

## QUADRATURE CLOCK CONVERTER

June 2015

### FEATURES:

- x1 and x4 mode selection
- Up to 16MHz output clock frequency
- Programmable output clock pulse width
- On-chip filtering of inputs for optical or magnetic encoder applications.
- TTL and CMOS compatible I/Os
- +3V to +12V operation ( $V_{DD} - V_{SS}$ )
- **LS7083N, LS7084N** (DIP);
- **LS7083NS, LS7084NS** (SOIC) - See Figure 1

### Applications:

- Interface incremental encoders to Up / Down Counters (See Figure 6A and Figure 6B)
- Interface rotary encoders to Digital Potentiometers (See Figure 7)

### DESCRIPTION:

The **LS7083N** and **LS7084N** are CMOS quadrature clock converters. Quadrature clocks derived from optical or magnetic encoders, when applied to the A and B inputs of the **LS7083N** or **LS7084N**, are converted to strings of Up Clocks and Down Clocks (**LS7083N**) or to a Clock and an Up/Down direction control (**LS7084N**). These outputs can be interfaced directly with standard Up/Down counters for direction and position sensing of the encoder.

### INPUT/OUTPUT DESCRIPTION:

#### RBIAS (Pin 1)

Input for external component connection. A resistor connected between this input and  $V_{SS}$  adjusts the output clock pulse width (Tow). For proper operation, the output clock pulse width must be less than or equal to the A, B pulse separation ( $TOW \leq T_{PS}$ ).

#### $V_{DD}$ (Pin 2)

Supply Voltage positive terminal.

#### $V_{SS}$ (Pin 3)

Supply Voltage negative terminal.

#### A (Pin 4)

Quadrature Clock Input A. This input has a filter circuit to validate input logic level and eliminate encoder dither.

#### B (Pin 5)

Quadrature Clock Input B. This input has a filter circuit identical to input A.

#### Mode (Pin 6)

Mode is a 3-state input to select resolutions x1, x2 or x4. The selected resolution multiplies the input quadrature clock rate by 1, 2 and 4, respectively, in producing the outputs  $\overline{UPCK}$  /  $\overline{DNCK}$  and CLK (see Figure 2).

The Mode input logic levels selects resolutions as follows:

**Logic 0 = x1    Float = x2    Logic 1 = x4**

### PIN ASSIGNMENT - TOP VIEW

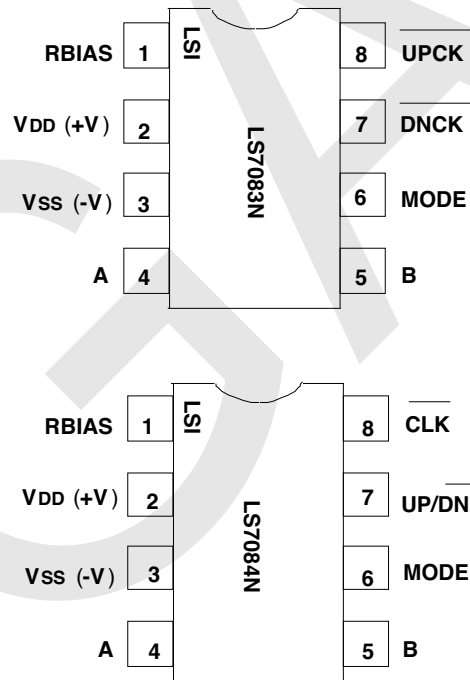


FIGURE 1

#### LS7083N - $\overline{DNCK}$ (Pin 7)

In **LS7083N**, this is the DOWN Clock Output. This output consists of low-going pulses generated when A input lags the B input.

#### LS7084N - $\overline{UP/DN}$ (Pin 7)

In **LS7084N**, this is the count direction indication output. When A input leads the B input, the  $\overline{UP/DN}$  output goes high indicating that the count direction is UP. When A input lags the B input,  $\overline{UP/DN}$  output goes low, indicating that the count direction is DOWN.

#### LS7083N - $\overline{UPCK}$ (Pin 8)

In **LS7083N**, this is the UP Clock output. This output consists of low-going pulses generated when A input leads the B input.

#### LS7084N - CLK (Pin 8)

In **LS7084N**, this is the combined UP Clock and DOWN Clock output. The count direction at any instant is indicated by the  $\overline{UP/DN}$  output (Pin 7).

**NOTE:** For the **LS7084N**, the timing of  $\overline{CLK}$  and  $\overline{UP/DN}$  requires that the counter interfacing with **LS7084N** counts on the rising edge of the CLK pulses.

**ABSOLUTE MAXIMUM RATINGS:**

PARAMETER	SYMBOL	VALUE	UNITS
DC Supply Voltage	$V_{DD} - V_{SS}$	16	V
Voltage at any input	$V_{IN}$	$V_{SS}-0.3$ to $V_{DD}+0.3$	V
Operating temperature	$T_A$	-20 to +85	°C
Storage temperature	$T_{STG}$	-55 to 150	°C

**DC ELECTRICAL CHARACTERISTICS:** (Unless otherwise specified  $V_{DD} = 3V$  to  $12V$  and  $T_A = -20^\circ C$  to  $+85^\circ C$ )

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITION
Supply Voltage	$V_{DD}$	3	-	12	V	-
Supply Current	$I_{DD}$	-	1.5	1.65	mA	$V_{DD} = 12V$ , all input frequencies=0 Hz and $R_{BIAS} = 2M\Omega$

**MODE INPUT:**

Logic 0	$V_{ml}$	-	-	0.5	V	-
Logic 1	$V_{mh}$	$V_{DD} - 0.5$	-	-	V	-
Logic Float	$V_{mf}$	$(V_{DD}/2) - 0.5$	$V_{DD}/2$	$(V_{DD}/2) + 0.5$	V	-
Logic 0 Input Current	$I_{ml}$	-	2.2	4.2	$\mu A$	$V_{DD} = 3V$
	$I_{ml}$	-	3.5	6.9	$\mu A$	$V_{DD} = 5V$
	$I_{ml}$	-	8.3	16.2	$\mu A$	$V_{DD} = 12V$
Logic 1 Input Current	$I_{mh}$	-	-2	-9.8	$\mu A$	$V_{DD} = 3V$
	$I_{mh}$	-	-3.4	-6.6	$\mu A$	$V_{DD} = 5V$
	$I_{mh}$	-	-8.2	-16	$\mu A$	$V_{DD} = 12V$

**A,B INPUTS:**

Logic 0	$V_{ABl}$	-	-	$0.25V_{DD}$	V	-
Logic 1	$V_{ABh}$	$0.7V_{DD}$	-	-	V	-
Input Current	$I_{ABlk}$	-	0	10	nA	-

**RBIAS INPUT:**

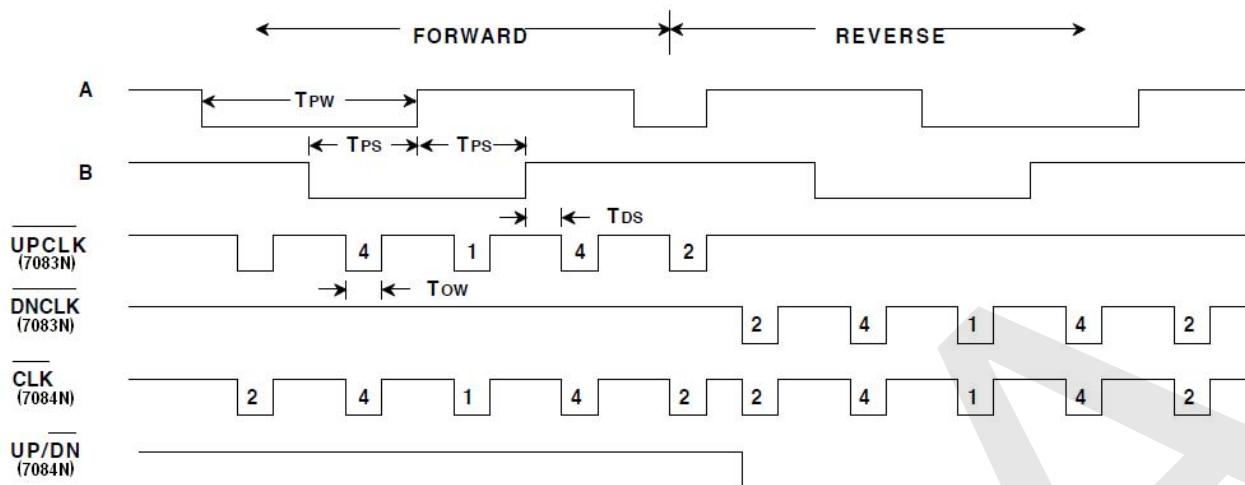
External Resistor	$R_B$	2K	-	10M	$\Omega$	-
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**ALL OUTPUTS:**

Sink Current	$I_{ol}$	-	-3.2	-	mA	-
	$I_{ol}$	-	-4.8	-	mA	-
	$I_{ol}$	-	-7.2	-	mA	-
Source Current	$I_{oh}$	-	1.7	-	mA	-
	$I_{oh}$	-	2.2	-	mA	-
	$I_{oh}$	-	3.1	-	mA	-

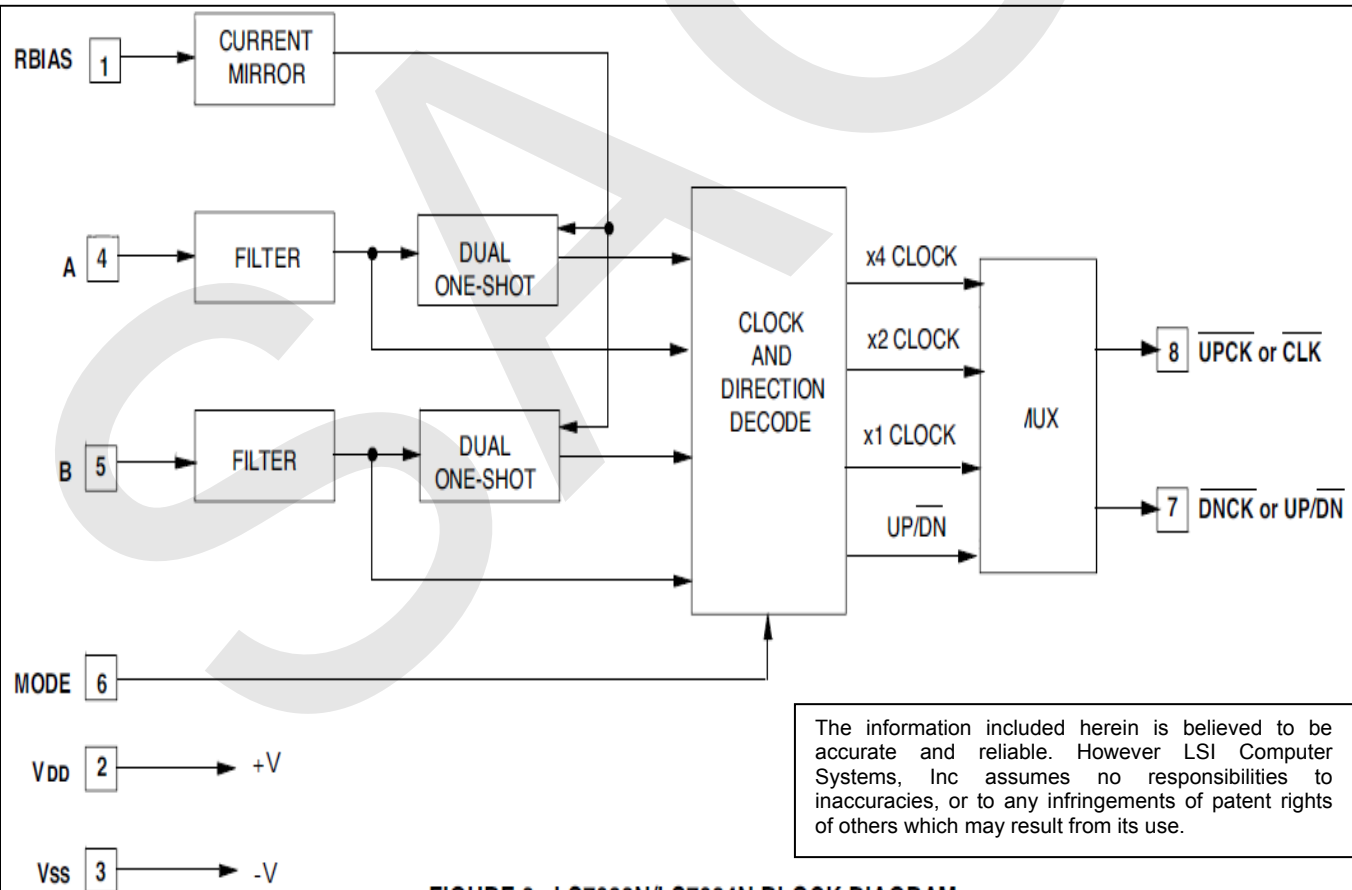
**TRANSIENT CHARACTERISTICS ( $T_A = -20^\circ C$  to  $+85^\circ C$ )**

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	CONDITION
Output Clock Pulse Width	$T_{OW}$	540	-	-	ns	$V_{DD} = 3V$
	$T_{OW}$	180	-	-	ns	$V_{DD} = 5V$
	$T_{OW}$	60	-	-	ns	$V_{DD} = 12V$
A,B INPUTS: Validation Delay	$T_{VD}$	-	450	-	-	$V_{DD} = 3V$
	$T_{VD}$	-	200	-	-	$V_{DD} = 5V$
	$T_{VD}$	-	90	-	-	$V_{DD} = 12V$
Phase Delay	$T_{PS}$	$T_{VD}+T_{OW}$	-	$\infty$	s	-
Pulse Width	$T_{PW}$	$2T_{PS}$	-	$\infty$	s	-
Frequency	$f_{A,B}$	-	-	$1/(2T_{PW})$	Hz	-
Input to output Delay	$T_{DS}$	-	490	565	ns	$V_{DD} = 3V$
	$T_{DS}$	-	220	345	ns	$V_{DD} = 5V$
	$T_{DS}$	-	125	135	ns	$V_{DD} = 12V$



**NOTE:** Output clocks labeled 1, 2 and 4 have the following interpretations.  
 1: Generated in x1, x2 and x4 modes  
 2: Generated in x2 and x4 modes only  
 4: Generated in x4 mode only

**FIGURE 2. LS7083N / LS7084N INPUT / OUTPUT TIMING**



The information included herein is believed to be accurate and reliable. However LSI Computer Systems, Inc assumes no responsibilities to inaccuracies, or to any infringements of patent rights of others which may result from its use.

**FIGURE 3. LS7083N/LS7084N BLOCK DIAGRAM**

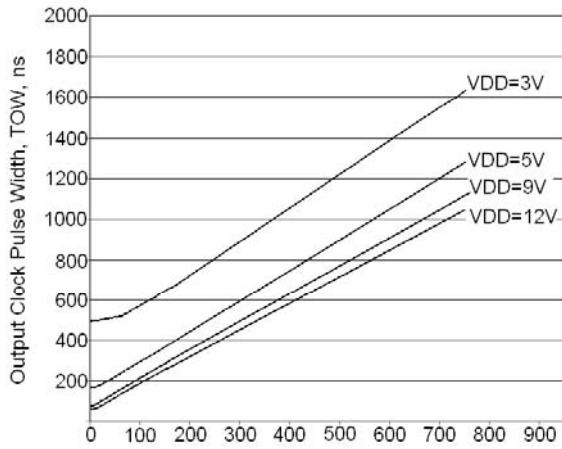


Figure 4.  $T_{OW}$  vs.  $R_{BIAS}$  ( $R$  in  $K\Omega$ )

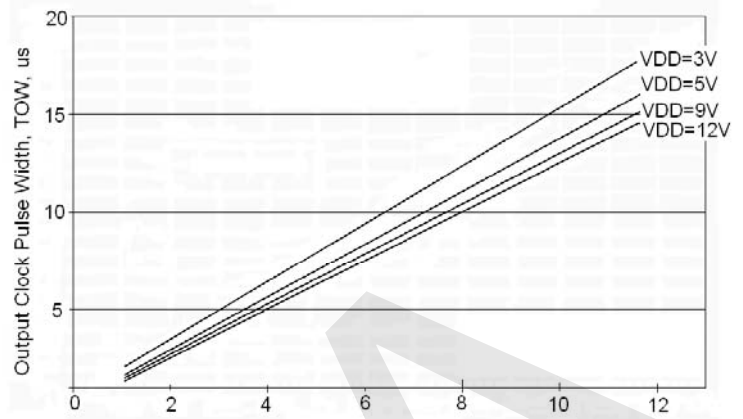


Figure 5.  $T_{OW}$  vs.  $R_{BIAS}$  ( $R$  in  $M\Omega$ )

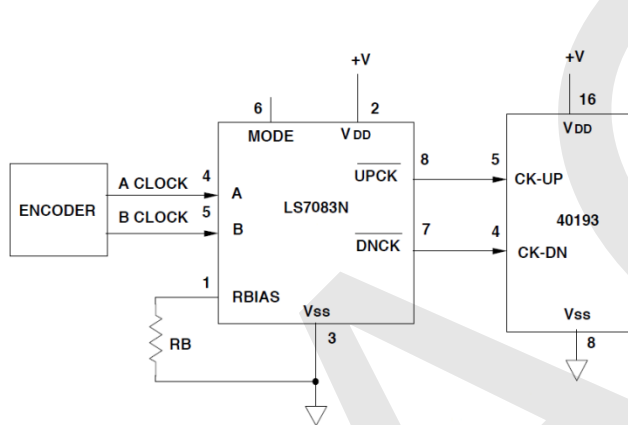


Figure 6A. Typical application for 7083N in x4 mode

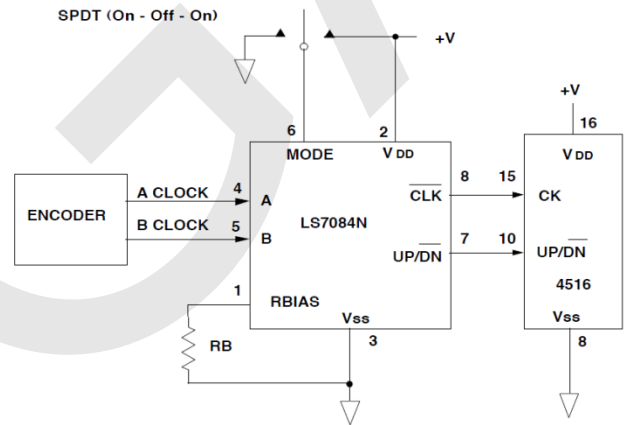


Figure 6B. Typical application for LS7084N in x2 mode

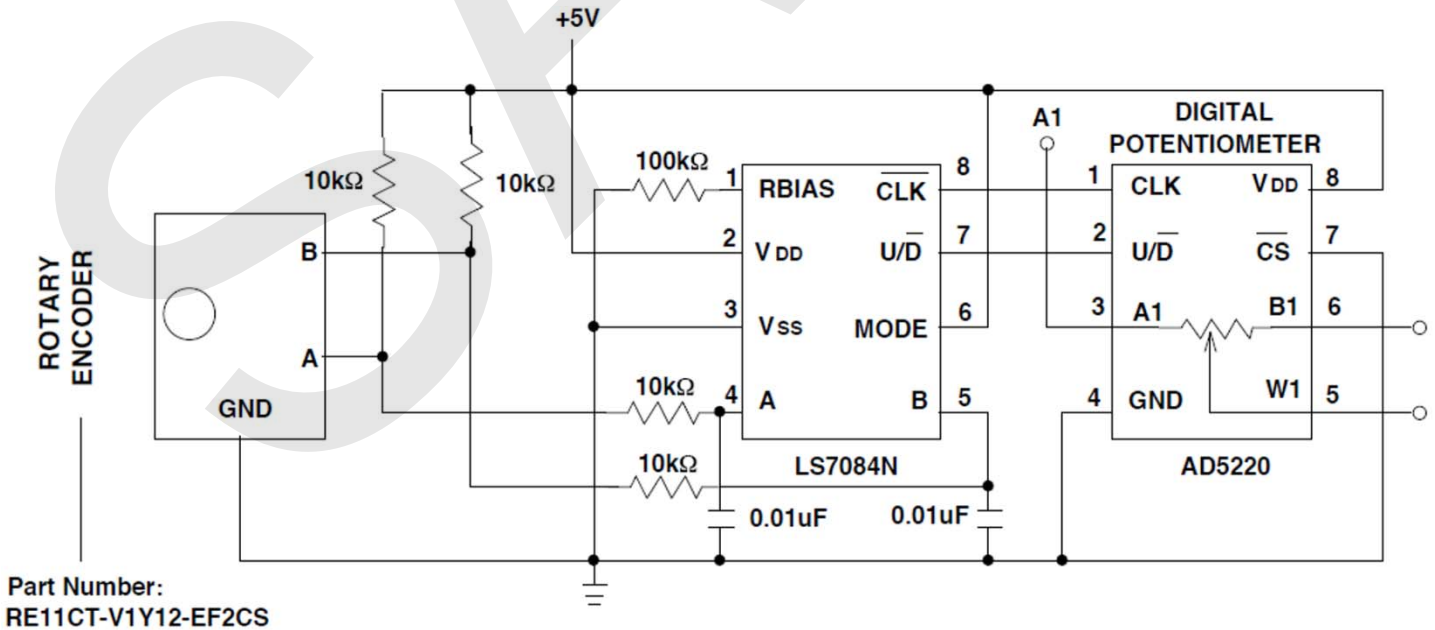


Figure 7. Rotary encoder control of digital potentiometer