CK1612 - FOUR DIGIT UP/DOWN COUNTER

INTRODUCTION
This is a low cost 4-digit Up/Down counter. Count range is from 0000, 1, 2 … to 9999 (counting up) or 0000, 9999, 9998, …. 0001 (counting down). The Overflow output pulses low when the count wraps around to zero. This output allows two counters to be connected together to make an 8 digit counter. The counter should really be only used for counting up or down in any particular application. However, if you know the count will not get near 9000 then you could connect the DOWN pins as required so that combined up/down readings will be summed. A later version of this counter will indicate if the count is positive or negative using a minus sign

There are 5 pairs of pins:
RESET
CLOCK
DOWN
DISABLE
OVERFLOW

The right hand pin of every pair is a ground pin. This can be checked by looking at the back of the PCB. A track joins all 5 right hand pins together (when looked at from the front.) All inputs are normally pulled high by the counter circuitry. The function of each pin pair may be driven by simple "make" contacts between the high and the low pin. That is, they are touched together. This can be from switches, relays, open collector outputs or just putting a jumper across two pins

The counter is triggered by a negative edge on its **CLOCK** input. That is, the CLOCK positive pin is momentarily connected to ground. The Clock input is debounced in the software to prevent false triggering when mechanical switches inputs are used. The debounce time is approx 15msec for each low/high or high/low transition, giving a maximum count rate of 3**0 to 35 counts per second.** The counters may be easily mounted together so the displays can merge together. You can work out for yourself how many months this dual unit will count for before an overflow is generated.

A **DOWN** input controls whether the counter counts up or down. When nothing is connected the counter counts up.

The **DISABLE** input, when low, prevents any counting at all.

The **RESET** input resets the counter to 0000.

The **OVERFLOW** output pulses low when the counter reaches 0000. The output pulse width is set at 25mS. However, this may vary a bit depending on the IC (see "Circuit Description – Note").

POWER SUPPLY
A 9 to 15V DC supply is required to power the kit, which has a current consumption of 20mA to 40mA, depending on the number displayed. The kit is constructed on single-sided printed circuit board using Protel for DOS.

CONSTRUCTION
Start with the lowest height components first like the resistors, diodes and IC socket. Next add the small capacitors and transistors. Lastly are the electrolytic capacitor and display. The electrolytic capacitor, diodes and transistors need to be inserted the correct way around. These are marked on the PCB overlay. Space is provided so the electrolytic capacitor may be laid on its side.

CIRCUIT DESCRIPTION
The circuit used in this kit uses only one IC – the AT90S1200. It is one of the AVR family of RISC based microcontrollers from ATMEL. The PDF data sheet can be viewed at "**www.atmel.com"**

The IC is preprogrammed. Using a microcontroller greatly reduces the component count while providing more features than could be found using dedicated logic ICs. Cost is also lower. The AT90S1200 was the choice in this kit because it has an internal RC oscillator, eliminating the need for an external crystal and loading capacitors.

NOTE: The speed of this internal oscillator may vary from chip to chip so the counting speeds may vary a bit.

The display is a single unit, common anode LED, MUX (multiplexed) display. This means that the anodes of every segment in a digit are connected together (internally) while the cathodes of like segments in each digit are tied to a common 7-segment bus line (A, B, C, etc). This minimizes the number of pins needed to drive the display but requires a more complex method to do it.

Multiplexing is a technique where each display is "active" for a short period of time. In this kit, each digit is turned ON once every 8mS for a period of 1mS. There is an OFF time of 1mS between digits.

Resistors R1-7 limit the maximum current that can flow through each segment. Transistors Q1-4 provide power to each digit.

Each input to the IC is connected via an RC network. This RC network provides some protection against high frequency noise. For the values used the time constant is approx. 20uS. Shorter duration pulses will not get through.

Transistor Q5 provides an active low, open collector overflow signal. Zener diode Z1 protects the transistor against high voltage spikes if it is used to drive an inductive load like a relay. The circuitry is powered by IC2, a 5V regulator. Diode D1 protects against polarity reversal on its input. Male and female right-angle connectors have been provided to ease connecting to the Counter to external circuitry.

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SOFTWARE

We have not provided the source code. In outline the software is arranged along the following lines:

Initialization is only executed once when the counter is powered up or reset. It sets up the I/O ports and internal flags and registers and sets the counter output to 0000.

Timer Overflow Interrupts occur every 200uS. They are used to update other software timers & refresh the display.

Main Loop is where the various inputs are checked. If a valid clock input occurs and the disable input is not active then the count up or count down routine is called depending on the direction input.

Count Up and **Count Down** routines which increment or decrement internal registers that are used to hold the count value. The internal count is stored as a BCD value. This eliminates the need to do a binary to BCD conversion before displaying the result. These routines also detect any counter overflow and pulse the Overflow output if necessary.

BCD to 7-Segment Conversion takes the current count value, converts it to seven segment data values and saves it in separate registers. These registers are used by the timer interrupt routine to display the count value.

IF IT DOES NOT WORK

Poor soldering ("dry joints") is the most common reason that the circuit does not work. Check all soldered joints carefully under a good light. Re-solder any that look suspicious. Check that all components are in their correct position on the PCB. Are the diodes and electrolytic capacitor the right way round?
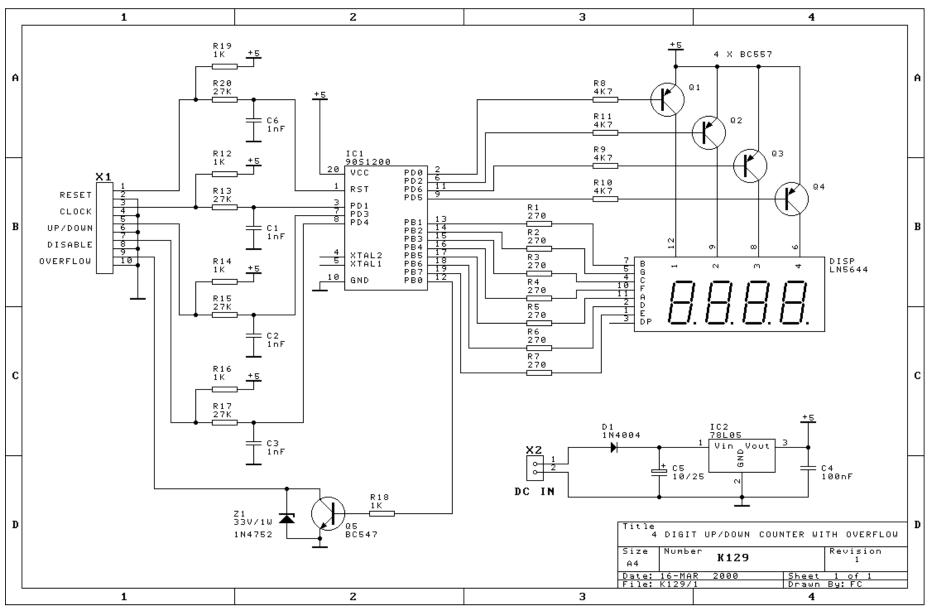
Use a multimeter to measure the DC input voltage on the cathode of D1. It should be at least 8 volts. Anything less and the 5V regulator, IC2, will not operate correctly.

What about the transistors? Q5 is an NPN transistor while all the others are PNP types. Did you get them mixed up?

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PARTS LIST

Resistors (0.25W carbon)

270R	R1-7	7
1K	R12,14,16,18,19	5
4K7	R8-11	4
27K	R13,15,17,20	4

Capacitors

1nF ceramic	C1,2,3,6	4
100nF monobloc	C4	1
10uF 25V electrolytic	C5	1

Semiconductors

33V 1W zener diode	Z1	1
1N4004	D1	1
BC557 transistor, PNP	Q1-4	4
BC547 transistor, NPN	Q5	1
AT90S1200-12PC	IC1	1
ATMEL AVR Microcontroller, preprogrammed		
78L05, 5V regulator	IC2	1
LED display, 4 digit, common anode, LN5644R		1
PCB, K129		1
20 pin IC socket		1
male and female 10 pin connectors right angled		1 set
2-pin SIL header		1

R19
1K
+5

R20
27K

C6
1nF

+5

4 X BC557

R8
4K7   Q1

R11
4K7   Q2

R9
4K7   Q3

R10
4K7   Q4

R12
1K   +5

IC1
90S1200

R13
27K

C1
1nF

+5

X1

1
2   RESET
3
4   CLOCK
5
6   UP/DOWN
7
8   DISABLE
9
10 OVERFLOW

20 VCC   PD0   2
                PD2   6
1   RST   PD6   11
                PD5   9
3   PD1
7   PD3
8   PD4

PB1   13
PB2   14
PB3   15
PB4   16
PB5   17
PB6   18
PB7   19
PB0   12

4   XTAL2
5   XTAL1

10 GND

R14
1K   +5

R15
27K

C2
1nF

R1
270

R2
270

R3
270

R4
270

R5
270

R6
270

R7
270

DISP
LN5644

7   B
5   G
4   C
10 F
11 A
2   D
1   E
3   DP

R16
1K   +5

R17
27K

C3
1nF

D1
1N4004

IC2
78L05
Vin Vout

C5
10/25

C4
100nF

+5

X2
1
2
DC IN

Z1
33V/1W
1N4752

Q5
BC547

R18
1K

Title
4 DIGIT UP/DOWN COUNTER WITH OVERFLOW

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