PBLE01
Co-projeto de produtos eletrônicos

Manual
Grupo 1

Rev 1 - Nov/2022

Sumário

Identificação

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Data:

28/11/22

1 Introdução

Apresentar o objetivo deste documento.

O objetivo deste documento é apresentar os detalhes de projeto de uma placa de desenvolvimento de propósito geral desenvolvida ao decorrer do curso. Detalhes de projeto como cálculos das especificações de componentes, custos e modo de uso do circuito final serão explicitados.

2 Requisitos

Os requisitos elétricos do projeto estão dispostos na tabela a seguir.

Tabela 1: Requisitos técnicos quanto à alimentação

Requisito	Classe	Descrição
R1	Alimentação	- Suportar tensão de entrada de 7 a 10V (CC); - Empregar conector de alimentação do tipo *jack J4*; - Possuir proteção contra tensão reversa; - Possuir regulador linear com saída de 5V (CC); - Possuir regulador linear com saída de 3.3V (CC); - Possuir LED de indicação de tensão de alimentação;
R2	Operação/gravação do embarcado	- Empregar microcontrolador da família LCP1114; - Possuir barra de pinos para gravação do padrão *JTAG*; - Possuir circuito baseado em "*jumper*" para permitir a gravação serial através de transceptor USB-serial; - Chave tactil de reinício;
R3	Interface de Usuário	- Possuir teclado numérico de cinco (5) teclas com disposição de controle (botões direcionais e de confirmação); - Possuir barra de pinos de conexão para visor LCD; - Possuir quatro (4) LEDs para sinalização diversa;
R4	Periféricos e expansão	- Empregar relógio de tempo real; - Empregar conversor digital para analógico; - Possuir entrada para sinal analógico diferencial; - Possuir duas barras de expansão independentes cada qual com sinais de comunicação I²C, de referência (terra) e de alimentação; - Possuir barra de expansão de sinais para pinos não utilizados do microcontrolador e a contemplar os sinais de alimentação;
R5	Comunicação	- Empregar conversor USB-serial;

3 Ambiente de desenvolvimento

A tabela a seguir indica os recursos utilizados no projeto bem como suas versões,

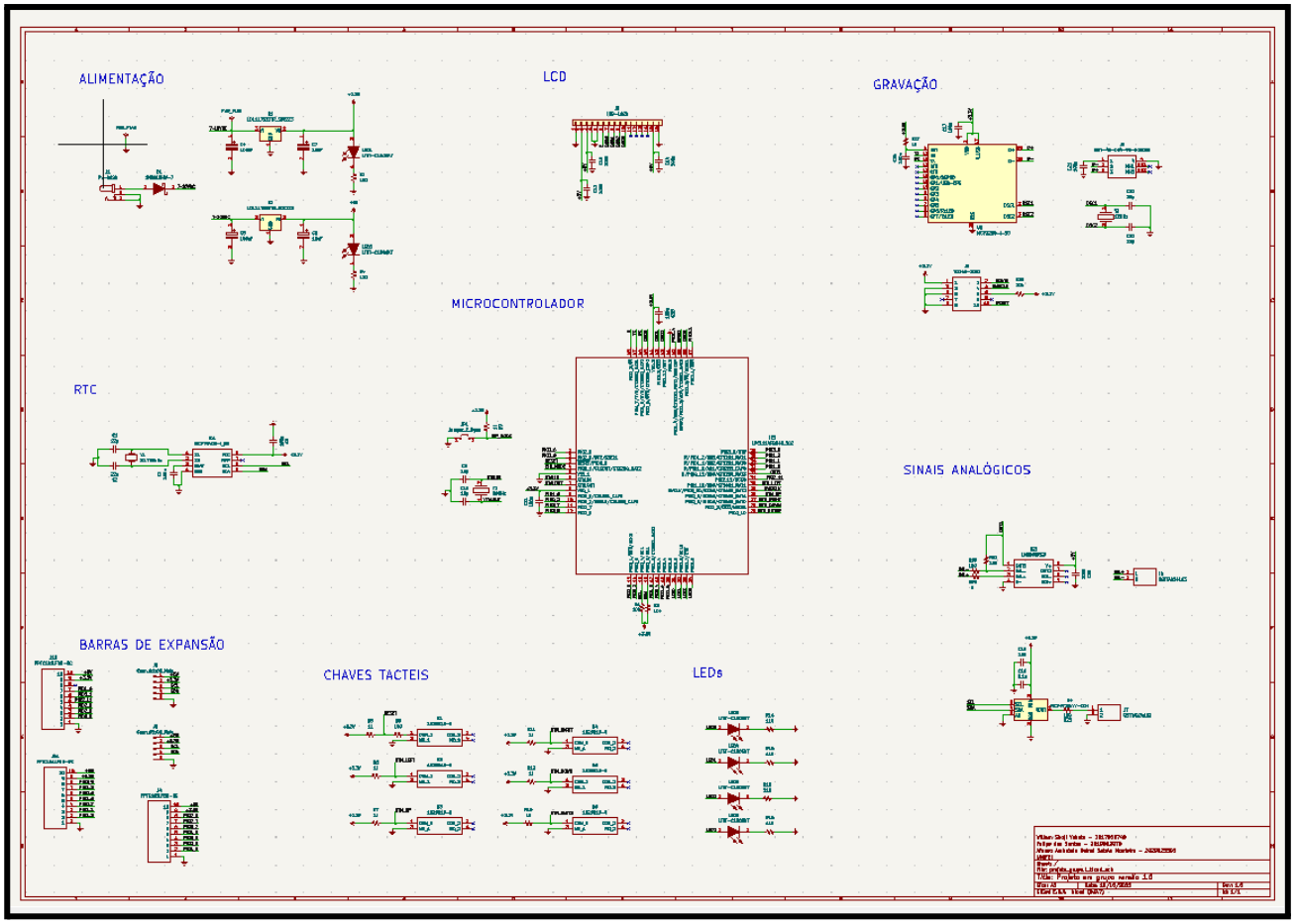
Tabela 2: Recursos de desenvolvimento

Recurso	Descrição	Versão
1	KiCad	6.0.7
2	MPLAB X IDE	6.05
3	PICSimLab	0.8.11

4 Esquema elétrico

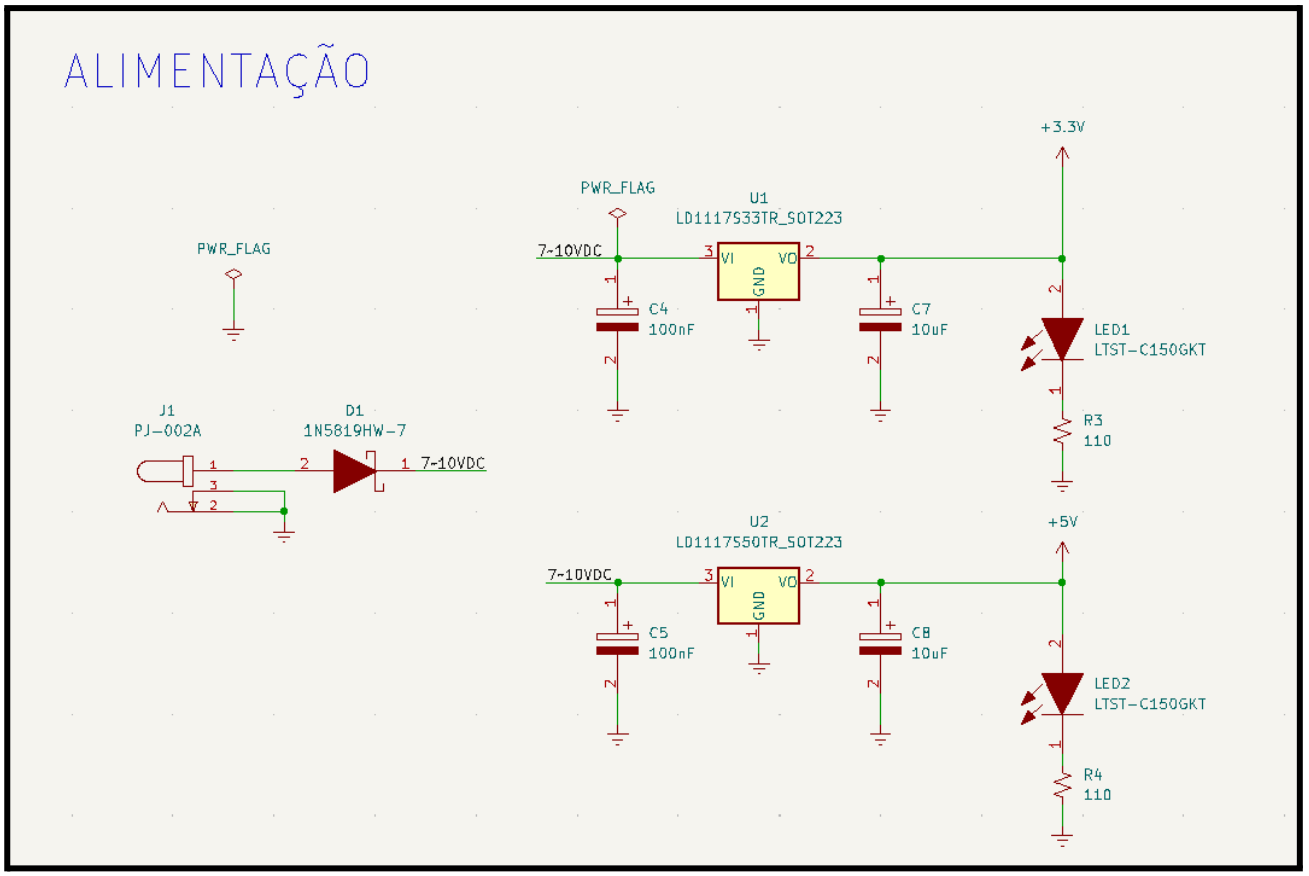
A partir dos requisitos, uma representação do esquema elétrico foi montada na ferramenta KiCad. Todo o projeto pôde ser desenvolvido em uma única página, subdividido nos seguintes blocos funcionais: alimentação, gravação, periféricos (relógio, sinais analógicos e barras de expansão) e interface (visor LCD, teclado e LEDs). Tais blocos funcionais vêm descritos a seguir.

4.1 Circuito Geral



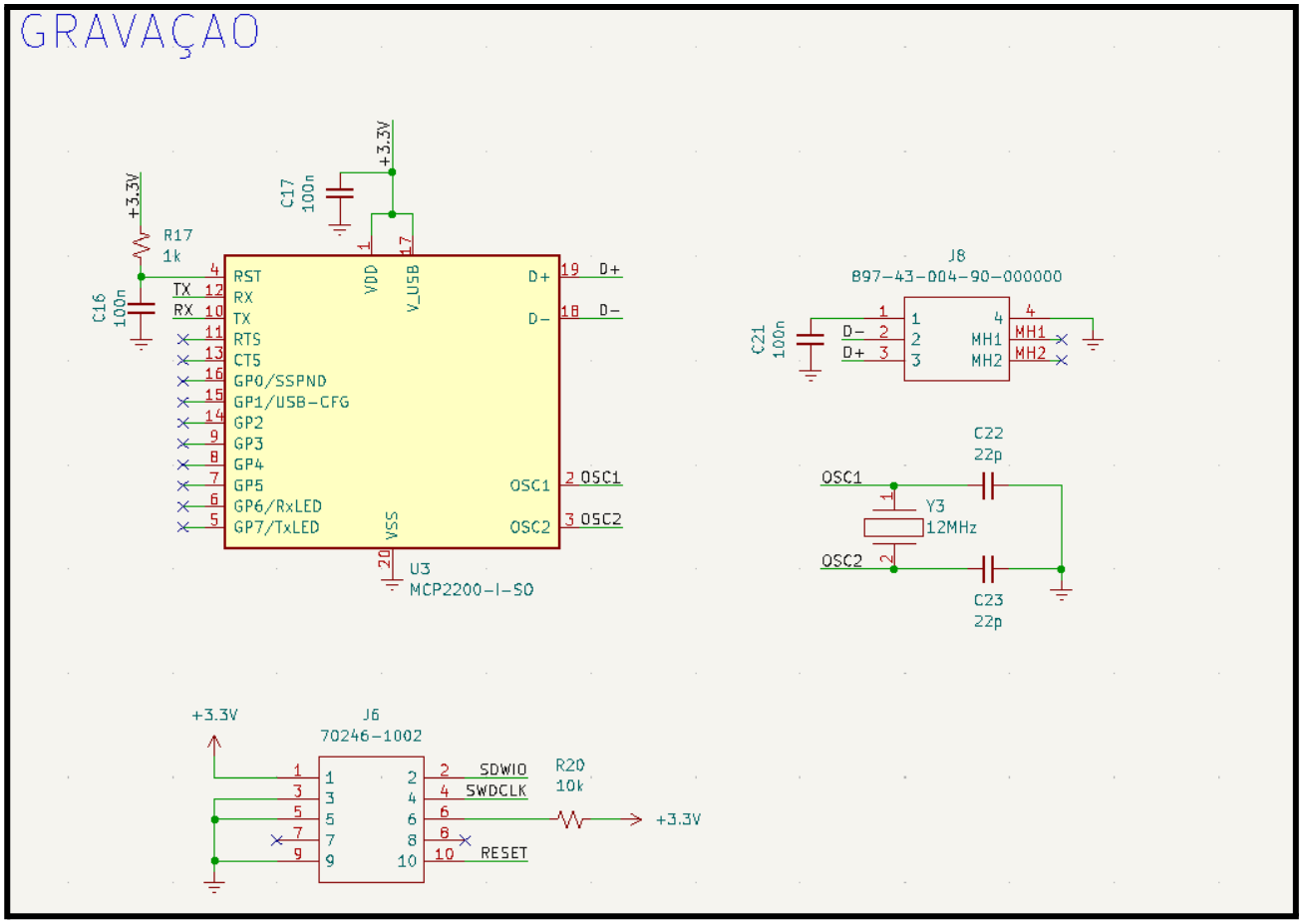
4.2 Circuito de alimentação

O primeiro bloco funcional é responsável por receber a alimentação do sistema e gerar sinais estáveis de 5V e 3.3V em corrente contínua. Também conta com um diodo para proteção contra polarização reversa.



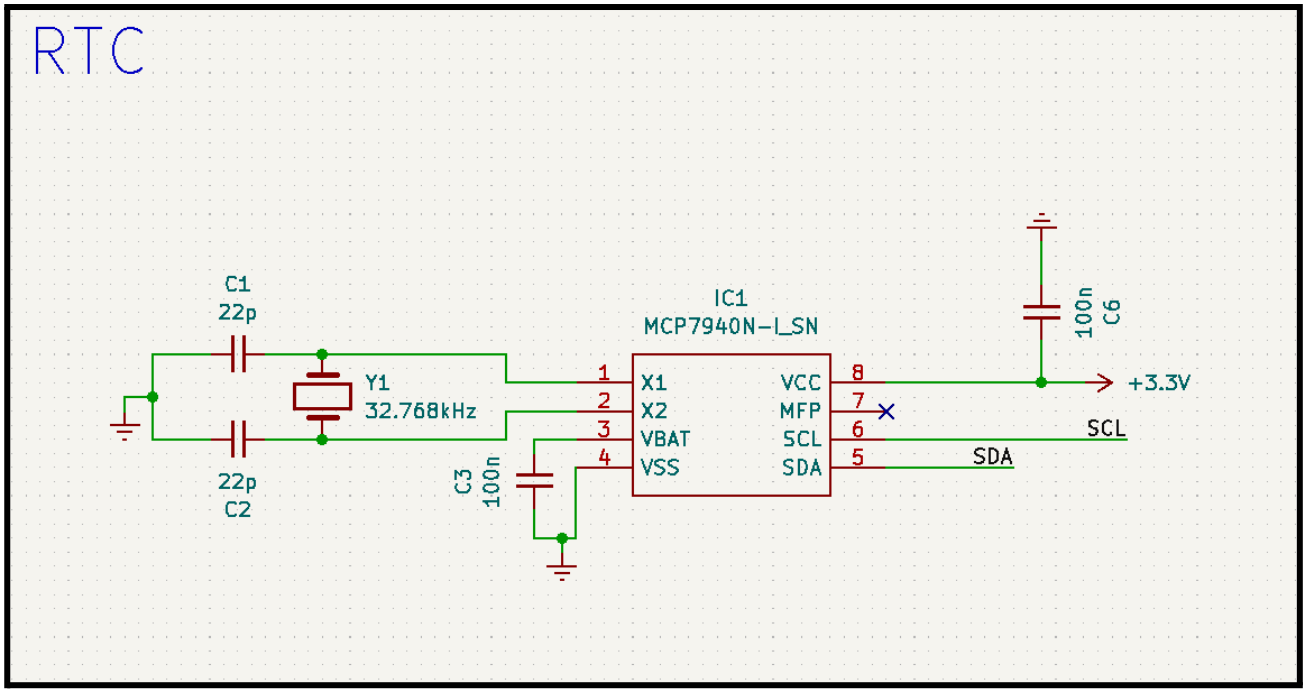
4.3 Circuito de gravação

O circuito de gravação conta com conectores JTAG e USB possibilitando que o firmware possa ser gravado de duas formas diferentes no microcontrolador.



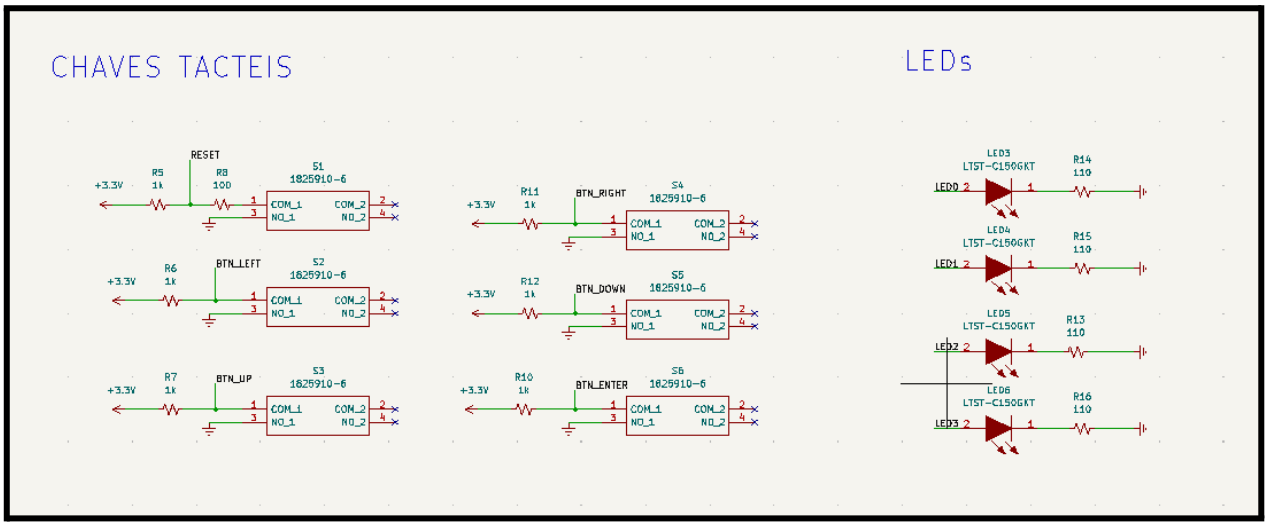
4.4 Circuito de relógio

Um dos periféricos presentes é um relógio de tempo real (*RTC*) responsável por fornecer horários de forma mais precisa, possibilitando ainda a configuração de alarmes. A comunicação entre o RTC e o microcontrolador se dá pelo protocolo *I²C*.



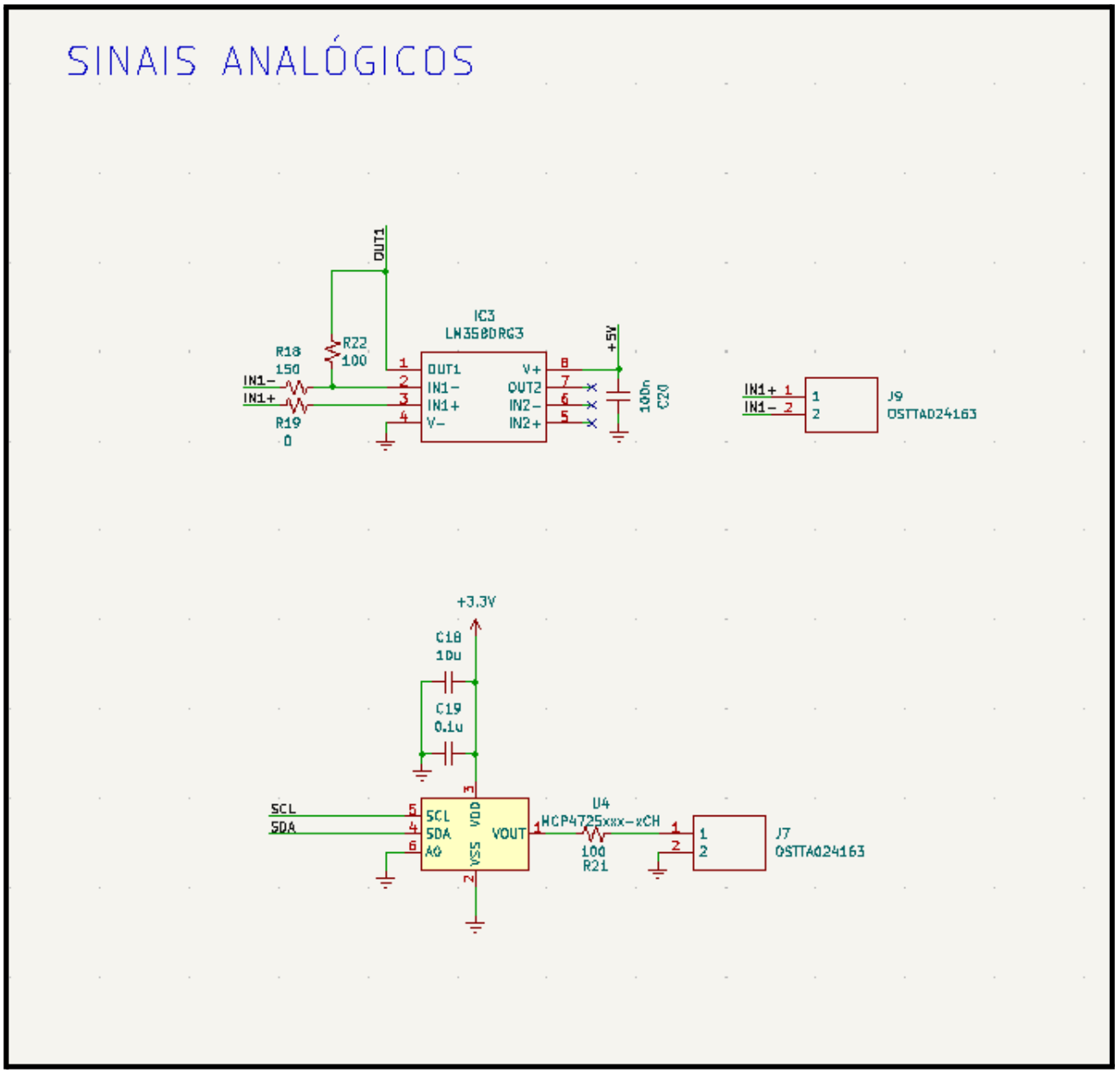
4.5 Circuito de chaves e LEDs

O circuito de teclado e LEDs é responsável pela interação com o usuário, possibilitando a navegação e seleção de funcionalidades no menu de controle do sistema, além de indicar estados através dos LEDs.



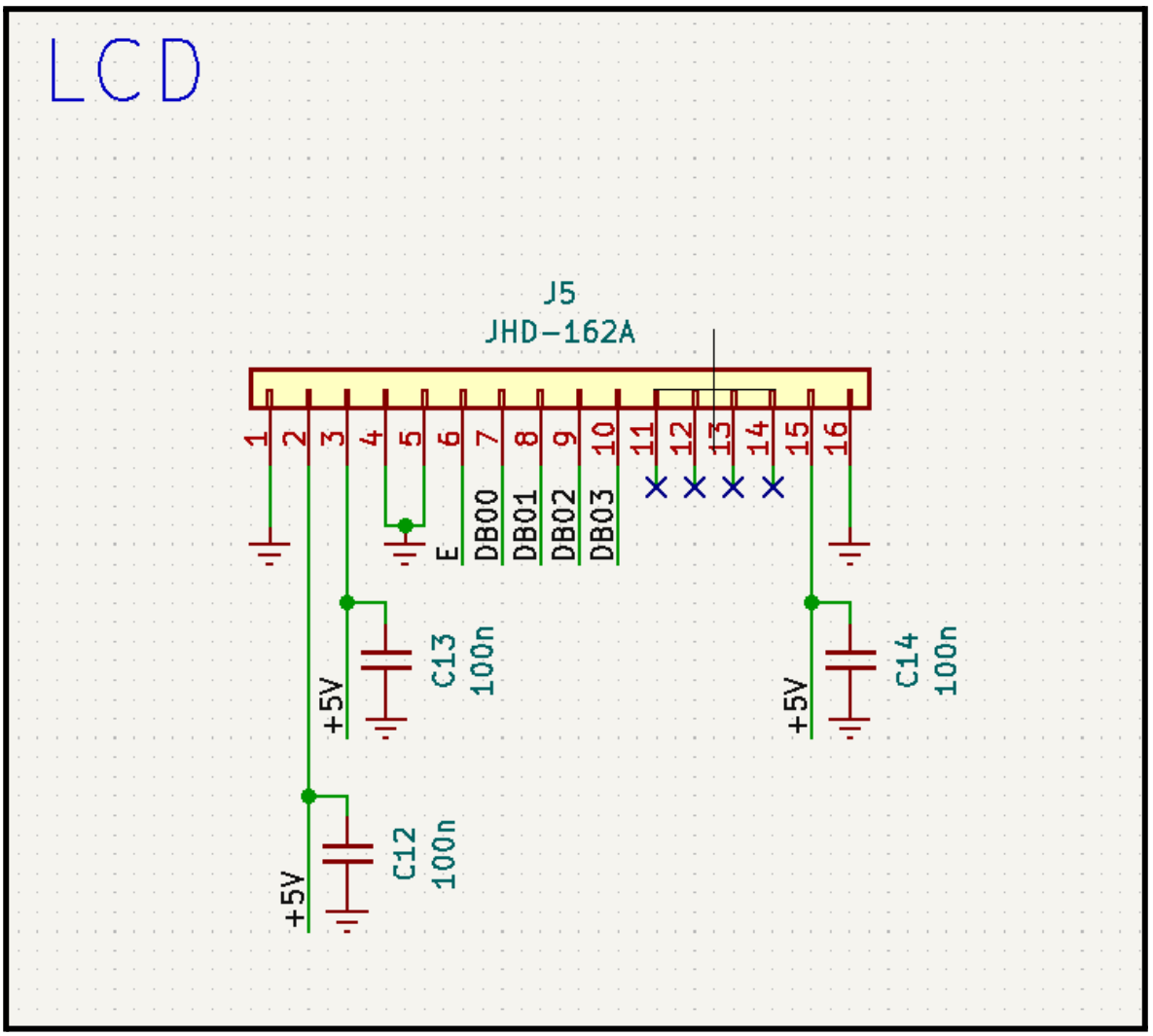
4.6 Circuito de sinais analógicos

O circuito de sinais analógicos conta com duas funcionalidades: ler dados de forma analógica e converter sinais digitais em analógicos. A entrada analógica é realizada por meio de um amplificador operacional com ganho equivalente às tensões de trabalho do microcontrolador (3.3V) e a saída analógica é realizada pelo conversor digital-analógico. Ambos possuem conectores diferenciais.



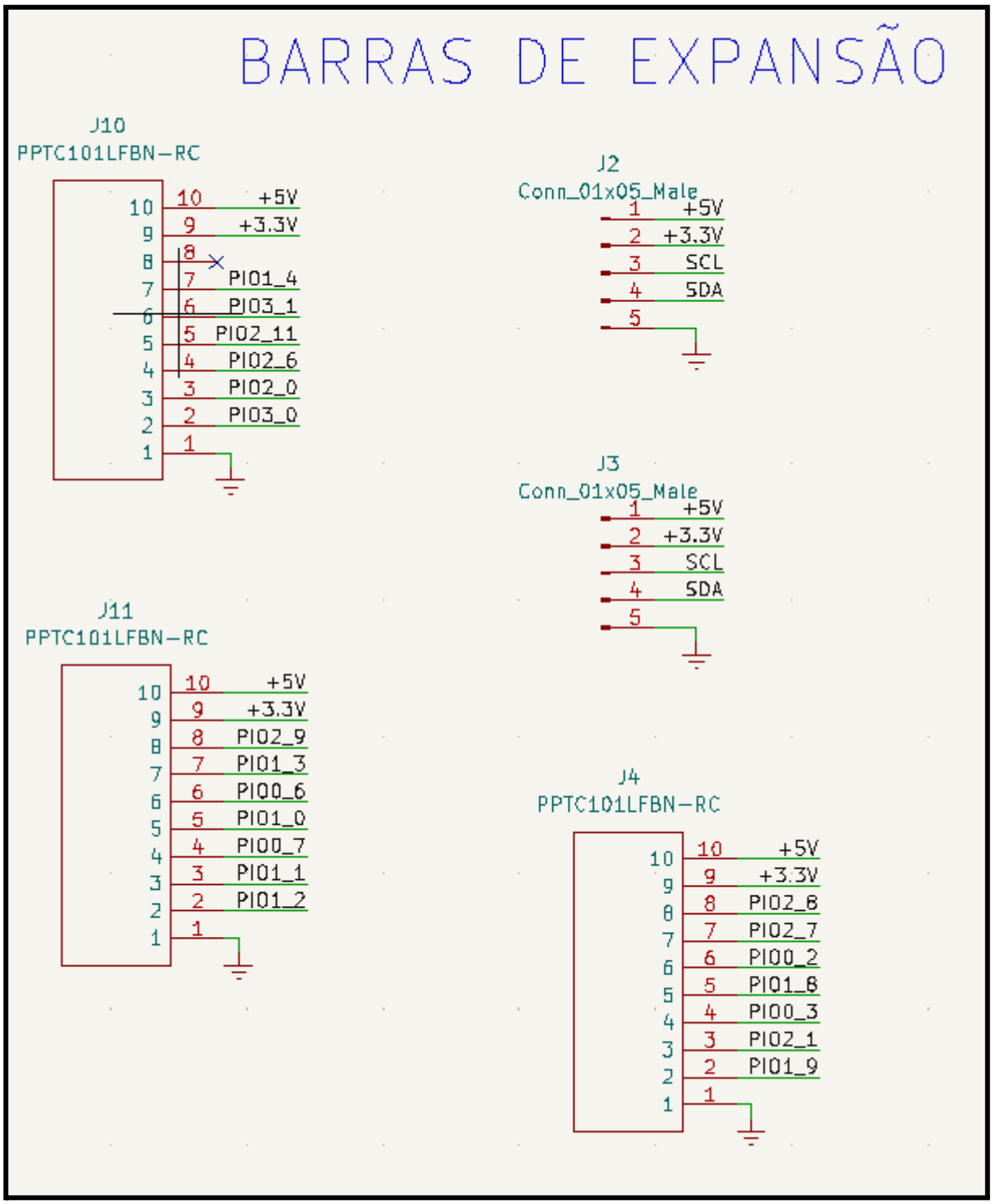
4.7 Circuito do LCD

O visor LCD é responsável pela interação com o usuário, sendo um dispositivo de saída.



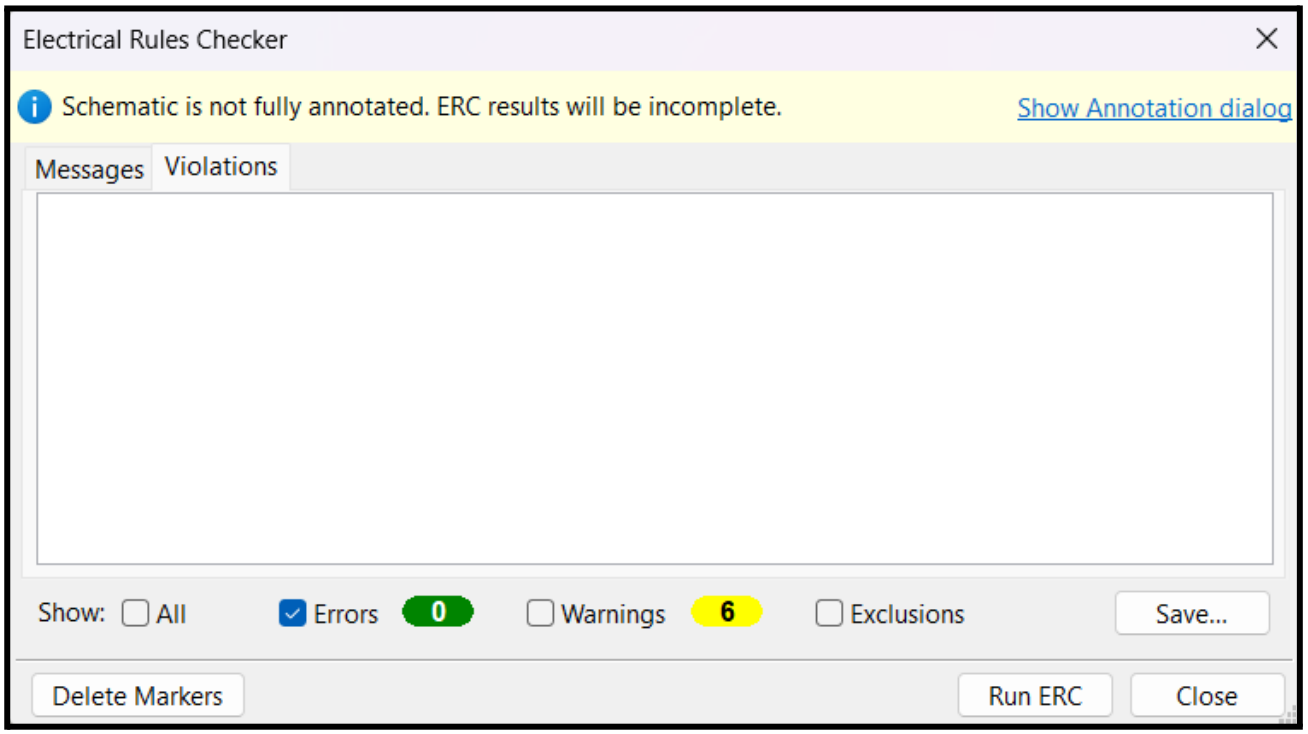
4.8 Circuito de barras de expansão

As barras de expansão estão previstas para garantir a possibilidade de futuras adaptações no projeto, além de dois canais de comunicação I²C com o microcontrolador para propósitos do usuário.



4.9 Relatório de verificação de erros de projeto elétrico

O relatório não apresentou erros e os avisos são relacionados a questões do próprio ambiente de desenvolvimento.



5 Placa de circuito impresso

Descrever o desenvolvimento da PCI e listar (de forma tabular) os requisitos de projeto para tanto (distanciamentos, número de faces, etc). Especificar caso tenha sido utilizado planos de “terra”.

A PCI foi desenvolvida a partir do esquema elétrico englobando as funcionalidades e periféricos nele apresentados.

Tabela 3: Requisitos da PCI

Requisito	Classe	Descrição
R1	Características gerais	- Ter dimensões de até 7x7cm; - Possuir dupla face de condução; - Utilizar a face inferior como plano de terra; - Possuir identificação dos componentes; - Possuir identificação do grupo de desenvolvimento; - Possuir identificação do pino de referência para conectores de programação e de alimentação; - Possuir identificação de pinos para demais conectores; - Possuir quatro furos de fixação posicionados nos cantos; - Possuir capacitores de supressão de tensão para todos os circuitos integrados;
R2	Espaçamento	- Mínima largura para trilhas de sinais: 8 mils; - Mínima largura para trilhas de alimentação: 12 mils; - Mínimo espaçamento entre linhas, furos e ilhas: 8 mils; - Mínimo diâmetro de furo de vias: 12 mils; - Mínimo diâmetro de ilhas de vias: 25 mils; - Não utilizar microvias;

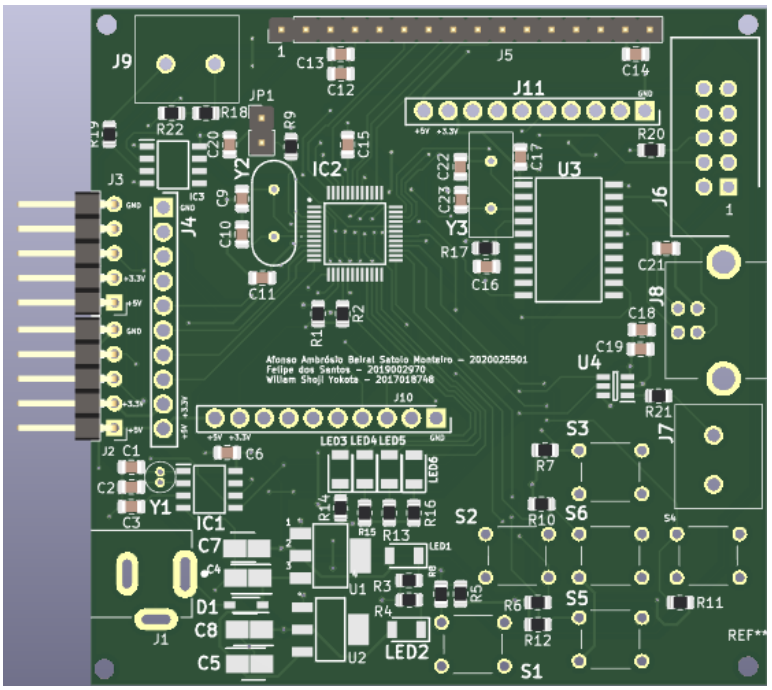
Tabela 4: Lista de componentes disponíveis

Item	***Part number***	**Fabricante**
Processador	LPC1114FBD48/302	NXP
Relógio de tempo real	MCP7940N–I/SN	Microchip
Transceptor USB–serial	MCP2200–I/SO	Microchip
Conversor digital para analógico	MCP4725A0T-E/CH	Microchip
Resistores diversos (100, 470, 1k, 4k7, 10k, 100k e 1 M)	SMD 0805	-
Capacitores cerâmicos (22 e 39 pF, 10 nF, 100 nF e 220 nF)	SMD 0805	-
Capacitores (regulador de tensão)	710-865090368008	Wurth Elektronik

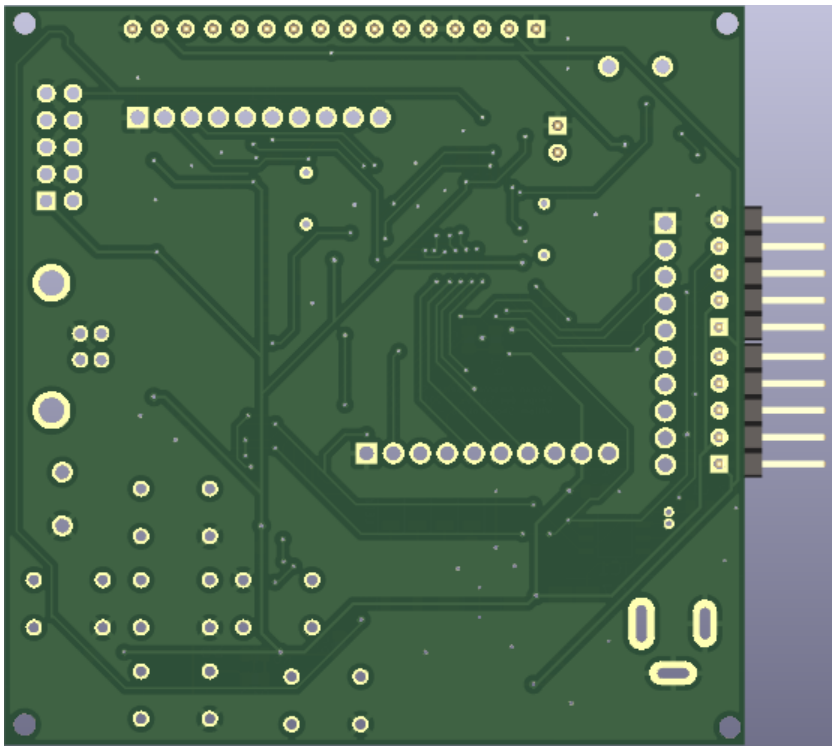
Trimpot de 10k	P160KN–0QC15B100K	TT Electronics
Trimmer de 10k	3296W–1–103RLF	Bourns Inc.
Barra de pinos	PPTC101LFBN–RC	Sullins Connector Solutions
Conector de energia	PJ–002A	CUI Devices
Diodos emissores de luz	LTST–C150GKT	Lite On
Amplificador operacional	LM358DR/LM358DG	On Semi
Conector USB	897–43–004–90–000000	Mill–Max
Chaves tácteis	1825910–6	TE Connectivity
Reguladores de tensão	LD1117AS33TR (3.3V) e LD1117AS50TR (5.0V)	STMicroelectronics
Cristal de 32.768 kHz	AB38T–32.768KHZ	ABRACON
Cristal de 20 MHz	ATS20A	CTS Electronic Components
Cristal de 12 MHz	ATS12A	CTS Electronic Components
Conector para entradas diferenciais	OSTTA024163	On Shore Technology Inc.
Conector para barra de expansão	3–644456–2 (por exemplo)	TE Connectivity
Diodo retificador	1N5819HW–7	Diodes Incorporated
Visor de 16x2 pontos	JHD162A	–
Conector JTAG (SWD)	70246-1002	Molex

5.1 Desenho da placa de circuito impresso

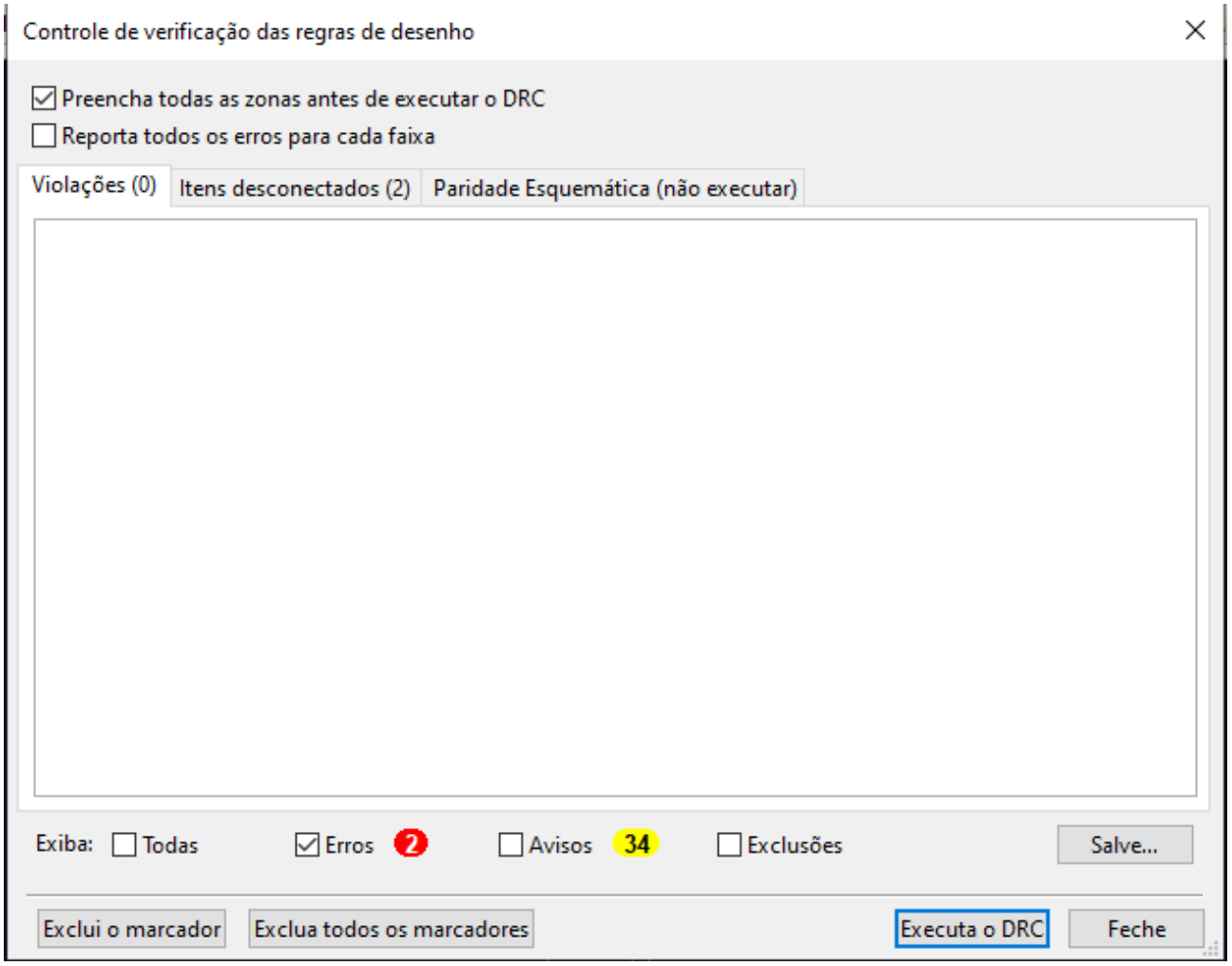
- Face superior:



- Face inferior:



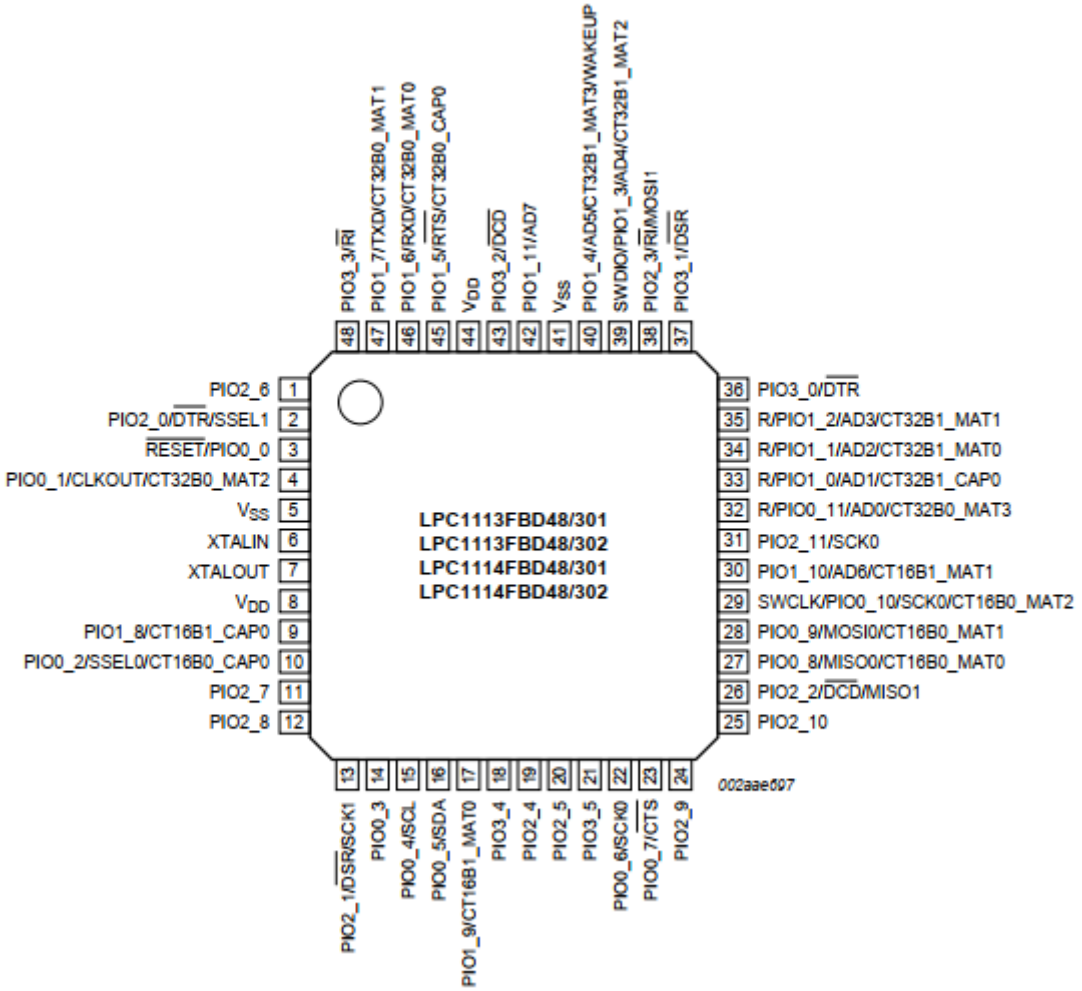
5.2 Relatório de verificação de erros de projeto



6 Características gerais

6.1 Mapas de pinos

6.1.1 Microcontrolador



Pino	Conexão	Pino	Conexão	Pino	Conexão	Pino	Conexão
01	PIO2_6	13	PIO2_1	25	BTN_ENTER	37	PIO3_1
02	PIO2_0	14	PIO0_3	26	BTN_DOWN	38	DB03
03	RESET	15	SCL	27	BTN_RIGHT	39	SWDIO
04	ISP_MODE	16	SDA	28	BTN_UP	40	PIO1_4
05	Earth	17	PIO1_9	29	SWDCLK	41	Earth

06	XTALIN	18	PIO3_4	30	BTN_LEFT	42	DB02
07	XTALOUT	19	PIO2_4	31	PIO2_11	43	DB01
08	+3.3V	20	PIO2_5	32	OUT1	44	+3.3V
09	PIO1_8	21	LED0	33	PIO1_0	45	DB00
10	PIO0_2	22	LED1	34	PIO1_1	46	RX
11	PIO2_7	23	LED2	35	PIO1_2	47	TX
12	PIO2_8	24	LED3	36	PIO3_0	48	E

6.1.2 Interface

- Gravação:
  a) MCP2200

Pinos	**Conexão**	**Pinos**	**Conexão**
1- VDD	3.3V	11 - RTS	N/C
2 - Oscilador	Crystal Y3	12 - RX	Micro (TX)
3 - Oscilador	Crystal Y3	13 - CTS	N/C
4 - RST	3.3V	14 - GP2	N/C
5 - GP7	N/C	15 - GP1	N/C
6 - GP6	N/C	16 - GP0	N/C
7 - GP5	N/C	17 - V_USB	3.3V
8 - GP4	N/C	18 - D-	USB 897-43-004-90-000000 (D-)
9 - GP3	N/C	19 - D+	USB - 897-43-004-90-000000 (D+)
10 - TX	Micro (RX)	20 - VSS	GND

b) J6

Pinos	**Conexão**	**Pinos**	**Conexão**
1	3.3V	6	3.3V
2	Micro (SWIO)	7	N/C

3	GND	8	N/C
4	Micro (SWDCLK)	9	GND
5	GND	10	Micro (RESET)

c) J8

Pinos	Conexão	Pinos	Conexão
1	GND	4	GND
2	D-	MH1	N/C
3	D+	MH2	N/C

- Relógio de tempo real (RTC - MCP7940N):

Pinos	Conexão	Pinos	Conexão
1- X1	Crystal Y1	VCC	3.3V
2 - X2	Crystal Y1	MFP	N/C
3 - VBAT	GND	SCL	Micro (SCL)
4 - VSS	GND	SDA	Micro (SDA)

- Sinais Analógicos:
  a) MCP4725

Pinos	Conexão	Pinos	Conexão
1 - VOUT	J7 (1)	4 - SDA	Micro (SDA)
2 - VSS	GND	5 - SCL	Micro (SCL)
3 - VDD	3.3V	6 - A0	GND

b) J7

Pinos	Conexão
1	MCP4725 (VOUT)

2	GND

c) LM358

Pinos	Conexão	Pinos	Conexão
1 - OUT1	Micro (OUT1)	5 - IN2+	N/C
2 - IN1-	J9 (2)	6 - IN2-	N/C
3 - IN1+	J9 (1)	7 - OUT2	N/C
4 - V-	GND	8 - V+	5V

d) J9

Pinos	Conexão
1	LM358 (IN1+)
2	LM358 (IN1-)

- Barras de Expansão:

a) J2 e J3

Pinos	Conexão	Pinos	Conexão
1	5V	4	Micro (SDA)
2	3.3V	5	GND
3	Micro(SCL)		

b) J4

Pinos	Conexão	Pinos	Conexão
1	GND	6	Micro (PIO0_2)
2	Micro (PIO1_9)	7	Micro (PIO2_7)
3	Micro (PIO2_1)	8	Micro (PIO2_8)
4	Micro (PIO0_3)	9	3.3V

5	Micro (PIO1_8)	10	5V

c) J10

Pinos	Conexão	Pinos	Conexão
1	GND	6	Micro (PIO3_1)
2	Micro (PIO3_0)	7	Micro (PIO1_4)
3	Micro (PIO2_0)	8	N/C
4	Micro (PIO2_6)	9	3.3V
5	Micro (PIO2_11)	10	5V

d) J11

Pinos	Conexão	Pinos	Conexão
1	GND	6	Micro (PIO0_6)
2	Micro (PIO1_2)	7	Micro (PIO1_3)
3	Micro (PIO1_1)	8	Micro (PIO2_9)
4	Micro (PIO0_7)	9	3.3V
5	Micro (PIO1_0)	10	5V

- LCD:

Pinos	Conexão	Pinos	Conexão
1	GND	9	Micro (DBO2)
2	5V	10	Micro (DBO3)
3	5V	11	N/C
4	GND	12	N/C
5	GND	13	N/C
6	E	14	N/C

7	Micro (DBO0)	15	5V
8	Micro (DBO1)	16	GND

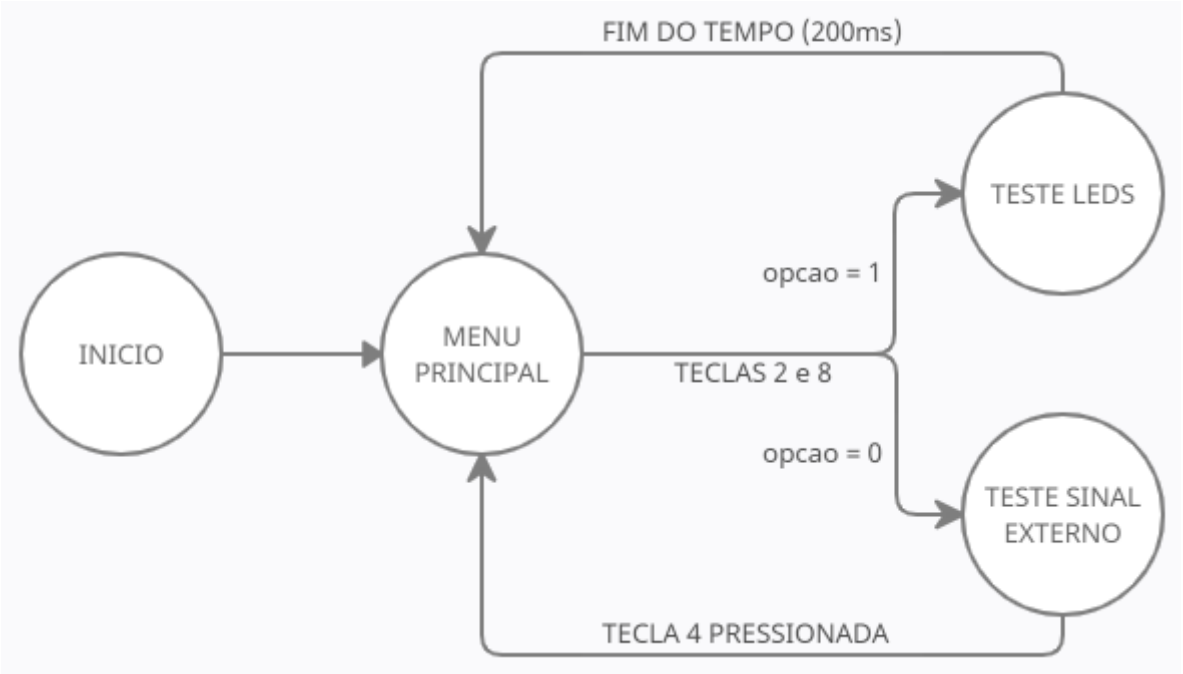
6.2 Alimentação e consumo

A placa deve ser alimentada com uma tensão de entre +7V e +15V CC. O consumo estimado do sistema é de 1.2 watts.

7 Programa embarcado de validação

O programa embarcado de validação tem por finalidade testar os componentes da placa. O programa desenvolvido testa o teclado, os LEDs de indicação, o visor de LCD e a entrada de sinal diferencial.

7.1 Modelo de operação geral



7.2 Arquitetura

delayX2ms [main.c - programa]	
Parâmetros	unsigned char t
Retorno	void
Gera um atraso (*delay*) de 2 x t milisegundos	
Dependência	-

bitSet [bits.h - driver]	
Parâmetros	int arg, int bit
Retorno	0 ou 1
Define o determinado bit (*bit*) de uma porta (*arg*) como ligado (*high*).	
Dependência	-

bitClr [bits.h - driver]	
Parâmetros	int arg, int bit
Retorno	0 ou 1
Define o determinado bit (*bit*) de uma porta (*arg*) como desligado (*low*).	
Dependência	-

bitTst [bits.h - driver]	
Parâmetros	int arg, int bit
Retorno	0 ou 1
Testa se determinado bit (*bit*) de uma porta (*arg*) está ligado ou desligado.	
Dependência	-

digitalWrite [io.c - driver]	
Parâmetros	int pin, int value
Retorno	void
Escreve o valor recebido (*value*) na porta recebida (*pin*).	
Dependência	bitSet, bitClr

pinMode [io.c - driver]	
Parâmetros	int pin, int type
Retorno	void
Configura um determinado pino como entrada ou saída.	
Dependência	bitSet, bitClr

Delay2ms [lcd.c - driver]	
Parâmetros	-
Retorno	void
Gera um atraso de 2 milissegundos	
Dependência	-

Delay40us [lcd.c - driver]	
Parâmetros	-
Retorno	void
Gera um atraso de 40 microsegundos.	
Dependência	-

lcdCommand [lcd.c - driver]	
Parâmetros	unsigned char opcao
Retorno	void
Responsável por enviar comandos ao visor, como posição do cursor e limpar o display.	
Dependência	digitalWrite, Delay2ms, Delay40us

lcdInit [lcd.c - driver]	
Parâmetros	-
Retorno	void
Configura as portas responsáveis por se comunicar com o *display* e envia os comandos iniciais configurando o modo de operação do mesmo.	
Dependência	pinMode, Delay2ms, lcdCommand

lcdData [lcd.c - driver]	
Parâmetros	unsigned char opcao
Retorno	void
Envia dados a serem impressos no *display* de acordo com a tabela *ASCII*.	
Dependência	digitalWrite, Delay40us

kpInit [keypad.c - driver]	
Parâmetros	-
Retorno	void
Inicializa as portas responsáveis pelo teclado matricial.	
Dependência	-

kpDebounce [keypad.c - driver]	
Parâmetros	-
Retorno	void
Verifica se há alguma tecla pressionada e armazena o endereço da tecla em uma variável interna.	
Dependência	bitSet, bitClr, bitTst

kpRead [keypad.c - driver]	
Parâmetros	-
Retorno	unsigned int
Retorna o valor que representa o endereço da tecla pressionada.	
Dependência	-

adcInit [adc.c - driver]	
Parâmetros	-
Retorno	void
Inicializa o conversor analógico-digital.	
Dependência	pinMode, bitSet

adcRead [adc.c - driver]	
Parâmetros	unsigned int channel
Retorno	int
Lê o valor presente no conversor analógico-digital e retorna um inteiro que varia de 0 a 100.	
Dependência	bitTst

menuLcd [main.c - programa]	
Parâmetros	unsigned char opcao
Retorno	void
Aciona o visor de LCD imprimindo o menu de opções. Recebe o parâmetro “opcao” representando a opção selecionada no menu. Se “opcao” for igual a 0, a seta indicando	

a opção selecionada será impressa na primeira linha, caso contrário, a seta é impressa na segunda linha.	
Dependência	lcdCommand, lcdData

proxMenu [main.c - programa]	
Parâmetros	unsigned char opcao
Retorno	void
“Move” a seta para cima ou para baixo a depender do valor recebido em “opcao”.	
Dependência	lcdCommand, lcdData

testeLed [main.c - programa]	
Parâmetros	-
Retorno	void
Acende os 4 LEDs por aproximadamente 100 milissegundos e então os apaga enquanto exibe uma barra de progresso no visor. Retorna ao menu principal ao término do teste.	
Dependência	lcdCommand, lcdData, delayX2ms

testeSinalExt [main.c - programa]	
Parâmetros	-
Retorno	void
Imprime o valor recebido do conversor analógico-digital no display de LCD o valor é lido e atualizado de forma indefinida até que a tecla referente à seta esquerda seja pressionada, retornando ao menu principal.	
Dependência	lcdCommand, lcdData, kpDebounce, kpRead, adcRead,

7.3 Casos de uso

Estado inicial	Após ser energizada, a placa é inicializada com todos os leds apagados, no display é exibido o menu principal com as seguintes opções: - **`Teste LEDs`** - **`Teste sinal ext`** Por padrão a primeira opção estará selecionada, sendo indicado por uma seta para a direita;
Navegação	Pressionando as teclas 2 (seta para cima) e 8 (seta para baixo) do teclado numérico é possível subir e descer, respectivamente. Ao atingir o fim da lista, a seta volta ao topo;
Selecionar	Para selecionar uma opção do menu, basta pressionar as teclas 5 (enter) ou 6 (direita);
Teste LEDs	Ao acessar esta opção, os 4 leds (B4-B7) serão ligados; O display exibirá a mensagem "**`Teste LEDs`**" seguida de uma barra de progresso; Ao término o programa retorna ao menu inicial;
Teste sinal ext	Ao acessar esta opção, o display exibirá o valor lido pelo potenciômetro P1 em uma escala de 0 a 3.3 V; Para retornar ao menu principal, pressione a tecla 4 (seta para esquerda);

8 Custos

8.1 Materiais

A estimativa de custo em materiais é de U$ 30,64 em componentes;

9 Apêndice

9.1 Memorial de cálculos

Os cálculos dos resistores de pull-up e outros foram realizados utilizando a 1ª Lei de Ohm (*U = R*I*) com base nos parâmetros de funcionamento do microcontrolador listados abaixo.

*Vih (min) = 0.7*Vdd*

*Vil (max) = 0.3*Vdd*

Voh (min) = Vdd - 0.4

*Vol (max) = 0.3*Vdd*

Para os capacitores, foram utilizados valores estipulados pelo professor e valores sugeridos nas folhas de dados dos componentes utilizados.

9.2 Código-fonte do programa de validação

A seguir estão os arquivos de código fonte do projeto, os drivers usados foram elaborados pelo professor Rodrigo Maximiano Antunes de Almeida.

9.2.1 main.c

```
#include <pic18f4520.h>
#include "lcd.h"
#include "bits.h"
#include "keypad.h"
#include "adc.h"

// t em milisegundos (de 2 em 2 ms)
// valor maximo de 256 x 2ms == 512ms
void delayX2ms(unsigned char t){
       unsigned char i, j;
    for(t ;t > 0; t--){
        for(i = 0; i < 50; i++){
            for(j = 0;j < 25; j++);
        }
    }
}
```

```
void menuLcd(unsigned char opcao){
    unsigned char i;
    char menu0[10] = "Teste LEDs";
    char menu1[15] = "Teste sinal ext";

    // imprime o menu inicial
    lcdCommand(0x0); // limpa o display
    lcdCommand(0x1);
    lcdCommand(0x8); // leva para a primeira posicao
    lcdCommand(0x0);

    if(opcao){
        lcdData(0x7E);
    }else{
        lcdData(' ');
    }

    for(i = 0;i < 11;i++){
        lcdData(menu0[i]);
    }

    // proxima linha
    lcdCommand(0xC);
    lcdCommand(0x0);

    if(!opcao){
        lcdData(0x7E);
    }else{
        lcdData(' ');
    }

    for(i = 0;i < 15;i++){
        lcdData(menu1[i]);
    }
}

void proxMenu(unsigned char opcao){
    lcdCommand(0x8);
    lcdCommand(0x0);

    // faz troca a seta de posicao
    if(opcao){
        lcdData(0x7E);
    }else{
        lcdData(' ');
    }
```

```
    lcdCommand(0xc);
    lcdCommand(0x0);

    if(!opcao){
        lcdData(0x7E);
    }else{
        lcdData(' ');
    }
}

void testeLed(){
    unsigned char i;
    char titulo[13] = "   Teste LEDs";

    lcdCommand(0x0); // limpa o display
    lcdCommand(0x1);
    lcdCommand(0x8); // leva para a primeira posicao
    lcdCommand(0x0);

    // imprime o titulo
    for(i = 0;i < 13;i++){
        lcdData(titulo[i]);
    }

    // acende os LEDs
    TRISB &= 0x0f;
    PORTB |= 0xf0;

    // proxima linha
    lcdCommand(0xC);
    lcdCommand(0x0);

    // efeito barra de progresso
    for(i = 0;i < 16;i++){
        lcdData(0xFF);
        delayX2ms(50); // aprox 100ms
    }

    // apaga os LEDs
    PORTB = 0x00;
}

void testeSinalExt(){
    unsigned char i;
    unsigned int valor, botao = 0x0;
    char titulo[10] = "Sinal ext.";
    char sair[5] = " sair";
```

```
    lcdCommand(0x0); // limpa o display
    lcdCommand(0x1);
    lcdCommand(0x8); // leva para a primeira posicao
    lcdCommand(0x0);

    // imprime o titulo
    for(i = 0;i < 10;i++){
        lcdData(titulo[i]);
    }

    // leva para a linha 2
    lcdCommand(0xC);
    lcdCommand(0x0);

    // imprime a opcao de sair
    lcdData(0x7F);
    for(i = 0;i < 5;i++){
        lcdData(sair[i]);
    }

    for(;;){
        // leva para a linha 1 coluna 12
        lcdCommand(0x8);
        lcdCommand(0xb);

        // varre o teclado
        kpDebounce();

        // valor do canal 0 do ADC
        valor = adcRead(0);

        // converte de 0 a 100 para 0 a 3.3
        valor = (valor * 33) / 100;

        // atualiza o valor no visor
        lcdData(((valor % 1000)/100) + '0');
        lcdData(',');
        lcdData(((valor % 100)/10) + '0');
        lcdData((valor % 10) + '0');
        lcdData('V');

        if(botao != kpRead()){
            botao = kpRead();
            if(botao == 0x04){
                // SETA PARA ESQUERDA (botão 4)
                // vola ao menu principal

                return;
```

```
            }
        }
    }
}

void main(void) {
    unsigned char opcao = 0x1;
    unsigned int botao = 0x0;

    TRISB = 0x00;
    TRISD = 0x00;
    PORTB = 0x00;
    PORTD = 0x00;

    adcInit();
    lcdInit();
    kpInit();

    menuLcd(opcao);

    for(;;){

        kpDebounce();

        if(botao != kpRead()){
            botao = kpRead();

            if(botao == 0x80){
                // SETA PARA CIMA (botão 2)
                // faz a seta caminhar para o proximo menu
                opcao = !opcao;
                proxMenu(opcao);
            }

            if(botao == 0x40){
                // ENTER (botão 5)
                if(opcao){
                    testeLed();
                    menuLcd(opcao);
                }else{
                    testeSinalExt();
                    menuLcd(opcao);
                }
            }

            if(botao == 0x20){
                // SETA PARA BAIXO (botão 8)
                // faz a seta caminhar para o proximo menu
```

```
                opcao = !opcao;
                proxMenu(opcao);
            }

            if(botao == 0x04){
                // SETA PARA ESQUERDA (botão 4)
                // não faz nada
            }

            if(botao == 0x400){
                // SETA PARA DIREITA (botão 6)
                // age como enter
                if(opcao){
                    testeLed();
                    menuLcd(opcao);
                }else{
                    testeSinalExt();
                    menuLcd(opcao);
                }
            }
        }
    }
}
```

9.2.2 adc.c

```
// ----------------------------------------------------------------------
//   Copyright (C) Rodrigo Almeida 2010
// ----------------------------------------------------------------------
//   Arquivo: adc.c
//            Biblioteca do conversor AD para o PIC18F4520
//   Autor:   Rodrigo Maximiano Antunes de Almeida
//            rodrigomax at unifei.edu.br
//   Licença: GNU GPL 2
// ----------------------------------------------------------------------
//   This program is free software; you can redistribute it and/or modify
//   it under the terms of the GNU General Public License as published by
//   the Free Software Foundation; version 2 of the License.
//
//   This program is distributed in the hope that it will be useful,
//   but WITHOUT ANY WARRANTY; without even the implied warranty of
//   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
//   GNU General Public License for more details.
// ----------------------------------------------------------------------

#include "adc.h"
#include <pic18f4520.h>
#include "io.h"
```

```
#include "bits.h"

void adcInit(void) {
    //AN0-A0, AN1-A1 e AN2-A2 são analógicos e entradas
    pinMode(PIN_A0, INPUT);
    pinMode(PIN_A1, INPUT);
    //temperatura compartilhado com Display
    //removido da biblioteca
   // pinMode(PIN_A2, INPUT);

    bitSet(ADCON0, 0); //liga ADC
    //config an0-2 como analógico
    //ADCON1 = 0b00001100; //apenas AN0 é analogico, a referencia é baseada na fonte
    ADCON2 = 0b10101010; //FOSC /32, 12 TAD, Alinhamento à direita e tempo de conv =
12 TAD

}

int adcRead(unsigned int channel) {
    unsigned int ADvalor;
    ADCON0 &= 0b11000011; //zera os bits do canal
    if (channel < 3) {
        ADCON0 |= channel << 2;
    }

    ADCON0 |= 0b00000010; //inicia conversao

    while (bitTst(ADCON0, 1)); // espera terminar a conversão;

    ADvalor = ADRESH; // le o resultado
    ADvalor <<= 8;
    ADvalor += ADRESL;
    return ADvalor;
}
```

9.2.3 bits.h

```
#ifndef BIT_H
#define      BIT_H

//funções de bit
#define bitSet(arg,bit) ((arg) |=  (1<<(bit)))
#define bitClr(arg,bit) ((arg) &= ~(1<<(bit)))
#define bitFlp(arg,bit) ((arg) ^=  (1<<(bit)))
#define bitTst(arg,bit) ((arg) &   (1<<(bit)))


#endif /* XC_HEADER_TEMPLATE_H */
```

9.2.4 io.c

```
/*
 * File:   io.c
 * Author: Avell
 *
 * Created on 4 de Agosto de 2020, 21:39
 */

#include "bits.h"
#include "io.h"
#include <pic18f4520.h>
//PORTB e PORTD apenas para demonstrar o funcionamento

void digitalWrite(int pin, int value){
    //porta
    if(pin <8){
        if (value){  bitSet(PORTA,pin);}
        else{        bitClr(PORTA,pin);}
    }else if(pin<16){
        pin -=8;
        if (value){  bitSet(PORTB,pin);}
        else{        bitClr(PORTB,pin);}
    }else if(pin<24){
        pin -=16;
        if (value){  bitSet(PORTC,pin);}
        else{        bitClr(PORTC,pin);}
    }else if(pin<32){
        pin -=24;
        if (value){  bitSet(PORTD,pin);}
        else{        bitClr(PORTD,pin);}
    }else if(pin<40){
        pin -=32;
        if (value){  bitSet(PORTE,pin);}
        else{        bitClr(PORTE,pin);}
    }
}

int digitalRead(int pin){
    if(pin <8){
        return bitTst(PORTA,pin);
    }else if(pin<16){
        return bitSet(PORTB,pin-8);
    }else if(pin<24){
        return bitSet(PORTC,pin-16);
```

```
    }else if(pin<32){
        return bitSet(PORTD,pin-24);
    }else if(pin<40){
        return bitSet(PORTE,pin-32);
    }
    return -1;
}

void pinMode(int pin, int type) {
    //porta
    if(pin <8){
        if (type){  bitSet(TRISA,pin);}
        else{       bitClr(TRISA,pin);}
    }else if(pin<16){
        if (type){  bitSet(TRISB,pin-8);}
        else{       bitClr(TRISB,pin-8);}
    }else if(pin<24){
        if (type){  bitSet(TRISC,pin-16);}
        else{       bitClr(TRISC,pin-16);}
    }else if(pin<32){
        if (type){  bitSet(TRISD,pin-24);}
        else{       bitClr(TRISD,pin-24);}
    }else if(pin<40){
        if (type){  bitSet(TRISE,pin-32);}
        else{       bitClr(TRISE,pin-32);}
    }
}
```

9.2.5 keypad.c

```
// ------------------------------------------------------------------------
//   Copyright (C) Rodrigo Almeida 2014
// ------------------------------------------------------------------------
//   Arquivo: keypad.c
//            Biblioteca de operação de um teclado matricial
//   Autor:   Rodrigo Maximiano Antunes de Almeida
//            rodrigomax at unifei.edu.br
//   Licença: GNU GPL 2
// ------------------------------------------------------------------------
//   This program is free software; you can redistribute it and/or modify
//   it under the terms of the GNU General Public License as published by
//   the Free Software Foundation; version 2 of the License.
//
//   This program is distributed in the hope that it will be useful,
//   but WITHOUT ANY WARRANTY; without even the implied warranty of
//   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
//   GNU General Public License for more details.
// ------------------------------------------------------------------------
```

```c
#include "keypad.h"
#include <pic18f4520.h>
#include "io.h"
#include "bits.h"

static unsigned int valor = 0x0000;

#define LIN0 PIN_D0
#define LIN1 PIN_D1
#define LIN2 PIN_D2
#define LIN3 PIN_D3
#define COL0 PIN_B0
#define COL1 PIN_B1
#define COL2 PIN_B2

unsigned int kpRead(void) {
    return valor;
}

void kpDebounce(void) {
    unsigned char i, j;
    static unsigned char tempo;
    static unsigned int valorNovo = 0x0000;
    static unsigned int valorAntigo = 0x0000;

    //store D to avoid mess with other periphels
    unsigned char old_D;
    old_D = PORTD;

    //PORTD é compartilhado, então tem
    //que garantir que é entrada
    TRISD |= 0x0f;

    for (i = 0; i < 3; i++) {
        //desabilita todas as colunas
        TRISB &= 0xF8;
        //Habilita apenas a coluna desejada
        bitSet(TRISB,i);
        //coloca nivel alto só na coluna desejada
        PORTB |= 0x07;
        bitClr(PORTB, i);

        //delay pra estabilizar os sinais
        for (int k = 0; k < 10; k++);

        //realiza o teste para cada bit e atualiza a variável
        for (j = 0; j < 4; j++) {
```

```
            if (!bitTst(PORTD, j)) {
                bitSet(valorNovo, (i * 4) + j);
            } else {
                bitClr(valorNovo, (i * 4) + j);
            }
        }
    }
    if (valorAntigo == valorNovo) {
        tempo--;
    } else {
        tempo = 10;
        valorAntigo = valorNovo;
    }
    if (tempo == 0) {
        valor = valorAntigo;
    }
    PORTD = old_D;
    TRISD = 0x00;
}

void kpInit(void) {
    //coloca 0-2 como saída
    TRISB &= 0xf8;
    //coloca 0-3 como entrada
    TRISD |= 0x0f;
}
```

9.2.6 lcd.c

Biblioteca alterada para comunicação com 4 bits entre o microcontrolador e o *display*.

```
// -------------------------------------------------------------------------
//   Copyright (C) Rodrigo Almeida 2010
// -------------------------------------------------------------------------
//   Arquivo: lcd.c
//            Biblioteca de manipulação do LCD
//   Autor:   Rodrigo Maximiano Antunes de Almeida
//            rodrigomax at unifei.edu.br
//   Licença: GNU GPL 2
// -------------------------------------------------------------------------
//   This program is free software; you can redistribute it and/or modify
//   it under the terms of the GNU General Public License as published by
//   the Free Software Foundation; version 2 of the License.
//
//   This program is distributed in the hope that it will be useful,
//   but WITHOUT ANY WARRANTY; without even the implied warranty of
//   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
//   GNU General Public License for more details.
// -------------------------------------------------------------------------
```

```
#include "lcd.h"
#include <pic18f4520.h>
#include "bits.h"
#include "io.h"

#define EN PIN_E1
#define RS PIN_E2

void Delay40us(void){
      unsigned char i;
      for(i=0; i < 25; i++); //valor aproximado
}

void Delay2ms(void){
      unsigned char i;
      for(i=0; i < 50; i++){
            Delay40us();
      }
}

void lcdCommand(unsigned char cmd){
    unsigned char old_D;
    old_D = PORTD;

    //garantir compatibilidade
    TRISD = 0x00;

    digitalWrite(RS, LOW);//comando

    PORTD = cmd << 4;

    digitalWrite(EN, HIGH);   //Pulso no Enable
    digitalWrite(EN, LOW);

    PORTD= old_D;

    if((cmd == 0x02)||(cmd == 0x01)){
       Delay2ms();
    }else{
         Delay40us();
    }
}

void lcdData(unsigned char valor)
{
    //garantir compatibilidade
    unsigned char old_D;
```

```
    old_D = PORTD;

    TRISD = 0x00;
      digitalWrite(RS, HIGH);   //comando

      PORTD = valor;

    digitalWrite(EN, HIGH);   //Pulso no Enable
      digitalWrite(EN, LOW);

    PORTD = valor << 4;

    digitalWrite(EN, HIGH);   //Pulso no Enable
      digitalWrite(EN, LOW);

    PORTD = old_D;

      Delay40us();
}

void lcdInit(void){
    // configurações de direção dos terminais
    pinMode(RS, OUTPUT);
    pinMode(EN, OUTPUT);
    TRISD = 0x00;         //dados

    // garante inicialização do LCD (+-10ms)
    Delay2ms(); Delay2ms(); Delay2ms(); Delay2ms(); Delay2ms();

    //precisa enviar 4x pra garantir 4 bits
    // 0 0 1 0 1 0 0 0
    lcdCommand(0x03);     // 8 bits
    Delay2ms();     Delay2ms();
    lcdCommand(0x03);     // 8 bits
    Delay2ms();
    lcdCommand(0x03);     // 8 bits

    lcdCommand(0x02);     // 4 bits

    lcdCommand(0x02);     // 4 bits
    lcdCommand(0x08);     // 2 linhas, 5x8

    lcdCommand(0x00);
    lcdCommand(0x06);     //modo incremental

    //habilitar o cursor, trocar 0x0C por 0x0F;
    lcdCommand(0x00);
    lcdCommand(0x0C);     //display e cursor on, com blink
```

```
    lcdCommand(0x00);
    lcdCommand(0x01);     //limpar display
}
```

9.3 Lista de compras

Relação tabular a conter a identificação do item (1, 2, 3, etc), a identificação do item na PCI (R1, C10, etc), a identificação do fabricante (*partnumber*), a quantidade necessária, um fornecedor e o preço por unidade (em dólar norte-americano).

ID	Identificação na PCI	*Part number*	Qtd	Fornecedor	Preço un. (USD)
1	IC2	LPC1114FBD48/302	1	Future Electronics	3.24
2	IC1	MCP7940N–I/SN	1	Mouser Electronics	0.86
3	U3	MCP2200–I/SO	1	Microchip	2.47
4	U4	MCP4725A0T-E/CH	1	Mouser Electronics	1.29
5	R19	0 ohm SMD 0805	1	Mouser Electronics	0.10
6	R8, R21, R22	100 ohm SMD 0805	3	Mouser Electronics	0.10
7	R3, R4, R13, R14, R15, R16	110 ohm SMD 0805	6	Mouser Electronics	0.10
8	R18	150 ohm SMD 0805	1	Mouser Electronics	0.10
9	R5, R6, R7, R9, R10, R11, R12, R17	1k ohm SMD 0805	8	Mouser Electronics	0.10
10	R1, R2, R20	10k ohm SMD 0805	3	Mouser Electronics	0.10
11	C9, C10	18 pF SMD 0805	2	Mouser Electronics	0.11
12	C1, C2, C22, C23	22 pF SMD 0805	4	Mouser Electronics	0.10
13	C3, C6, C11, C12, C13, C14, C15, C16, C17, C20, C21	100 nF SMD 0805	11	Mouser Electronics	0.10
14	C19	0.1 uF SMD 0805	1	Mouser Electronics	0.10
15	C18	10 uF SMD 0805	1	Mouser Electronics	0.12
16	C4, C5. C7, C8	710-865090368008	4	Mouser Electronics	0,31
17	J1	PJ–002A	1	Mouser Electronics	0.77
18	LED1, LED2, LED3, LED4, LED5, LED6	LTST–C150GKT	6	Digi-Key	0.31

19	IC3	LM358DR/LM358DG	1	Mouser Electronics	0.37
20	J8	897–43–004–90–000000	1	Mouser Electronics	1.70
21	S1, S2, S3, S4, S5, S6	1825910–6	6	TE Connectivity	0.20
22	U1	LD1117AS33TR (3.3V)	1	Mouser Electronics	0.90
23	U2	LD1117AS50TR (5V)	1	Mouser Electronics	0.67
24	Y1	AB38T–32.768KHZ	1	Mouser Electronics	0.17
25	Y2	ATS20A	1	Mouser Electronics	0.36
26	Y3	ATS12A	1	Mouser Electronics	0.36
27	J7, J9	OSTTA024163	2	Digi-Key	0.73
28	J4, J10, J11	PPTC101LFBN-RC	3	Digi-Key	0.65
29	D1	1N5819HW–7	1	Mouser Electronics	0.45
30	J5	JHD162A	1	My Techno Care	2.30
31	J6	70246-1002	1	Digi-Key	2.63
32	JP1	M20-9990546	1	Mouser Electronics	0.25

10 Bibliografia

- Folhas de dados dos componentes

11 Anexo

Em anexo seguem as folhas de rosto das folhas de dados referentes aos componentes utilizados.

LPC1110/11/12/13/14/15

32-bit ARM Cortex-M0 microcontroller; up to 64 kB flash and 8 kB SRAM

Rev. 9.2 — 26 March 2014 Product data sheet

1. General description

The LPC1110/11/12/13/14/15 are an ARM Cortex-M0 based, low-cost 32-bit MCU family, designed for 8/16-bit microcontroller applications, offering performance, low power, simple instruction set and memory addressing together with reduced code size compared to existing 8/16-bit architectures.

The LPC1110/11/12/13/14/15 operate at CPU frequencies of up to 50 MHz.

The peripheral complement of the LPC1110/11/12/13/14/15 includes up to 64 kB of flash memory, up to 8 kB of data memory, one Fast-mode Plus I^2C-bus interface, one RS-485/EIA-485 UART, up to two SPI interfaces with SSP features, four general purpose counter/timers, a 10-bit ADC, and up to 42 general purpose I/O pins.

Remark: The LPC111x series consists of the LPC1100 series (parts LPC111x/101/201/301), LPC1100L series (parts LPC111x/002/102/202/302), and the LPC1100XL series (parts LPC111x/103/203/303/323/333). The LPC1100L and LPC1100XL series include the power profiles, a windowed watchdog timer, and a configurable open-drain mode.

For related documentation, see Section 16 “References”.

2. Features and benefits

- System:
  - ARM Cortex-M0 processor, running at frequencies of up to 50 MHz.
  - ARM Cortex-M0 built-in Nested Vectored Interrupt Controller (NVIC).
  - Non-Maskable Interrupt (NMI) input selectable from several input sources (LPC1100XL series only).
  - Serial Wire Debug.
  - System tick timer.
- Memory:
  - 64 kB (LPC1115), 56 kB (LPC1114/333), 48 kB (LPC1114/323), 32 kB (LPC1114/102/201/202/203/301/302/303), 24 kB (LPC1113), 16 kB (LPC1112), 8 kB (LPC1111), or 4 kB (LPC1110) on-chip flash programming memory.
  - 256 byte page erase function (LPC1100XL series only)
  - 8 kB, 4 kB, 2 kB, or 1 kB SRAM.
  - In-System Programming (ISP) and In-Application Programming (IAP) via on-chip bootloader software.

MCP7940N

Battery-Backed I²C™ Real-Time Clock/Calendar with SRAM

Timekeeping Features:

- Real-Time Clock/Calendar (RTCC):
  - Hours, Minutes, Seconds, Day of Week, Day, Month, Year
  - Leap year compensated to 2399
  - 12/24 hour modes
- Oscillator for 32.768 kHz Crystals:
  - Optimized for 6-9 pF crystals
- On-Chip Digital Trimming/Calibration:
  - ±1 PPM resolution
  - ±129 PPM range
- Dual Programmable Alarms
- Versatile Output Pin:
  - Clock output with selectable frequency
  - Alarm output
  - General purpose output
- Power-Fail Time-Stamp:
  - Time logged on switchover to and from Battery mode

Low-Power Features:

- Wide Voltage Range:
  - Operating voltage range of 1.8V to 5.5V
  - Backup voltage range of 1.3V to 5.5V
- Low Typical Timekeeping Current:
  - Operating from VCC: 1.2 µA at 3.3V
  - Operating from battery backup: 925 nA at 3.0V
- Automatic Switchover to Battery Backup

User Memory:

- 64-byte Battery-Backed SRAM

Operating Ranges:

- 2-Wire Serial Interface, I²C™ Compatible
  - I²C clock rate up to 400 kHz
- Temperature Range:
  - Industrial (I): -40°C to +85°C
  - Extended (E): -40°C to +125°C

Packages:

- 8-Lead SOIC, MSOP, TSSOP, PDIP and 2x3 TDFN

General Description:

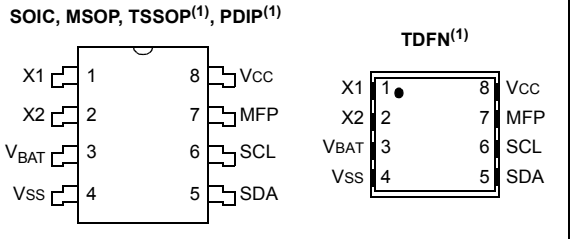
The MCP7940N Real-Time Clock/Calendar (RTCC) tracks time using internal counters for hours, minutes, seconds, days, months, years, and day of week. Alarms can be configured on all counters up to and including months. For usage and configuration, the MCP7940N supports I²C communications up to 400 kHz.

The open-drain, multi-functional output can be configured to assert on an alarm match, to output a selectable frequency square wave, or as a general purpose output.

The MCP7940N is designed to operate using a 32.768 kHz tuning fork crystal with external crystal load capacitors. On-chip digital trimming can be used to adjust for frequency variance caused by crystal tolerance and temperature.

SRAM and timekeeping circuitry are powered from the back-up supply when main power is lost, allowing the device to maintain accurate time and the SRAM contents. The times when the device switches over to the back-up supply and when primary power returns are both logged by the power-fail time-stamp.

Package Types



Note 1: Available in I-temp only.

MCP2200

USB 2.0 to UART Protocol Converter with GPIO

Features

Universal Serial Bus (USB)

- Supports full-speed USB (12 Mb/s)
- Implements USB protocol composite device:
  - Communication Device Class (CDC) for communications and configuration
  - Human Interface Device (HID) for I/O control
- 128-byte buffer to handle data throughput at any UART baud rate:
  - 64-byte transmit
  - 64-byte receive
- Fully configurable VID and PID assignments, and string descriptors
- Bus powered or self-powered
- USB 2.0 Compliant: TID 40001150

USB Driver and Software Support

- Uses standard Windows® drivers for Virtual Com Port (VCP): Windows XP (SP2 or later), Vista, 7
- Configuration utility for initial configuration

Universal Asynchronous Receiver/Transmitter (UART)

- Responds to `SET LINE CODING` commands to dynamically change baud rates
- Supports baud rates: 300-1000k
- Hardware flow control
- UART signal polarity option

General Purpose Input/Output (GPIO) Pins

- Eight general purpose I/O pins

EEPROM

- 256 bytes of user EEPROM

Other

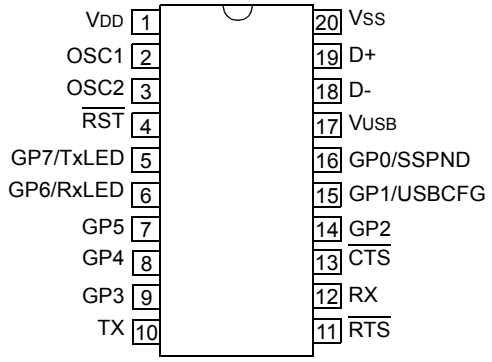
- USB activity LED outputs (TxLED and RxLED)
- SSPND output pin
- USBCFG output pin (indicates when the enumeration is completed)
- Operating voltage: 3.0-5.5V
- Oscillator input: 12 MHz
- ESD protection: > 4 kV HBM
- Industrial (I) Operating Temperature: -40°C to +85°C

Package Types

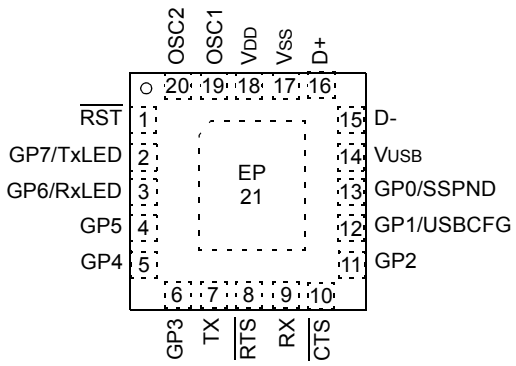
The device will be offered in the following packages:

- 20-lead QFN (5 x 5 mm)
- 20-lead SOIC
- 20-lead SSOP

MCP2200
SOIC, SSOP



MCP2200
5x5 QFN*



* Includes Exposed Thermal Pad (EP); see Table 1-1.

MCP4725

12-Bit Digital-to-Analog Converter with EEPROM Memory in SOT-23-6

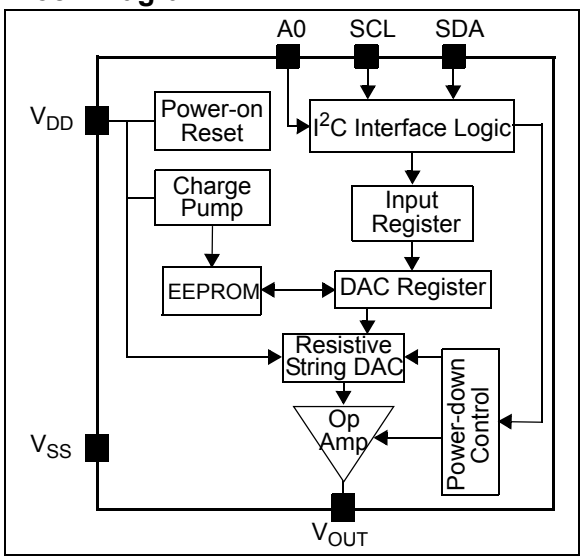
Features

- 12-Bit Resolution
- On-Board Non-Volatile Memory (EEPROM)
- ±0.2 LSB DNL (typical)
- External A0 Address Pin
- Normal or Power-Down Mode
- Fast Settling Time: 6 µs (typical)
- External Voltage Reference (V_{DD})
- Rail-to-Rail Output
- Low Power Consumption
- Single-Supply Operation: 2.7V to 5.5V
- I^2C^{TM} Interface:
  - Eight Available Addresses
  - Standard (100 kbps), Fast (400 kbps), and High-Speed (3.4 Mbps) Modes
- Small 6-lead SOT-23 Package
- Extended Temperature Range: -40°C to +125°C

Applications

- Set Point or Offset Trimming
- Sensor Calibration
- Closed-Loop Servo Control
- Low Power Portable Instrumentation
- PC Peripherals
- Data Acquisition Systems

Block Diagram



DESCRIPTION

The MCP4725 is a low-power, high accuracy, single channel, 12-bit buffered voltage output Digital-to-Analog Convertor (DAC) with non-volatile memory (EEPROM). Its on-board precision output amplifier allows it to achieve rail-to-rail analog output swing.

The DAC input and configuration data can be programmed to the non-volatile memory (EEPROM) by the user using I^2C interface command. The non-volatile memory feature enables the DAC device to hold the DAC input code during power-off time, and the DAC output is available immediately after power-up. This feature is very useful when the DAC device is used as a supporting device for other devices in the network.

The device includes a Power-On-Reset (POR) circuit to ensure reliable power-up and an on-board charge pump for the EEPROM programming voltage. The DAC reference is driven from V_{DD} directly. In power-down mode, the output amplifier can be configured to present a known low, medium, or high resistance output load.

The MCP4725 has an external A0 address bit selection pin. This A0 pin can be tied to V_{DD} or V_{SS} of the user's application board.

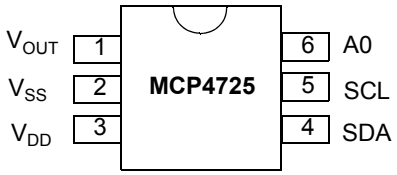
The MCP4725 has a two-wire I^2C™ compatible serial interface for standard (100 kHz), fast (400 kHz), or high speed (3.4 MHz) mode.

The MCP4725 is an ideal DAC device where design simplicity and small footprint is desired, and for applications requiring the DAC device settings to be saved during power-off time.

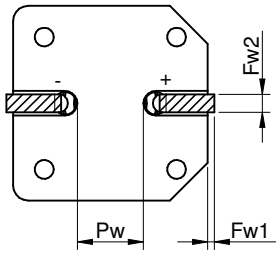
The device is available in a small 6-pin SOT-23 package.

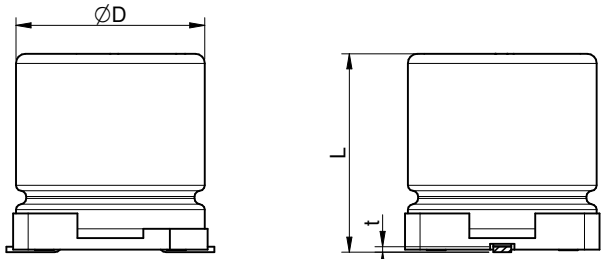
Package Type

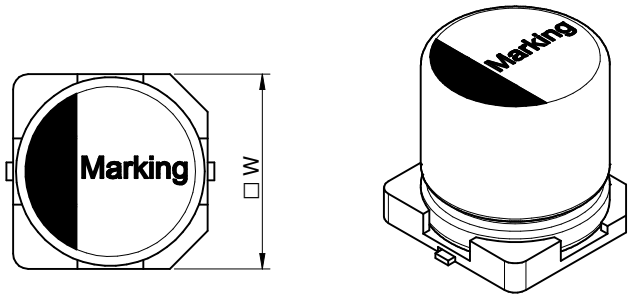
SOT-23-6



Dimensions: [mm]







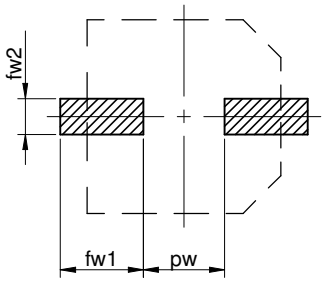
Properties		Value	Unit	Tol.
Diameter	Ø D	3	mm	±0.5
Length	L	5.5	mm	max.
Width	W	3.3	mm	±0.2
Material Thickness	t	0.3	mm	max.

Pw	0.8 ±0.2	mm
p_w	0.8	mm

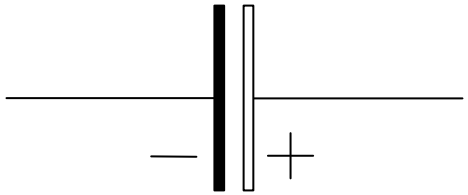
Fw1	0.25 +0/-0.5	mm
fw1	2.2	mm

Fw2	0.65 +0.15/-0.2	mm
fw2	1.6	mm

Recommended Land Pattern: [mm]



Schematic:



Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Capacitance	C	0.25 V/ 120 Hz/ +20 °C	10	µF	±20%
Rated Voltage	U_R		16	V (DC)	max.
Surge Voltage	U_S	1000 cycles @ 20 °C	18.4	V (DC)	max.
Leakage Current	I_{Leak}	2 min./ +20 °C	3	µA	max.
Dissipation Factor	DF	0.25 V/ 120 Hz/ +20 °C	18	%	max.
Ripple Current	I_{RIPPLE}	120 Hz @ 85 °C	20	mA	max.

General Information:

Aluminum Electrolytic Capacitors	
Operating Temperature	-40 up to +85 °C
Storage Conditions (in original packaging)	5 °C up to 35 °C; 10 % up to 75 % RH
Endurance	2000 h
Moisture Sensitivity Level (MSL)	1
Test conditions of Electrical Properties: +20 °C, 35 % RH if not specified differently	
FIT according to separate documentation	
Surge Voltage: Charging time 30s, discharging time 330s for a cycle	
Component conform to REACh and RoHS requirements and standards	

Würth Elektronik eiSos GmbH & Co. KG
EMC & Inductive Solutions
Max-Eyth-Str. 1
74638 Waldenburg
Germany
Tel. +49 (0) 79 42 945 - 0
www.we-online.com
eiSos@we-online.com

WÜRTH ELEKTRONIK

CREATED	CHECKED	GENERAL TOLERANCE	PROJECTION METHOD
KaS	PSL	DIN ISO 2768-1m	

DESCRIPTION: **WCAP-ASLU Aluminum Electrolytic Capacitors**

TECHNICAL REFERENCE: ASBA055100M016DVCTAB000

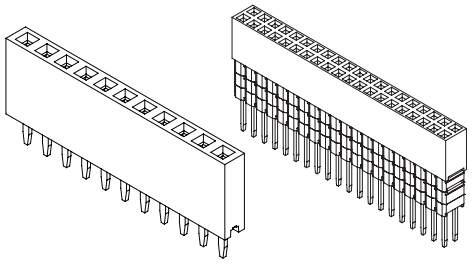
ORDER CODE: **865090368008**

SIZE	REVISION	STATUS	DATE (YYYY-MM-DD)	BUSINESS UNIT	PAGE
3.0 x 5.5	001.000	Valid	2018-11-10	eiCap	1/9

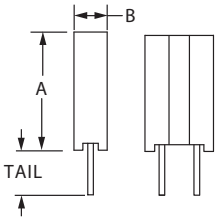
.100" [2.54 mm] Contact Centers, Female Headers, Straight/Right Angle/SMT

SPECIFICATIONS

- 3 Amps current rating
- UL Flammability Rating : 94V-0
- Insulator Material : PBT, Nylon
- Contact Material : Phosphor Bronze

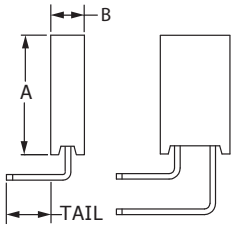


TERMINATION TYPE



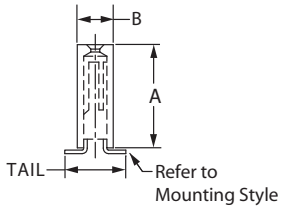
STRAIGHT

P/N CODE	ROWS	TERMINATION TYPE	A	B	TAIL
LFB	1	STRAIGHT	.335" [8.50]	.100" [2.54]	.126" [3.20]
	2	STRAIGHT	.335" [8.50]	.200" [5.08]	.126" [3.20]



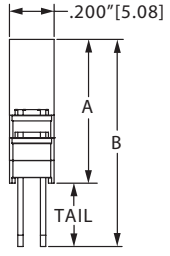
RIGHT ANGLE

P/N CODE	ROWS	TERMINATION TYPE	A	B	TAIL
LGB	1	RIGHT ANGLE	.335" [8.50]	0.100" [2.54]	.124" [3.15]
LJB	2	RIGHT ANGLE	.335" [8.50]	0.200" [5.08]	.124" [3.15]



SMT

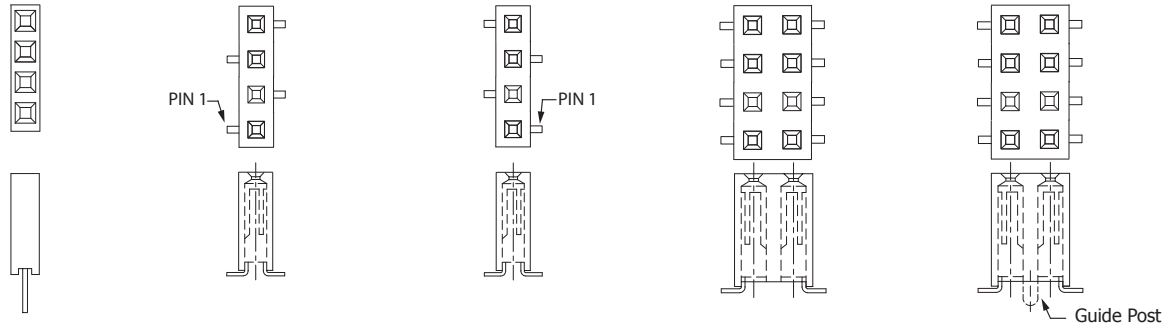
P/N CODE	ROWS	TERMINATION TYPE	ENTRY	A	B	TAIL
KFX	1	SMT	TOP ENTRY	.280" [7.10]	.098" [2.50]	.169" [4.30]
KFM	2	SMT	TOP ENTRY	.280" [7.10]	.197" [5.00]	.270" [6.85]



2 ROW STRAIGHT WITH ELEVATED SPACER

P/N CODE	ROWS	MODIFI-CATION	# OF SPACERS	A	B	TAIL
LFH	2	M44	1	.435" [11.04]	.725" [18.42]	.291" [7.38]
	2	M45	2	.535" [13.58]	.725" [18.42]	.191" [4.84]
	2	M46	3	.635" [16.12]	.725" [18.42]	.091" [2.30]
	2	M50	1	.435" [11.04]	.525" [13.34]	.091" [2.30]
	2	M51	1	.435" [11.04]	.915" [23.24]	.480" [12.20]
	2	M52	2	.535" [13.58]	.915" [23.24]	.380" [9.65]
	2	M53	3	.635" [16.12]	.914" [23.22]	.280" [7.10]
	2	M54	4	.735" [18.66]	.916" [23.26]	.181" [4.60]

MOUNTING STYLE



No Mounting Standard (N) | **One Row SMT, Pin 1 Left (C)** | **One Row SMT, Pin 1 Right (D)** | **Two Row SMT, Without Guide Post (S)** | **Two Row SMT, With Guide Post (P)**

CUI INC®

MODEL: PJ-002A | DESCRIPTION: DC POWER JACK

FEATURES

- 2.0 mm center pin
- 2.5 A rating
- right-angle orientation
- through hole

RoHS

SPECIFICATIONS

parameter	conditions/description	min	typ	max	units
rated input voltage			24		Vdc
rated input current				2.5	A
contact resistance[1]	between terminal and mating plug between terminal in a closed circuit			50 30	mΩ mΩ
insulation resistance	at 500 Vdc	100			MΩ
voltage withstand	at 50/60Hz for 1 minute			500	Vac
insertion/withdrawal force		0.3		3	kg
terminal strength	any direction for 10 seconds			500	g
operating temperature		-25		85	°C
life			5,000		cycles
flammability rating	UL94V-0				
RoHS	2011/65/EU				

Note: 1. When measured at a current of less than 100 mA/1 kHz

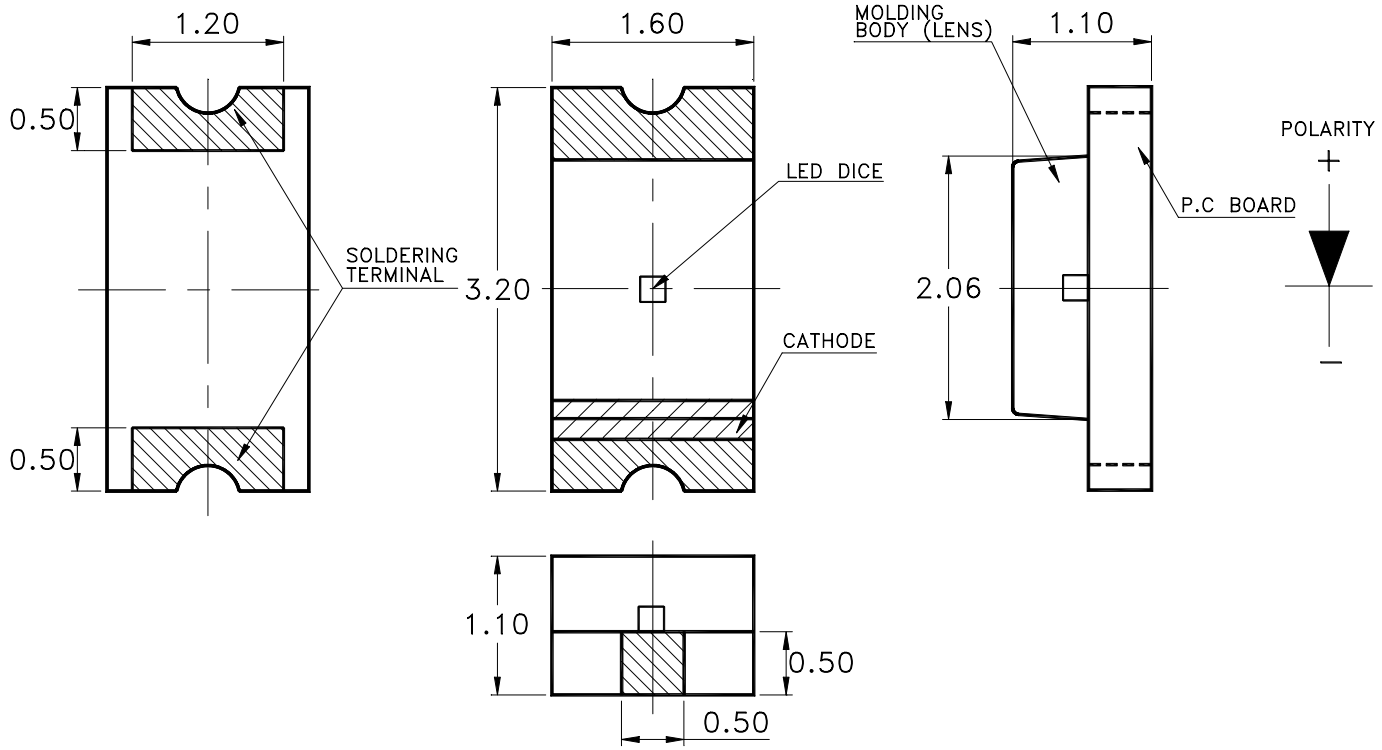
SOLDERABILITY

parameter	conditions/description	min	typ	max	units
wave soldering	dipped in solder pot for 5 ±0.5 seconds	255	260	265	°C

Features

* Meet ROHS, Green Product.
* Package In 8mm Tape On 7" Diameter Reels.
* Compatible With Automatic Placement Equipment.
* Compatible With Infrared And Vapor Phase Reflow Solder Process.
* EIA STD package.
* I.C. compatible.

Package Dimensions



Part No.	Lens	Source Color
LTST-C150GKT	Water Clear	GaP on GaP Green

Notes:

1. All dimensions are in millimeters (inches).
2. Tolerance is ± 0.10 mm (.004") unless otherwise noted.

LM158, LM158A, LM258, LM258A
LM2904, LM2904B, LM2904BA, LM2904V
LM358, LM358A, LM358B, LM358BA
SLOS068AA – JUNE 1976 – REVISED MARCH 2022

Industry-Standard Dual Operational Amplifiers

1 Features

- Wide supply range of 3 V to 36 V (B, BA versions)
- Quiescent current: 300 µA/ch (B, BA versions)
- Unity-gain bandwidth of 1.2 MHz (B, BA versions)
- Common-mode input voltage range includes ground, enabling direct sensing near ground
- 2-mV input offset voltage max. at 25°C (BA version)
- 3-mV input offset voltage max. at 25°C (A, B versions)
- Internal RF and EMI filter (B, BA versions)
- On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

2 Applications

- Merchant network and server power supply units
- Multi-function printers
- Power supplies and mobile chargers
- Motor control: AC induction, brushed DC, brushless DC, high-voltage, low-voltage, permanent magnet, and stepper motor
- Desktop PC and motherboard
- Indoor and outdoor air conditioners
- Washers, dryers, and refrigerators
- AC inverters, string inverters, central inverters, and voltage frequency drives
- Uninterruptible power supplies
- Electronic point-of-sale systems

3 Description

The LM358B and LM2904B devices are the next-generation versions of the industry-standard operational amplifiers (op amps) LM358 and LM2904, which include two high-voltage (36 V) op amps. These devices provide outstanding value for cost-sensitive applications, with features including low offset (300 µV, typical), common-mode input range to ground, and high differential input voltage capability.

The LM358B and LM2904B op amps simplify circuit design with enhanced features such as unity-gain stability, lower offset voltage maximum of 3 mV (2 mV maximum for LM358BA and LM2904BA), and lower quiescent current of 300 µA per amplifier (typical). High ESD (2 kV, HBM) and integrated EMI and RF filters enable the LM358B and LM2904B devices to be used in the most rugged, environmentally challenging applications.

The LM358B and LM2904B amplifiers are available in micro-sized packaging, such as the SOT23-8, as well as industry standard packages including SOIC, TSSOP, and VSSOP.

Device Information

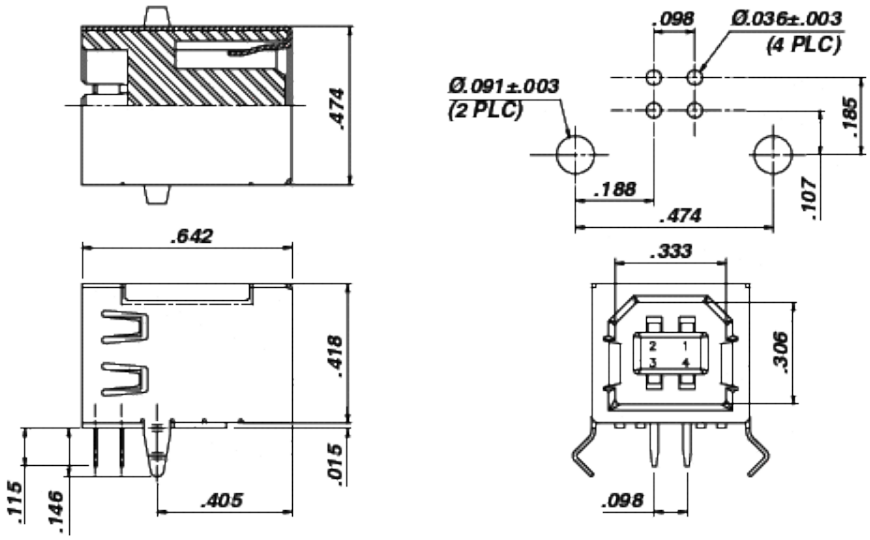
PART NUMBER(1)	PACKAGE	BODY SIZE (NOM)
LM358B, LM358BA, LM2904B, LM2904BA, LM358, LM358A, LM2904, LM2904V, LM258, LM258A	SOIC (8)	4.90 mm × 3.90 mm
LM358B, LM358BA, LM2904B, LM2904BA, LM358, LM358A, LM2904, LM2490V	TSSOP (8)	3.00 mm × 4.40 mm
LM358B, LM358BA, LM2904B, LM2904BA, LM358, LM358A, LM2904, LM2904V, LM258, LM258A	VSSOP (8)	3.00 mm × 3.00 mm
LM358B, LM358BA, LM2904B, LM2904BA	SOT-23 (8)	2.90 mm × 1.60 mm
LM358, LM2904	SO (8)	5.20 mm × 5.30 mm
LM358, LM2904, LM358A, LM258, LM258A	PDIP (8)	9.81 mm × 6.35 mm
LM158, LM158A	CDIP (8)	9.60 mm × 6.67 mm
LM158, LM158A	LCCC (20)	8.89 mm × 8.89 mm

Family Comparison

Specification	LM358B LM358BA	LM2904B LM2904BA	LM358 LM358A	LM2904	LM2904V LM2904AV	LM258 LM258A	LM158 LM158A	Units
Supply voltage	3 to 36	3 to 36	3 to 30	3 to 26	3 to 30	3 to 30	3 to 30	V
Offset voltage (max, 25°C)	± 3 ± 2	± 3 ± 2	± 7 ± 3	± 7	± 7 ± 2	± 5 ± 3	± 5 ± 2	mV
Input bias current (typ / max)	10 / 35	10 / 35	20 / 250 15 / 100	20 / 250	20 / 250	20 / 150 15 / 80	20 / 150 15 / 50	nA
Gain bandwidth product	1.2	1.2	0.7	0.7	0.7	0.7	0.7	MHz
Supply current (typ, per channel)	0.3	0.3	0.35	0.35	0.35	0.35	0.35	mA
ESD (HBM)	2000	2000	500	500	500	500	500	V
Operating ambient temperature	−40 to 85	−40 to 125	0 to 70	−40 to 125	−40 to 125	−25 to 85	−55 to 125	°C

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Product Number: 897-43-004-90-000000



Description:
USB Socket
Type B
USB 2.0
Through Hole
Plating Code:
43
Shell Plating:
200 µ" Tin (matte finish) over 100 µ" Nickel
Inner Contact Plating:
30 µ" Gold over 50 µ" Nickel

3D model of this series is unavailable

# Of Pins	Qty. per Tube	Mill-Max Part Number	RoHS Compliant
4	150	897-43-004-90-000000	RoHS 2002/95/EC

Certificate of Compliance:

This is to Certify that the product described above is manufactured to Mill-Max quality standards in accordance with all applicable specifications and drawing. Mill-Max certifies this product to be free from defects of materials and workmanship.

This Certificate of Compliance covers the following requirements:

- Dimensional (all features verified to be within tolerances described on the applicable drawing).
- Raw Material (materials and properties verified to be as described on the applicable drawing).
- Plating (platings as required, thickness verified, and performance including solderability per mil-standard).
- Performance (insertion extraction or other force requirements as described on the applicable drawing).

RoHS Compliance Statement for the restriction of lead, mercury, cadmium and hexavalent chromium PBB, PBDE, including Octa-BDE, Penta-BDE, Deca -BDE, in electronic equipment and use of PFOA and PFOS in metal plating processes.

Reference:

1. Directive 2002/95/EC of the European Parliament and of the Council of January 27 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

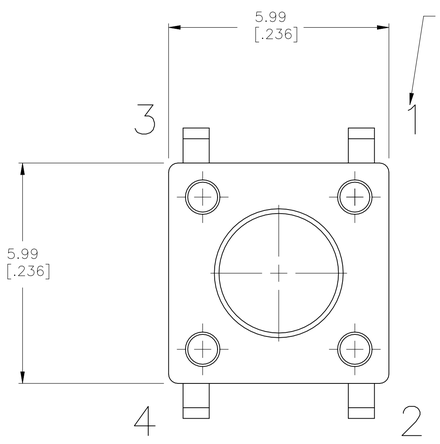
2. Directive 2003/11/EC which amends Council Directive 76/769/EC to include pentabromodiphenyl ether and octabromodiphenyl ether.

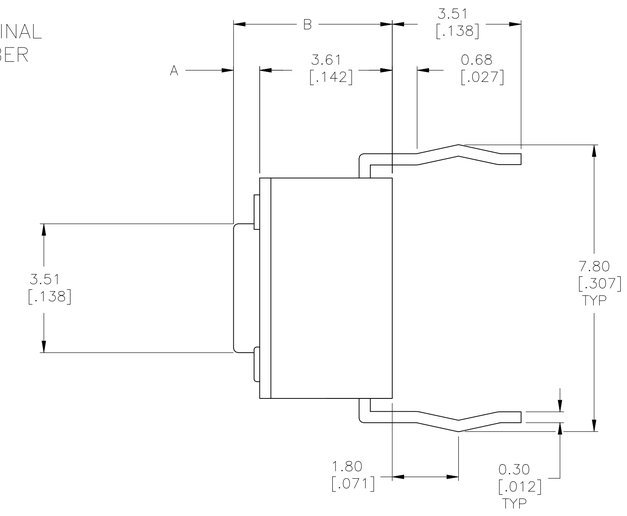
3. Directive 2005/618/EC Commission decision of 18 August 2005 amending Directive 2002/95/EC. Establishes threshold limits for Lead, Mercury, Cadmium, Hexavalent Chromium, PBB, and PBDE.

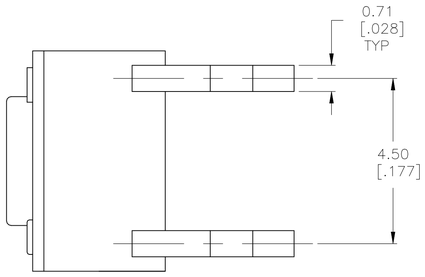
4. Judgment of the Court (Grand Chamber) 1 April 2008, Directive 2002/95/EC-Electrical and electronic equipment - Decabromodiphenyl ether (Deca-BDE) Actions for annulment of exemption.

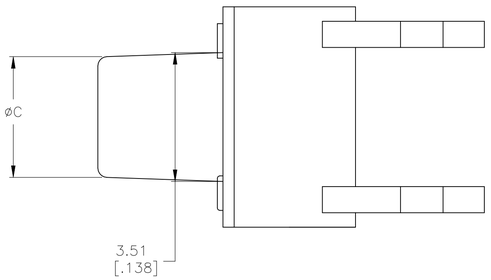
5. EU Directive 2006/122/EC of the European Parliament and of the Council of 12 December 2006, amending Council Directive 76/769/EEC on the restriction of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfanates (PFOS) used during metal plating processes.

REVISIONS					
P	LTR	DESCRIPTION	DATE	DWN	APVD
	C11	ECR-22-142281	20JUN2022	LP	DM



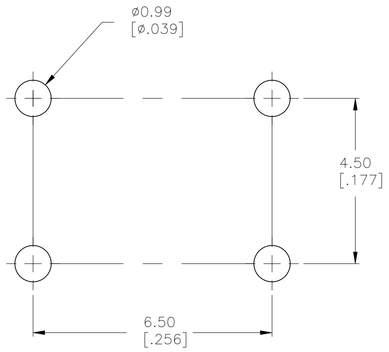






VIEW A–A
FSM6J THRU FSM18J

( )–INDICATES MOMENTARY POSITION		
CIRCUIT CHARACTERISTICS		
CONTACT POSITION		CIRCUIT DIAGRAM
OFF	(ON) 1–3 2–4	1 3 2 4



RECOMMENDED HOLE LAYOUT
TOLERANCE ±0.05[.002] UNLESS
OTHERWISE NOTED

SPECIFICATIONS:

MATERIALS:
CASE: NYLON 66 UL94HB, 30% GF–BLACK
ACTUATOR: PBT OR NYLON 66 UL94HB, SEE P/N TABLE
COVER: PET FILM, WHITE FINISH
MOVING CONTACT: COPPER ALLOY–SILVER FINISH
FIXED CONTACT/TERMINAL: COPPER ALLOY–SILVER OVER NICKEL FINISH

ELECTRICAL:
MAX CONTACT RATING: 50MILLIAMPS@24V DC,
MIN CONTACT RATING: 10MICROAMPS@1V DC
INITIAL CONTACT RESISTANCE, 100 MILLIOHMS MAX
INSULATION RESISTANCE, 100 MEGOHM MIN. @ 100V DC
DIELECTRIC STRENGTH, 500 V AC FOR 1 MINUTE
LIFE EXPECTANCY, 100,000 CYCLES MIN (2 CYCLES PER SECOND AND 150% ACTUATION FORCE), EXCEPT FOR THE 520 GF MODEL WHICH WOULD BE 50,000 CYCLES MIN.

MECHANICAL:
ACTUATION FORCE, SEE TABLE
ACTUATION TRAVEL, .010 +.008/–.004
LIFE EXPECTANCY, 100,000 CYCLES MIN (2 CYCLES PER SECOND AND 150% ACTUATION FORCE), EXCEPT FOR THE 520 GF MODEL WHICH WOULD BE 50,000 CYCLES MIN.

ENVIRONMENTAL:
OPERATING TEMPERATURE, –40 to +105 DEGREES C
STORAGE TEMPERATURE, –40 to +105 DEGREES C
THERMAL SHOCK, PER EIA–364–32C, –35 TO +85 DEGREES C
SOLDERABILITY, PER EIA–364–52, CLASS 2, CATEGORY 1, CATEGORY 2, 95% MINIMUM COVERAGE
RESISTANCE TO SOLDER HEAT, PER 109–202, CONDITION B

Notes
1 ALL MATERIALS AND FINISHES SHALL COMPLY WITH EU DIRECTIVE 2002/95/EC OF 27JAN2003 (ROHS).

	ACTUATOR MAT'L	ACTUATOR COLOR	ACTUATION FORCE	DIM C	DIM B	DIM A	ALCO P/N	P/N
	NYLON 6/6	BROWN	100 +/–50 GF	3.30 (.130)	7.00 (.276)	3.40 (.134)	FSM6JLHTB	3–1825910–9
OBSOLETE	PBT	BROWN	100 +/–50 GF	N/A	5.00 (.196)	1.40 (.055)	FSM4JLHTB	3–1825910–8
OBSOLETE	NYLON 6/6	YELLOW	520 +/–100 GF	3.09 (.122)	8.50 (.335)	4.90 (.193)	FSM18JAAH	3–1825910–7
OBSOLETE	NYLON 6/6	RED	260 +/–50 GF	3.09 (.122)	8.50 (.335)	4.90 (.193)	FSM18JAH	~~3–1825910–6~~
	NYLON 6/6	BLACK	160 +/–50 GF	3.09 (.122)	8.50 (.335)	4.90 (.193)	FSM18JH	3–1825910–5
OBSOLETE	NYLON 6/6	BROWN	100 +/–50 GF	3.09 (.122)	8.50 (.335)	4.90 (.193)	FSM18JLH	3–1825910–4
	NYLON 6/6	YELLOW	520 +/–100 GF	2.80 (.110)	17.00 (.669)	13.40 (.527)	FSM16JAAH	3–1825910–3
	NYLON 6/6	RED	260 +/–50 GF	2.80 (.110)	17.00 (.669)	13.40 (.527)	FSM16JAH	3–1825910–2
	NYLON 6/6	BLACK	160 +/–50 GF	2.80 (.110)	17.00 (.669)	13.40 (.527)	FSM16JH	3–1825910–1
OBSOLETE	NYLON 6/6	BROWN	100 +/–50 GF	2.80 (.110)	17.00 (.669)	13.40 (.527)	FSM16JLH	~~3–1825910–0~~
	NYLON 6/6	YELLOW	520 +/–100 GF	2.87 (.113)	13.00 (.512)	9.40 (.370)	FSM14JAAH	2–1825910–9
	NYLON 6/6	RED	260 +/–50 GF	2.87 (.113)	13.00 (.512)	9.40 (.370)	FSM14JAH	2–1825910–8
	NYLON 6/6	BLACK	160 +/–50 GF	2.87 (.113)	13.00 (.512)	9.40 (.370)	FSM14JH	2–1825910–7
	NYLON 6/6	BROWN	100 +/–50 GF	2.87 (.113)	13.00 (.512)	9.40 (.370)	FSM14JLH	2–1825910–6
OBSOLETE	NYLON 6/6	YELLOW	520 +/–100 GF	3.20 (.126)	8.00 (.315)	4.40 (.173)	FSM12JAAH	2–1825910–5
OBSOLETE	NYLON 6/6	BLACK	260 +/–50 GF	3.20 (.126)	8.00 (.315)	4.40 (.173)	FSM12JABH	2–1825910–4
OBSOLETE	NYLON 6/6	RED	260 +/–50 GF	3.20 (.126)	8.00 (.315)	4.40 (.173)	FSM12JAH	2–1825910–3
	NYLON 6/6	WHITE	160 +/–50 GF	3.20 (.126)	8.00 (.315)	4.40 (.173)	FSM12JH	2–1825910–2
OBSOLETE	NYLON 6/6	BROWN	100 +/–50 GF	3.20 (.126)	8.00 (.315)	4.40 (.173)	FSM12JLH	2–1825910–1
OBSOLETE	NYLON 6/6	YELLOW	520 +/–100 GF	3.25 (.128)	7.30 (.287)	3.70 (.146)	FSM10JAAH	2–1825910–0
	NYLON 6/6	RED	260 +/–50 GF	3.25 (.128)	7.30 (.287)	3.70 (.146)	FSM10JAH	1–1825910–9
	NYLON 6/6	IVORY	160 +/–50 GF	3.25 (.128)	7.30 (.287)	3.70 (.146)	FSM10JH	1–1825910–8
OBSOLETE	NYLON 6/6	BROWN	100 +/–50 GF	3.25 (.128)	7.30 (.287)	3.70 (.146)	FSM10JLH	~~1–1825910–7~~
OBSOLETE	PBT	YELLOW	520 +/–100 GF	3.10 (.122)	9.50 (.374)	5.90 (.232)	FSM8JAAH	~~1–1825910–6~~
	PBT	RED	260 +/–50 GF	3.10 (.122)	9.50 (.374)	5.90 (.232)	FSM8JAH	1–1825910–5
	PBT	BLACK	160 +/–50 GF	3.10 (.122)	9.50 (.374)	5.90 (.232)	FSM8JH	1–1825910–4
	PBT	BROWN	100 +/–50 GF	3.10 (.122)	9.50 (.374)	5.90 (.232)	FSM8JLH	1–1825910–3
	NYLON 6/6	YELLOW	520 +/–100 GF	3.30 (.130)	7.00 (.276)	3.40 (.134)	FSM6JAAH	1–1825910–2
	NYLON %	RED	260 +/–50 GF	3.30 (.130)	7.00 (.276)	3.40 (.134)	FSM6JAH	1–1825910–1
	NYLON 6/6	BLUE	160 +/–50 GF	3.30 (.130)	7.00 (.276)	3.40 (.134)	FSM6JH	1–1825910–0
	NYLON 6/6	BROWN	100 +/–50 GF	3.30 (.130)	7.00 (.276)	3.40 (.134)	FSM6JLH	1825910–9
	PBT	YELLOW	520 +/–100 GF	N/A	5.00 (.196)	1.40 (.055)	FSM4JAAH	1825910–8
	PBT	RED	260 +/–50 GF	N/A	5.00 (.196)	1.40 (.055)	FSM4JAH	1825910–7
	PBT	BLACK	160 +/–50 GF	N/A	5.00 (.196)	1.40 (.055)	FSM4JH	1825910–6
OBSOLETE	PBT	BROWN	100 +/–50 GF	N/A	5.00 (.196)	1.40 (.055)	FSM4JLH	1825910–5
OBSOLETE	PBT	YELLOW	520 +/–100 GF	N/A	4.30 (.169)	0.70 (.028)	FSM2JAAH	1825910–4
	PBT	RED	260 +/–50 GF	N/A	4.30 (.169)	0.70 (.028)	FSM2JAH	1825910–3
	PBT	NATURAL	160 +/–50 GF	N/A	4.30 (.169)	0.70 (.028)	FSM2JH	1825910–2
	PBT	BROWN	100 +/–50 GF	N/A	4.30 (.169)	0.70 (.028)	FSM2JLH	1825910–1

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: mm [INCHES]

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ± –
1 PLC ± –
2 PLC ± 0.30 [.012]
3 PLC ± –
4 PLC ± –
ANGLES ± –

MATERIAL: SEE SPECIFICATIONS
FINISH: –
WEIGHT:

DWN M.BINNER 07NOV06
CHK M.SARVER 07NOV06
APVD M.SARVER 07NOV06
PRODUCT SPEC –
APPLICATION SPEC –

TE Connectivity

NAME: 6MM TACT SWITCH, THRU–HOLE HIGH TEMP

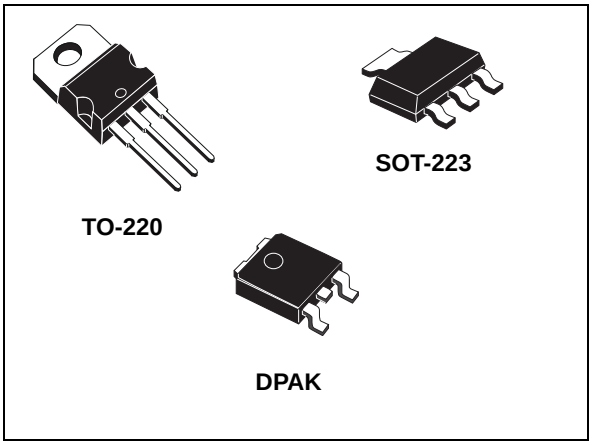
SIZE A1 | CAGE CODE 00779 | DRAWING NO C-1825910 | RESTRICTED TO –

CUSTOMER DRAWING | SCALE 12:1 | SHEET 1 OF 1 | REV C11

LD1117A

Low drop fixed and adjustable positive voltage regulators

Datasheet - production data



Features

- Low dropout voltage:
  - 1.15 V typ. @ I_{OUT} = 1 A, 25 °C
- Very low quiescent current:
  - 5 mA typ. @ 25 °C
- Output current up to 1 A
- Fixed output voltage of:
  - 1.2 V, 1.8 V, 3.3 V
- Adjustable version availability (V_{REF} = 1.25 V)
- Internal current and thermal limit
- Only 10 µF for stability
- Available in ± 2% (at 25 °C) and 4% in full temperature range
- High supply voltage rejection:
  - 80 dB typ. (at 25 °C)
- Temperature range: 0 °C to 125 °C

Description

The LD1117A is a low drop voltage regulator able to provide up to 1 A of output current, available also in adjustable versions (V_{REF} = 1.25 V). In fixed versions, the following output voltages are offered: 1.2 V, 1.8 V, and 3.3 V. The device is supplied in: SOT-223, DPAK and TO-220. Surface mounted packages optimize the thermal characteristics while offering a relevant space saving advantage. High efficiency is assured by an NPN pass transistor. Only a very common 10 µF minimum capacitor is needed for stability. Chip trimming allows the regulator to reach a very tight output voltage tolerance, within ± 2% at 25 °C.

Table 1. Device summary

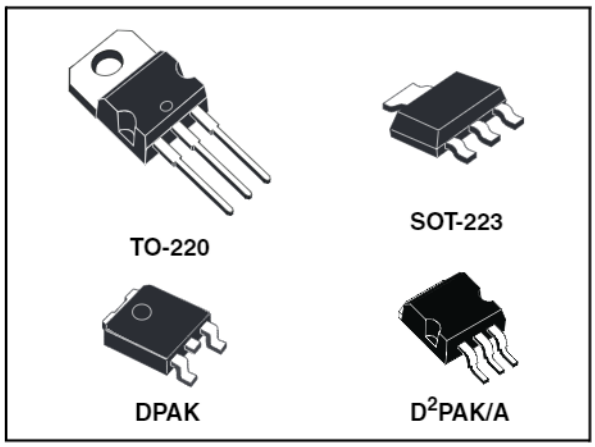
Order codes			Output voltage
SOT-223	DPAK	TO-220	
LD1117AS12TR	LD1117ADT12TR		1.2 V
LD1117AS18TR	LD1117ADT18TR		1.8 V
LD1117AS33TR	LD1117ADT33TR	LD1117AV33	3.3 V
LD1117ASTR	LD1117ADT-TR		Adjustable from 1.25 V

LD1117A series

Low drop fixed and adjustable positive voltage regulators

Features

- Low dropout voltage (1.15V typ. @ I_{OUT} = 1A, 25°C)
- Very low quiescent current (5 mA typ. @ 25°C)
- Output current up to 1A
- Fixed output voltage of: 1.2V, 1.8V, 2.5V, 2.85V, 3.3V, 5.0V
- Adjustable version availability (V_{rel} = 1.25V)
- Internal current and thermal limit
- Only 10 µF for stability
- Available in ± 2% (at 25°C) and 4% in full temperature range
- High supply voltage rejection:
  - 80dB typ. at 25°C)
- Temperature range: 0°C to 125°C

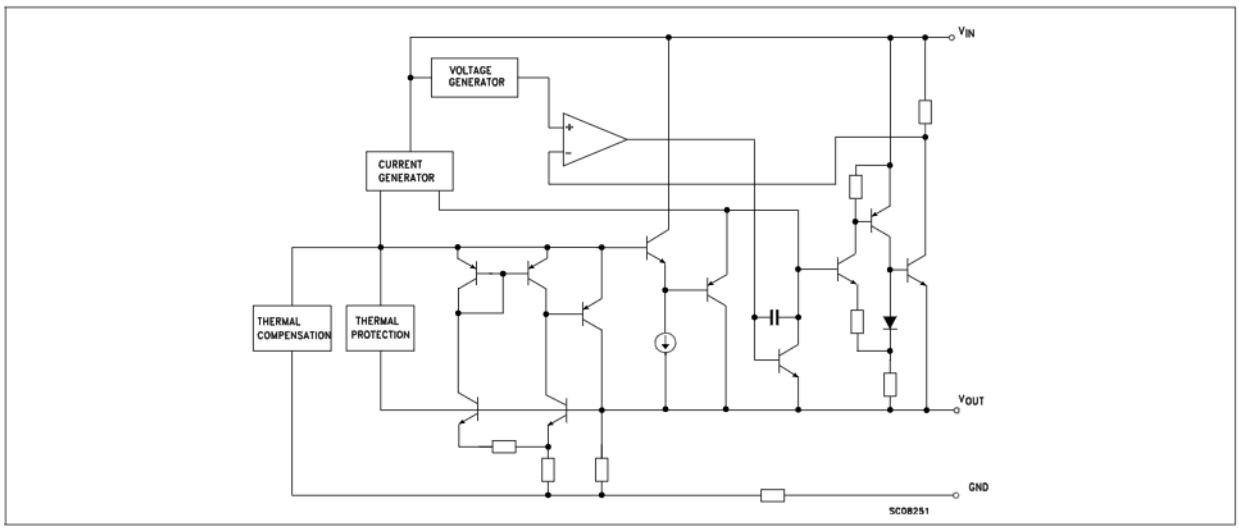


Description

The LD1117A is a LOW DROP Voltage Regulator able to provide up to 1A of Output Current, available even in adjustable version (Vref=1.25V).

Concerning fixed versions, are offered the following Output Voltages: 1.2V, 1.8V, 2.5V, 2.85V, 3.3V and 5.0V. The 2.85V type is ideal for SCSI-2 lines active termination. The device is supplied in: SOT-223, DPAK, D^2PAK/A and TO-220. Surface mount packages optimize the thermal characteristics even offering a relevant space saving effect. High efficiency is assured by NPN pass transistor. Only a very common 10µF minimum capacitor is needed for stability. Only chip trimming allows the regulator to reach a very tight output voltage tolerance, within ± 2% at 25°C.

Block diagram



LOW FREQUENCY, 32.768kHz CYLINDRICAL TYPE

TUNING FORK CRYSTALS

AB38T and AB26T

8.3 x Ø3.2 mm or 6.2 x Ø2.1 mm

FEATURES:

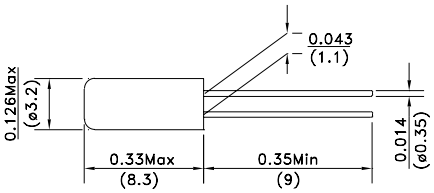
- Watch frequency.
- Frequency range from 30kHz to 200kHz.
- Excellent heat resistance.

APPLICATIONS:

- Real time clock.
- Measuring instruments.
- Clock source for communication or A/V equipment.

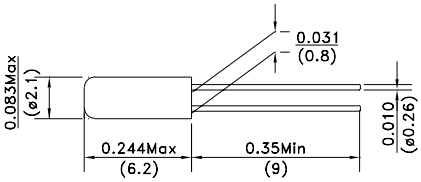
STANDARD SPECIFICATIONS

PARAMETERS	AB38T	AB26T
Frequency Range	**32.768kHz**	**32.768kHz** **30kHz to 200kHz**
Operating Temperature	-10°C to +60°C *(See Options)*	
Storage Temperature	-40°C to +85°C	
Turnover Temperature	25°C to ±5°C	
Frequency Tolerance @ 25°C	±20ppm max.	±20ppm max.(32.768kHz) & ±30ppm max.(others)
Frequency Stability over Temp	-0.034 ±0.006ppm / (25-T)² **	
Equivalent Series Resistance (ESR)	30kΩ max.	35kΩ max.(32.768kHz) 35kΩ ~ 50KΩ (others)
Shunt Capacitance C_0	1.6pF typical	0.8 to 1.7pF typical
Load Capacitance C_L *(See Note)*	12.5pF typical *(See Options)*	
Motion Capacitance C_1	0.0035pF typ.	0.001 ~ 0.004pF typ.
Drive Level	1µW max.	
Quality Factor Q	90,000 typical	70,000 typical
Capacitance Ratio C_0 / C_1	460 typical	425 - 800 typical
Insulation Resistance	500 MΩ min. at 100 Vdc ±15 V	
Aging @ 25°C First year	±3ppm max.	±3ppm (32.768kHz) ±5ppm (others)



AB38T

Dimensions: Inches (mm)

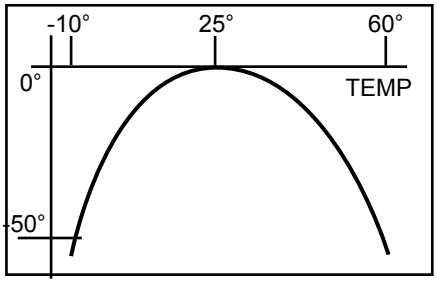


AB26T

Note : Custom C_L upon request at 6 pF. Check with us for other C_L value.
** Example: Stability at -20°C is: -0.035 x [25-(-20)]² = -71ppm.

Environmental, and mechanical specifications, see appendix C. Group 3.
Marking, see appendix G.
Recommended handling, see appendix F.
Application notes, see appendix A.

TYPICAL FREQUENCY
-vs-
TEMPERATURE CURVE



ORDERING OPTIONS

ABXXT - Frequency - CL - Temperature - Tolerance

- ABXXT: 38 or 26
- Frequency: XX.XXXX kHz
- CL: Load cap. in pF or -S for Series
- Temperature: -E for 0°C to +70°C; -B for -20°C to +70°C; -C for -30°C to +70°C; -N for -30°C to +85°C; -D for -40°C to +85°C
- Tolerance: -1 for ± 10ppm*; -7 for ± 15ppm

* Please call for availability.

NOTE: Left blank if standard • All specifications and markings subject to change without notice

ABRACON IS ISO 9001 / QS 9000 CERTIFIED

29 Journey • Aliso Viejo, CA 92656 • USA
(949) 448-7070 • FAX: (949) 448-8484
E-MAIL: **abinfo@abracon.com** • INTERNET ADDRESS: **www.abracon.com**

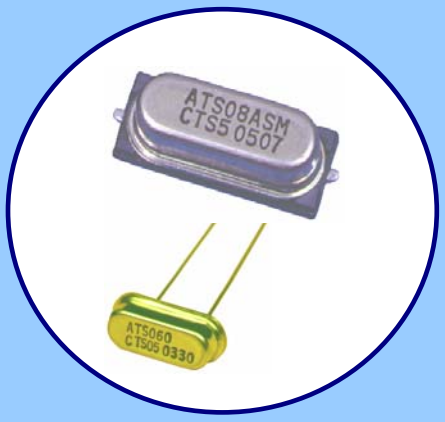
ABRACON® CORPORATION

ATS/ATS-SM Series

Quartz Crystal

FEATURES

- Standard HC-49/US [thru-hole] and HC-49/US-SM [surface mount] Packages
- Stable Frequency Over Temperature and Drive Level
- **Fundamental and 3rd Overtone Crystals**
- Frequency Range 3.2 – 64 MHz
- Frequency Tolerance, ±30 ppm Standard
- Frequency Stability, ±50 ppm Standard
- Operating Temperature, –20°C to +70°C Standard, -40°C to +85°C Available
- Tape & Reel Packaging Available
- **RoHS/Green Compliant [6/6]**



APPLICATIONS

The ATS/ATS-SM crystal series offers excellent long-term stability and reliability in a proven resistance-weld metal package. The excellent shock performance makes it suitable for microprocessor, telecommunication, industrial, consumer electronics and networking applications.

ORDERING INFORMATION

ATS

ATS □□□□ - □□□

PRODUCT OPTIONS
INS - Insulation Spacer

TEMPERATURE RANGE OPTIONS
Blank - Standard, -20°C to +70°C
E - Extended Temperature Range, -40°C to +85°C

PACKAGING OPTIONS
Blank - Bulk
1 - Radial Taping (Ammopak) *

FREQUENCY
Product Frequency/Load Code. [3 to 4 digits]
Refer to Standard Product Part Numbers tables on Pages 2 and 3.

*** Standard packaging is bulk in a bag.**

ATS-SM

ATS □□□□ SM - □□

TEMPERATURE RANGE OPTIONS
Blank - Standard, -20°C to +70°C
E - Extended Temperature Range, -40°C to +85°C

PACKAGING OPTIONS
Blank - Bulk
1 - Tape and Reel **

FREQUENCY
Product Frequency/Load Code. [3 to 4 digits]
Refer to Standard Product Part Numbers tables on Pages 2 and 3.

**** Standard packaging is tape and reel.**
CTS Distributors may use -T for tape and reel indicator.

Non-Standard Ordering Options

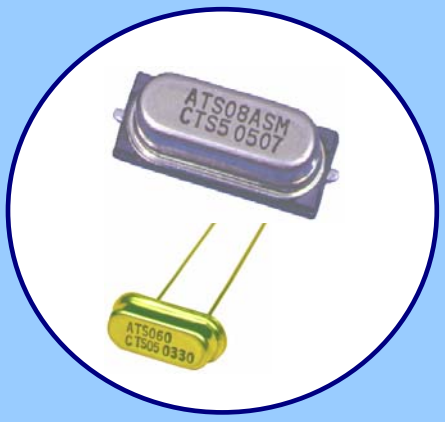
- Contact your local CTS Representative or CTS Inside Sales Representative for assistance.

ATS/ATS-SM Series

Quartz Crystal

FEATURES

- Standard HC-49/US [thru-hole] and HC-49/US-SM [surface mount] Packages
- Stable Frequency Over Temperature and Drive Level
- **Fundamental and 3rd Overtone Crystals**
- Frequency Range 3.2 – 64 MHz
- Frequency Tolerance, ±30 ppm Standard
- Frequency Stability, ±50 ppm Standard
- Operating Temperature, –20°C to +70°C Standard, -40°C to +85°C Available
- Tape & Reel Packaging Available
- **RoHS/Green Compliant [6/6]**



APPLICATIONS

The ATS/ATS-SM crystal series offers excellent long-term stability and reliability in a proven resistance-weld metal package. The excellent shock performance makes it suitable for microprocessor, telecommunication, industrial, consumer electronics and networking applications.

ORDERING INFORMATION

ATS

ATS □□□□ - □□□

PRODUCT OPTIONS
INS - Insulation Spacer

TEMPERATURE RANGE OPTIONS
Blank - Standard, -20°C to +70°C
E - Extended Temperature Range, -40°C to +85°C

PACKAGING OPTIONS
Blank - Bulk
1 - Radial Taping (Ammopak) *

FREQUENCY
Product Frequency/Load Code. [3 to 4 digits]
Refer to Standard Product Part Numbers tables on Pages 2 and 3.

*** Standard packaging is bulk in a bag.**

ATS-SM

ATS □□□□ SM - □□

TEMPERATURE RANGE OPTIONS
Blank - Standard, -20°C to +70°C
E - Extended Temperature Range, -40°C to +85°C

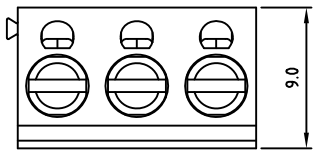
PACKAGING OPTIONS
Blank - Bulk
1 - Tape and Reel **

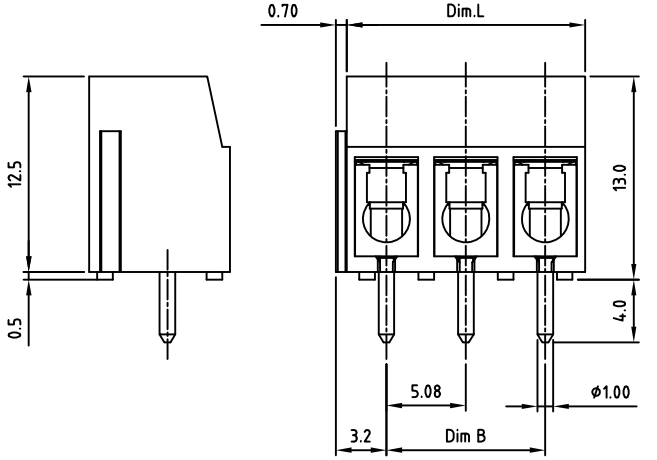
FREQUENCY
Product Frequency/Load Code. [3 to 4 digits]
Refer to Standard Product Part Numbers tables on Pages 2 and 3.

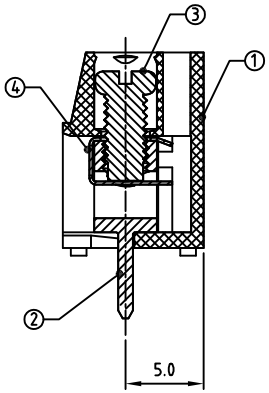
**** Standard packaging is tape and reel.**
CTS Distributors may use -T for tape and reel indicator.

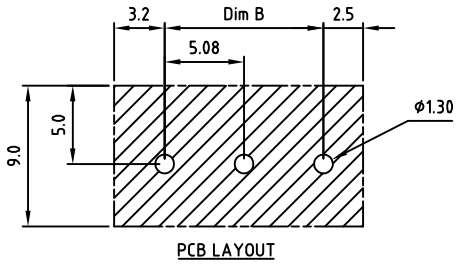
Non-Standard Ordering Options

- Contact your local CTS Representative or CTS Inside Sales Representative for assistance.









PCB LAYOUT

Technical data

1.Nominal voltage: 300V/16A
PITCH:5.08mm

2.Connection capacity:
AWG 26-14

3.Insulation Withstanding Voltage:
AC 1600V/MIN

4.Insulation Resistance:
1000MΩor more at DC500V

5.Tightening torque:
4.0kgf.cm (0.4N.m)

6.Screw thread: M3

7.Stripping length: 6-7mm

8.Operating temperature range:-40°C ~ 115°C
Soldering temperature:250±10°C /5s

9.Undimensioned Tolerances:

Dim.L=Px5.08
Dim.B=(P-1)x5.08
P= number of poles(2-24p)

	Dim B	Dim L
0-30mm	±0.15	±0.20
over 30mm-60mm	±0.20	±0.25
over 60mm-90mm	±0.25	±0.30
over 90mm	±0.30	±0.40

10.Safety approval:
11.RoHS Compliance

Part No.:

OSTTAXX4163

No. of Poles
02 2 Poles
03 3 Poles
... ...
24 24 Poles

COLOR
0: Black
2: Red
3: Orange
4: Yellow
5: Green
6: Blue (Standard)
8: Grey

Nonstandard colors
Mins could apply

ITEM	NAME OF PART	MATERIAL	NOTES	Q"TY
4	WIRE GUARD	Stainless steel		P
3	SCREW	STEEL	M3×0.5, Zn Plated	P
2	CAGE	BRASS	M3×0.5, Tin PLATED	P
1	BODY	PA66 UL94V-0	ALL COLOR	1

DWG.	WF. Zhang	DATE	2016.04.02	UNITS:	MM	SHEET: 1 OF 1	Tolerance
CHK.	WF. Zhang	DATE	2016.06.12	SCALE:	NONE 3:1 (:)	REV.: A	X. ±0.50
APP.		DATE		TITLE:	OSTTA 5.08 Series 1-Interlock "-" slot type screw		X.X ±0.30
							X.XX ±0.10
							X° ±1°
				PART NO.	OSTTAXX4163		
				DWG NO.	OSTTAXX4163.dwg		

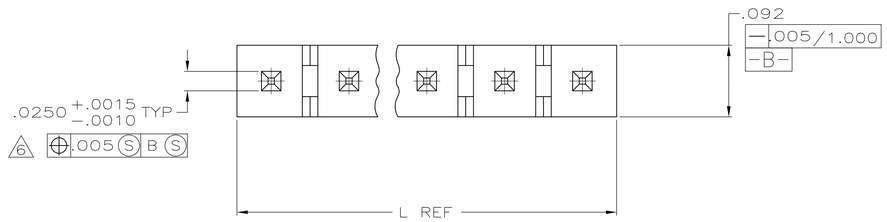
ON-SHORE TECHNOLOGY, INC.

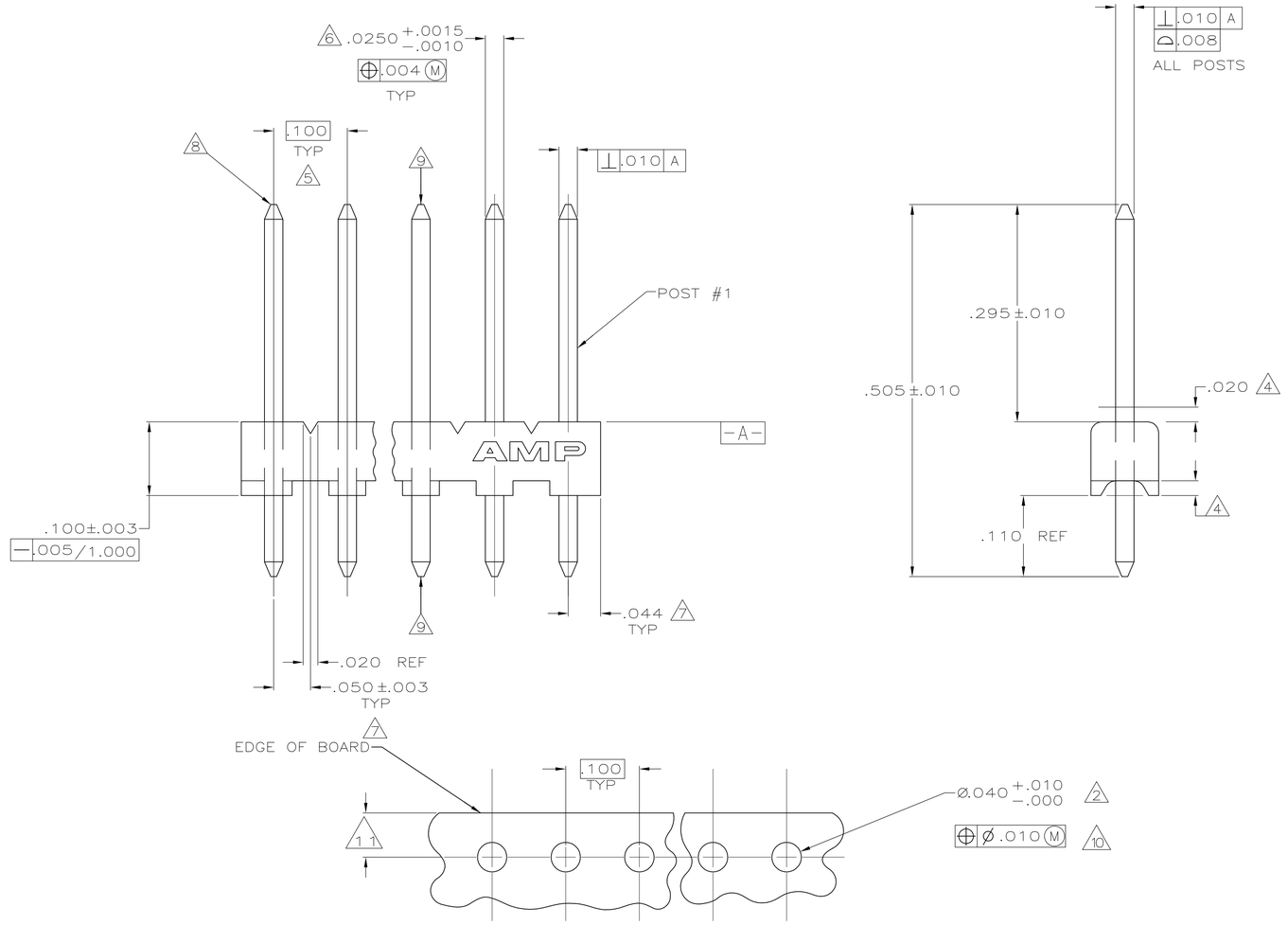
SIGN	DESCRIPTION	CHK.	DATE
⚠			

LOC	DIST
CM	00

REVISIONS

P	LTR	DESCRIPTION	DATE	DWN	APVD
	D2	REVISED PER ECO-11-004587	11MAR11	RK	HMR





RECOMMENDED MOUNTING HOLE PATTERN
FOR .063 THICK P.C. BOARD

1. MATERIAL:
   BASE: THERMOPLASTIC POLYESTER,UL 94V-O (NATURAL).
   POST: COPPER ALLOY (TIN OR TIN LEAD PLATED,.000150 MIN THK).
2. ONE HOLE MAY BE UNDERSIZED (.032-.035 DIA) FOR ASSEMBLY RETENTION DURING WAVE SOLDERING.
3. PARTS MUST COMPLY WITH AMP SOLDERABILITY SPEC 109-11-2.
4. PLASTIC AROUND POST PERMISSIBLE IN THIS AREA ONLY.
5. DIMENSION APPLIES WHEN HEADER IS HELD FLAT.
6. MEASURED AT -A-
7. COORDINATE DIMENSION APPLIES FROM CENTER OF ACTUAL FEATURE.
8. RADIUS AT TIP PERMITTED, BOTH ENDS.
9. POST MUST WITHSTAND 3.0 LB MIN AXIAL FORCE IN BOTH DIRECTIONS WITHOUT DISLODGING.
10. SOLDER SIDE OF BOARD IS SHOWN.
11. DIMENSION SHOULD BE .060 MIN WHEN MATING WITH A MTA 100 CONNECTOR ASSEMBLY OR A CST 100 CONNECTOR.
12. AMP LOGO MAY OR MAY NOT APPEAR ON MOLDING HOUSING.

⊥.010 A
⌓.008
ALL POSTS

LEADFREE	NO. OF POSTS	L IN	L MM	NO. OF CIRCUITS	
YES	28	2.788	70.82	28	5-644456-8
	27	2.688	68.28	27	5-644456-7
	26	2.588	65.74	26	5-644456-6
	25	2.488	63.20	25	5-644456-5
	24	2.388	60.66	24	5-644456-4
	23	2.288	58.12	23	5-644456-3
	22	2.188	55.58	22	5-644456-2
	21	2.088	53.04	21	5-644456-1
	20	1.988	50.50	20	5-644456-0
	19	1.888	47.96	19	4-644456-9
	18	1.788	45.42	18	4-644456-8
	17	1.688	42.88	17	4-644456-7
	16	1.588	40.34	16	4-644456-6
	15	1.488	37.80	15	4-644456-5
	14	1.388	35.26	14	4-644456-4
	13	1.288	32.72	13	4-644456-3
	12	1.188	30.18	12	4-644456-2
	11	1.088	27.64	11	4-644456-1
	10	.988	25.10	10	4-644456-0
	9	.888	22.56	9	3-644456-9
	8	.788	20.02	8	3-644456-8
	7	.688	17.48	7	3-644456-7
	6	.588	14.94	6	3-644456-6
	5	.488	12.40	5	3-644456-5
	4	.388	9.86	4	3-644456-4
	3	.288	7.32	3	3-644456-3
	2	.188	4.78	2	3-644456-2
NO	28	2.788	70.82	28	2-644456-8
	27	2.688	68.28	27	2-644456-7
	26	2.588	65.74	26	2-644456-6
	25	2.488	63.20	25	2-644456-5
	24	2.388	60.66	24	2-644456-4
	23	2.288	58.12	23	2-644456-3
	22	2.188	55.58	22	2-644456-2
	21	2.088	53.04	21	2-644456-1
	20	1.988	50.50	20	2-644456-0
	19	1.888	47.96	19	1-644456-9
	18	1.788	45.42	18	1-644456-8
	17	1.688	42.88	17	1-644456-7
	16	1.588	40.34	16	1-644456-6
	15	1.488	37.80	15	1-644456-5
	14	1.388	35.26	14	1-644456-4
	13	1.288	32.72	13	1-644456-3
	12	1.188	30.18	12	1-644456-2
	11	1.088	27.64	11	1-644456-1
	10	.988	25.10	10	1-644456-0
	9	.888	22.56	9	644456-9
	8	.788	20.02	8	644456-8
	7	.688	17.48	7	644456-7
	6	.588	14.94	6	644456-6
	5	.488	12.40	5	644456-5
	4	.388	9.86	4	644456-4
	3	.288	7.32	3	644456-3
	2	.188	4.78	2	644456-2

LEADFREE	NO. OF POSTS	L IN	L MM	NO. OF CIRCUITS	
NO	SUPERSEDED BY 5-644456-8				
	SUPERSEDED BY 5-644456-7				
	SUPERSEDED BY 5-644456-6				
	SUPERSEDED BY 5-644456-5				
	SUPERSEDED BY 5-644456-4				
	SUPERSEDED BY 5-644456-3				
	SUPERSEDED BY 5-644456-2				
	SUPERSEDED BY 5-644456-1				
	SUPERSEDED BY 5-644456-0				
	SUPERSEDED BY 4-644456-9				
	SUPERSEDED BY 4-644456-8				
	SUPERSEDED BY 4-644456-7				
	SUPERSEDED BY 4-644456-6				
	SUPERSEDED BY 4-644456-5				
	SUPERSEDED BY 4-644456-4				
	SUPERSEDED BY 4-644456-3				
	SUPERSEDED BY 4-644456-2				
	SUPERSEDED BY 4-644456-1				
	SUPERSEDED BY 4-644456-0				
	SUPERSEDED BY 3-644456-9				
	SUPERSEDED BY 3-644456-8				
	SUPERSEDED BY 3-644456-7				
	SUPERSEDED BY 3-644456-6				
	SUPERSEDED BY 3-644456-5				
	SUPERSEDED BY 3-644456-4				
	SUPERSEDED BY 3-644456-3				
	SUPERSEDED BY 3-644456-2				

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ±
1 PLC ±
2 PLC ±
3 PLC ± .005
4 PLC ±
ANGLES ±

MATERIAL 1
FINISH 1

DWN	S. CARPENTER	23MAY2003
CHK	D. BOSSI	23MAY2003
APVD	D. BOSSI	23MAY2003

TE Connectivity

NAME: MTA-100 HEADER ASSEMBLY,NARROW, .025 SQUARE STRAIGHT POST, TIN PLATED

PRODUCT SPEC
APPLICATION SPEC
WEIGHT

SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A1	00779	C-644456	-

CUSTOMER DRAWING | SCALE 10:1 | SHEET 1 OF 1 | REV D2

1.0A SURFACE MOUNT SCHOTTKY BARRIER RECTIFIER

Product Summary (@ T_A = +25°C)

V_{RRM} (V)	I_O (A)	$V_{F(MAX)}$ (mV)	$I_{R(MAX)}$ (µA)
40	1.0	450	50

Description and Applications

The device is a single rectifier offering low V_F and excellent high temperature stability. This device is ideal for use in general rectification applications:

- For Use in Low Voltage, High Frequency Inverters
- Free Wheeling
- Polarity Protection Application

Features and Benefits

- High Surge Capability
- Low Power Loss, High Efficiency
- High Current Capability and Low Forward Voltage Drop
- Guard Ring Die Construction for Transient Protection
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**
- **An Automotive-Compliant Part is Available Under Separate Datasheet (1N5819HWQ)**

Mechanical Data

- Case: SOD123
- Plastic Material: Molded Plastic. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Polarity: Cathode Band
- Leads: Matte Tin Finish Annealed over Alloy 42 Leadframe (Lead Free Plating) Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.01 grams (Approximate)

Device Schematic

Top View

Ordering Information (Note 4)

Part Number	Case	Packaging
1N5819HW-7-F	SOD123	3000/Tape & Reel

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen and Antimony free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

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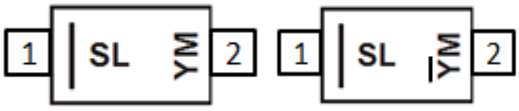
Marking Information



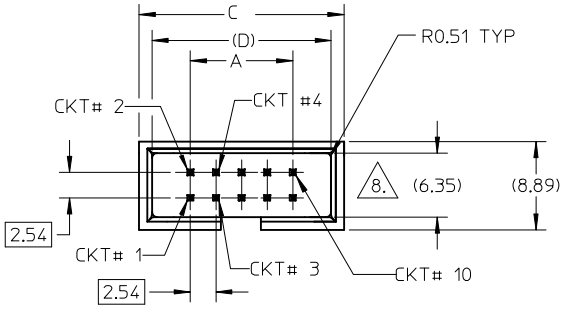
SL = Product Type Marking Code
YM & $\overline{Y}$M = Date Code Marking
Y & $\overline{Y}$ = Year (ex: H = 2020)
M = Month (ex: 9 = September)

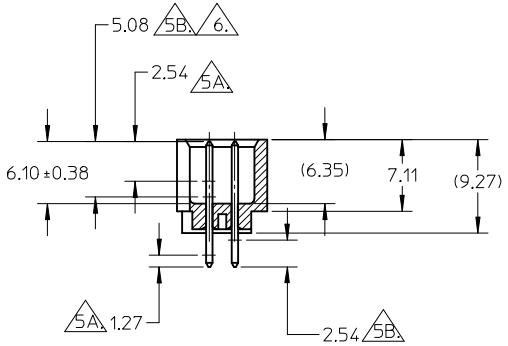
Date Code Key

Year	2003	…	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Code	P	…	H	I	J	K	L	M	N	O	P	R

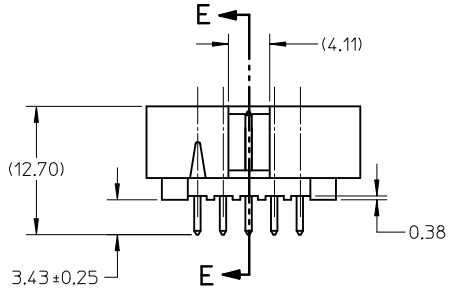
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Code	1	2	3	4	5	6	7	8	9	O	N	D

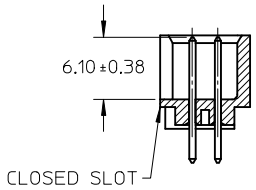
CONTENTS





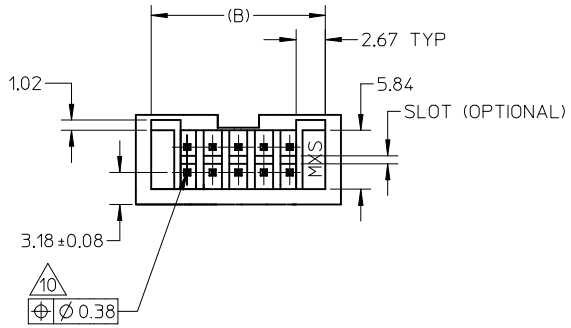
SECTION E-E

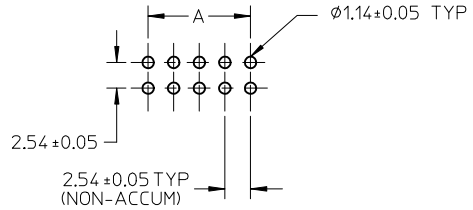




MOLEX IRELAND PRODUCTION ONLY

(OPTION)





RECOMMENDED PCB HOLE LAYOUT

NOTES:

1. PIN PUSHOUT FORCE (.9072KG)/2LBS MIN.
2. PIN SOLDERABILITY PER MOLEX SPEC. ES-152.
3. PRODUCT SPEC: PS-70246-100 APPLIES.
4. WAFER TO BE FLAT WITHIN .003 MM/MM.
5. DIMENSIONS FOR PLATING LOCATION:
   - 5A. MEASURE POINT FOR THICKNESS
   - 5B. MINIMUM COVERAGE
6. GOLD END OF PIN UNLESS OVERALL PLATED.
7. FINISH:
   - 571 : 15 MICRO INCHES MIN GOLD PLATE ON CONTACT AND 75 MICRO INCHES MIN TIN PLATE ON SOLDERTAIL BOTH OVER 50 MICRO INCHES MIN NICKEL OVERALL.
   - 574 : 30 MICRO INCHES MIN GOLD PLATE ON CONTACT AND 75 MICRO INCHES MIN TIN PLATE ON SOLDERTAIL BOTH OVER 50 MICRO INCHES MIN NICKEL OVERALL.
   - 544 : 5 MICRO INCHES MIN GOLD PLATE ON CONTACT AND 75 MICRO INCHES MIN TIN PLATE ON SOLDERTAIL BOTH OVER 50 MICRO INCHES MIN NICKEL OVERALL.
   - 573 : 20 MICRO INCHES MIN GOLD PLATE ON CONTACT AND 100 MICRO INCHES MIN TIN PLATE ON SOLDERTAIL BOTH OVER 50 MICRO INCHES MIN NICKEL OVERALL.
8. DIM AT THE CENTRE OF THE SHROUDED WALL SHALL BE 5.91MM MIN. THIS SPEC IS VALID FOR ALL CKT SIZE.
9. MATERIAL:
   HSG: GLASS FILLED PBT, UL94V-0, COLOUR BLACK
   PIN: 0.64MM SQ. PIN PHOSPHOR BRONZE.
10. SOLDERTAIL POSITIONAL TOLERANCE SHALL BE GAUGED.

UPDATE NOTE #3.
EC NO: S2013-0029
DRWN:ATSEE 2012/07/20
CH'KD:SKANG 2012/08/06
APPR:MLONG 2012/10/08
DESCRIPTION
REV
J6

QUALITY SYMBOLS
▼=0
Ⓒ=0

GENERAL TOLERANCES (UNLESS SPECIFIED)

	mm	INCH
4 PLACES	± ---	± ---
3 PLACES	± ---	± ---
2 PLACES	± 0.20	± ---
1 PLACE	± ---	± ---
ANGULAR ± 3 °		

DRAFT WHERE APPLICABLE MUST REMAIN WITHIN DIMENSIONS

DIMENSION STYLE: MM ONLY
SCALE: NTS
DESIGN UNITS: METRIC
THIRD ANGLE PROJECTION

DRAWN BY: JENNIFER DATE: 1987/09/18
CHECKED BY: RWONG DATE: 1987/09/18
APPROVED BY: ALANB DATE: 1987/09/18

TITLE: C-GRID, SHROUDED HEADER (SLOTTED W/O STANDOFFS)

MOLEX INCORPORATED

MATERIAL NO.: SEE TABLE
DOCUMENT NO.: SDA-70246-**20-25_39-41
SHEET NO.: 1 OF 2
SIZE: A3