Application Note 511
Using the DS1672 Low-Voltage Serial Timekeeping IC

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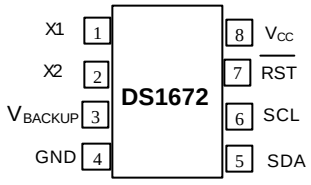
DESCRIPTION

The DS1672 is a low-voltage serial timekeeping IC. The DS1672 counts seconds in a 32-bit register. Using a 32-bit binary register instead of a BCD representation of the time and date, as many real-time clocks do, can be useful where time intervals are to be measured. The DS1672 operates from a low-voltage supply (2.0V, 3.0V, or 3.3V) and includes a V_{BACKUP} input, which allows the DS1672 to continue running the counter from a backup supply, such as a battery, while the main supply is off.

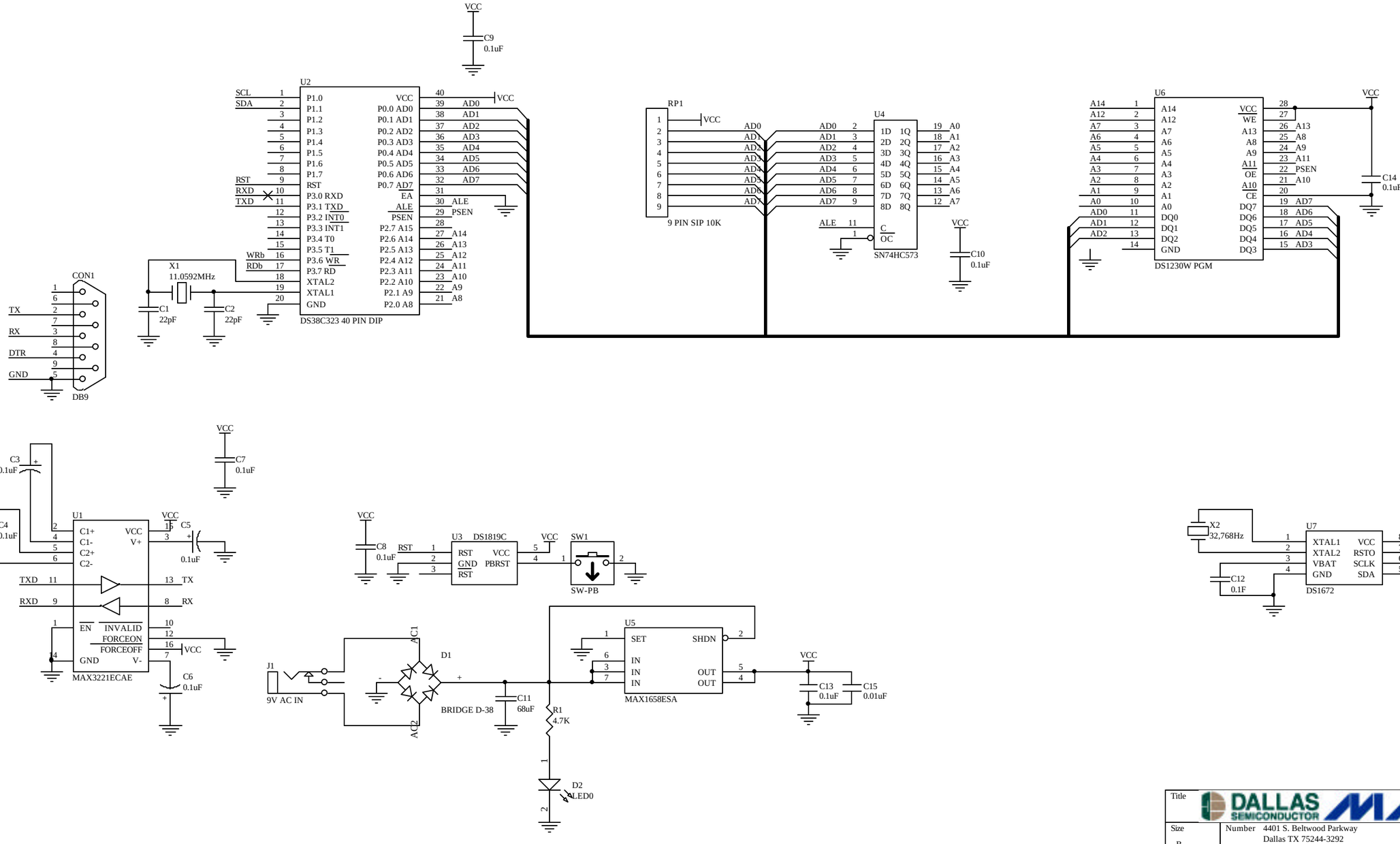
PIN ASSIGNMENT (Top View)



The DS1672 also incorporates a trickle charger. The trickle charger register uses four bits to enable the charger. Two bits are used to select one of three current-limiting resistors and two bits to select one or zero series diodes. The trickle charger circuit is capable of charging a rechargeable battery or a large capacitor. The V_{BACKUP} pin can also be connected to a nonrechargeable battery, such as a lithium coin-cell. In that case, the trickle charger should not be enabled.

In this example, the DS1672 is configured to charge a capacitor connected to V_{BACKUP}.

A schematic of the circuit is shown in the figure on page 2. Figure 2 shows the discharge voltage versus time in a typical application. Software for initializing the DS1672 and reading the registers is shown in Figure 3.



Title	DALLAS SEMICONDUCTOR MAXIM	
Size: B	Number 4401 S. Beltwood Parkway Dallas TX 75244-3292 DS1672 32-bit Binary Counter with trickle charger	Revision: A
Date: 16-Aug-2002	Sheet 1 of 1	
File: C:\Data\Designlab\DS1672AN\DS1672AN.ddb	Drawn By:	

Figure 2. DS1672-3 V_{BACKUP} Timekeeping Operation with 0.1F Backup Capacitor

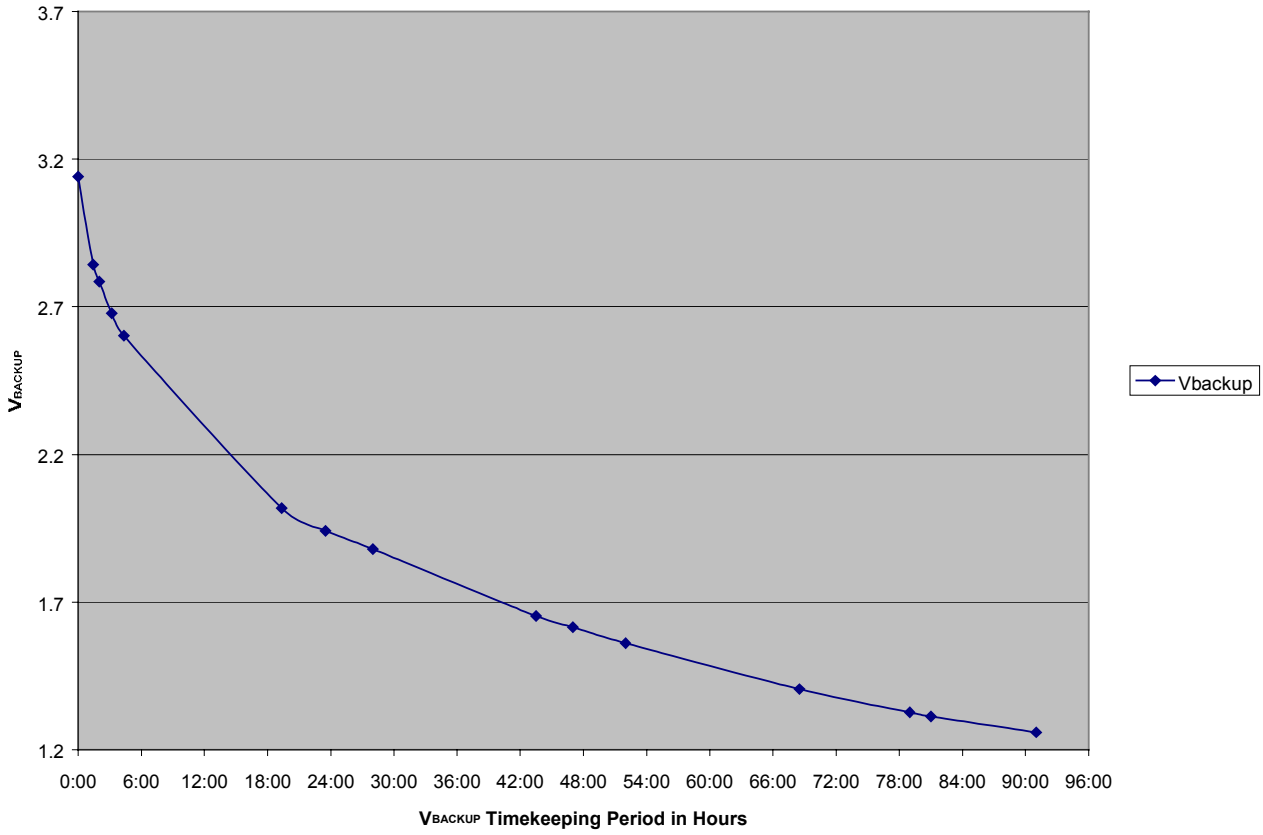


Figure 3. DS1672 Initialization Software

```
/*************************************************************************/
/* DS1672AN.C - This file is provided to show an example of communication  */
/* routines for interfacing to the DS1672.  These routines are provided    */
/* for example only and are not supported by Dallas Semiconductor/Maxim    */
/*************************************************************************/
#include    <stdio.h>         /* Prototypes for I/O functions */
#include    <DS5000.h>        /* Register declarations for DS5000 */
#define     ACK   0
#define     NACK  1
#define     ADDRTC      0xd0        /* 2-wire addresses */
sbit  scl = P1^0;             /* 2-wire pin definitions */
sbit  sda = P1^1;
sbit  RSTb = P0^2;
void  start2w();
void  stop2w();
void  writebyte2w(uchar d);
uchar readbyte2w(int);
void  writebyte1672();
void  initialize_DS1672();
void  disp_clk_regs();
void  en_tc();
unsigned long     date2day(uint, uint, uint, uint, uint, uint);
void  day2date(unsigned long);
/* global variables */

void start2w()          /* --------- Initiate start condition ---------- */
{
      sda = 1;  scl = 1;
      sda = 0;
}
void stop2w()           /* ---------- Initiate stop condition ----------- */
{
      sda = 0;  sda = 0;
      scl = 1;  scl = 1;  sda = 1;
}
void writebyte2w(uchar d)           /* ------------------------------ */
{
int i;

      scl = 0;
      for (i = 0;i < 8; i++)
      {
            if (d & 0x80)
                  sda = 1; /* Send the msbits first */
            else
                  sda = 0;
            scl = 0;
            scl = 1;
            d = d << 1; /* do shift here to increase scl high time */
            scl = 0;
      }
      sda = 1;    /* Release the sda line */
      scl = 0;
      scl = 1;
      if (sda) printf("Ack bit missing  %02X\n",(unsigned int)d);
      scl = 0;
}
uchar readbyte2w(int b) /* ---------------------------------- */
{
```

```
int i;
uchar d;

      d = 0;
      sda = 1;             /* Let go of sda line */
      scl = 0;
      for (i = 0; i < 8; i++) /* read the msb first */
      {
            scl = 1;
            d = d << 1;
            d = d | (unsigned char)sda;
            scl = 0;
      }
      sda = b;          /* low for ack, high for nack */
      scl = 1;
      scl = 0;

      sda = 1;          /* Release the sda line */
      return d;
}
void day2date(unsigned long x)      /* ------ convert binary time to date format ---
--- */
{
int   yrs = 99, mon = 99, day = 99, tmp, jday, hrs, min, sec;
unsigned long j, n;

      j = x / 60;                   /* whole minutes since 1/1/70 */
      sec = x - (60 * j);           /* leftover seconds */
      n = j / 60;
      min = j - (60 * n);
      j = n / 24;
      hrs = n - (24 * j);

      j = j + (365 + 366);          /* whole days since 1/1/68 */
      day = j / ((4 * 365) + 1);
      tmp = j % ((4 * 365) + 1);

      if(tmp >= (31 + 29))          /* if past 2/29 */
            day++;                  /* add a leap day */

      yrs = (j - day) / 365;        /* whole years since 1968 */
      jday = j - (yrs * 365) - day; /* days since 1/1 of current year */
      if(tmp <= 365 && tmp >= 60)   /* if past 2/29 and a leap year then */
            jday++;                 /* add a leap day */
      yrs += 1968;                  /* calculate year */

      for(mon = 12; mon > 0; mon--)
      {
            switch(mon)
            {
                  case 1:     tmp = 0;    break;
                  case 2:     tmp = 31;   break;
                  case 3:     tmp = 59;   break;
                  case 4:     tmp = 90;   break;
                  case 5:     tmp = 120;  break;
                  case 6:     tmp = 151;  break;
                  case 7:     tmp = 181;  break;
                  case 8:     tmp = 212;  break;
                  case 9:     tmp = 243;  break;
                  case 10:    tmp = 273;  break;
```

```
                  case 11:    tmp = 304;  break;
                  case 12:    tmp = 334;  break;
            }
            if((mon > 2) && !(yrs % 4))   /* adjust for leap year */
                  tmp++;
            if(jday >= tmp)   break;
      }
      day = jday - tmp + 1;         /* calculate day in month */

      printf("\n%04d %02d %02d %02d:%02d:%02d", yrs ,mon, day, hrs, min, sec);
}

/* ---- convert date to elapsed days in binary ---- */
unsigned long     date2day(uint yr, uint mo, uint da, uint hrs, uint min, uint sec)
{
unsigned long x;

      /* the following is broken down for clarity */
      x = 365 * (yr - 1970);              /* calculate number of days for previous
years */
      x += (yr - 1969) >> 2;              /* add a day for each leap year */
      if((mo > 2) && (yr % 4 == 0))       /* add a day if current year is leap and
past Feb 29th */
            x++;

      switch(mo)
      {
            case 1:     x += 0;     break;
            case 2:     x += 31;    break;
            case 3:     x += 59;    break;
            case 4:     x += 90;    break;
            case 5:     x += 120;   break;
            case 6:     x += 151;   break;
            case 7:     x += 181;   break;
            case 8:     x += 212;   break;
            case 9:     x += 243;   break;
            case 10:    x += 273;   break;
            case 11:    x += 304;   break;
            case 12:    x += 334;   break;
      }

      x += da - 1;                              /* finally, add the days into the
current month */
      x = x * 86400;                      /* and calculate the number of seconds in
all those days */
      x += (hrs * 1800);                  /* add the number of seconds in the hours
*/
      x += (hrs * 1800);                  /* add the number of seconds in the hours
*/
      x += (min * 60);                    /* ditto the minutes */
      x += sec;                           /* finally, the seconds */
      return(x);
}
void writebyte1672()    /* ---------------------------------------------- */
{
uchar Add;
uchar Data;
/* Get Address & Data */
   printf("\nEnter the Read Address\nADDRESS:");
   scanf("%bx", &Add);
```

```
   printf("\nDATA:");
   scanf("%bx", &Data);

   start2w();
   writebyte2w(ADDRTC);
   writebyte2w(Add);
   writebyte2w(Data);
   stop2w();
}
void initialize_DS1672()      /* ---------------------------------------- */
/* Note: NO error checking is done on the user entries! */
{
uchar a, b, c, d;
uint  yr, mn, dt, dy, hr, min, sec, day;
unsigned long y;

      start2w();
      writebyte2w(ADDRTC);
      writebyte2w(0x04);
      writebyte2w(0x00);            /* enable the oscillator */
      stop2w();

      printf("\nEnter the year (1970-2099): ");
      scanf("%d", &yr);
      printf("\nEnter the month (1-12): ");
      scanf("%d", &mn);
      printf("\nEnter the date (1-31): ");
      scanf("%d", &dt);
      /* printf("\nEnter the day (1-7): "); */
      /*   scanf("%d", &dy); */
      printf("\nEnter the hour (1-24): ");
      scanf("%d", &hr);
      printf("\nEnter the minute (0-59): ");
      scanf("%d", &min);
      printf("\nEnter the second (0-59): ");
      scanf("%d", &sec);

      y = date2day(yr, mn, dt, hr, min, sec);

      a = (y & 0xff);
      b = ((y >> 8) & 0xff);
      c = ((y >> 16) & 0xff);
      d = ((y >> 24) & 0xff);

      start2w();
      writebyte2w(ADDRTC);    /* write slave address, write 1672 */
      writebyte2w(0x00);      /* write register address, 1st clock register */
      writebyte2w(a);
      writebyte2w(b);
      writebyte2w(c);
      writebyte2w(d);
      stop2w();
}
void disp_clk_regs()          /* ---------------------------------------- */
{
uchar reg1, prv_sec = 99, reg2, reg3, reg4;
unsigned long z;

while(!RI)  /* Read & Display Clock Registers */
{
```

```
      start2w();
      writebyte2w(ADDRTC);    /* write slave address, write 1672 */
      writebyte2w(0x00);      /* write register address, 1st clock register */
      start2w();
      writebyte2w(ADDRTC | 1);      /* write slave address, read 1672 */
      reg1 = readbyte2w(ACK); /* starts w/last address stored in register pointer */
      reg2 = readbyte2w(ACK);
      reg3 = readbyte2w(ACK);
      reg4 = readbyte2w(NACK);
      stop2w();
      if(reg1 != prv_sec)     /* display every time seconds change */
      {
            z = reg4;
            z <<= 8;
            z += reg3;
            z <<= 8;
            z += reg2;
            z <<= 8;
            z += reg1;
            day2date(z);
      }
      prv_sec = reg1;
}
   RI = 0;  /* Swallow keypress to exit loop */
}
void  en_tc(dat)  /* ----- enable the trickle-charger ------ */
{
      start2w();
      writebyte2w(ADDRTC);
      writebyte2w(5);
      writebyte2w(dat);       /* enable the trickle-charger */
      stop2w();
}
main (void)       /* ------------------------------------------------------ */
{
uchar i, M, M1;

      RSTb = 1;
      while (1)
      {
            printf("\nDS1672\n");
            printf("I Init DS1672 D/E  Disable/Enable TC\n");
            printf("R Read Time   W Write Byte\n");
            printf("\nEnter Menu Selection:");

            M = _getkey();

            switch(M)
            {
                  case 'R':
                  case 'r':   disp_clk_regs();  break;

                  case 'W':
                  case 'w':   writebyte1672();  break;

                  case 'D':
                  case 'd':   en_tc(0);   break;

                  case 'E':
                  case 'e':   en_tc(0xa6);      break;
```

```
                case 'I':
                case 'i':   initialize_DS1672();    break;

            }
        }
}
```