Universidad de Costa Rica

Escuela de Ingeniería Eléctrica

IE-0624: Laboratorio de Microcontroladores

Reporte de laboratorio #1: Introducción a microcontroladores y manejo de GPIOS

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I-2025

Contenido

Introducción

Los microcontroladores son dispositivos con muchas funcionalidades que permiten realizar muchas tareas de forma muy eficiente. Son dispositivos versátiles y de bajo costo que se pueden encargar de realizar una amplia cantidad de funciones dependiendo de en dónde sean implementados. En este laboratorio se utilizó un microcontrolador para funcionar como un dado que muestra un número seleccionado encendiendo una cierta cantidad de leds. Para implementarlo se utiliza el PIC12F683 y se creó un pequeño programa que permite leer cuándo se hace click en el botón incluido, y genera un numero pseudo-aleatorio, el cual se utiliza para encender los leds e indicar el numero seleccionado. Para completar este laboratorio fue necesario manipular los registros del microcontrolador y realizar un proceso de análisis y diseño del código utilizado para implementar la solución. A continuación, se muestra el proceso seguido, los elementos utilizados y el resultado obtenido.

El repositorio con los archivos base se puede encontrar en: https://github.com/marionabe/LabMicro

Nota teórica

Información general del PIC12F683

El PIC12F683 es un microcontrolador de 8 bits que utiliza instrucciones RISC y posee una frecuencia de operación de 20 MHz. Posee seis terminales GPIO y dos terminales para alimentación. En la figura 1 se muestra un diagrama de la función de cada terminal.

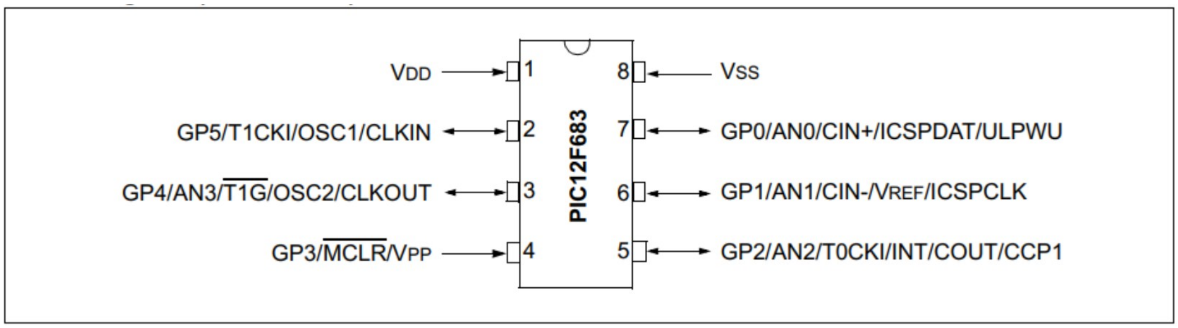

Figura 1: Diagrama de función de cada terminal. Obtenido de la hoja de datos del fabricante.

Es importante tener claras las características eléctricas de este dispositivo. En la figura 2 se muestra una tabla con las principales especificaciones para el control de energía de sus terminales.

Absolute Maximum Ratings(†)

Ambient temperature under bias	-40° to +125°C
Storage temperature	-65°C to +150°C
Voltage on V_{DD} with respect to V_{SS}	-0.3V to +6.5V
Voltage on $\overline{MCLR}$ with respect to Vss	-0.3V to +13.5V
Voltage on all other pins with respect to V_{SS}	-0.3V to (V_{DD} + 0.3V)
Total power dissipation(1)	800 mW
Maximum current out of V_{SS} pin	95 mA
Maximum current into V_{DD} pin	95 mA
Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD})	± 20 mA
Output clamp current, I_{OK} (Vo < 0 or Vo >V_{DD})	± 20 mA
Maximum output current sunk by any I/O pin	25 mA
Maximum output current sourced by any I/O pin	25 mA
Maximum current sunk by GPIO	90 mA
Maximum current sourced GPIO	90 mA

Figura 2: Especificaciones eléctricas del PIC12F683. Obtenidas de la hoja de datos del fabricante.

Por otra parte, en la figura 3 se muestra un diagrama de bloques que describe, de forma general, la construcción interna de este microcontrolador.

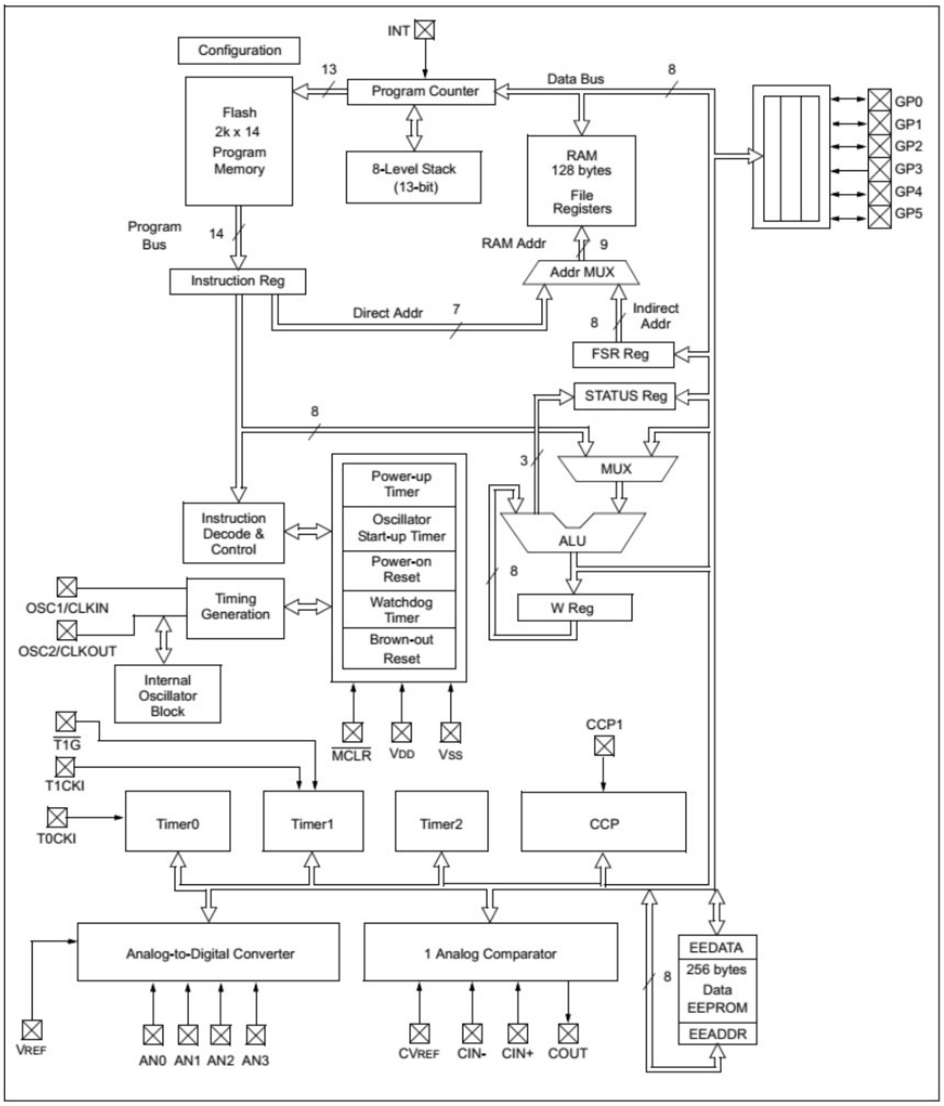

Figura 3: Diagrama de construcción del microcontrolador. Obtenida de la hoja de datos del fabricante.

Este microcontrolador posee, entre otros, varios registros que permiten configurar su modo de funcionamiento, y que además permite decidir cómo manipular cada uno de sus registros de propósito general. A continuación, se dá una explicación de los registros que fueron utilizados para realizar este laboratorio.

Registro Watchdog Timer:

Este registro posee 4 bits dedicados a configurar el tiempo que el registro WD esperará antes de aplicar un reset al programa. Posee además un bit que permite activarlo o desactivarlo mediante código durante la ejecución.

U-0	U-0	U-0	R/W-0	R/W-1	R/W-0	R/W-0	R/W-0
—	—	—	WDTPS3	WDTPS2	WDTPS1	WDTPS0	SWDTEN
bit 7							bit 0

Figura 4: Bits del registro WD Timer. Obtenido de la hoja de datos del fabricante.

Registro TRISIO:

El registro TRISIO se utiliza para manipular los buffers triestado que se ubican en las terminales GPIO, esto permite configurarlas como entradas o como salidas dependiendo del uso que se desee. Cada bit de este registro modifica una de las terminales GPIO.

U-0	U-0	R/W-1	R/W-1	R-1	R/W-1	R/W-1	R/W-1
—	—	TRISIO5[2,3]	TRISIO4[2]	TRISIO3[1]	TRISIO2	TRISIO1	TRISIO0
bit 7							bit 0

Figura 5: Bits del registro TRISIO. Obtenido de la hoja de datos del fabricante.

Registro GPIO:

El tercer registro que fue utilizado para la realización de este laboratorio es el registro GPIO. Este registro contiene los valores digitales detectados en cada una de sus terminales, si se configuran como entradas. O contiene el valor que se desea generar en sus salidas si estas fueron configuradas como salidas

U-0	U-0	R/W-x	R/W-0	R-x	R/W-0	R/W-0	R/W-0
—	—	GP5	GP4	GP3	GP2	GP1	GP0
bit 7							bit 0

Figura 6: Bits del registro GPIO. Obtenido de la hoja de datos del fabricante.

Otros elementos utilizados

Además del microcontrolador, se utilizó un decodificador 4 a 10, de esta forma se pueden utilizar solo 3 pines para poder controlar el encendido de los 6 leds. En la figura 7 se muestra una captura de pantalla de este elemento en el simulador.

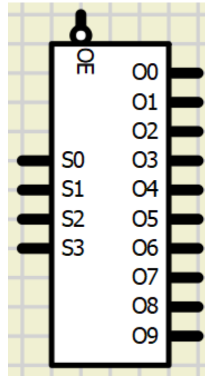

Figura 7: Decodificador genérico 4 a 10 utilizado para controlar el encendido de los leds.

Este decodificador funciona con la tabla de verdad que se muestra a continuación. Se resaltan en verde las salidas utilizadas.

S0	S1	S2	S3	Salida activa
0	0	0	0	O0
0	0	0	1	O1
0	0	1	0	O2
0	0	1	1	O3
0	1	0	0	O4
0	1	0	1	O5
0	1	1	0	O6
0	1	1	1	O7
1	0	0	0	O8
1	0	0	1	O9
1	0	1	0	O10
1	0	1	1	O11
1	1	0	0	O12

1	1	0	1	O13
1	1	1	0	O14
1	1	1	1	O15

Además de este elemento, se utilizaron otros componentes genéricos:

- LEDS.
- Diodos.
- Buffer (Para regenerar la señal).
- Pulsador.
- Resistencias.

Por lo tanto en total se tienen los siguientes componentes:

Componente	Cantidad	Precio total (₡)
Pulsador	1	190

Resistencia (100Ω y 50Ω)	7	322
Diodo	11	1,193
Buffer (74LS125 para referencia)	5	868
Leds	6	488
Decodificador 4 a 16 (74LS154 para referencia)	1	2 686
PIC12f683	1	3 676
Total	-	9 423

Diseño del circuito

En la siguiente figura se muestra una captura de pantalla de circuito final obtenido.

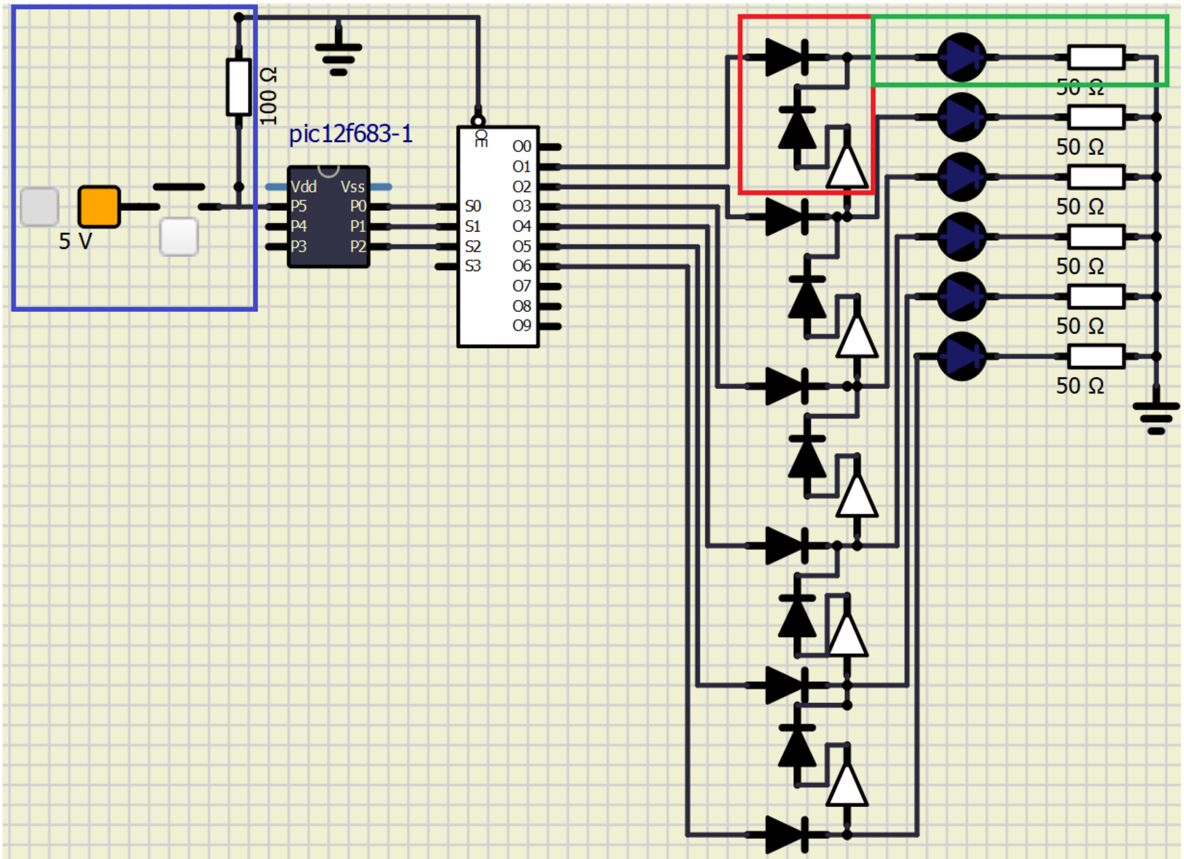

Figura 8: Captura de pantalla de circuito implementado.

Como se observa en la figura anterior, el circuito se realiza utilizando como núcleo el microcontrolador PIC12F683. Conectado a tres de sus terminales se coloca un decodificador que permite encender cada uno de los 6 leds usando unicamente 3 señales. A la salida de este decodificador se coloca un conjunto de dos diodos rectificadores y un buffer (señalado en la figura 8 con un rectángulo rojo). La idea de este circuito es permitir que cuando se encienda un led, se puedan encender todos los leds anteriores, de esta forma si se enciende el led número 5, por ejemplo, se encienden también los leds 1, 2, 3 y 4. Seguido de esto se conecta individualmente cada led con una resistencia de 50 Ω que permita regular la corriente por el led.

Conectado al pin P5 del microcontrolador, se encuentra el circuito señalado con color azul. Este circuito consiste unicamente de un pulsador con una resistencia de pull-up y una fuente de 5 V, esto permite detectar cuando el usuario haga un click.

Desarrollo y Análisis

Análisis del programa

Para complementar el circuito mostrado en la figura 8, se realizó un pequeño programa en C que permitiera desarrollar las funcionalidades solicitadas para este laboratorio. En la figura 9 se muestra el diagrama de flujo utilizado para la implementación. Como se indica en la figura, cada vez que inicia el programa, lo primero que se realiza es una configuración de los registros (más adelante se detalla cómo se configuran), luego el programa entra en un bucle esperando a que se haga click. Cuando se detecta el click, se procede a encender la cantidad de leds correspondiente al número seleccionado, luego de esto se genera un delay para que el usuario pueda ver la cantidad de leds encendidos, y luego de este delay se apagan todos los leds y se devuelve al estado inicial, a la espera de otro click. Durante todo el funcionamiento del programa, la variable counter se encuentra moviéndose entre los valores 1-6, lo que permite generar el numero pseudo-aleatorio.

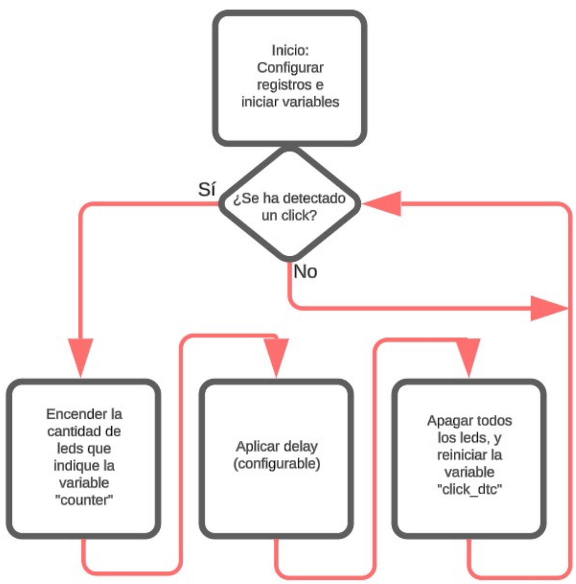

Figura 9: Diagrama de flujo del programa implementado

Análisis electrónico:

La parte del circuito que inicia la funcionalidad del programa corresponde al pulsador, según se muestra en la figura 10. A la izquierda se muestra en el voltímetro que la tensión en el pin P5 del microcontrolador es de 0 V, lo que indica que no se ha hecho click. A la derecha se muestra la medida de tensión cuando se hace click, en este caso el pin P5 se conecta a la fuente de 5V, y el programa detecta que se ha hecho un click. La resistencia de 100 Ω se agregó simplemente para evitar un cortocircuito y poder generar la caída de tensión que el microcontrolador va a medir.

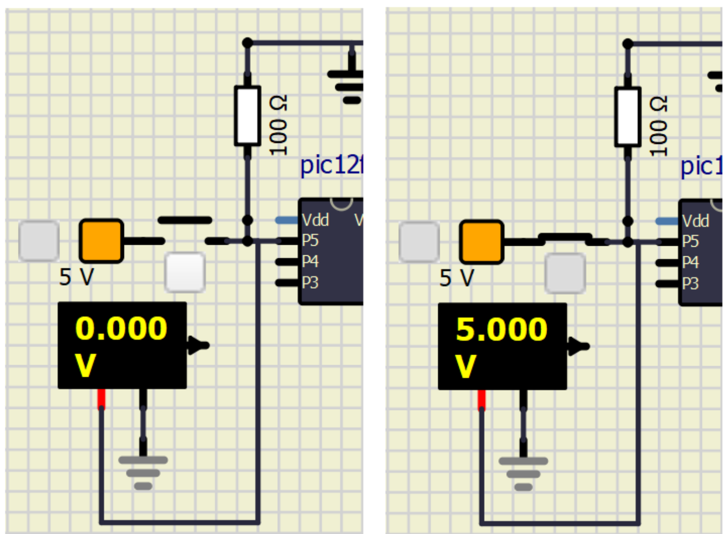

Figura 10: Circuito del pulsador. A la izquierda sin hacer click y a la derecha haciendo click.

Continuando el circuito, a los pines P0, P1 y P2 de este se conecta un decodificador 4 a 16, cuya funcionalidad ya se explicó anteriormente. Se puede observar en la figura 11 que este decodificador posee una entrada OE, que permite activarlo cuando se encuentra en bajo, y ya que no se requiere controlar cuándo activar o no todas las salidas, este pin se conecta directamente a tierra.

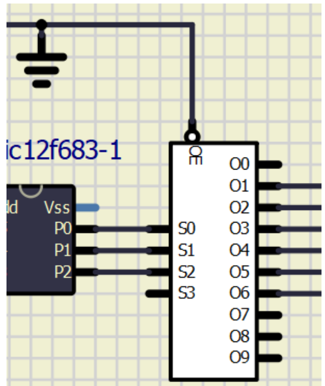

Figura 11: Decodificador utilizado.

A la salida del decodificador se conectar los leds con su respectivo circuito, tal como se muestra en la figura 12. En esta figura se señalan 3 elementos que son importantes para controlar la funcionalidad del dado. El decodificador permite controlar cuándo activar cada salida con base en la entrada S0-S3, sin embargo, este decodificador no permite encender varias salidas al mismo tiempo, por lo que se requiere una etapa que permita encender los leds anteriores a este, así se pueden encender una cantidad de leds que indiquen el numero que dio el dado. Para realizar esto se conecta los elementos 2 y 3 (señalados en la figura 12). El elemento 3 (un buffer) se encarga de regenerar la señal para que todos los leds puedan encender con la misma intensidad, el elemento 2 (un diodo) evita que existe retorno de tensión cuando se activa un led y no se desea que se active el siguiente, además de aislar al buffer. Igualmente el diodo 1, permite aislar el decodificador cuando se activa un led desde la señal de otro led, de este modo se evita que pueda existir alguna tensión no deseada en el circuito decodificador.

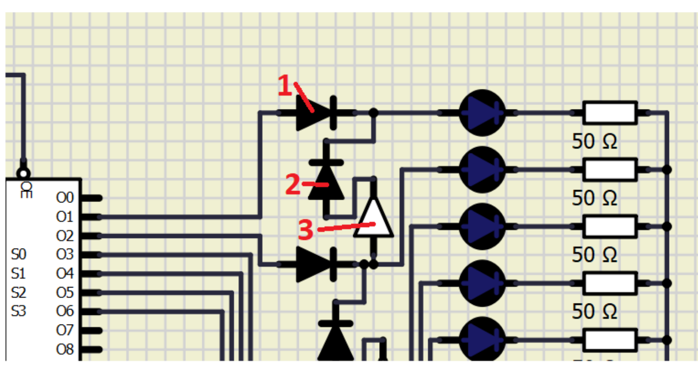

Figura 12: Circuito para encender cada led.

Luego del circuito mostrado en la figura 12, se conecta un led con un resistor, para permitir regular la corriente por diodo, y luego todos estos elementos se conectan a tierra para volver a cerrar el circuito.

Capturas de pantalla del circuito en funcionamiento

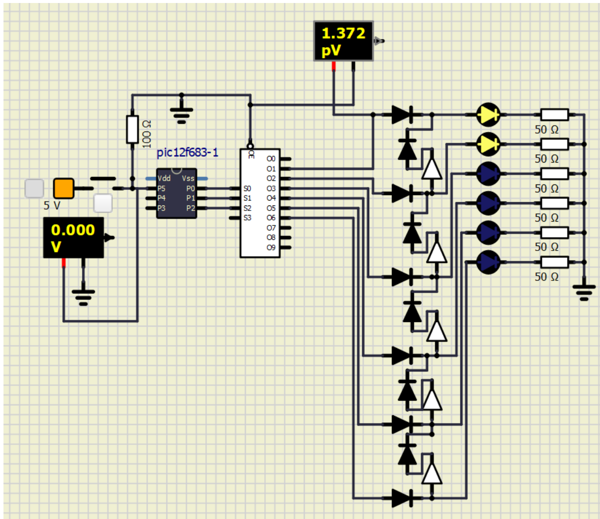

Figura 13: Circuito del dado mostrando el numero 2 mediante dos leds encendidos

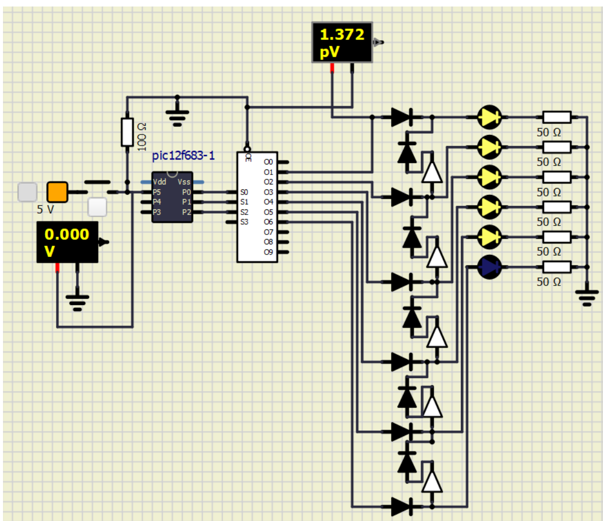

Figura 14: Circuito del dado mostrando el numero 3 mediante los leds encendidos.

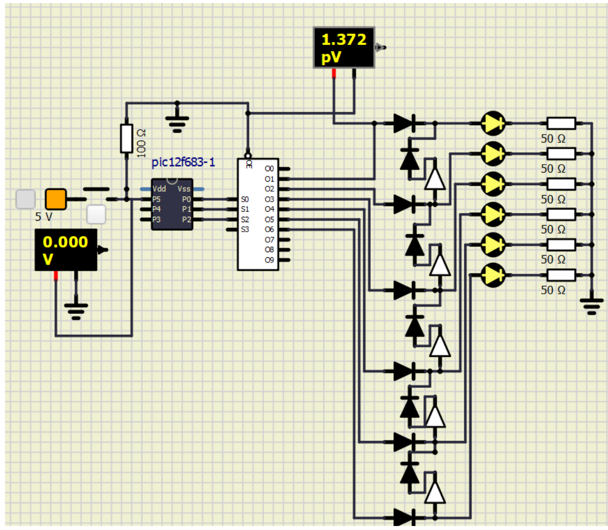

Figura 15: Circuito del dado mostrando el numero 6 mediante los leds encendidos.

Conclusiones y Recomendaciones

- Se logró programar correctamente el microcontrolador PIC12F683 con el programa diseñado, además de lograr utilizar correctamente sus pines.

- Se logró manipular de forma exitosa los pines GPIO del microcontrolador mediante la programación y la manipulación de los registros que los controlan.

- Se logró implementar el circuito de dado solicitado, ya que este muestra exitosamente un numero aleatorio de leds cada vez que se presiona.

- En el código se intentó utilizar la biblioteca stdlib.h de C, sin embargo, se generaron algunos errores, por lo tanto para futuros trabajos se recomendaría realizar una investigación más a fondo sobre el porqué no fue posible, ya sea un error con el compilador, o un error con la computadora utilizada, entre otros que se puedan generar.

Bibliografía

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Fairchild Semiconductor. “DM74LS154 4-Line to 16-Line Decoder/Demultiplexer”. 2000. Obtenido de: https://www.alldatasheet.es/datasheet-pdf/view/51038/FAIRCHILD/74LS154.html

Apéndices

FAIRCHILD
SEMICONDUCTOR™

August 1986
Revised March 2000

DM74LS125A
Quad 3-STATE Buffer

General Description

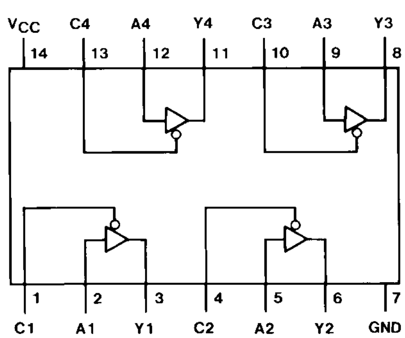
This device contains four independent gates each of which performs a non-inverting buffer function. The outputs have the 3-STATE feature. When enabled, the outputs exhibit the low impedance characteristics of a standard LS output with additional drive capability to permit the driving of bus lines without external resistors. When disabled, both the output transistors are turned off presenting a high-impedance state to the bus line. Thus the output will act neither as a significant load nor as a driver. To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the disable time is shorter than the enable time of the outputs.

Ordering Code:

Order Number	Package Number	Package Description
DM74LS125AM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
DM74LS125ASJ	M14D	14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
DM74LS125AN	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter “X” to the ordering code.

Connection Diagram



Function Table

Y = A

Inputs		Output
A	**C**	**Y**
L	L	L
H	L	H
X	H	Hi-Z

H = HIGH Logic Level
L = LOW Logic Level
X = Either LOW or HIGH Logic Level
Hi-Z = 3-STATE (Outputs are disabled)

Absolute Maximum Ratings (Note 1)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Units
V_{CC}	Supply Voltage	4.75	5	5.25	V
V_{IH}	HIGH Level Input Voltage	2			V
V_{IL}	LOW Level Input Voltage			0.8	V
I_{OH}	HIGH Level Output Current			−2.6	mA
I_{OL}	LOW Level Output Current			24	mA
T_A	Free Air Operating Temperature	0		70	°C

Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −18 mA			−1.5	V
V_{OH}	HIGH Level Output Voltage	V_{CC} = Min, I_{OH} = Max V_{IL} = Max, V_{IH} = Min	2.4	3.4		V
V_{OL}	LOW Level Output Voltage	V_{CC} = Min, I_{OL} = Max V_{IL} = Max		0.35	0.5	V
		I_{OL} = 12 mA, V_{CC} = Min		0.25	0.4	
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 7V			0.1	mA
I_{IH}	HIGH Level Input Current	V_{CC} = Max, V_I = 2.7V			20	μA
I_{IL}	LOW Level Input Current	V_{CC} = Max, V_I = 0.4V			−0.4	mA
I_{OZH}	Off-State Output Current with HIGH Level Output Voltage Applied	V_{CC} = Max, V_O = 2.4V V_{IH} = Min, V_{IL} = Max			20	μA
I_{OZL}	Off-State Output Current with LOW Level Output Voltage Applied	V_{CC} = Max, V_O = 0.4V V_{IH} = Min, V_{IL} = Max			−20	μA
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 3)	−20		−100	mA
I_{CC}	Supply Current	V_{CC} = Max (Note 4)		11	20	mA

Note 2: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.

Note 4: I_{CC} is measured with the data control (C) inputs at 4.5V and the data inputs grounded.

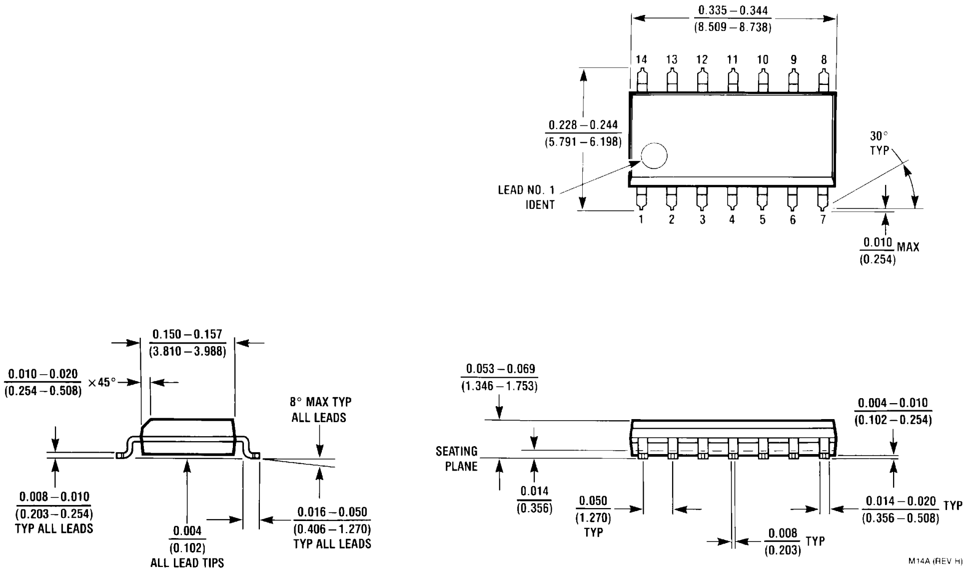
Switching Characteristics

at V_{CC} = 5V and T_A = 25°C

Symbol	Parameter	R_L = 667Ω				Units
		C_L = 50 pF		C_L = 150 pF		
		Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time LOW-to-HIGH Level Output		15		21	ns
t_{PHL}	Propagation Delay Time HIGH-to-LOW Level Output		18		22	ns
t_{PZH}	Output Enable Time to HIGH Level Output		25		35	ns
t_{PZL}	Output Enable Time to LOW Level Output		25		40	ns
t_{PHZ}	Output Disable Time from HIGH Level Output (Note 5)		20			ns
t_{PLZ}	Output Disable Time from LOW Level Output (Note 5)		20			ns

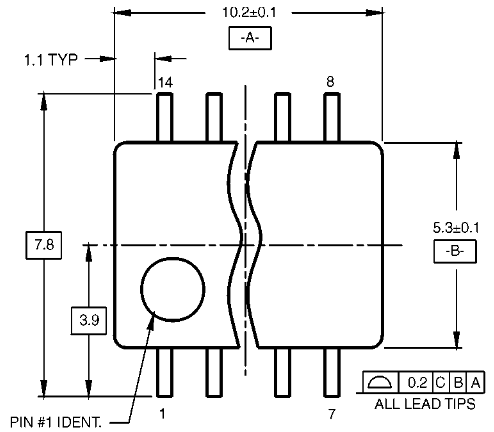
Note 5: C_L = 5pF.

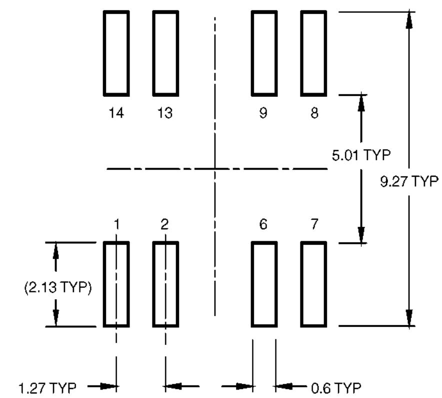
Physical Dimensions inches (millimeters) unless otherwise noted



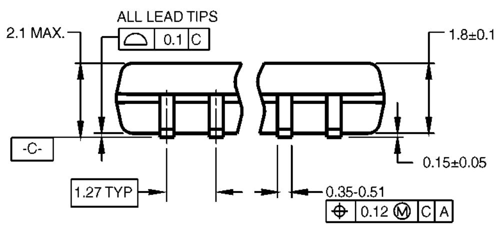
14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150 Narrow
Package Number M14A

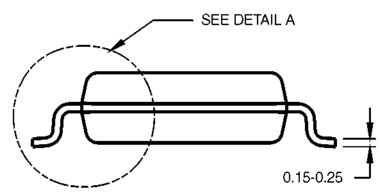
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



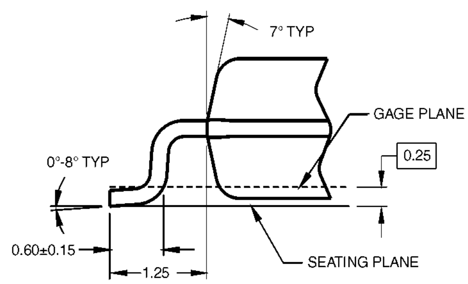


LAND PATTERN RECOMMENDATION





DIMENSIONS ARE IN MILLIMETERS



DETAIL A

NOTES:

A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.

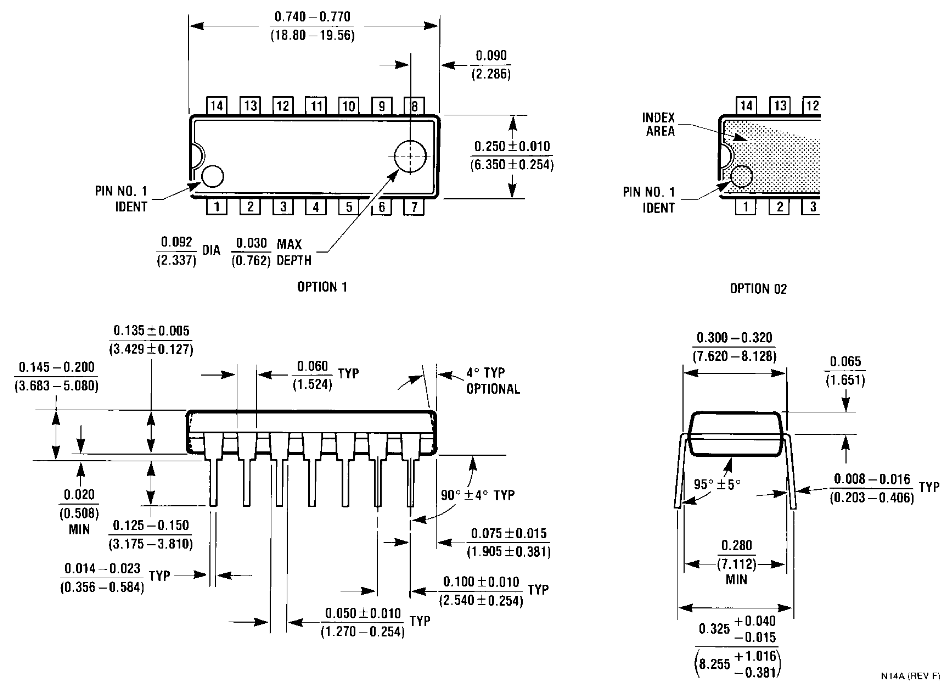
B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

M14DRevB1

14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
Package Number M14D

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide
Package Number N14A

FAIRCHILD
SEMICONDUCTOR™

August 1986
Revised March 2000

DM74LS154
4-Line to 16-Line Decoder/Demultiplexer

General Description

Each of these 4-line-to-16-line decoders utilizes TTL circuitry to decode four binary-coded inputs into one of sixteen mutually exclusive outputs when both the strobe inputs, G1 and G2, are LOW. The demultiplexing function is performed by using the 4 input lines to address the output line, passing data from one of the strobe inputs with the other strobe input LOW. When either strobe input is HIGH, all outputs are HIGH. These demultiplexers are ideally suited for implementing high-performance memory decoders. All inputs are buffered and input clamping diodes are provided to minimize transmission-line effects and thereby simplify system design.

Features

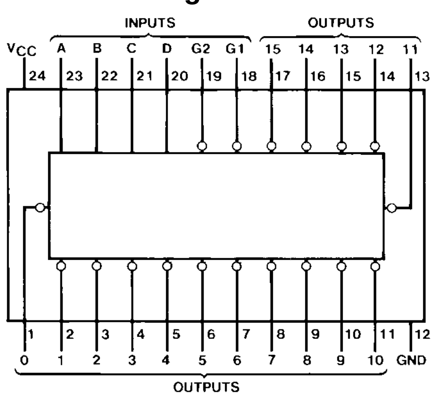
- Decodes 4 binary-coded inputs into one of 16 mutually exclusive outputs
- Performs the demultiplexing function by distributing data from one input line to any one of 16 outputs
- Input clamping diodes simplify system design
- High fan-out, low-impedance, totem-pole outputs
- Typical propagation delay
  - 3 levels of logic 23 ns
  - Strobe 19 ns
- Typical power dissipation 45 mW

Ordering Code:

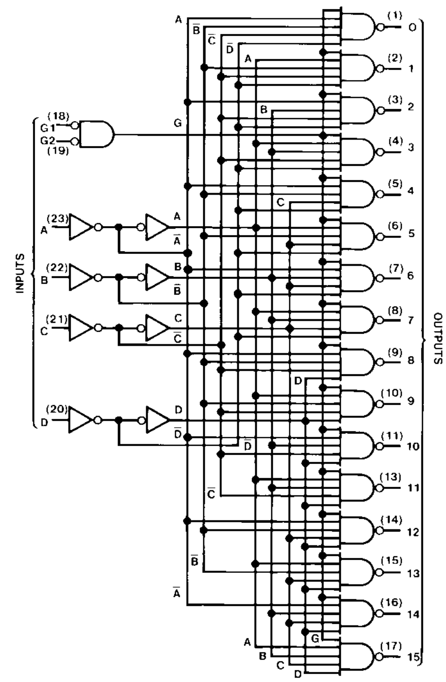
Order Number	Package Number	Package Description
DM74LS154WM	M24B	24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
DM74LS154N	N24A	24-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.600 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter “X” to the ordering code.

Connection Diagram



Logic Diagram



Function Table

Inputs						Outputs															
G1	**G2**	**D**	**C**	**B**	**A**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = HIGH Level
L = Low Level
X = Don't Care

Absolute Maximum Ratings(Note 1)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Units
V_{CC}	Supply Voltage	4.75	5	5.25	V
V_{IH}	HIGH Level Input Voltage	2			V
V_{IL}	LOW Level Input Voltage			0.8	V
I_{OH}	HIGH Level Output Current			−0.4	mA
I_{OL}	LOW Level Output Current			8	mA
T_A	Free Air Operating Temperature	0		70	°C

Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −18 mA			−1.5	V
V_{OH}	HIGH Level Output Voltage	V_{CC} = Min, I_{OH} = Max V_{IL} = Max, V_{IH} = Min	2.7	3.4		V
V_{OL}	LOW Level Output Voltage	V_{CC} = Min, I_{OL} = Max		0.25	0.4	V
		V_{IL} = Max, V_{IH} = Min		0.35	0.5	
		I_{OL} = 4 mA, V_{CC} = Min		0.25	0.4	
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 7V			0.1	mA
I_{IH}	HIGH Level Input Current	V_{CC} = Max, V_I = 2.7V			20	μA
I_{IL}	LOW Level Input Current	V_{CC} = Max, V_I = 0.4V			−0.4	mA
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 3)	−20		−100	mA
I_{CC}	Supply Current	V_{CC} = Max (Note 4)		9	14	mA

Note 2: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.

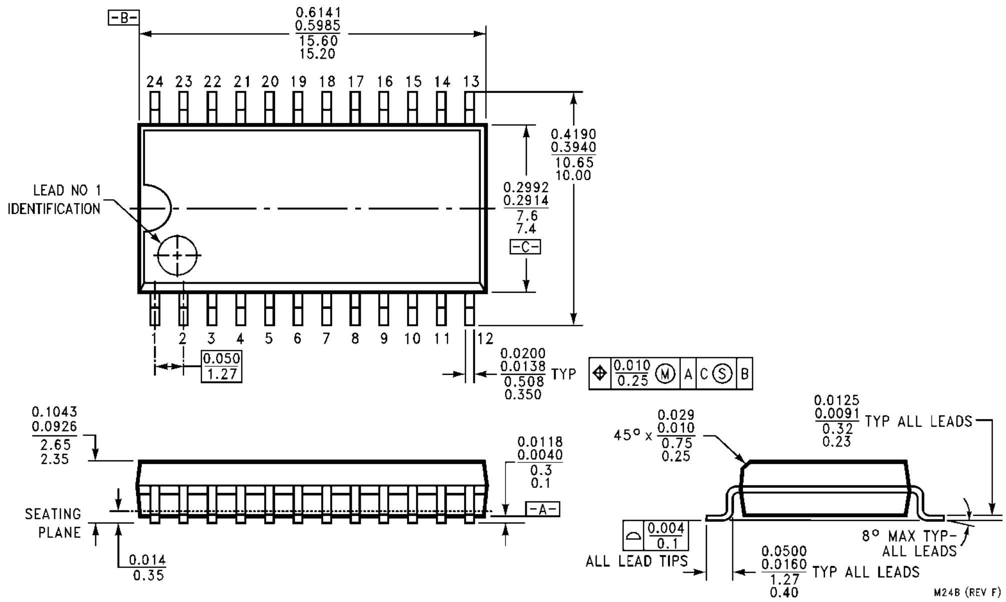
Note 4: I_{CC} is measured with all outputs OPEN and all inputs GROUNDED.

Switching Characteristics

at V_{CC} = 5V and T_A = 25°C

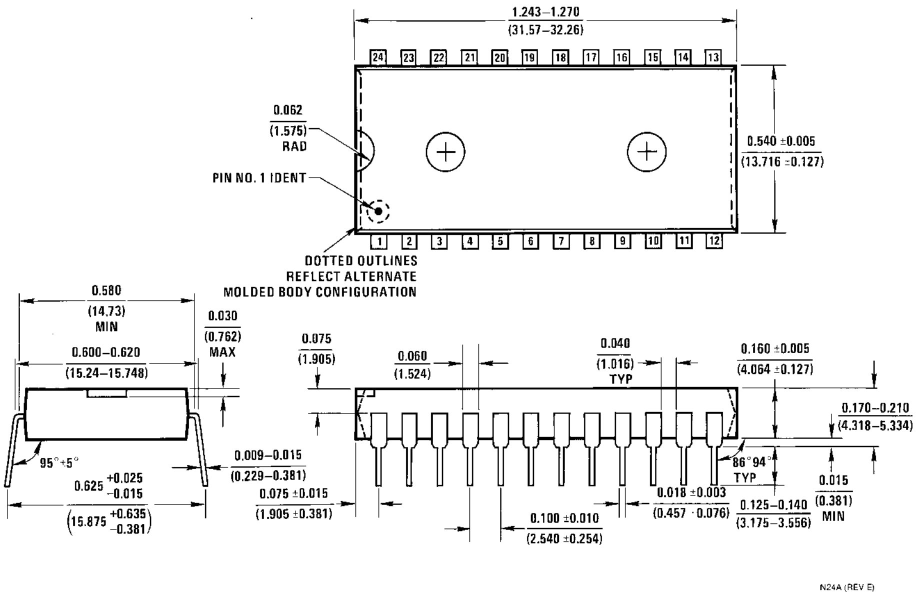
Symbol	Parameter	From (Input) To (Output)	R_L = 2 kΩ				Units
			C_L = 15 pF		C_L = 50 pF		
			Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time LOW-to-HIGH Level Output	Data to Output		30		35	ns
t_{PHL}	Propagation Delay Time HIGH-to-LOW Level Output	Data to Output		30		35	ns
t_{PLH}	Propagation Delay Time LOW-to-HIGH Level Output	Strobe to Output		20		25	ns
t_{PHL}	Propagation Delay Time HIGH-to-LOW Level Output	Strobe to Output		25		35	ns

Physical Dimensions inches (millimeters) unless otherwise noted



24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
Package Number M24B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



24-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-010, 0.600 Wide
Package Number N24A

PIC12F683 Data Sheet

8-Pin Flash-Based, 8-Bit

CMOS Microcontrollers with

nanoWatt Technology

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PIC12F683

8-Pin Flash-Based, 8-Bit CMOS Microcontrollers with nanoWatt Technology

High-Performance RISC CPU:

- Only 35 instructions to learn:
  - All single-cycle instructions except branches
- Operating speed:
  - DC – 20 MHz oscillator/clock input
  - DC – 200 ns instruction cycle
- Interrupt capability
- 8-level deep hardware stack
- Direct, Indirect and Relative Addressing modes

Special Microcontroller Features:

- Precision Internal Oscillator:
  - Factory calibrated to ±1%, typical
  - Software selectable frequency range of 8 MHz to 125 kHz
  - Software tunable
  - Two-Speed Start-up mode
  - Crystal fail detect for critical applications
  - Clock mode switching during operation for power savings
- Power-Saving Sleep mode
- Wide operating voltage range (2.0V-5.5V)
- Industrial and Extended temperature range
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Brown-out Reset (BOR) with software control option
- Enhanced Low-Current Watchdog Timer (WDT) with on-chip oscillator (software selectable nominal 268 seconds with full prescaler) with software enable
- Multiplexed Master Clear with pull-up/input pin
- Programmable code protection
- High Endurance Flash/EEPROM cell:
  - 100,000 write Flash endurance
  - 1,000,000 write EEPROM endurance
  - Flash/Data EEPROM Retention: > 40 years

Low-Power Features:

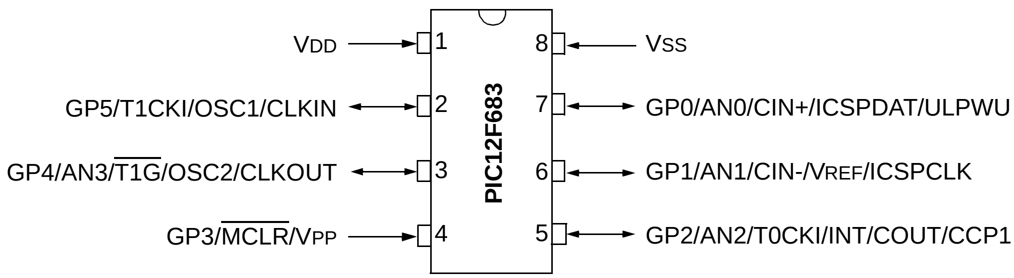
- Standby Current:
  - 50 nA @ 2.0V, typical
- Operating Current:
  - 11 μA @ 32 kHz, 2.0V, typical
  - 220 μA @ 4 MHz, 2.0V, typical
- Watchdog Timer Current:
  - 1 μA @ 2.0V, typical

Peripheral Features:

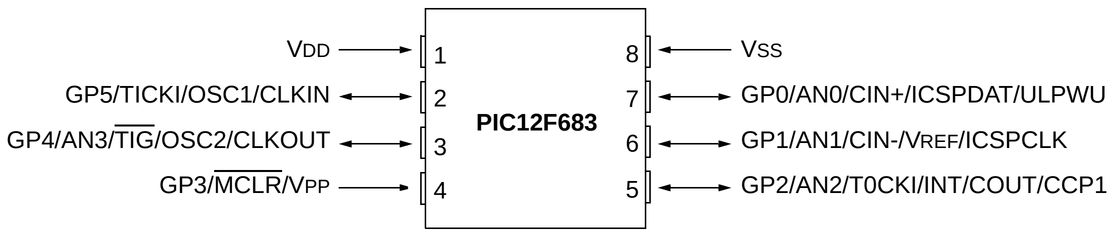
- 6 I/O pins with individual direction control:
  - High current source/sink for direct LED drive
  - Interrupt-on-pin change
  - Individually programmable weak pull-ups
  - Ultra Low-Power Wake-up on GP0
- Analog Comparator module with:
  - One analog comparator
  - Programmable on-chip voltage reference (CV_{REF}) module (% of V_{DD})
  - Comparator inputs and output externally accessible
- A/D Converter:
  - 10-bit resolution and 4 channels
- Timer0: 8-bit timer/counter with 8-bit programmable prescaler
- Enhanced Timer1:
  - 16-bit timer/counter with prescaler
  - External Timer1 Gate (count enable)
  - Option to use OSC1 and OSC2 in LP mode as Timer1 oscillator if INTOSC mode selected
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Capture, Compare, PWM module:
  - 16-bit Capture, max resolution 12.5 ns
  - Compare, max resolution 200 ns
  - 10-bit PWM, max frequency 20 kHz
- In-Circuit Serial Programming™ (ICSP™) via two pins

Device	Program Memory	Data Memory		I/O	10-bit A/D (ch)	Comparators	Timers 8/16-bit
	Flash (words)	SRAM (bytes)	EEPROM (bytes)				
PIC12F683	2048	128	256	6	4	1	2/1

8-Pin Diagram (PDIP, SOIC)



8-Pin Diagram (DFN)



8-Pin Diagram (DFN-S)

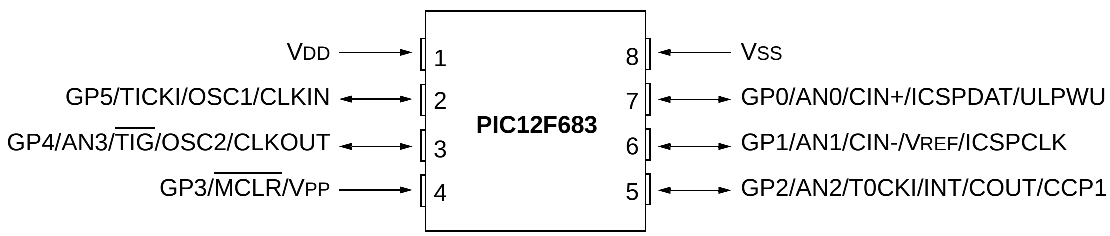


TABLE 1: 8-PIN SUMMARY

I/O	Pin	Analog	Comparators	Timer	CCP	Interrupts	Pull-ups	Basic
GP0	7	AN0	CIN+	—	—	IOC	Y	ICSPDAT/ULPWU
GP1	6	AN1/V_{REF}	CIN-	—	—	IOC	Y	ICSPCLK
GP2	5	AN2	COUT	T0CKI	CCP1	INT/IOC	Y	—
GP3(1)	4	—	—	—	—	IOC	Y(2)	$\overline{\text{MCLR}}$/V_{PP}
GP4	3	AN3	—	$\overline{\text{T1G}}$	—	IOC	Y	OSC2/CLKOUT
GP5	2	—	—	T1CKI	—	IOC	Y	OSC1/CLKIN
—	1	—	—	—	—	—	—	V_{DD}
—	8	—	—	—	—	—	—	V_{SS}

Note 1: Input only.

2: Only when pin is configured for external $\overline{\text{MCLR}}$.

Table of Contents

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PUSH-4

PUSH MINI 4MM 4 PINES

DESCRIPCIÓN

Mini interruptor pulsador de cuatro terminales con botón de 4 mm de altura, configuración DPST (por sus siglas en ingles que significan Double Pole Single Throw) o Polo Doble Corte Simple, donde polo se refiere al número de circuitos controlados por el interruptor y corte se refiere a la posición extrema del interruptor. Las cuatro terminales están interconectadas**,** se conectan todas al presionar el botón del pulsado.

CARACTERÍSTICAS

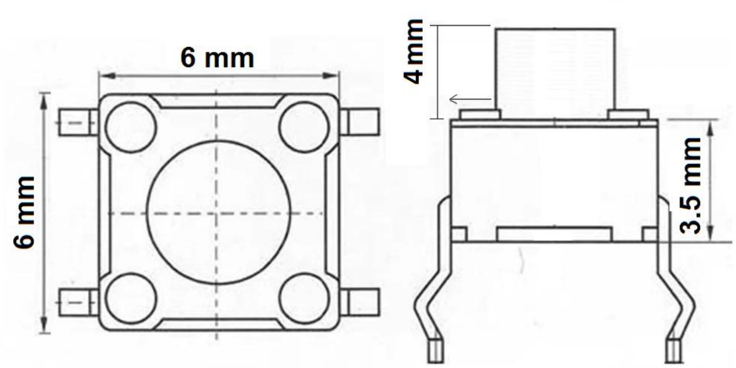
- Permite el flujo de corriente solamente mientras es presionado.
- Permite desviar o interrumpir el curso de una corriente eléctrica.
- El push button se puede utilizar para la creación de circuitos electrónicos que requieran un interruptor para controlar el flujo de corriente y alimentar diferentes partes del circuito o elegir diferentes configuraciones de forma temporal, ya que al dejar de presionar el push button, se abre el circuito.

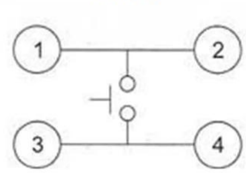
.

ESPECIFICACIONES

Parámetro	Descripción
Tipo de producto	Interruptor pulsador de 4 pines.
Voltaje máximo	12 VCD
Corriente máxima	50 mA
Altura	4 mm
Fuerza de presión	250±50gf
Vida útil	50000 ciclos
Resistencia de aislamiento	100mΩ
Resistencia de contacto	100mΩ

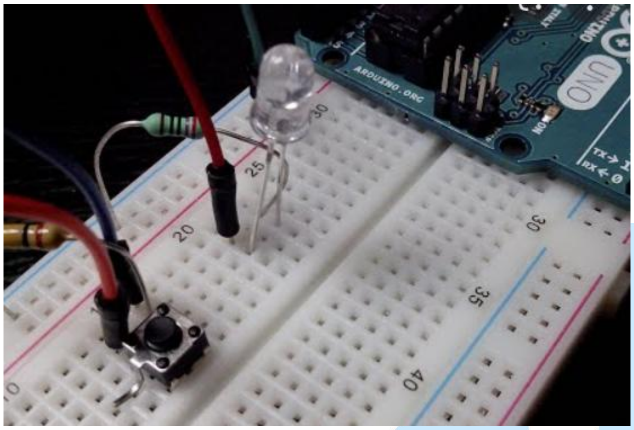
Dimensiones

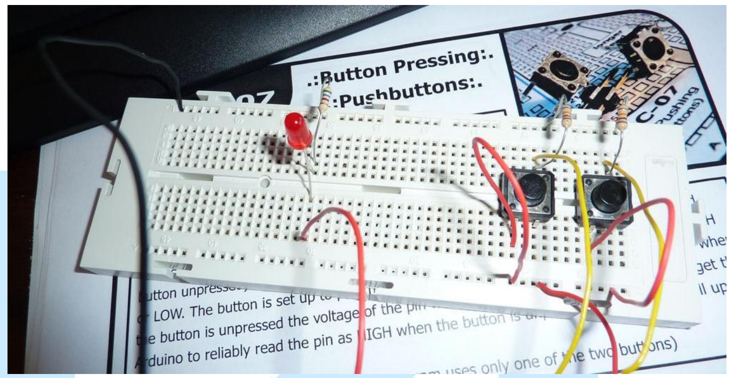


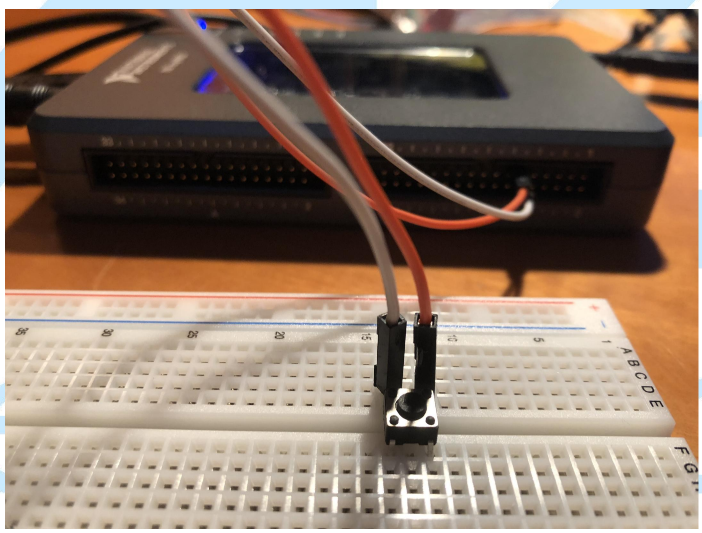


APLICACIONES

- Practicas de electrónica
- Proyectos
- Prototipado







Innovative Service Around the Globe YAGEO

DATA SHEET

METAL FILM RESISTORS

General Purpose

MFR Series

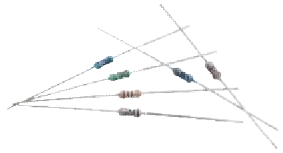
±0.5%, ±1%, ±2%, ±5%

1/6W to 3W

RoHS compliant & Halogen Free

Product specification – September 28, 2021 V.1

YAGEO



APPLICATIONS

Ÿ All general purpose applications

Ÿ Power applications

EATURES

Ÿ AEC-Q200 qualified

Ÿ Wide resistance range

Ÿ PPAP ready (MFR-25/MFR50S/MFR-50)

Ÿ High stability

Ÿ RoHS compliant & halogen-free

ORDERING INFORMATION

Part number of the general purpose metal film resistor are identified by the series, power rating, tolerance, packing, temperature coefficient, forming and resistance value.

PART NUMBER

MFR	200	F	T	F	73-	100R
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) SERIES

MFR Series

(2) POWER RATING

-12 = 1/6W	-50 = 1/2W	200 = 2W
25S = 1/4W	100 = 1W	3WS = 3W
-25 = 1/4W	2WS = 2W	1WS = 1W
50S = 1/2W		

(3) TOLERANCE

D = ±0.5%	F = ±1%	G = ±2%
J = ±5%		

(4) PACKAGING

R = Reel Pack	T = Box Pack	B = Bulk

(5) TEMPERATURE COEFFICIENT OF RESISTANCE

E=±50ppm/°C	F=±100ppm/°C	- = Based on spec

(6) FORMING

26- = 26mm	FFK = F-form Kink
52- = 52.4mm	FKK = FKK Type
73- = 73mm	MT = MT Type Forming
M = M-Type Forming	FT = FT Type Forming
MB = M-form W/fla	PN = PANAsert
F = F Type	AV = AVIsert
FK = FK Type	

52A=52.4mm, ψd 0.4±0.02mm

52B=52.4mm, ψd 0.45±0.02mm

52C=52.4mm, ψd 0.5±0.02mm

52G=52.4mm, ψd ≥ 0.6mm

52H=52.4mm , non-painting on soldering spots

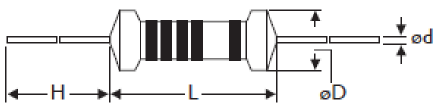
(7) RESISTANCE VALUE

E24 & E96 & E192 Series
Example:

100R = 100Ω, 10K = 10,000Ω, 1M = 1,000,000Ω

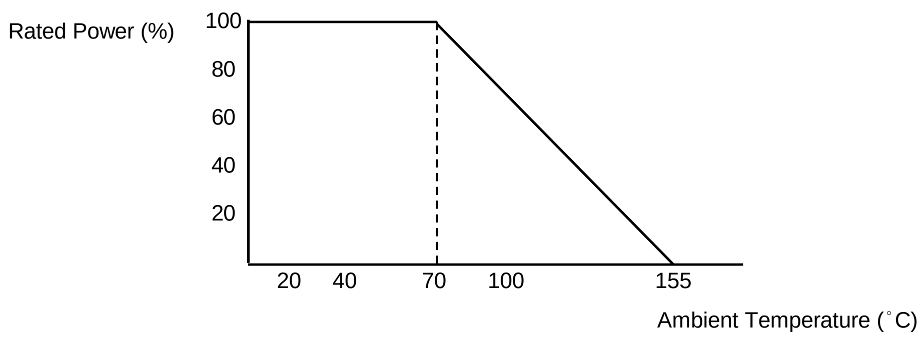
DIMENSIONS

Unit: mm



Normal	Miniature	L	ψD	H	ψd
MFR-12	MFR25S	3.4 ± 0.3	1.9 ± 0.2	28 ± 2.0	0.45 ± 0.05
MFR-25	MFR50S	6.3 ± 0.5	2.4 ± 0.2	28 ± 2.0	0.55 ± 0.05
MFR-50	MFR1WS	9.0 ± 0.5	3.3 ± 0.3	26 ± 2.0	0.55 ± 0.05
MFR100	MFR2WS	11.5 ± 1.0	4.5 ± 0.5	35 ± 2.0	0.8 ± 0.05
MFR200	MFR3WS	15.5 ± 1.0	5.0 ± 0.5	33 ± 2.0	0.8 ± 0.05

DERATING CURVE



ELECTRICAL CHARACTERISTICS

CHARACTERISTICS	MFR-12	MFR25S	MFR-25	MFR50S	MFR-50	MFR1WS	MFR100	MFR2WS	MFR3WS
Power Rating at 70 °C	1/6W	1/4W	1/4W	1/2W	1/2W	1W	1W	2W	3W
Maximum Working Voltage	200V	200V	250V	300V	350V	400V	500V	500V	500V
Maximum Overload Voltage	400V	400V	500V	600V	700V	800V	1000V	1000V	1000V
Voltage Proof on Insulation	300V	400V	500V	500V	500V	700V	1000V	1000V	1000V
Resistance Range	1Ω ~ 4M7Ω for E24 & E96 series value								
Operating Temp. Range	- 55°C to +155°C								
Temperature Coefficient	±50ppm/°C , ±100ppm/°C								

Note: For resistance value out of above range is by request.

TEST AND REQUIRMENTS

TEST	TEST METHOD	PROCEDURE	APPRAISE
Short Time Overload	IEC 60115-1 4.13	2.5 times RCWV for 5 sec.(Not more than maximum overload voltage)	±0.25%+0.05Ω
Voltage Proof on Insulation	IEC 60115-1 4.7	In V-Block for 60 sec. test voltage as above table	No Breakdown
Temperature Coefficient	IEC 60115-1 4.8	Between -55°C to +155°C	By Type
Insulation Resistance	IEC 60115-1 4.6	In V-Block for 60 sec.	>10,000MΩ
Solderability	IEC 60115-1 4.17	245±5°C for 3±0.5 Sec.	95% Min. coverage
Solvent Resistance of Marking	IEC 60115-1 4.30	IPA for 5±0.5 Min. with ultrasonic	No deterioration of coatings and markings
Robustness of Terminations	IEC 60115-1 4.16	Direct load for 10 Sec. in the direction of the terminal leads	≥2.5Kg(24.5N)
Periodic-pulse Overload	IEC 60115-1 4.39	4 times RCWV 10,000 cycles (1 Sec. on, 25 Sec.off)	±1.0%+0.05Ω
Damp Heat Steady State	IEC 60115-1 4.24	40±2°C,90-95% RH for 56 days, loaded with 0.1 times RCWV	±1.5%+0.05Ω
Endurance at 70°C	IEC 60115-1 4.25	70±2°C at RCWV(or Umax., whichever less) for 1,000 Hr.(1.5 Hr.on,0.5 Hr. off)	±1.5%+0.05Ω
Temperature Cycling	IEC 60115-1 4.19	è -55°C è Room Temp. è +155°C Room Temp.(5 cycles)	±0.75%+0.05Ω
Resistance to Soldering Heat	IEC 60115-1 4.18	260±3°C for 10±1 Sec., immersed to a point 3±0.5mm from the body	±0.25%+0.05Ω

Note:

RCWV (Rated Continuous Working Voltage):

The DC or AC (rms) continuous working voltage corresponding to the rated power is determined by the following formula:

$V=\sqrt{(P \times R)}$
or max. working voltage whichever is less

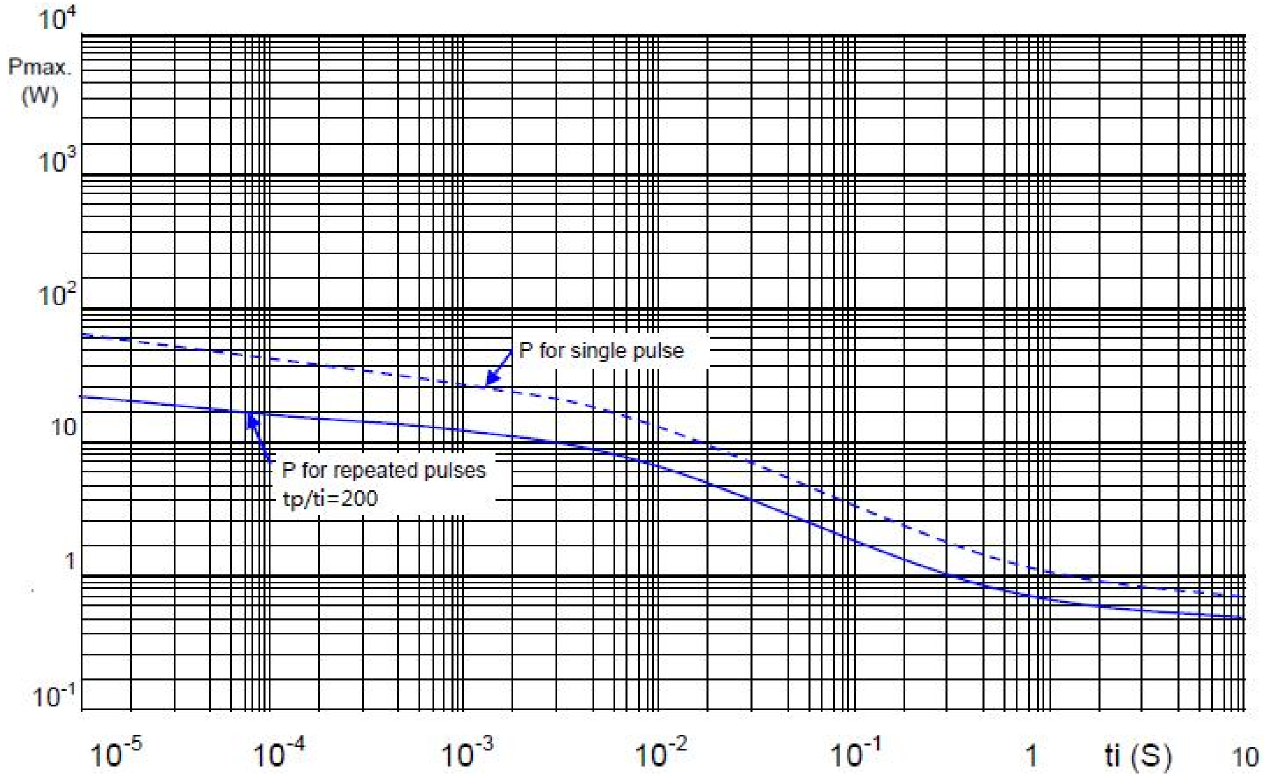
Where

V=Continuous rated DC or
AC (rms) working voltage (V)

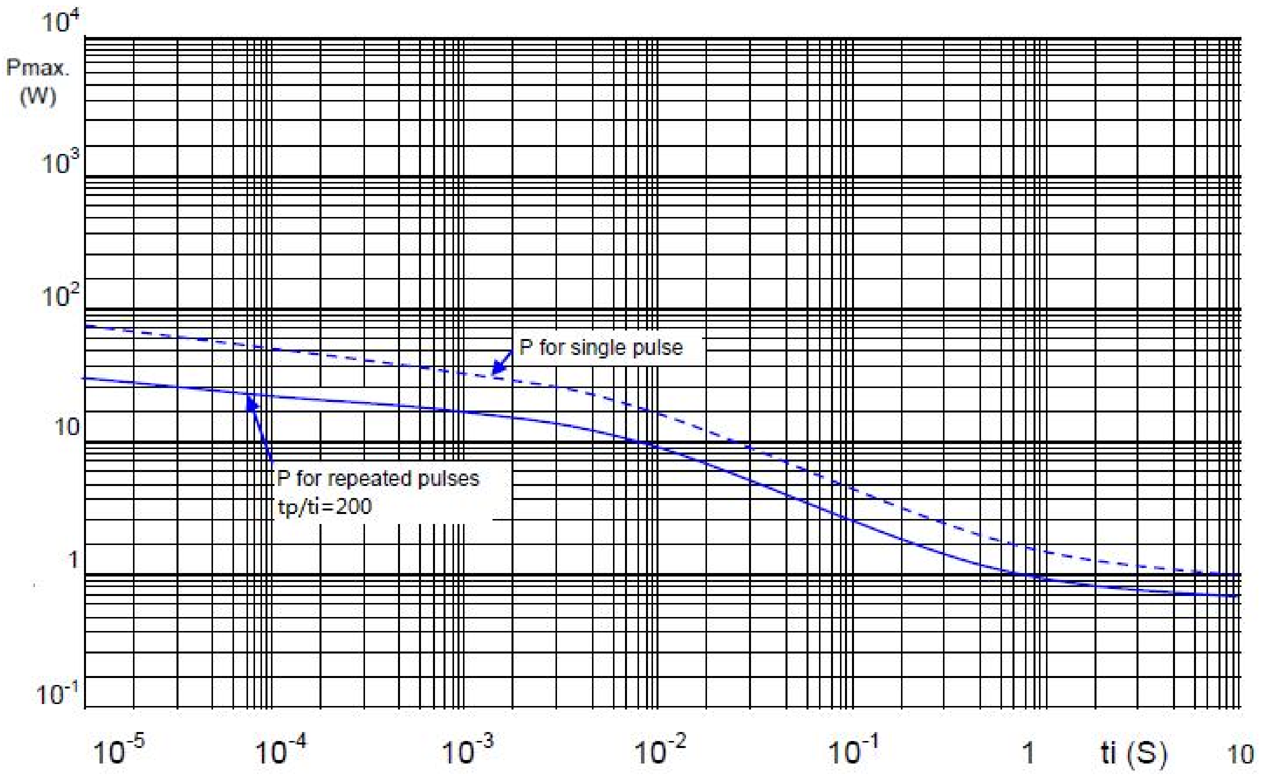
P=Rated power (W)

R=Resistance value (Ω)

PULSE DIAGRAMS



MFR25S Series: Pmax.: Maximum permissible peak pulse power
ti: Pulse duration
tp: Pulse repetition time



MFR50S Series: Pmax.: Maximum permissible peak pulse power
ti: Pulse duration
tp: Pulse repetition time