and try again.

3) Run on remote control through the 4 On/Off lines HF, HR, LF, LR. Set the running mode 2. Check the On/Off lines on line 4. Return to baseline and run using the rules of page 7.

4) Run on remote control through the 0÷±10V signal. Set the running mode 3. Return to baseline and run. With positive signal the Codecx runs forward, with negative voltage runs reverse.

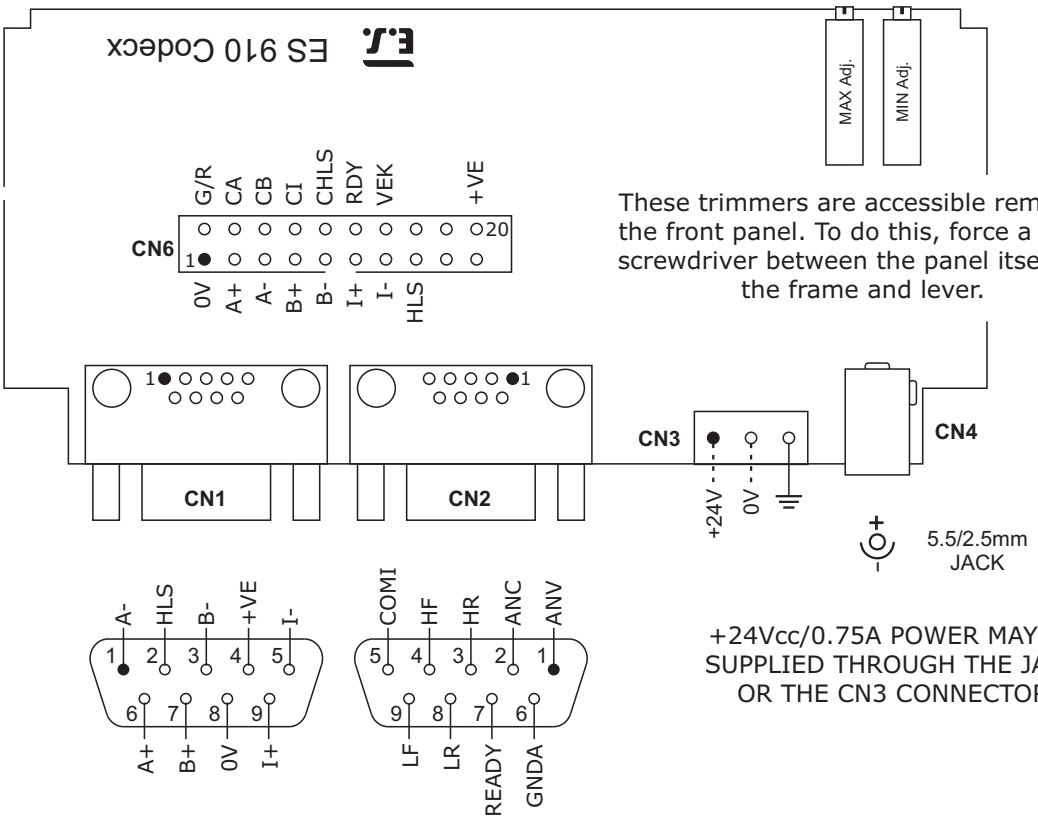
5) Run on remote control through the 4÷20mA signal plus HF and RF. Set the running mode 5. Return to baseline and run. Apply 4÷20mA for the speed and HF or RF for the direction.

6) PPR counting. Change setup line 7 to 1 and run. Data is the first time displayed at the 3th CHI cross and then refreshed every 3 crossings. T2 clear the data and starts a new reading.
   - Removing any interface adapter for counting the Codecx' its own PPR programmed on line 5.
   - Insert a receiving interface adapter for counting the PPR of an external encoder.

   If the display remains steadily lighted the reading is good, while flickering display means frequency too high or bad reading.
   CHI has to be met 3 times before displaying the rate, then it is refreshed every 3 CHI crosses. T2 will clear the data and start a new cycle. Repeat the test at different speed, back and forth.

7) Receiving on basic counting mode. Insert a receiver interface adapter before plugging the power. Basic counting mode requires no particular attention. But when also CHI is involved, adjust the switches on the receiver interface ES911C or invert the differential lines on ES911B in such a way that LEDs CHA, CHB and CHI are all lighted at the home point. Even the LED LHS, if present, must light across the home point.

GENERATOR USER'S CONNECTORS



CN1 - QUADRATURE SIGNALS

A+	Output. True signal of channel A.
A-	Output. Inverted signal of channel A.
B+	Output. True signal of channel B.
B-	Output. Inverted signal of channel B.
I+	Output. True signal of the Index channel.
I-	Output. Inverted signal of the Index channel.
HLS	Output. Home Limit Switch.
+VE	Input. Interface adapter power supply.
0V	Common ground.

CN2 - REMOTE CONTROL SIGNALS

ANV	Input. Analog voltage.
ANC	Input. Analog current .
GNDA	Analog Common Ground.
READY	Output. Sinks a 24Vdc/30mA after status and position are restored at power on: the Codecx is ready to generate.
HF LF	Inputs. Forward motion control lines.
HR LR	Inputs. Reverse motion control lines.
COMI	Common of the four motion control lines.

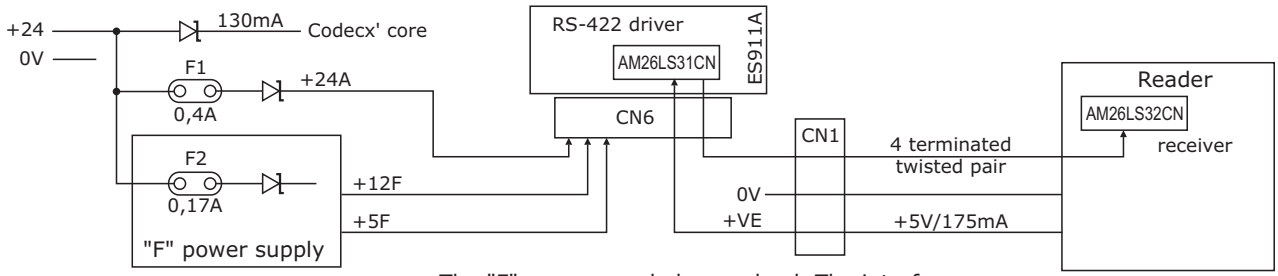
Note: The isolated On/Off motion control lines become active when brought to +24Vcc with respect to COMI. Each line draws 7.5mA.

CN6 - SIGNALS TO/FROM THE INTERFACE ADAPTER

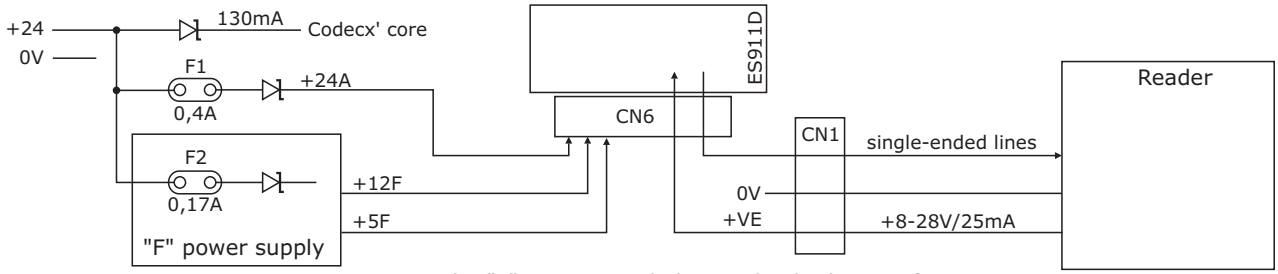
CA	To. Driving channel A.
CB	To. Driving channel B.
CI	To. Driving the Index channel.
CHLS	To. Driving the Home Limit Switch.
G/R	From. Pulled-up Generator/Receiver mode on the main board. Left open by the adapters.
RDY	To. Disables the drivers during power on and off. Drives also the output READY.
VEK	From. Pulled-up input on the main board. Brought low by the ES911A adapter if the external +5V falls below 4.61V (typically). At this occurrence the generator is stopped and L.u. sign appears. Leave it open if not used.
+VE	To. Carries the external supply powering the driver interface adapters.
0V	Power supply common ground.

GENERATOR POWER MAP

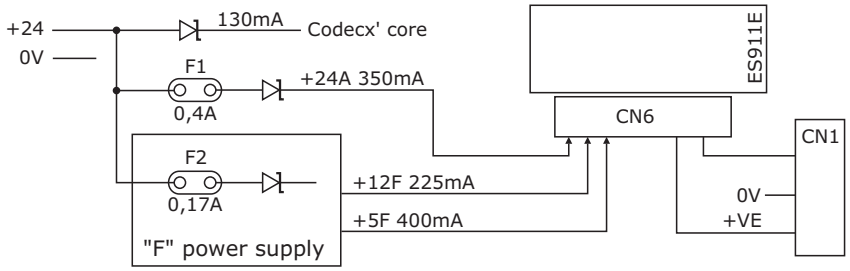
In generator mode the Codecx draws only150mA for itself. But a little boost is needed at power on to charge the capacitors. So, a 90-240V/0.5A - AC/DC Adaptor is suitable.
In receiving mode however, the Codecx must also supply the external encoder being read. So, an adaptor of 0.8A output is shipped as standard.



The "F" power supply has no load. The interface is supplied by the remote reader.

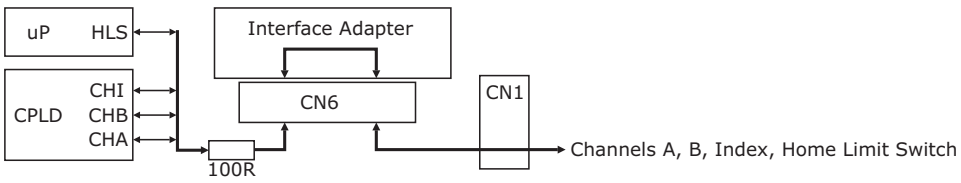


The "F" power supply has no load. The interface is supplied by the remote reader.



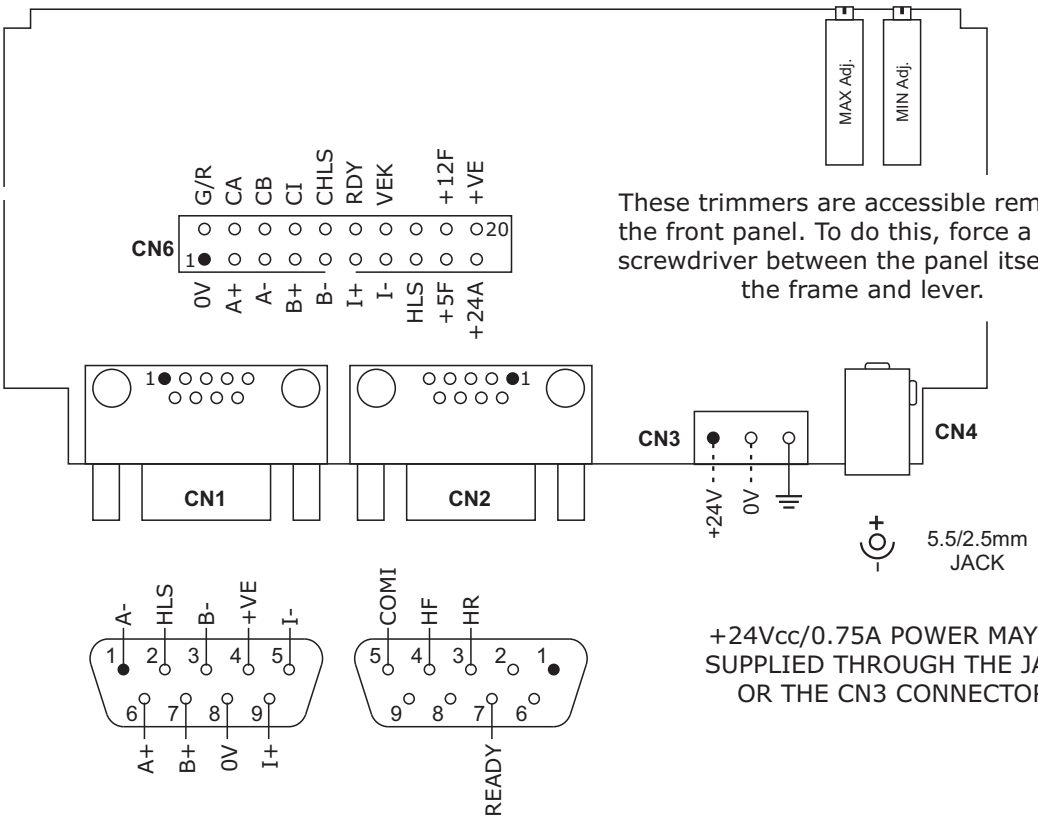
Short circuit proof, switching power supply board.

For custom application, the total current drawn from the 3 power lines should not exceed 400mA. The line +VE can also be used as power carrier.



Path of the quadrature signals

RECEIVER USER'S CONNECTORS



CN1 - QUADRATURE SIGNALS

A+	Input. True signal of channel A.
A-	Input. Inverted signal of channel A.
B+	Input. True signal of channel B.
B-	Input. Inverted signal of channel B.
I+	Input. True signal of the Index channel.
I-	Input. Inverted signal of the Index channel.
HLS	Input. Home Limit Switch.
+VE	Output. Encoder power supply.
0V	Common ground.

CN2 - REMOTE CONTROL SIGNALS

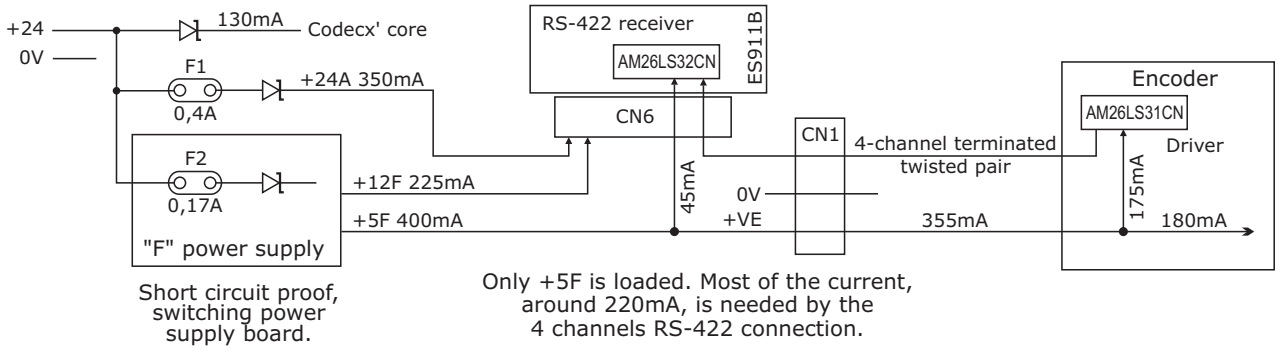
READY	Output. Sinks to 0V a +24Vdc/30mA load after status and position are restored at power on: the Codecx is ready to receive.
HF LR	Inputs. For remote clearing purpose only: Both high clear the Codecx' display.
COMI	Common to the two clearing lines.

Note: The isolated On/Off clearing lines become active when brought to +24Vcc with respect to COMI. Each line draws 7.5mA.

CN6 - SIGNALS TO/FROM THE INTERFACE ADAPTER

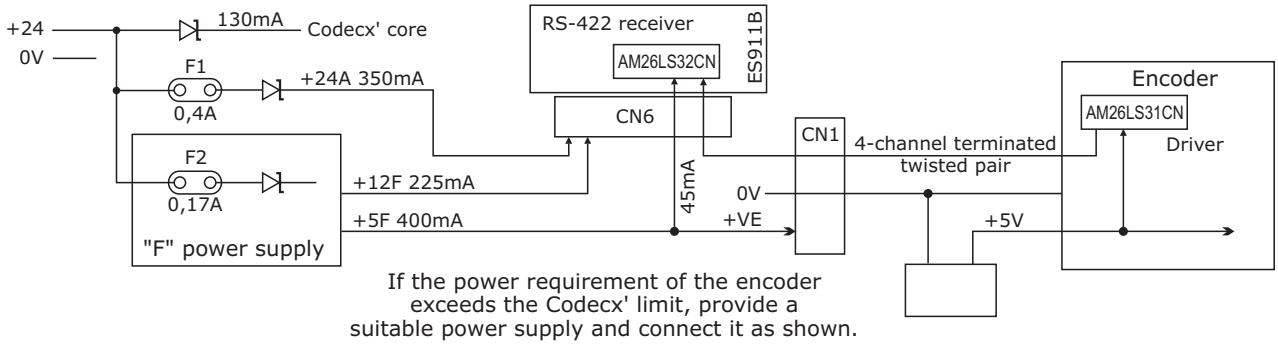
CA	From. Receiving channel A.
CB	From. Receiving channel B.
CI	From. Receiving the Index channel.
CHLS	From. Receiving the Home Limit Switch.
G/R	From. Pulled-up Generator/Receiver mode on the main board. Grounded by the adapters.
RDY	To. Disables the receivers during power on and off. Drives also the output READY.
VEK	Not connected. Not used by the receiving adapters.
+5F	To. +5V/400mA switched to +VE.
+12F	To. +12V/225mA switched to +VE.
+24A	To. +24V/350mA switched to +VE.
+VE	Bears the power supply for the external encoder being read, either +5F, +12F or +24A.
0V	Digital Common Ground.

RECEIVER POWER MAP

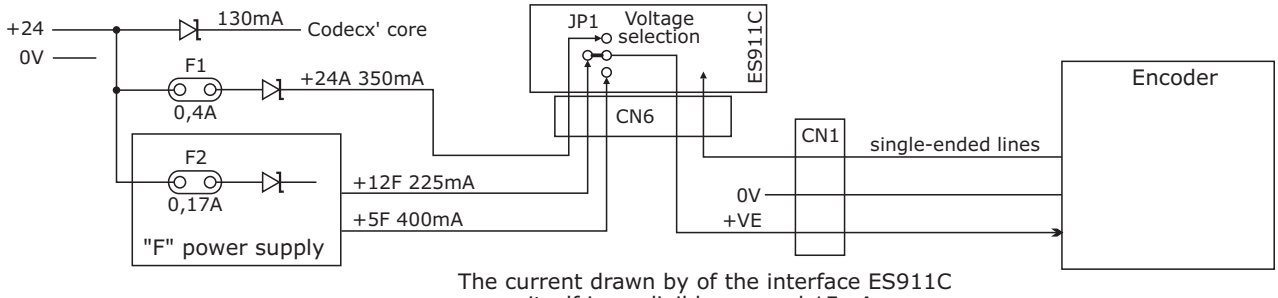


Short circuit proof, switching power supply board.

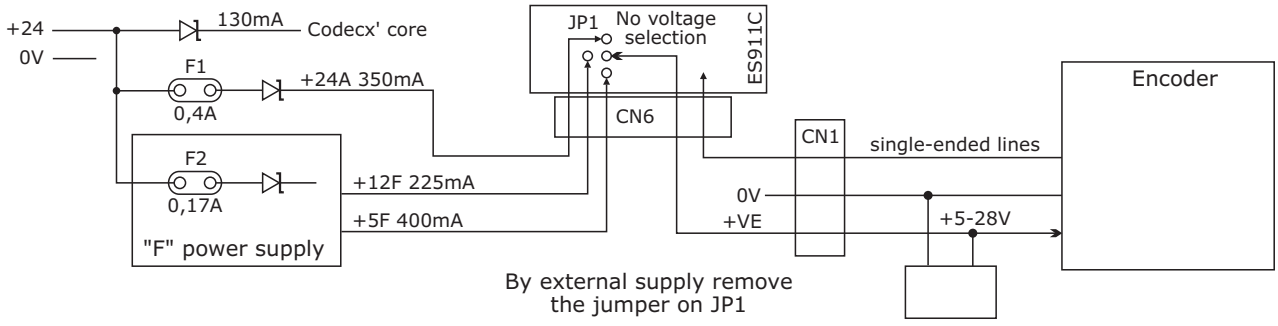
Only +5F is loaded. Most of the current, around 220mA, is needed by the 4 channels RS-422 connection.



If the power requirement of the encoder exceeds the Codecx' limit, provide a suitable power supply and connect it as shown.



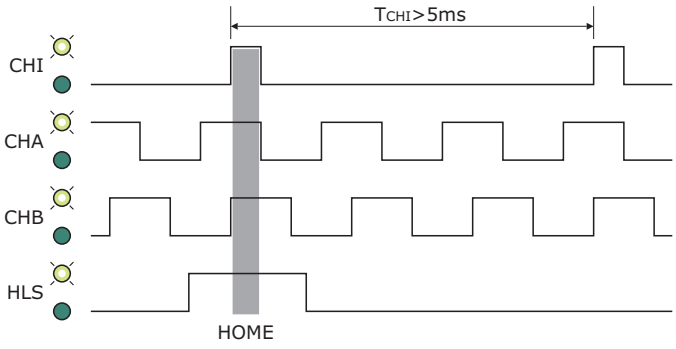
The current drawn by of the interface ES911C itself is negligible, around 15mA.



By external supply remove the jumper on JP1

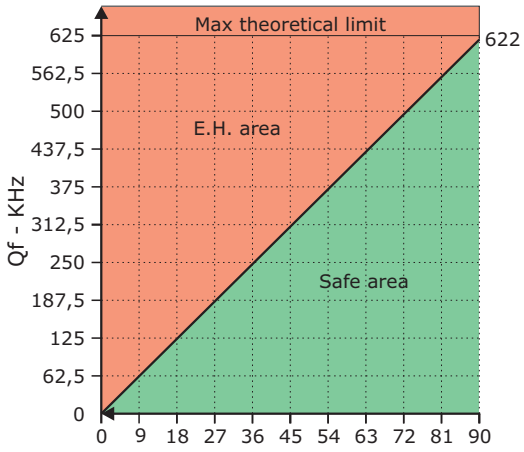
Insert a receiving interface adapter prior to powering on.
First of all turn the encoder slowly and check the LEDs on the front panel. Make sure that CHA and CHB switch on and off following the quadrature diagram, see below. If even CHI is concerned, check that it lights at home point only. Even CHA and CHB must be lighting at home. If not manage the connections or the switches on the interface adapter to invert the wrong levels. Even HLS must light at home point if operating in pseudo absolute mode. See also page 12.

- **Basic quadrature reading**. CHA and CHB only are involved. Program setup line 1 to 1 and setup line 7 to 0. Run the encoder at different speeds, check if any warning shows up. Clear the display and revolve the encoder for one tour. The counts roughly represent the PPR of the encoder. Check both directions.
- **PPR count**. CHA, CHB and CHI are involved. Program setup line 7 to 1. Turn the encoder for at least 3 turns to see the PPR. After this, the data is refreshed every 3 turns. Watch for the flickering of the display. It means that the Index strobe shows up too rapidly. Reduce the speed, clear with T2 and wait for the new data. As general rule, the Index' period must be over 5ms, corresponding to 12000 RPM for rotatory encoders. If the warning E.H. appears, reduce the speed and try again. If after 3 turns no data appears, probably the Codecx doesn't see the Index mark. Check the LEDs as described above. When finished restore the previous operating mode on line 7.
- **Pseudo-absolute mode**. CHA, CHB, CHI and HLS (Home Limit Switch) are involved. Program setup line 7 to 2 or 3 and run the system.
- **Checking the encoder**. The quadrature digital filter is a sophisticate digital block capable to spot some flaws in the middle of the regular motion. Those flaws are signaled as:
- **E.H.** - Means that two quadrature transitions have fallen too close each other, less than 400ns apart, not enough for the filter to screen both properly. The position is lost.
  E.H. may also be a way to measure the worst quadrature shift among channels. For the Codecx 2.0 the equation is: Shift°=90*Qf$_{E.H.}$/625, where 90 are the out of phase degrees for the perfect quadrature, Qf$_{E.H.}$ is the frequency at which E.H. appears and 625KHz is the theoretical upper limit for 90° quadrature. When generating for itself, with no interface adapters inserted, the Codecx issues E.H. at 622KHz (using finely tuned 0-10V remote control). So, the resulting shift at the input of the filter is 90*622/625=89,568°.
- **O.L.** - Means that oscillation occurred. One channel switched back and forth. Harmless to the position because 100% managed by the filter. Its report must be enabled in the setup line 3, bit D.
  Oscillation probably means roughness in the mechanic gear. In pseudo-absolute mode it would be easy even to know where it happened.
- **C.t.** - Means that common mode transition occurred. The two quadrature channels switched at the same time. Harmless to the position because 100% managed by the filter. Its report must be enabled in the setup line 3, bit D. Common mode is due to crosstalk in long single-ended transmission or induced electromagnetic noise.

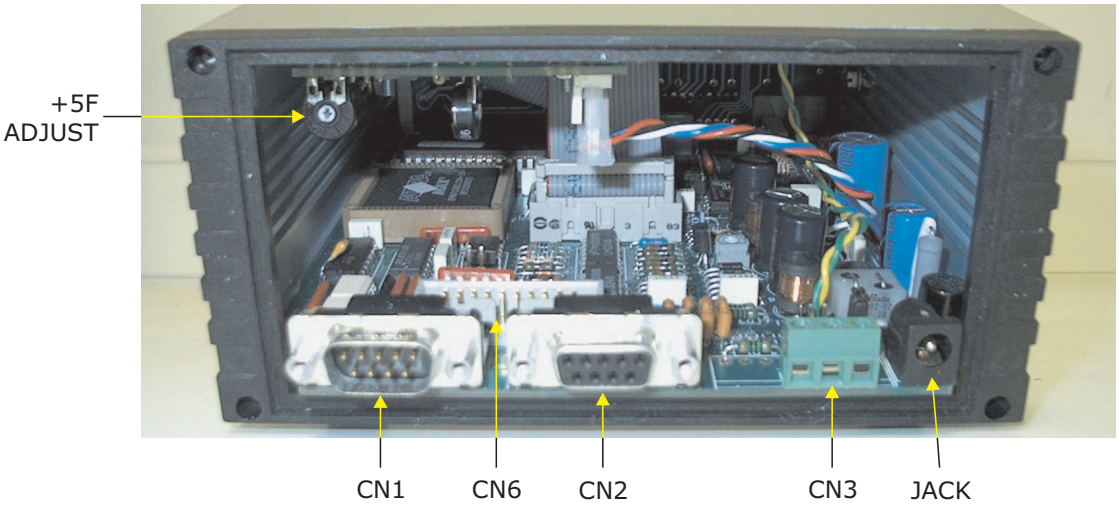


In pseudo-absolute mode all LEDs must light at HOME point. Manage the connections or the switches on interface board to obtain this.

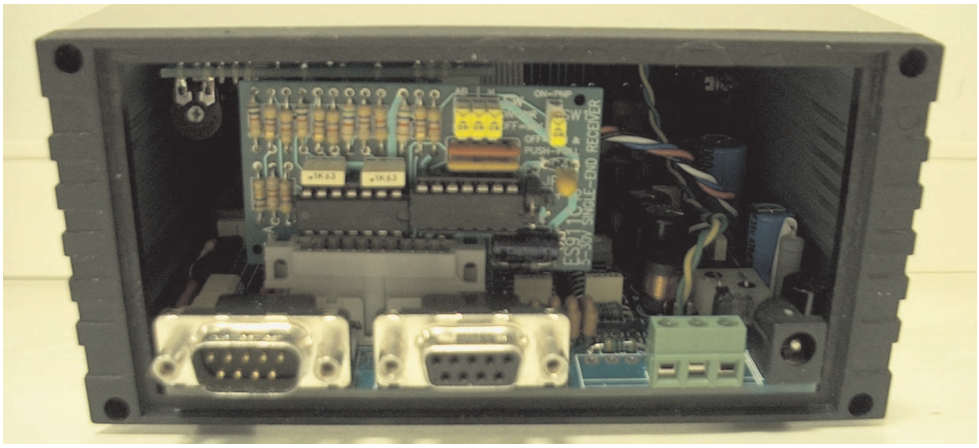
QUADRATURE AND HOMING LINES RELATIONSHIP



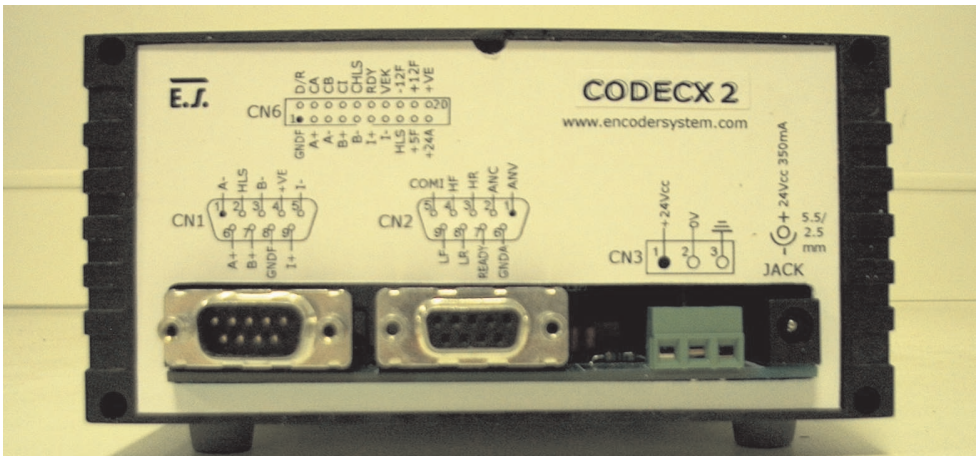
E.H. AND QUADRATURE SHIFT RELATIONSHIP



REAR VIEW WITH NO INTERFACE ADAPTER



REAR VIEW WITH INTERFACE ADAPTER 911C INSERTED



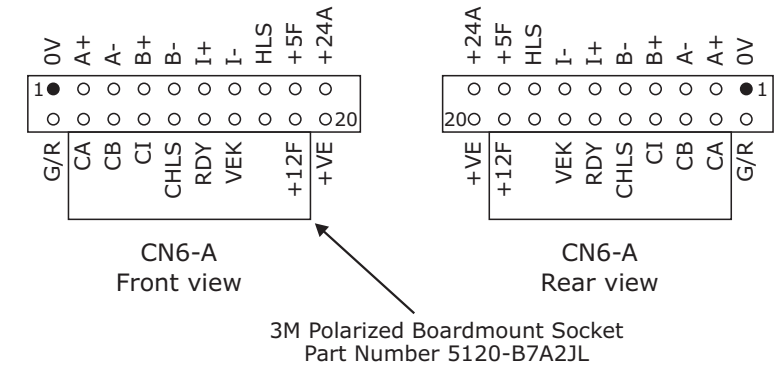
REAR VIEW WITH THE COVER

INTERFACE ADAPTERS

Plugged on connector CN6 at the rear, are protective buffers and level translators between field and Codecx logic. The Generator adapters drive the signals outside the Codecx simulating an incremental quadrature encoder or axis system. The Receiver ones receive the signals from the field and the Codecx becomes a reader unit.
These boards mount standard discrete components for easy customizing and repair. A series of switches allow to invert the signals to adapt the logic levels to the specific requirement, particularly when CHI is involved.
Just to recall, the Codecx "works" on positive logic, so the signals are true when high at connector CN6.

LIST OF ADAPTERS

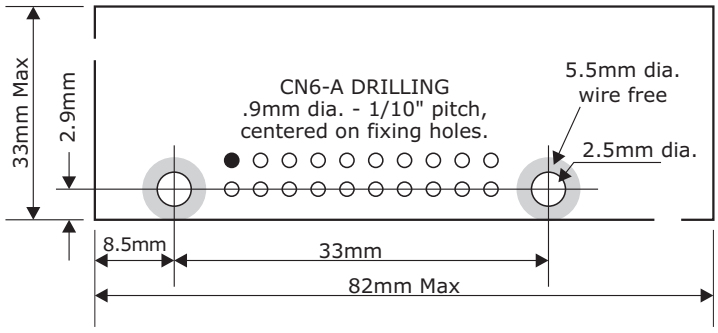
ES911A	Quad, 5V differential line driver RS-422, 10MHz.
ES911B	Quad, 5V differential line receiver RS-422, 10MHz and single-ended mode.
ES911C	Quad, 5-28V single-ended PNP, NPN or Push-Pull receiver, 200KHz.
ES911D	Quad, 8-28V single-ended Push-Pull driver, 200KHz.
ES911Z	Empty, drilled Card, 1/10" pitch, for custom purpose.



CN6-A
Front view

CN6-A
Rear view

3M Polarized Boardmount Socket
Part Number 5120-B7A2JL

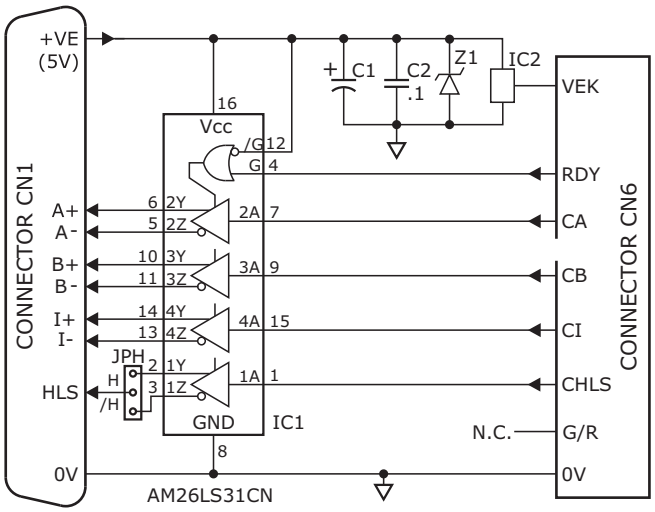


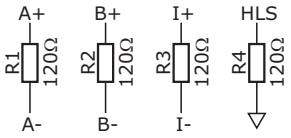
INTERFACE ADAPTER BOARD LAYOUT

ES911A **10 MHz**

4-CHANNEL - 5V DIFFERENTIAL LINE DRIVER RS-422

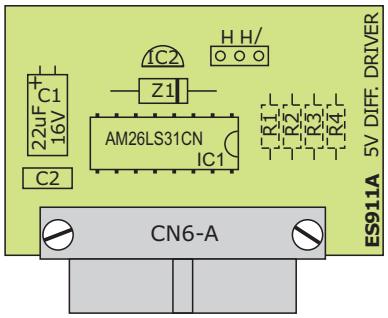
The board is equipped with a quad 5V differential, RS-422 driver AM26LS31CN type. RDY, at power on and off, forces the outputs to high impedance inhibiting false signals going out. The card is powered by the remote reader through +VE and 0V lines. +VE is sensed by IC2 which stops the generator when the voltage drops below 4,61V typ. HLS is single-ended and its polarity must be selected with JPH.



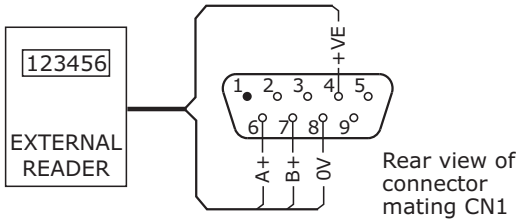


Optional terminating resistors

C1-22uF, 16V
Z1-P6KE6V8A
IC2-MC34064P-5 Under-voltage sensing

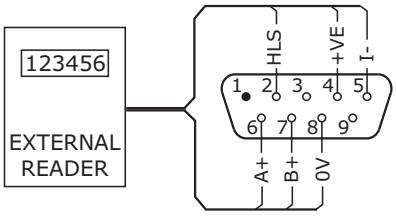


THE CODECX DOESN'T FUNCTION PROPERLY IF THIS BOARD IS NOT POWERED THROUGH THE CONNECTOR CN1

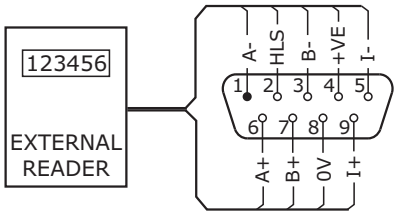


Rear view of connector mating CN1

BASIC SINGLE-ENDED CONNECTION

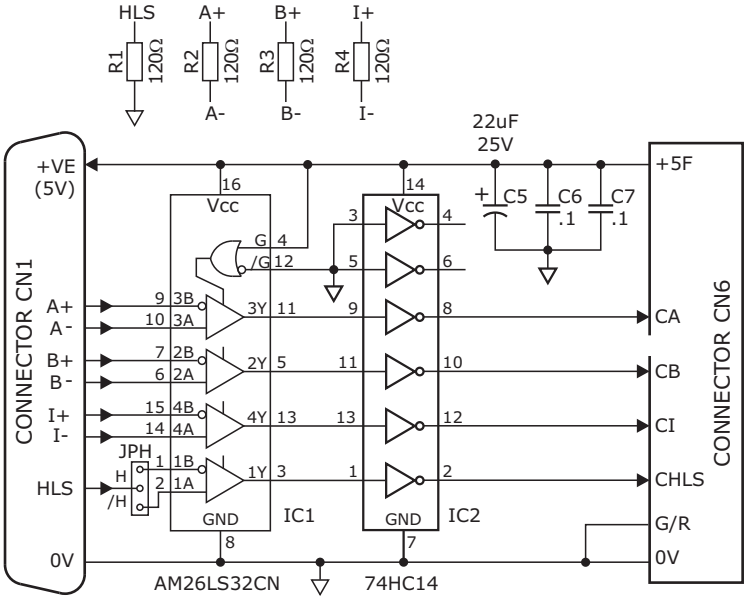


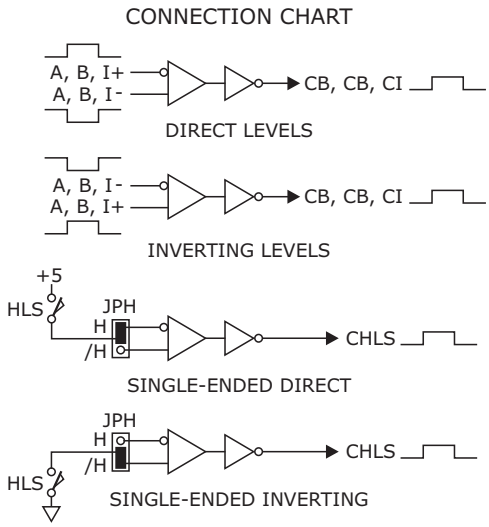
PSEUDO-ABSOLUTE SINGLE-ENDED CONNECTION

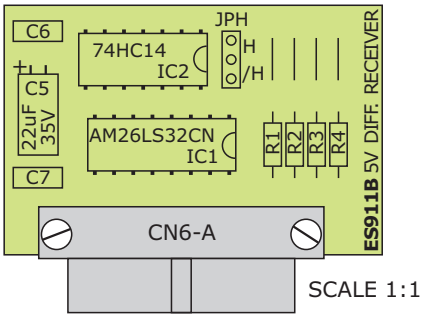


PSEUDO-ABSOLUTE RS-422 CONNECTION

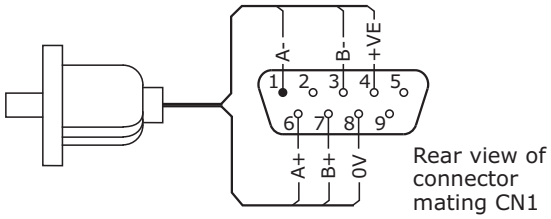
The board receives the quadrature signals from an external generator such an encoder and feeds the Codecx. The encoder may be powered by the Codecx (up to 355mA) or by an external source. The connection of the pair can be direct or inverting, see chart below. This help to match the logic levels of the system with the Codecx's requirements. In fact it detects the Home Point when CA, CB, CI and CHLS are all high (positive logic). The LEDs on front panel should all light. Fix CHA and CHB first otherwise CHI and HLS will never light. If running on basic quadrature mode (only Channels A and B) live LEDs CHI and HLS switched off. The inverters have been added to have low outputs when the encoder is disconnected.





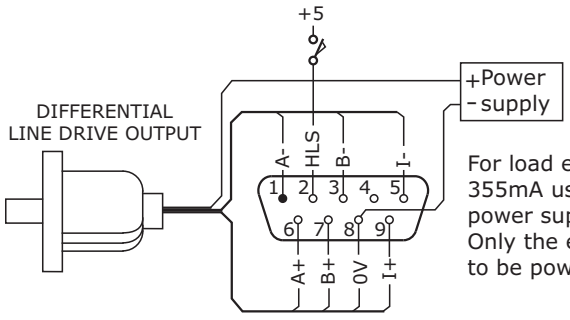


SCALE 1:1



Rear view of connector mating CN1

5V DIFFERENTIAL RECEIVER.
BASIC QUADRATURE CONNECTION



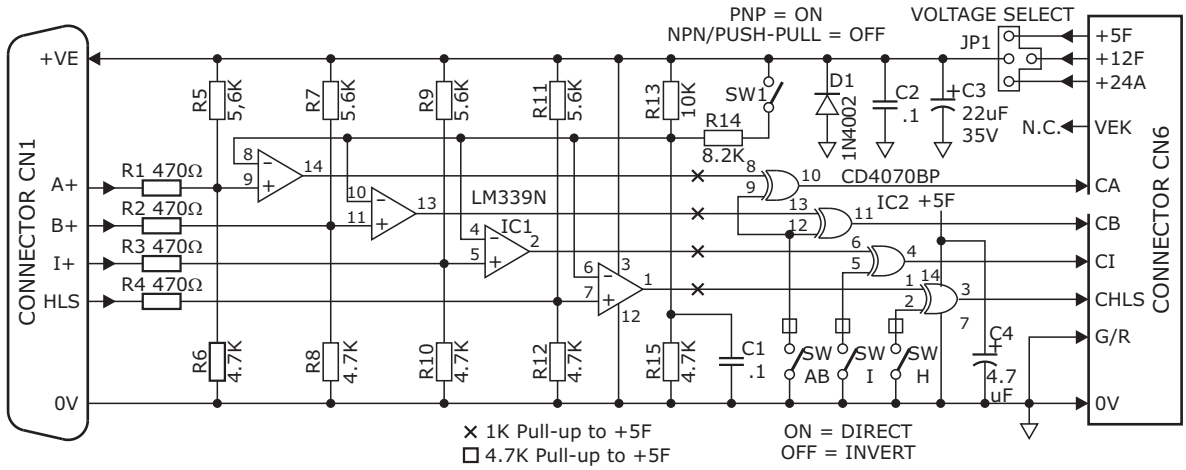
For load exceeding 355mA use an external power supply.
Only the encoder has to be powered.

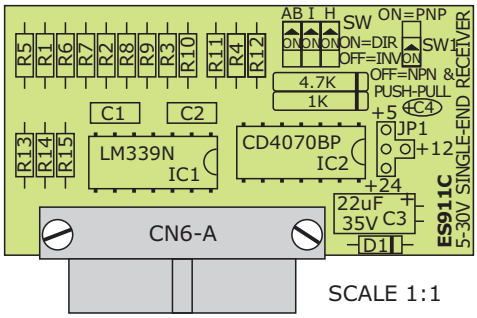
5V DIFFERENTIAL RECEIVER.
PSEUDO-ABSOLUTE CONNECTION

ES911C **200KHz**

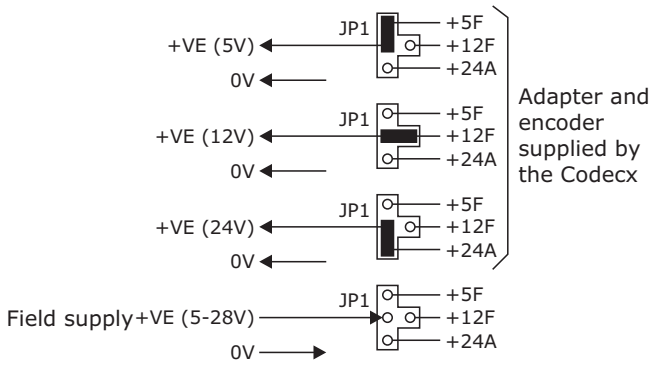
4-CHANNEL RECEIVER. 5-28V SINGLE-ENDED NPN, PNP AND PUSH-PULL

The board receives the signals from an external generator such an encoder and feeds the Codecx. The encoder may be powered by the Codecx with 5, 12 or 24V, selectable through JP1. If an external source is used, on the range 5-28V, make sure that JP1 is completely disconnected. Select SW1: ON for PNP, OFF for NPN (open collector or pulled), Push-Pull or singled line drive. Inverting switches SW AB, SW I and SW H help to match the system logic level with the Codecx' requirements. In fact, when running in pseudo-absolute mode, it detects the Home Point when CA, CB, CI and CHLS are all high (positive logic). The LEDs on front panel should all light. Fix CHA and CHB first otherwise CHI and HLS will never light. If running on basic quadrature mode (only Channels A and B) make sure that CHI and HLS LEDs remain switched off.

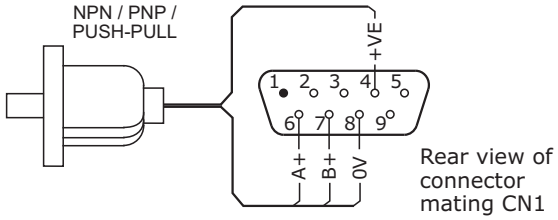




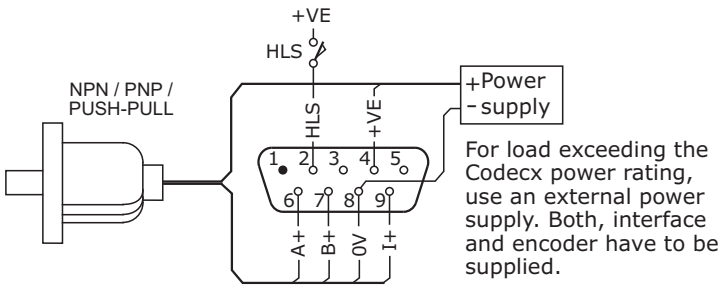
SCALE 1:1



BY FIELD SUPPLY REMOVE JUMPER FROM JP1



THE ENCODER IS POWERED BY THE CODEX

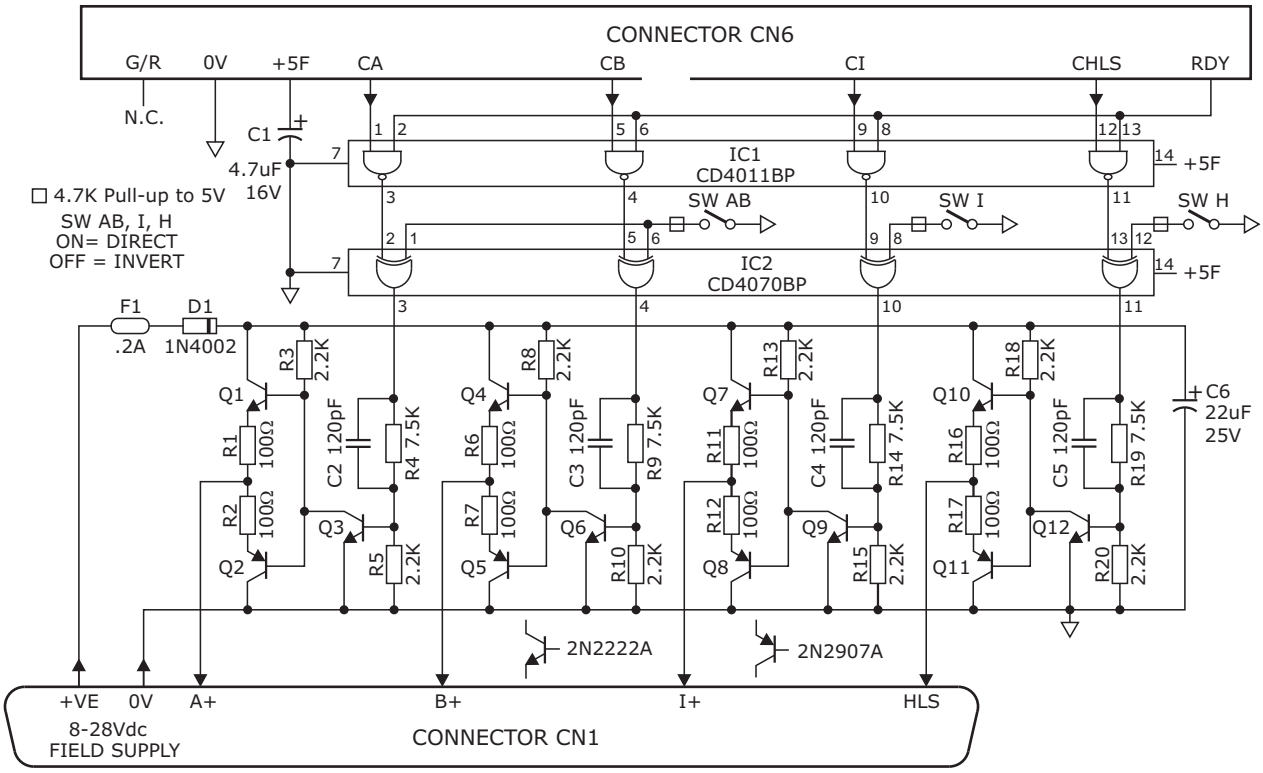


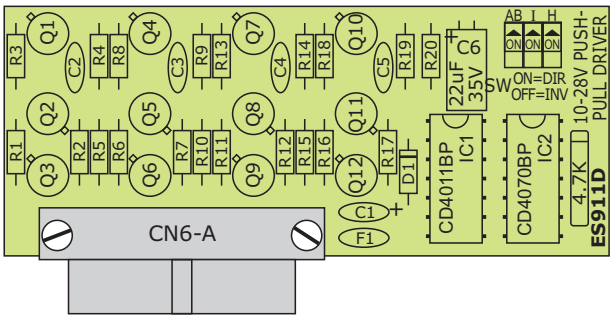
THE ENCODER AND THE ADAPTER ARE POWERED BY AN EXTERNAL SUPPLY

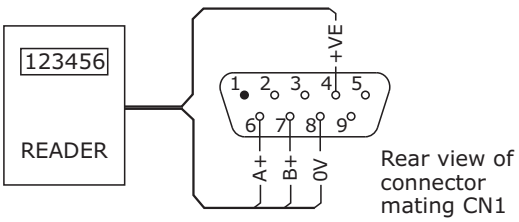
ES911D
4-CHANNEL DRIVER. 8-28 PUSH-PULL

200KHz

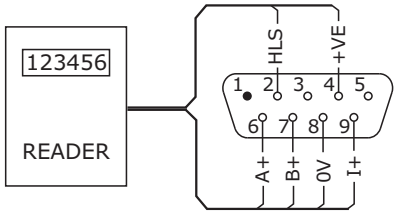
The board sends out the signals produced by the Codecx. The outputs are inhibited by RDY at power on and off. The driver section is powered by the remote reader through +VE. The outputs can be selected direct or inverted. The switches SW AB, SW I and SW H live the signals direct when on and invert them when off.







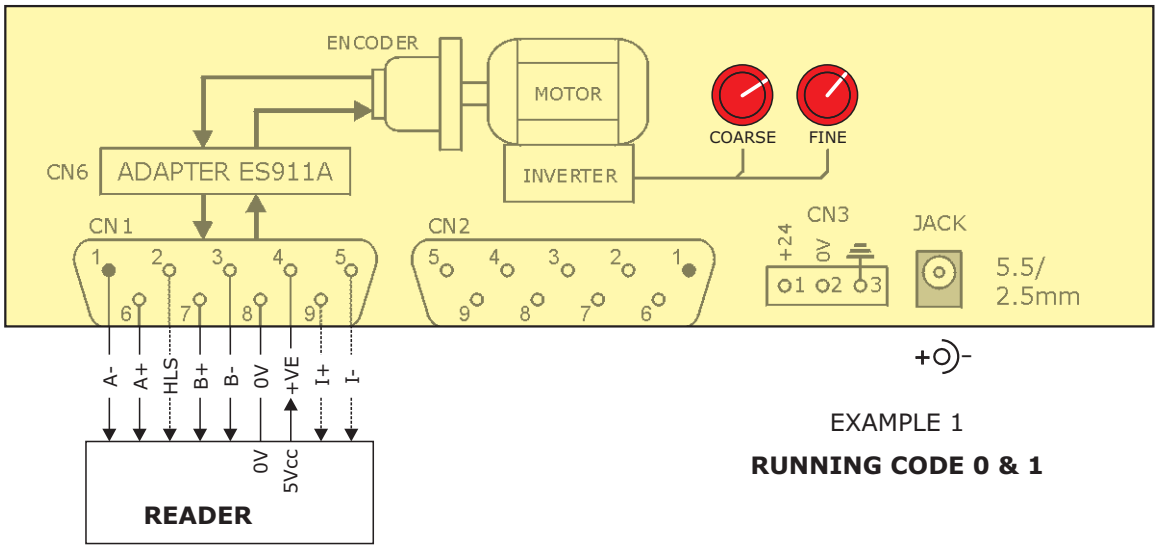
SINGLE-ENDED BASIC
QUADRATURE CONNECTION



SINGLE-ENDED
PSEUDO-ABSOLUTE CONNECTION

GENERATOR MODE - ENCODER AND MOTION SIMULATOR

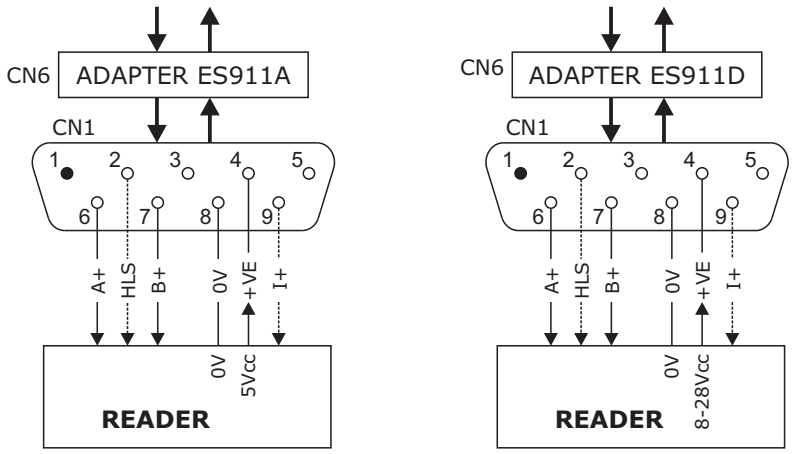
THE BEHAVIOR IS LIKE AN ENCODER DRIVEN BY AN SPEED CONTROLLED MOTOR



EXAMPLE 1

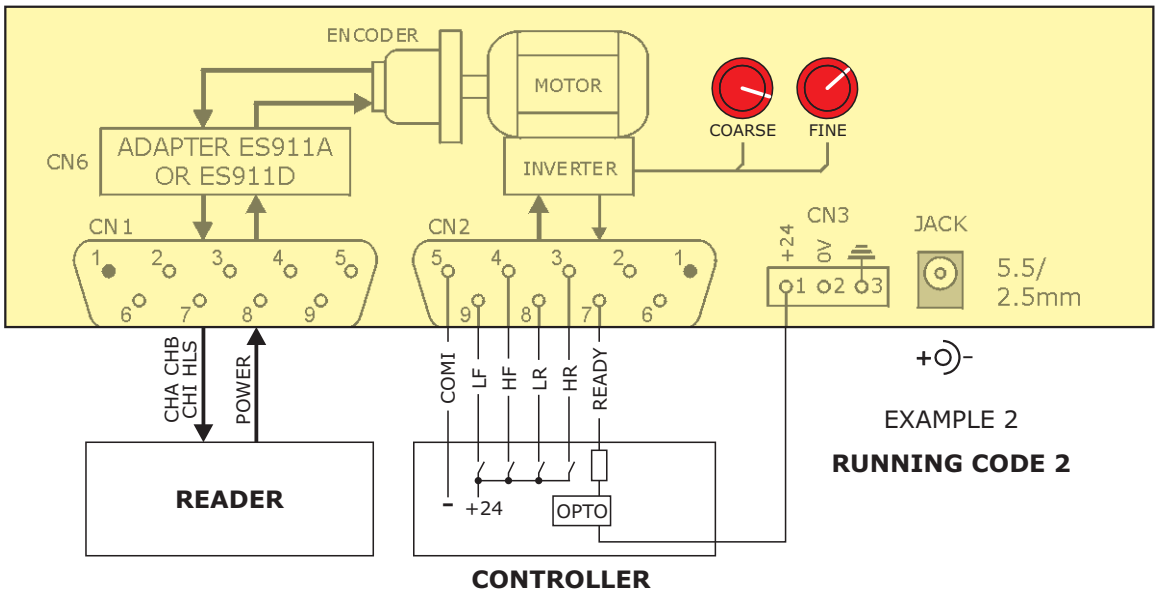
RUNNING CODE 0 & 1

Locally controlled motion with COARSE and FINE Pots. The transmission shown is RS-422.

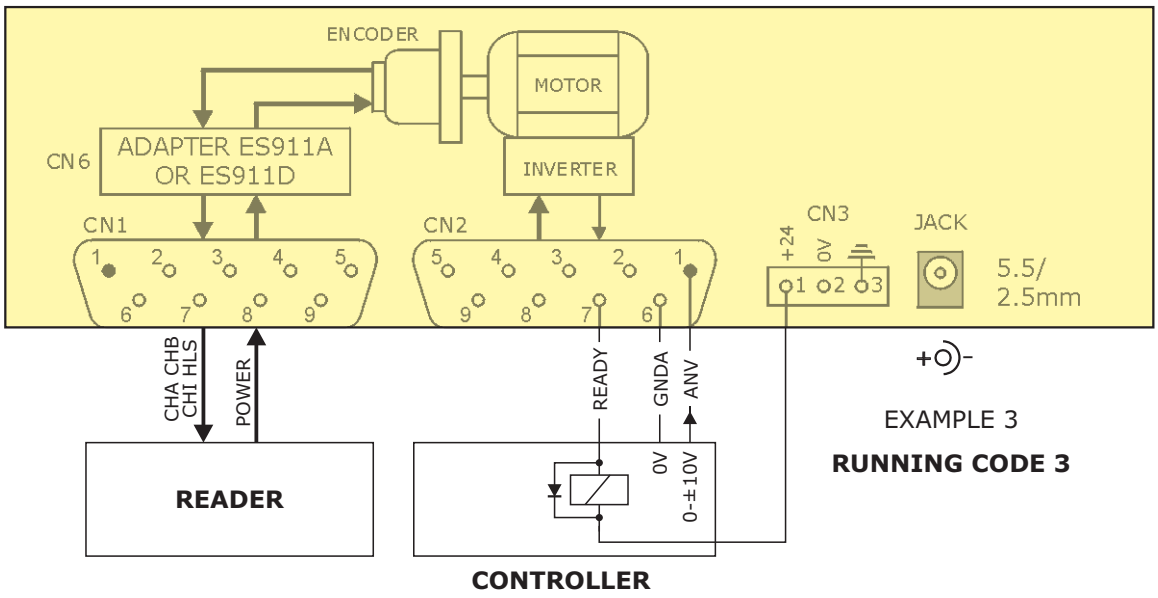


Examples of single-ended wiring

IN GENERATOR MODE THE READER MUST SUPPLY THE DRIVING ADAPTER ON THE CODECX WITH THE PROPER VOLTAGE: 5Vcc FOR ES911A AND 8-28Vcc FOR ES911D.

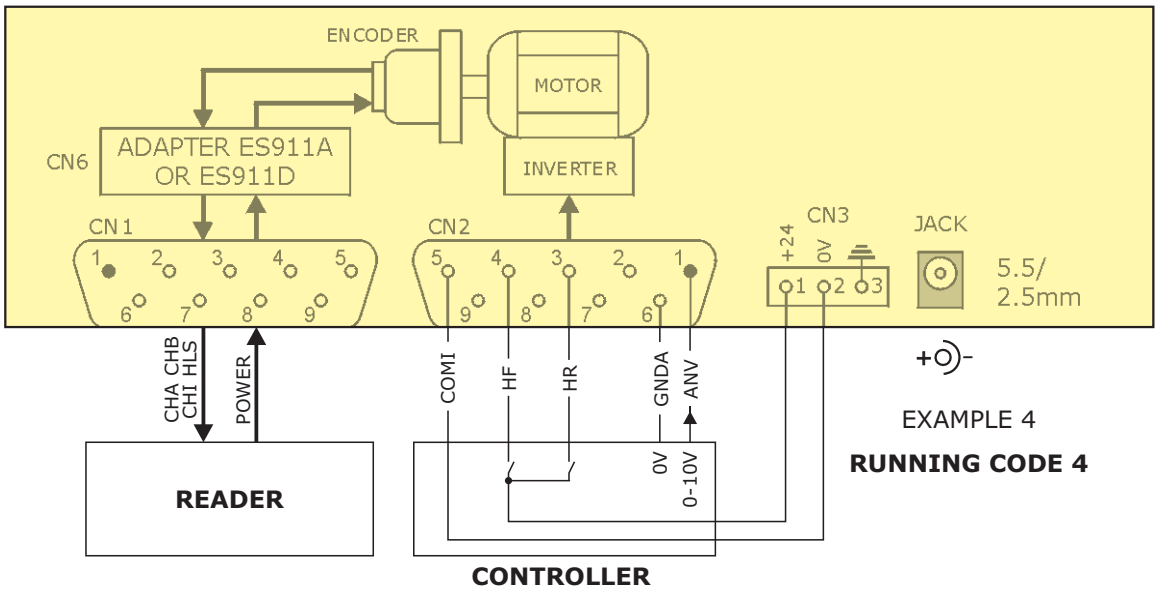


Remote controlled motion driven by isolated on/off lines. HF or HR enable the speed, forward or reverse, selected by the COARSE pot. LF or LR enable the speed, forward or reverse, selected by the FINE pot.

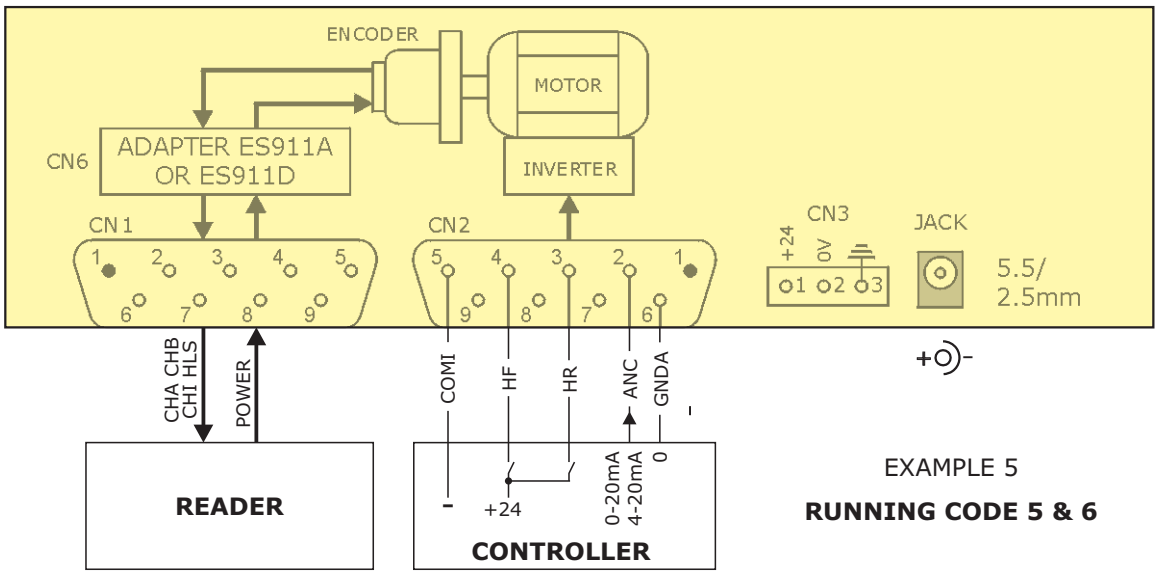


Remote controlled motion driven by 0-±10V. The polarity establishes the direction and the voltage the speed.

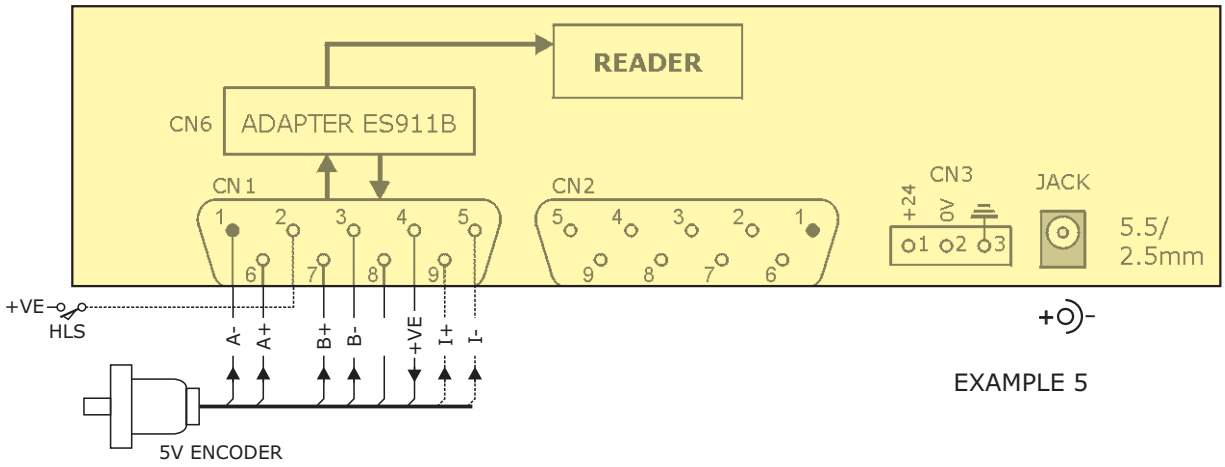
GENERATOR MODE - ENCODER AND MOTION SIMULATOR



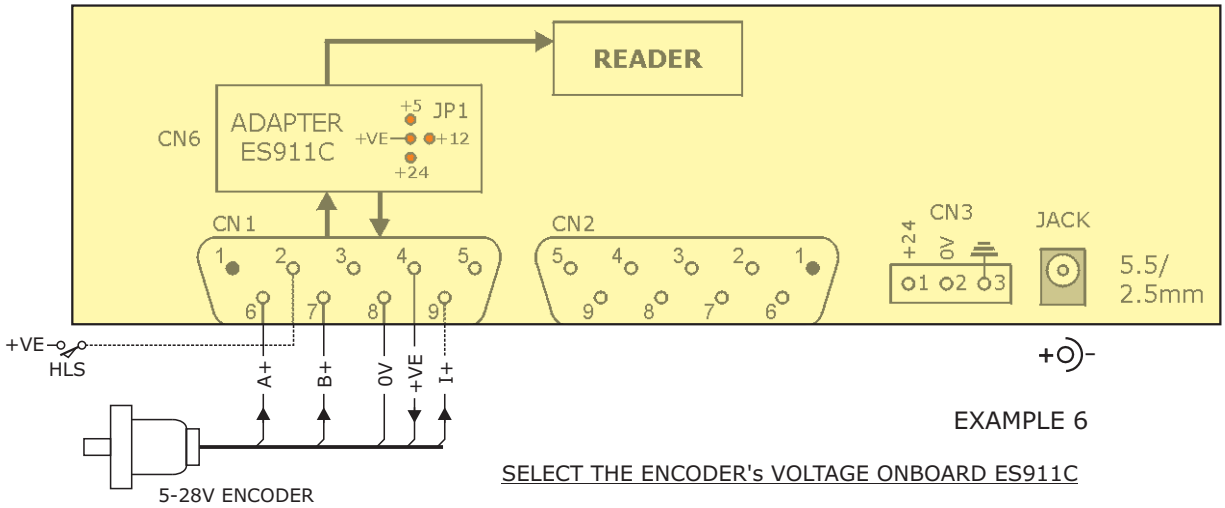
Remote controlled motion driven by 0-10V and non isolated on/off lines. HF or HR give the direction and the voltage the speed. The Codecx is powered through the Jack.



Remote controlled motion driven by 0-20mA or 4-20mA and on/off lines. HF or HR give the direction and the current the the speed. Both HF and HR active clear the Codecx' position accumulator. The Codecx is powered through CN3.



Reading a 5V differential encoder. The power available is 5V, 350mA. CHI and HLS are optional.



Reading a 5-28V single-ended transmission encoder. Encoder's voltage is selectable on ADAPTER board. CHI and HLS are optional.

A 4-ENCODER-SIMULATOR BOX USED TO TEST THE BOARD PC864

DEFAULT DATA CHART

Default data are loaded holding T2 pressed at power up until the end of the count down, when the display blanks for a while.
Qf value in KHz is withing ±2.5%

01

1	1
2	0
3	1.3000
4	o0000
5	1000
6	002
7	0
Qf	123.0

02

1	4
2	2
3	1.3101
4	o0000
5	0100
6	010
7	0
Qf	490.0

03

1	1
2	3
3	1.3001
4	o0000
5	2500
6	025
7	0
Qf	490.0

04

1	2
2	0
3	1.3000
4	o0000
5	1000
6	050
7	1
Qf	

05

1	2
2	5
3	1.3100
4	o0000
5	1000
6	100
7	2
Qf	61.5

06

1	4
2	2
3	1.7000
4	o0000
5	4000
6	100
7	2
Qf	246.0

07

1	2
2	6
3	1.4000
4	o0000
5	16000
6	100
7	3
Qf	490.0

08

1	4
2	0
3	1.3100
4	o0000
5	0004
6	100
7	3
Qf	0.24

09

1	4
2	1
3	1.3000
4	o0000
5	9000
6	100
7	3
Qf	490.0

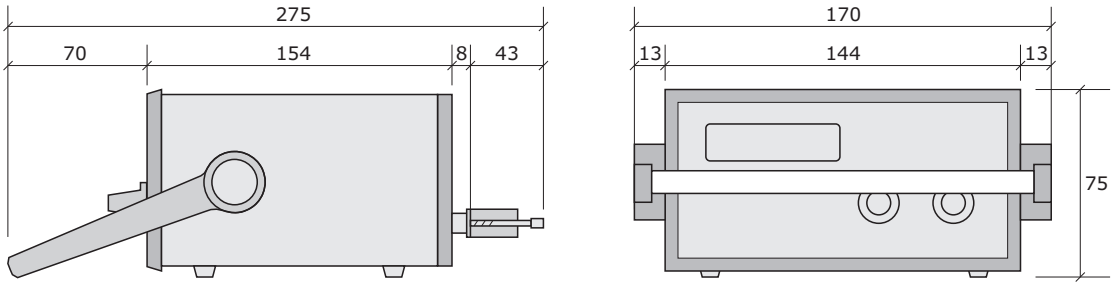
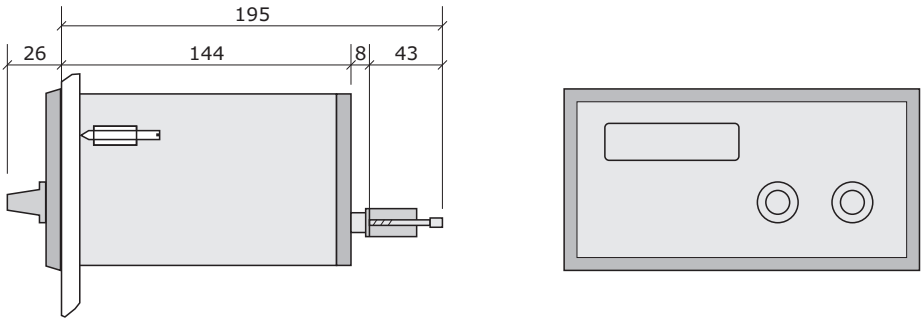
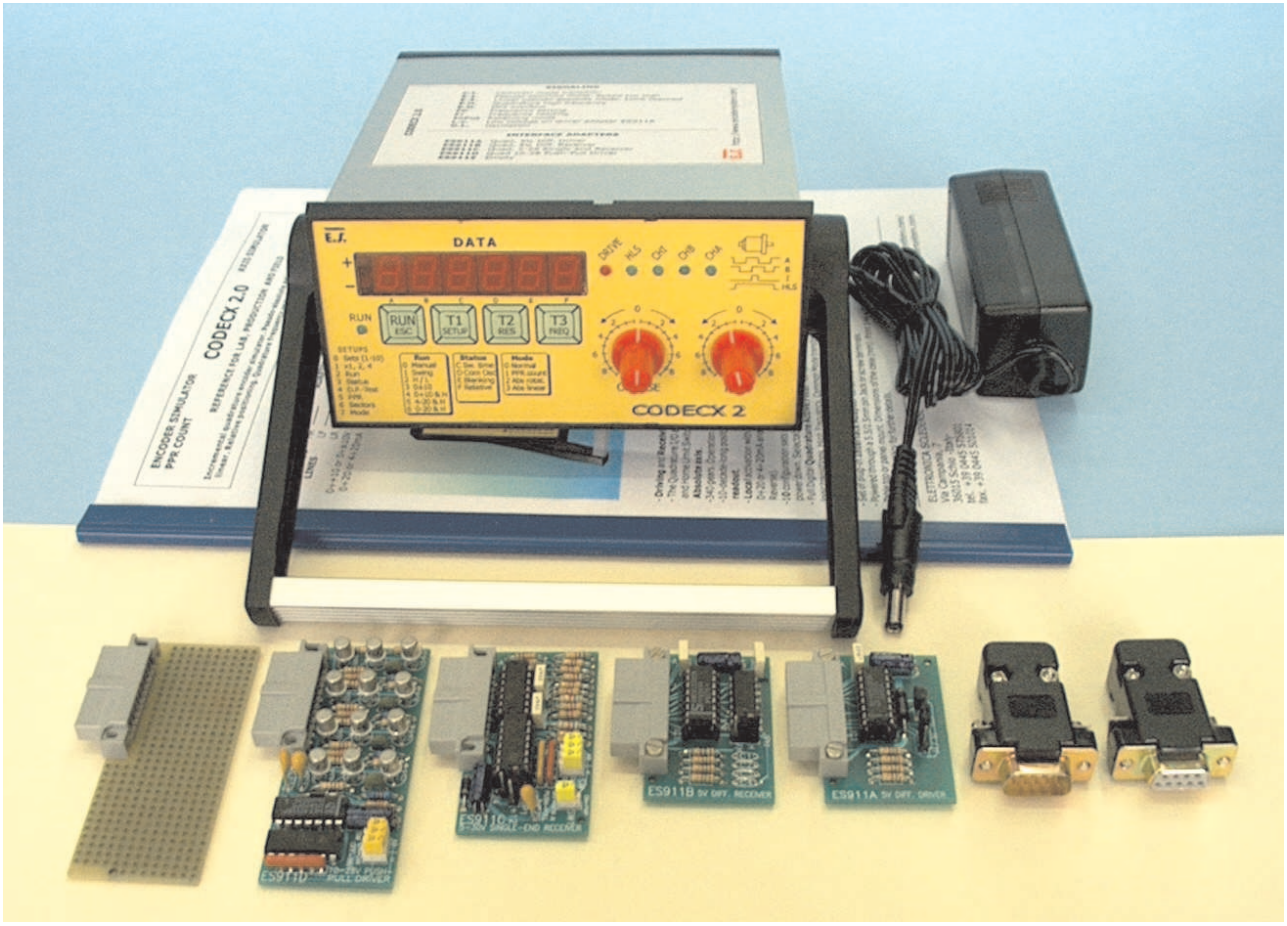


TABLE TOP



PANEL MOUNT

Aluminum Body:138,5 x 137 x 66
Frame: 144 x 72
Panel cutout: 138+1 x 68+0.7
Panel thickness: 1-10
Dimensions are in millimeters



ITEM LIST: One of each

1 - Codecx 2.0
2 - Main Adaptor, 50/60Hz, 90-240Vac/24Vdc 0,8A
3 - Adapter ES911A, Quad Driver 5V RS-422 10MHz
4 - Adapter ES911B, Quad Receiver 5V RS-422 10MHz
5 - Adapter ES911C, Quad Receiver 5-28V single-ended PNP, NPN or Push-Pull 200KHz
6 - Adapter ES911D, Quad Driver 5-28V Push-Pull 200KHz
7 - Adapter ES911Z, Empty, drilled 0,1" for customer purpose
8 - Hooded 9DB Male
9 - Hooded 9DB Socket
10 - User's Manual