PIC16F87X
Data Sheet

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

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PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

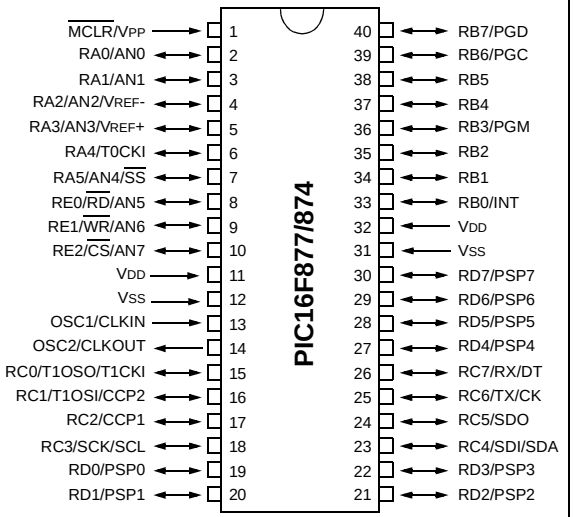
- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 μA typical @ 3V, 32 kHz
  - < 1 μA typical standby current

Pin Diagram

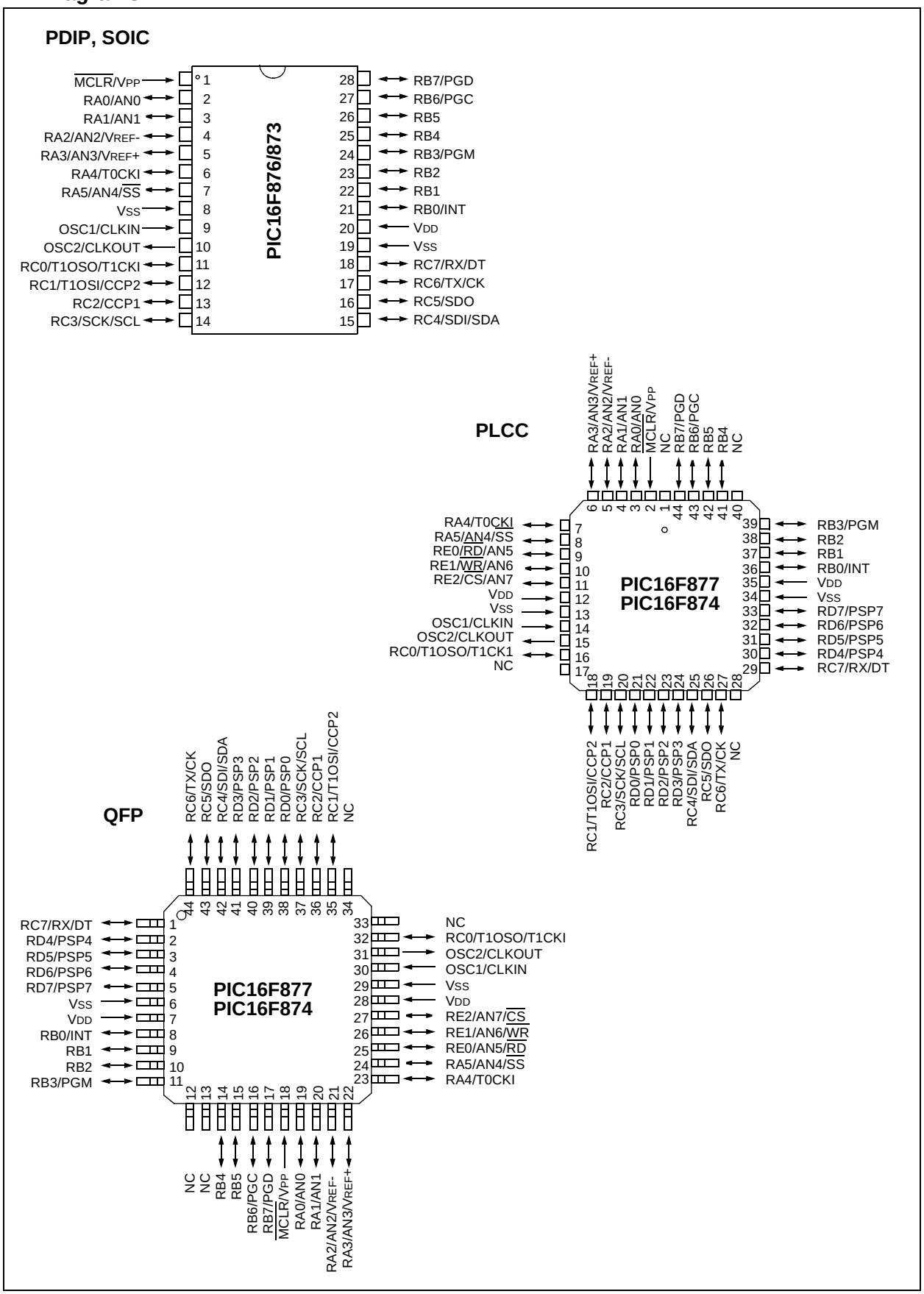
PDIP



Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Pin Diagrams



Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz
RESETS (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory	128	128	256	256
Interrupts	13	14	13	14
I/O Ports	Ports A,B,C	Ports A,B,C,D,E	Ports A,B,C	Ports A,B,C,D,E
Timers	3	3	3	3
Capture/Compare/PWM Modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Instruction Set	35 instructions	35 instructions	35 instructions	35 instructions

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1.0 DEVICE OVERVIEW

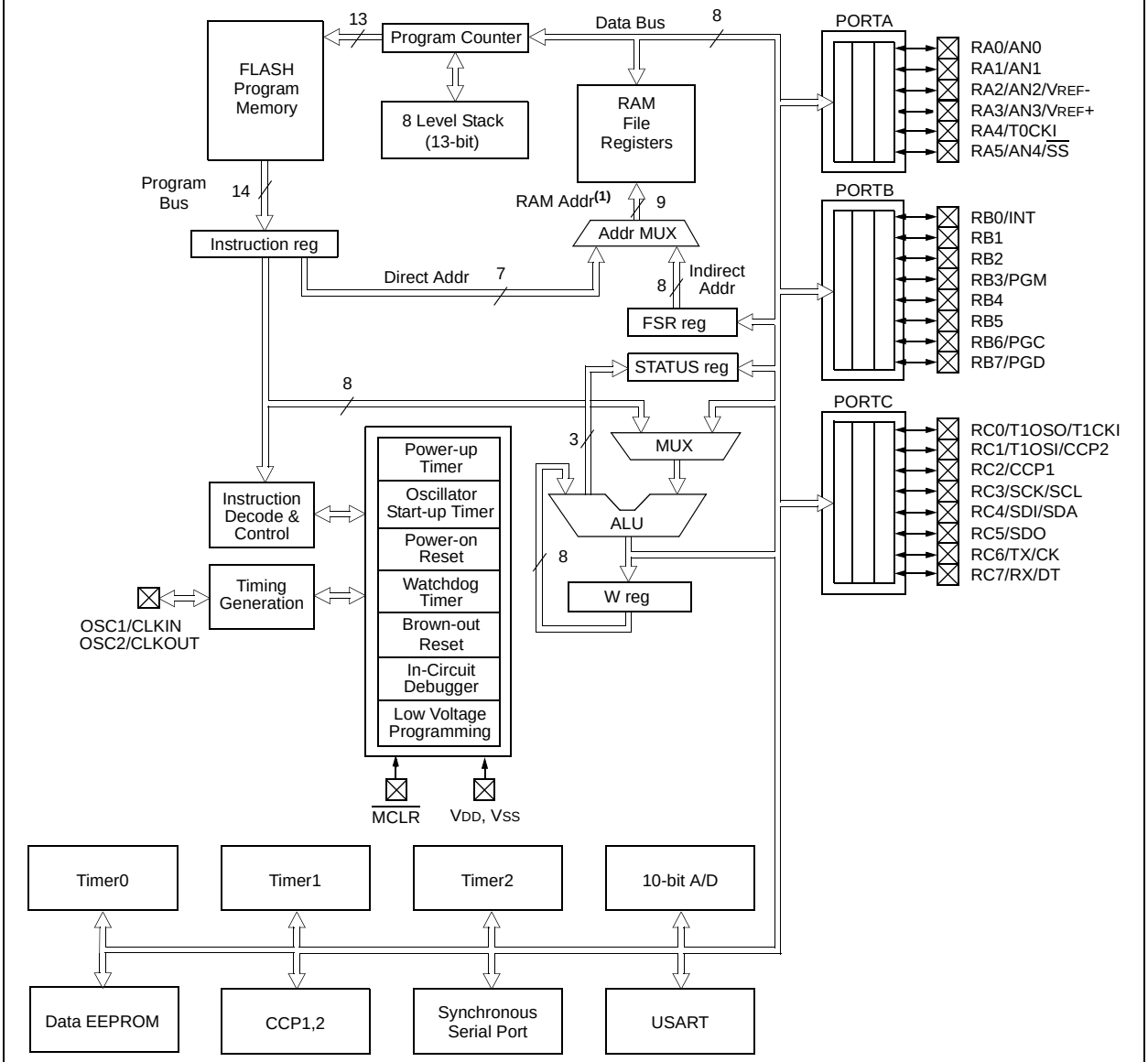
This document contains device specific information. Additional information may be found in the PICmicro™ Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip website. The Reference Manual should be considered a complementary document to this data sheet, and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

There are four devices (PIC16F873, PIC16F874, PIC16F876 and PIC16F877) covered by this data sheet. The PIC16F876/873 devices come in 28-pin packages and the PIC16F877/874 devices come in 40-pin packages. The Parallel Slave Port is not implemented on the 28-pin devices.

The following device block diagrams are sorted by pin number; 28-pin for Figure 1-1 and 40-pin for Figure 1-2. The 28-pin and 40-pin pinouts are listed in Table 1-1 and Table 1-2, respectively.

FIGURE 1-1: PIC16F873 AND PIC16F876 BLOCK DIAGRAM

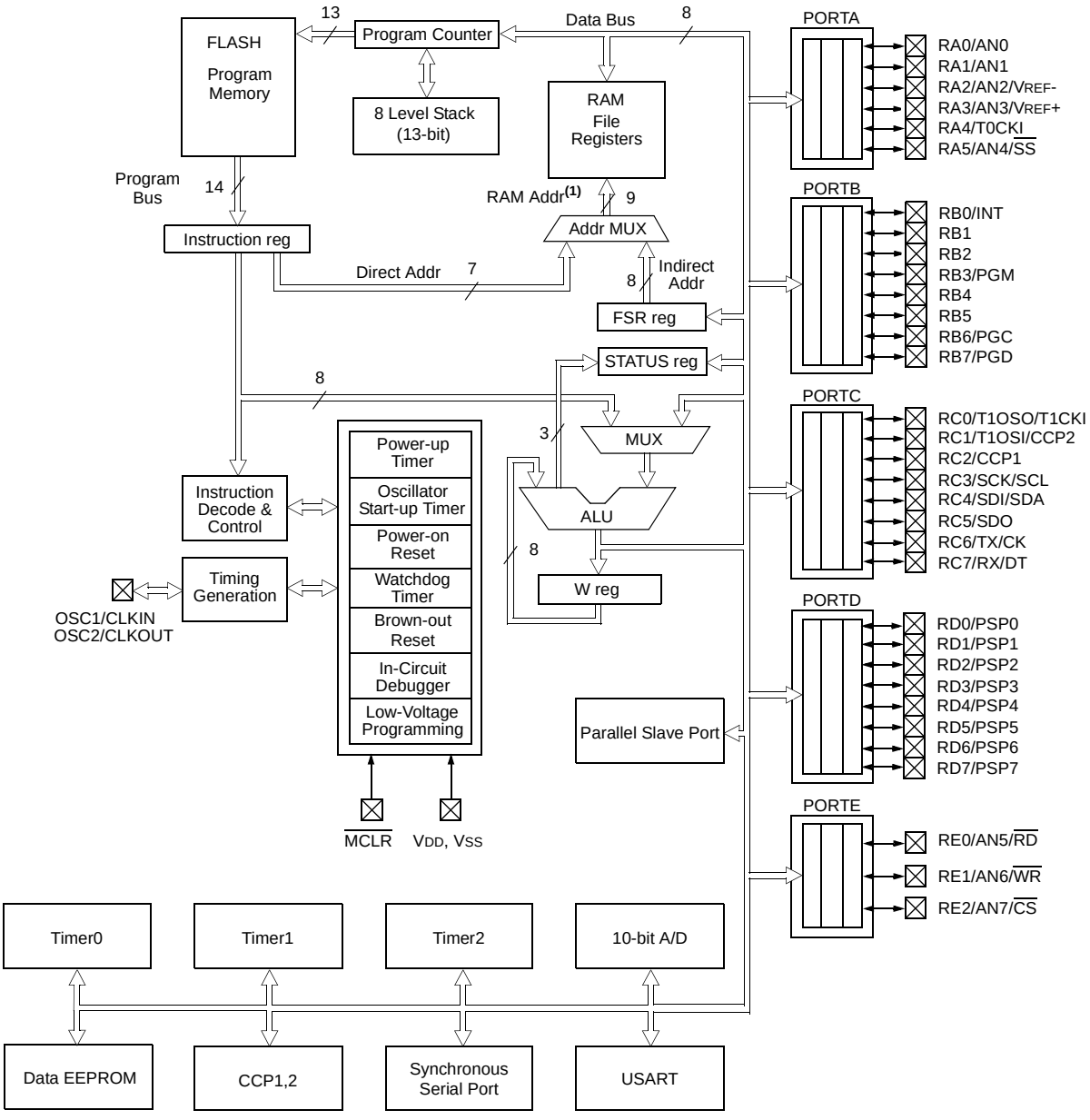
Device	Program FLASH	Data Memory	Data EEPROM
PIC16F873	4K	192 Bytes	128 Bytes
PIC16F876	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

FIGURE 1-2: PIC16F874 AND PIC16F877 BLOCK DIAGRAM

Device	Program FLASH	Data Memory	Data EEPROM
PIC16F874	4K	192 Bytes	128 Bytes
PIC16F877	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

TABLE 1-1: PIC16F873 AND PIC16F876 PINOUT DESCRIPTION

Pin Name	DIP Pin#	SOIC Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	9	9	I	ST/CMOS(3)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	10	10	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, the OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP	1	1	I/P	ST	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.
					PORTA is a bi-directional I/O port.
RA0/AN0	2	2	I/O	TTL	RA0 can also be analog input0.
RA1/AN1	3	3	I/O	TTL	RA1 can also be analog input1.
RA2/AN2/VREF-	4	4	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage.
RA3/AN3/VREF+	5	5	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage.
RA4/T0CKI	6	6	I/O	ST	RA4 can also be the clock input to the Timer0 module. Output is open drain type.
RA5/$\overline{SS}$/AN4	7	7	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
					PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	21	21	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	22	22	I/O	TTL	
RB2	23	23	I/O	TTL	
RB3/PGM	24	24	I/O	TTL	RB3 can also be the low voltage programming input.
RB4	25	25	I/O	TTL	Interrupt-on-change pin.
RB5	26	26	I/O	TTL	Interrupt-on-change pin.
RB6/PGC	27	27	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	28	28	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming data.
					PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	11	11	I/O	ST	RC0 can also be the Timer1 oscillator output or Timer1 clock input.
RC1/T1OSI/CCP2	12	12	I/O	ST	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
RC2/CCP1	13	13	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	14	14	I/O	ST	RC3 can also be the synchronous serial clock input/output for both SPI and I^2C modes.
RC4/SDI/SDA	15	15	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	16	16	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6/TX/CK	17	17	I/O	ST	RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	18	18	I/O	ST	RC7 can also be the USART Asynchronous Receive or Synchronous Data.
VSS	8, 19	8, 19	P	—	Ground reference for logic and I/O pins.
VDD	20	20	P	—	Positive supply for logic and I/O pins.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

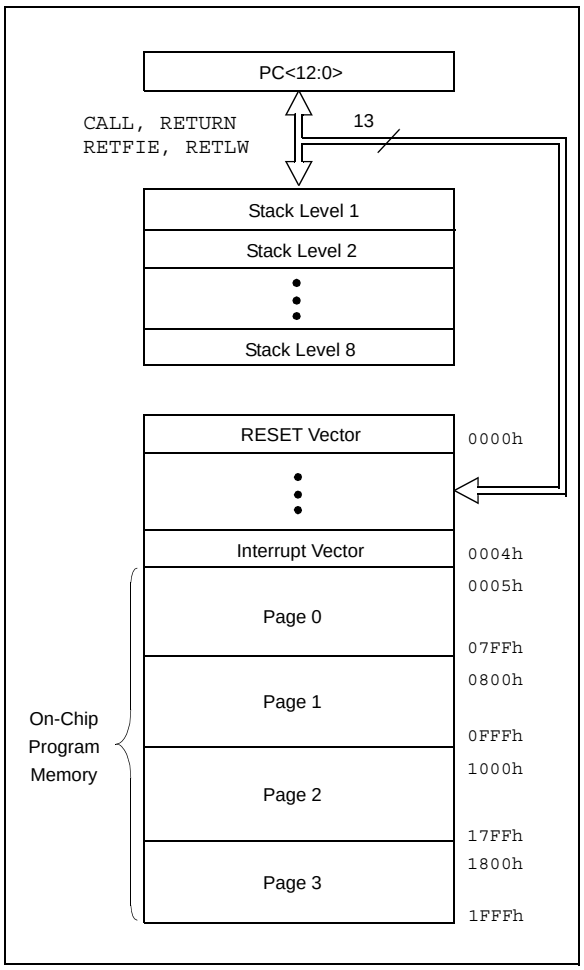
Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

2.0 MEMORY ORGANIZATION

There are three memory blocks in each of the PIC16F87X MCUs. The Program Memory and Data Memory have separate buses so that concurrent access can occur and is detailed in this section. The EEPROM data memory block is detailed in Section 4.0.

Additional information on device memory may be found in the PICmicro™ Mid-Range Reference Manual, (DS33023).

FIGURE 2-1: PIC16F877/876 PROGRAM MEMORY MAP AND STACK

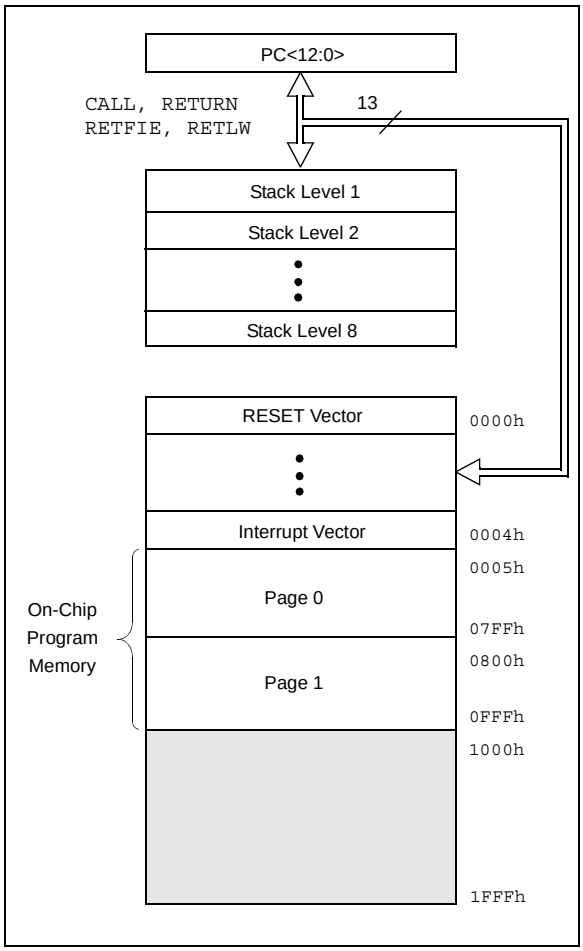


2.1 Program Memory Organization

The PIC16F87X devices have a 13-bit program counter capable of addressing an 8K x 14 program memory space. The PIC16F877/876 devices have 8K x 14 words of FLASH program memory, and the PIC16F873/874 devices have 4K x 14. Accessing a location above the physically implemented address will cause a wraparound.

The RESET vector is at 0000h and the interrupt vector is at 0004h.

FIGURE 2-2: PIC16F874/873 PROGRAM MEMORY MAP AND STACK



2.2 Data Memory Organization

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 (STATUS<6>) and RP0 (STATUS<5>) are the bank select bits.

RP1:RP0	Bank
00	0
01	1
10	2
11	3

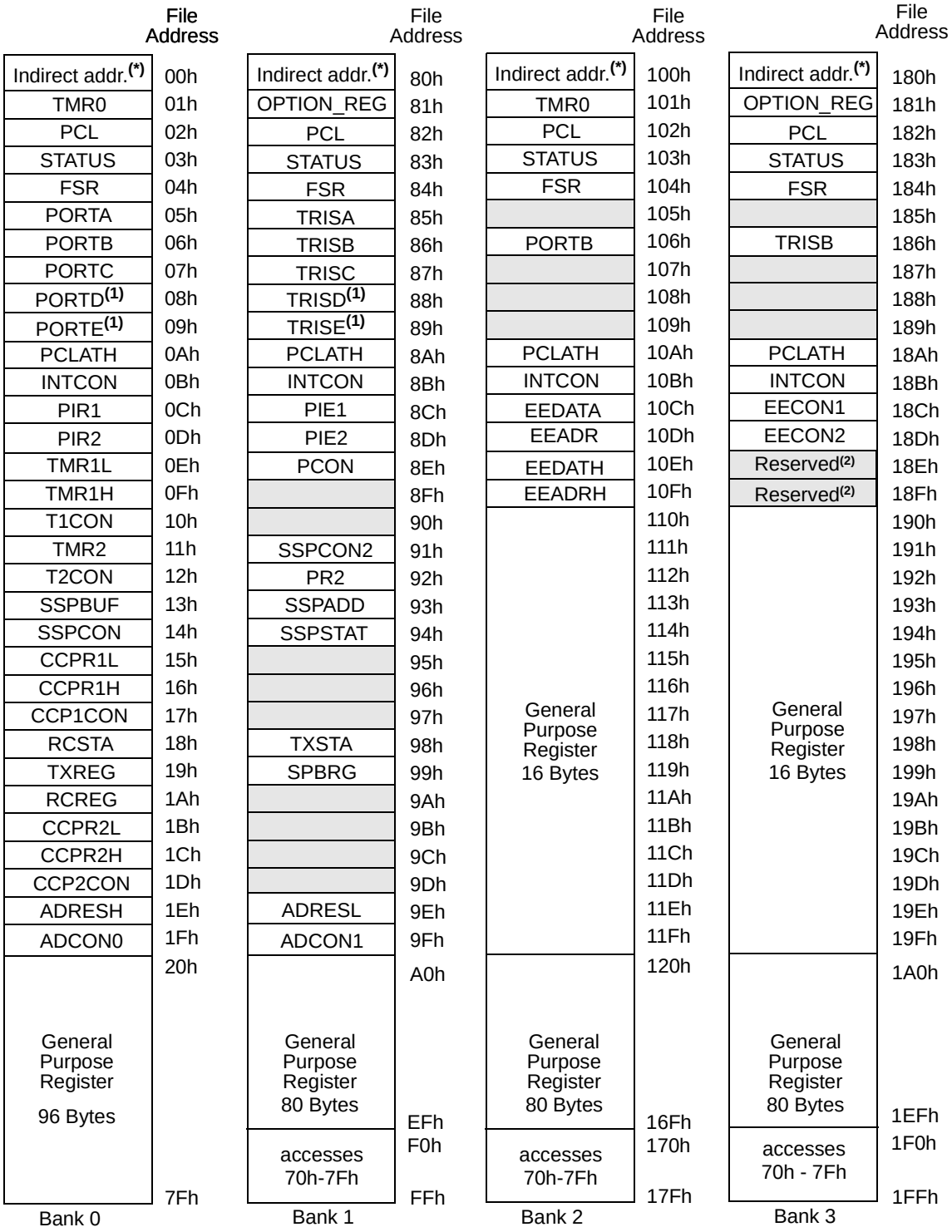
Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access.

Note: EEPROM Data Memory description can be found in Section 4.0 of this data sheet.

2.2.1 GENERAL PURPOSE REGISTER FILE

The register file can be accessed either directly, or indirectly through the File Select Register (FSR).

FIGURE 2-3: PIC16F877/876 REGISTER FILE MAP



Unimplemented data memory locations, read as '0'.

* Not a physical register.

Note 1: These registers are not implemented on the PIC16F876.

2: These registers are reserved, maintain these registers clear.

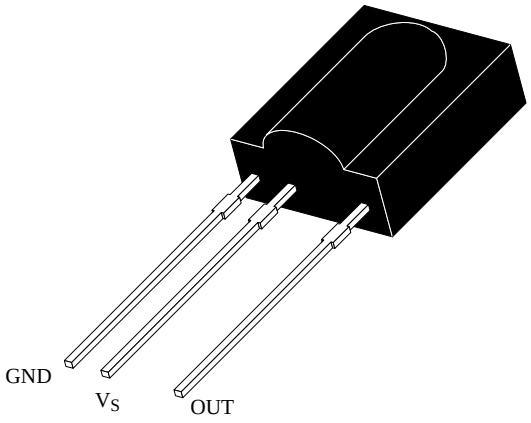
Photo Modules for PCM Remote Control Systems

Available types for different carrier frequencies

Type	fo	Type	fo
TSOP1730	30 kHz	TSOP1733	33 kHz
TSOP1736	36 kHz	TSOP1737	36.7 kHz
TSOP1738	38 kHz	TSOP1740	40 kHz
TSOP1756	56 kHz		

Description

The TSOP17.. – series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter.
The demodulated output signal can directly be decoded by a microprocessor. TSOP17.. is the standard IR remote control receiver series, supporting all major transmission codes.



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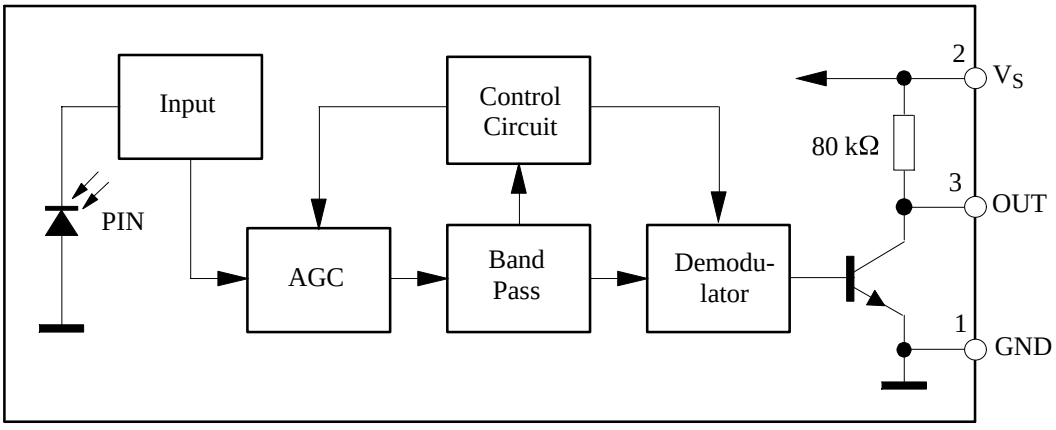
Features

- Photo detector and preamplifier in one package
- Internal filter for PCM frequency
- Improved shielding against electrical field disturbance
- TTL and CMOS compatibility
- Output active low
- Low power consumption
- High immunity against ambient light
- Continuous data transmission possible (up to 2400 bps)
- Suitable burst length ≥10 cycles/burst

Block Diagram



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Absolute Maximum Ratings

T_{amb} = 25°C

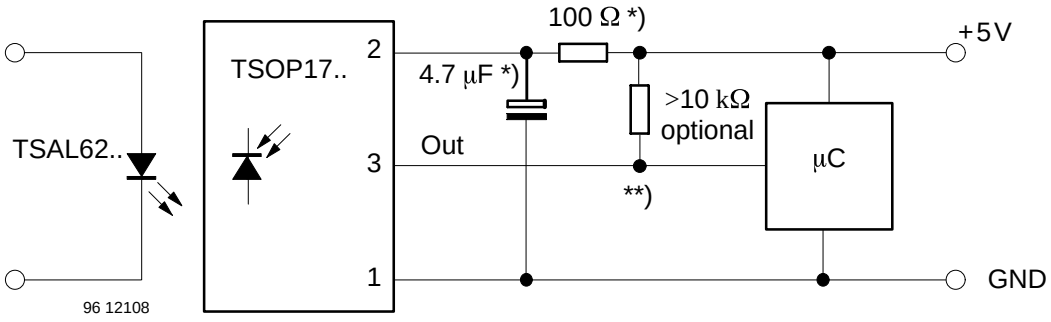
Parameter	Test Conditions	Symbol	Value	Unit
Supply Voltage	(Pin 2)	V_S	–0.3...6.0	V
Supply Current	(Pin 2)	I_S	5	mA
Output Voltage	(Pin 3)	V_O	–0.3...6.0	V
Output Current	(Pin 3)	I_O	5	mA
Junction Temperature		T_j	100	˚C
Storage Temperature Range		T_{stg}	–25...+85	˚C
Operating Temperature Range		T_{amb}	–25...+85	˚C
Power Consumption	(T_{amb} ≦ 85 ˚C)	P_{tot}	50	mW
Soldering Temperature	t ≦ 10 s, 1 mm from case	T_{sd}	260	˚C

Basic Characteristics

T_{amb} = 25°C

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
Supply Current (Pin 2)	V_S = 5 V, E_v = 0	I_{SD}	0.4	0.6	1.5	mA
	V_S = 5 V, E_v = 40 klx, sunlight	I_{SH}		1.0		mA
Supply Voltage (Pin 2)		V_S	4.5		5.5	V
Transmission Distance	E_v = 0, test signal see fig.7, IR diode TSAL6200, I_F = 400 mA	d		35		m
Output Voltage Low (Pin 3)	I_{OSL} = 0.5 mA,E_e = 0.7 mW/m^2, f = f_o, t_p/T = 0.4	V_{OSL}			250	mV
Irradiance (30 – 40 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal (see fig.7)	$E_{e\ min}$		0.35	0.5	mW/m^2
Irradiance (56 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal (see fig.7)	$E_{e\ min}$		0.4	0.6	mW/m^2
Irradiance	$t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$	$E_{e\ max}$	30			W/m^2
Directivity	Angle of half transmission distance	$\varphi_{1/2}$		±45		deg

Application Circuit



*) recommended to suppress power supply disturbances

**) The output voltage should not be hold continuously at a voltage below 3.3V by the external circuit.

Suitable Data Format

The circuit of the TSOP17.. is designed in that way that unexpected output pulses due to noise or disturbance signals are avoided. A bandpassfilter, an integrator stage and an automatic gain control are used to suppress such disturbances.
The distinguishing mark between data signal and disturbance signal are carrier frequency, burst length and duty cycle.

The data signal should fullfill the following condition:

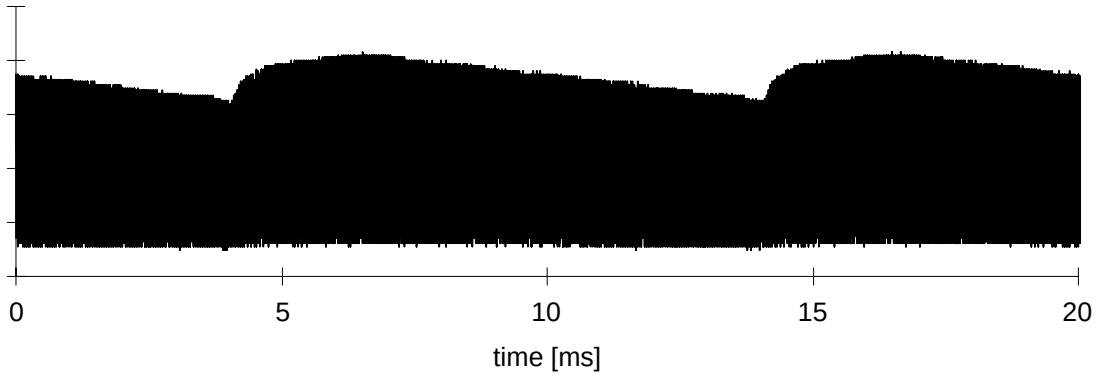
- Carrier frequency should be close to center frequency of the bandpass (e.g. 38kHz).
- Burst length should be 10 cycles/burst or longer.
- After each burst which is between 10 cycles and 70 cycles a gap time of at least 14 cycles is neccessary.
- For each burst which is longer than 1.8ms a corresponding gap time is necessary at some time in the data stream. This gap time should have at least same length as the burst.
- Up to 1400 short bursts per second can be received continuously.

Some examples for suitable data format are:
NEC Code, Toshiba Micom Format, Sharp Code, RC5 Code, RC6 Code, R–2000 Code, Sony Format (SIRCS).

When a disturbance signal is applied to the TSOP17.. it can still receive the data signal. However the sensitivity is reduced to that level that no unexpected pulses will occure.

Some examples for such disturbance signals which are suppressed by the TSOP17.. are:

- DC light (e.g. from tungsten bulb or sunlight)
- Continuous signal at 38kHz or at any other frequency
- Signals from fluorescent lamps with electronic ballast (an example of the signal modulation is in the figure below).



IR Signal from Fluorescent Lamp with low Modulation

Typical Characteristics (T_{amb} = 25°C unless otherwise specified)

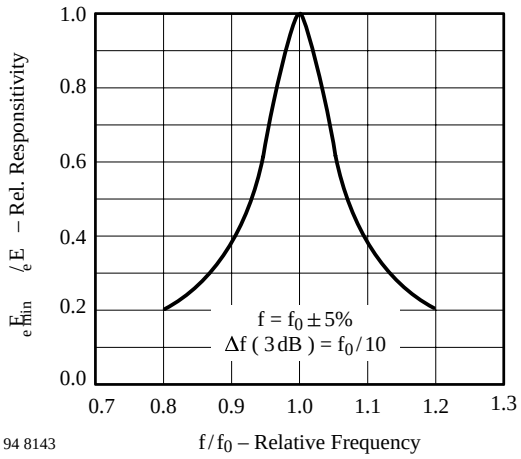


Figure 1. Frequency Dependence of Responsivity

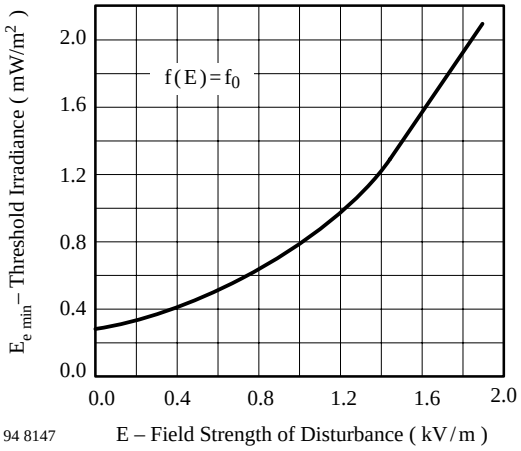


Figure 4. Sensitivity vs. Electric Field Disturbances

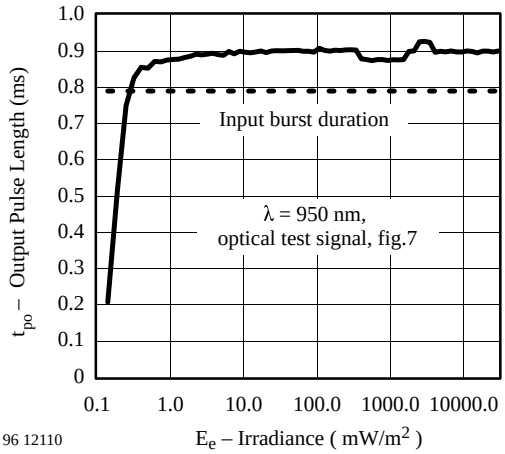


Figure 2. Sensitivity in Dark Ambient

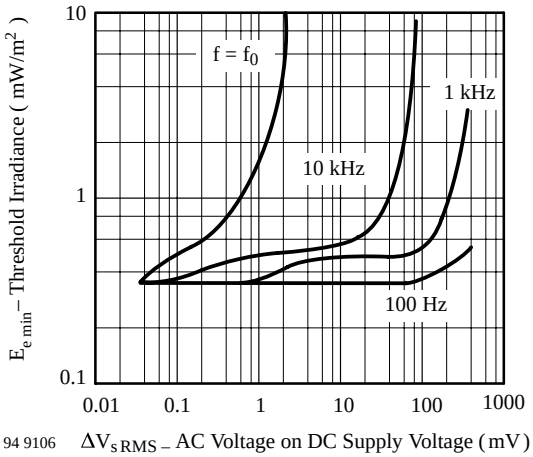


Figure 5. Sensitivity vs. Supply Voltage Disturbances

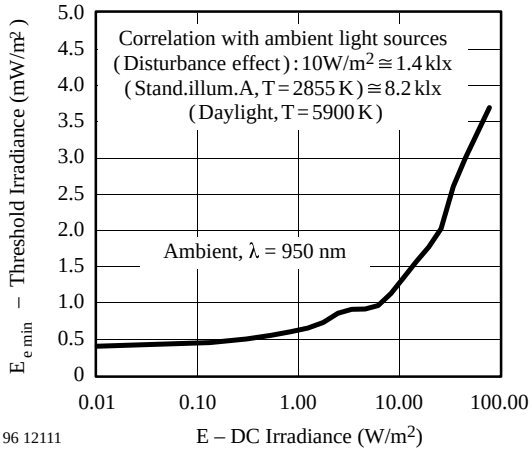


Figure 3. Sensitivity in Bright Ambient

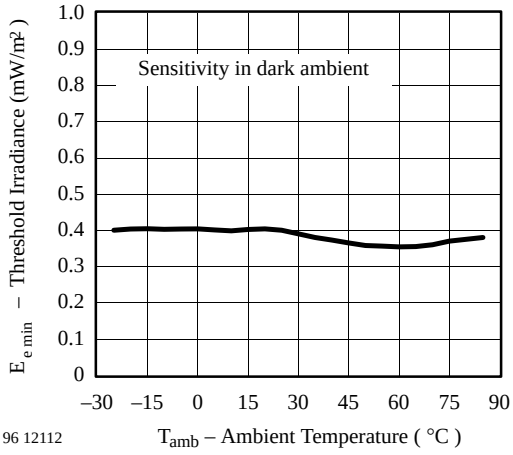


Figure 6. Sensitivity vs. Ambient Temperature

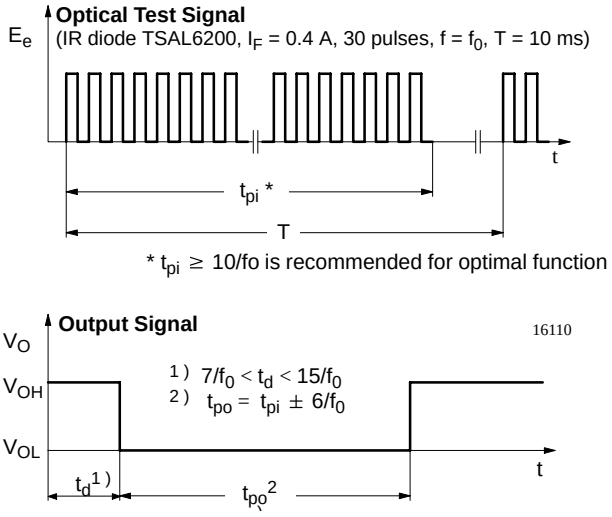


Figure 7. Output Function

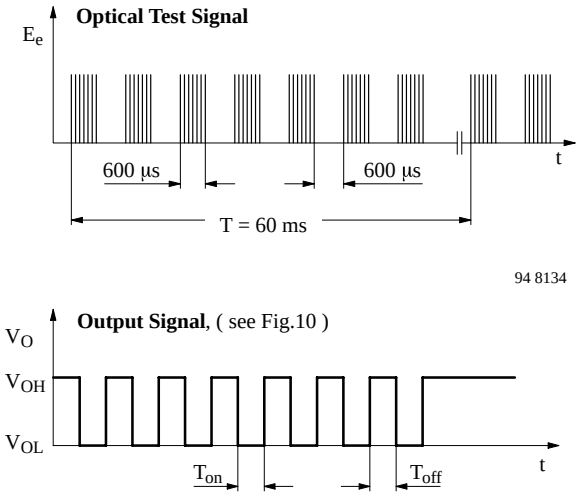


Figure 8. Output Function

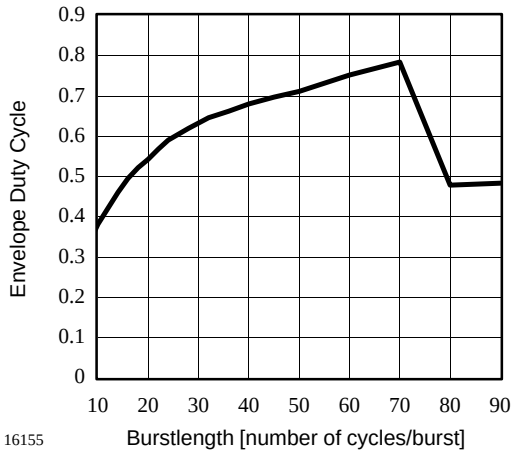


Figure 9. Max. Envelope Duty Cycle vs. Burstlength

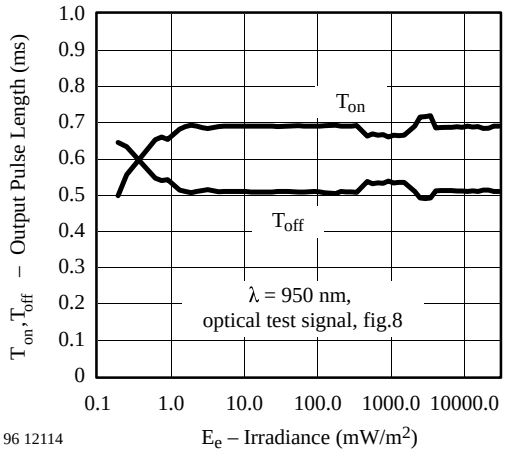


Figure 10. Output Pulse Diagram

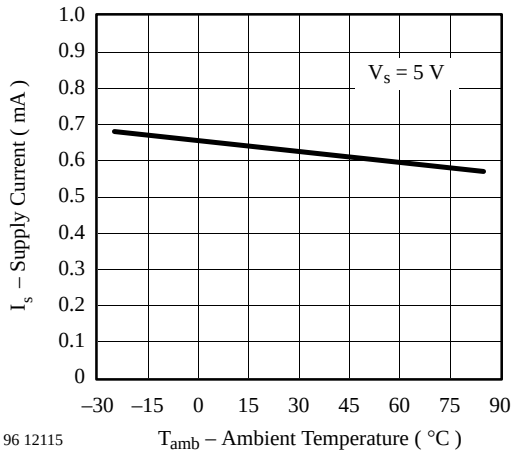


Figure 11. Supply Current vs. Ambient Temperature

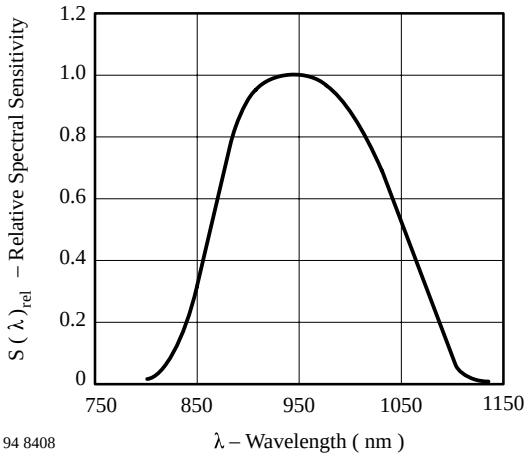


Figure 12. Relative Spectral Sensitivity vs. Wavelength

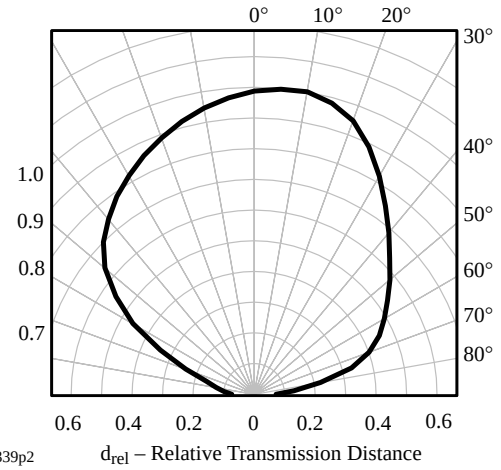


Figure 13. Vertical Directivity φ_y

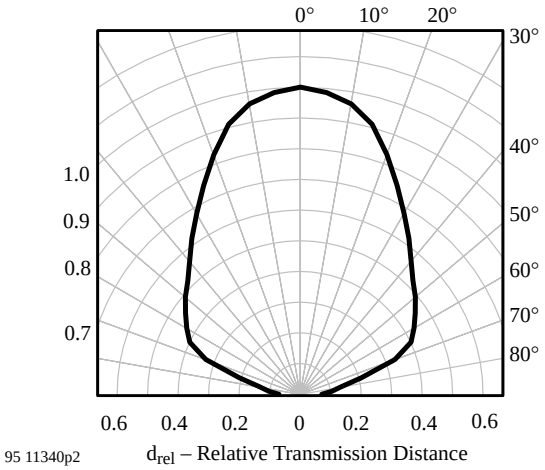
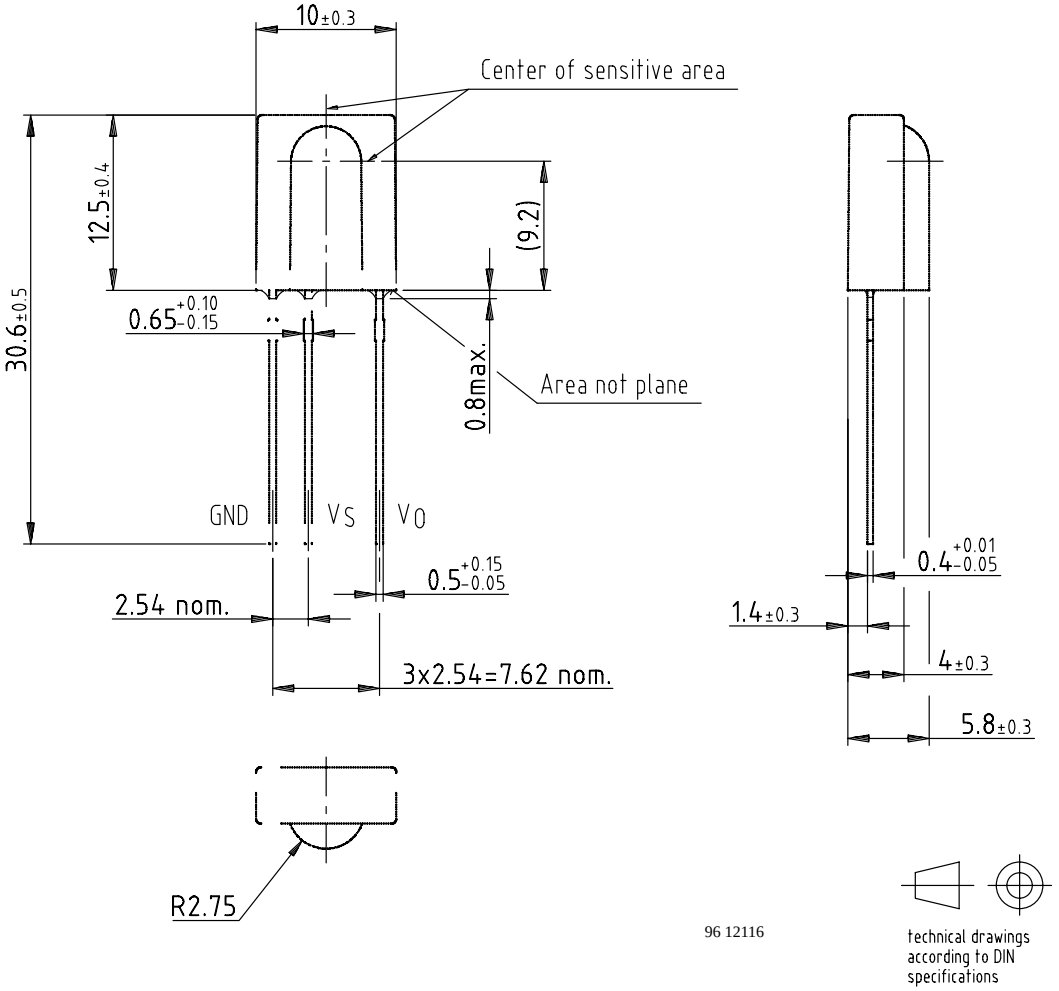


Figure 14. Horizontal Directivity φ_x

Dimensions in mm



Ozone Depleting Substances Policy Statement

It is the policy of **Vishay Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Vishay Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Vishay Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

Vishay Semiconductor GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany
Telephone: 49 (0)7131 67 2831, Fax number: 49 (0)7131 67 2423

Open Impulse

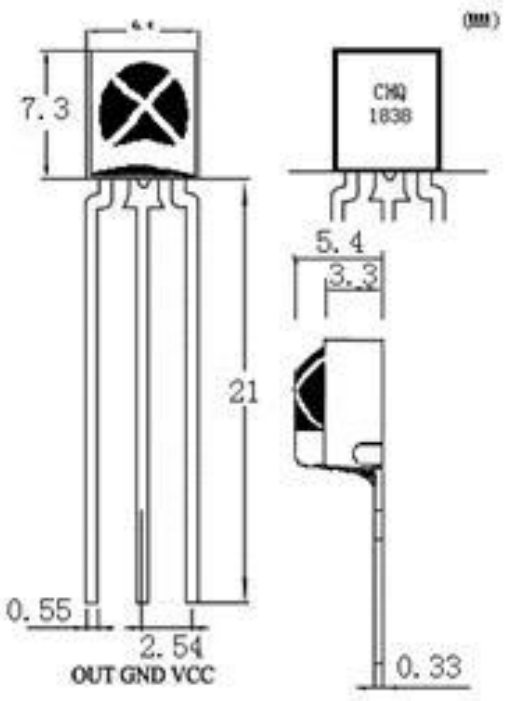
http://www.openimpulse.com

TL1838 Infrared Receiver Datasheet

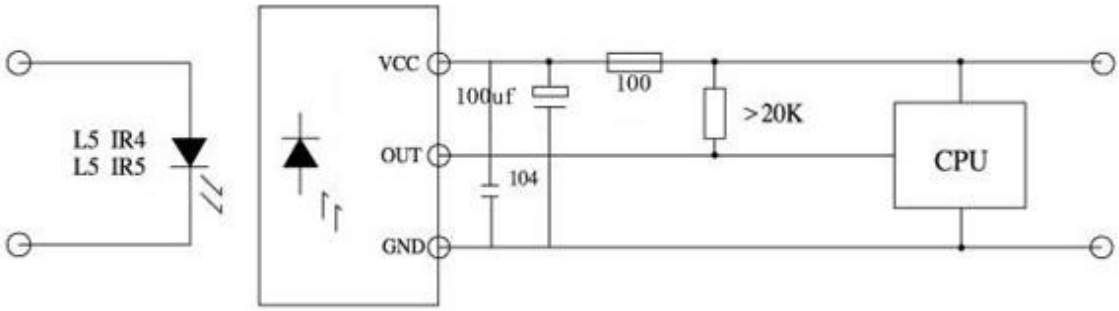
1. Features

* Compact design;
* Built-in dedicated IC;
* wide-angle and long distance reception;
* anti-stem worries ability;
* can more than offset the impact of ambient light;
* Low voltage operation;

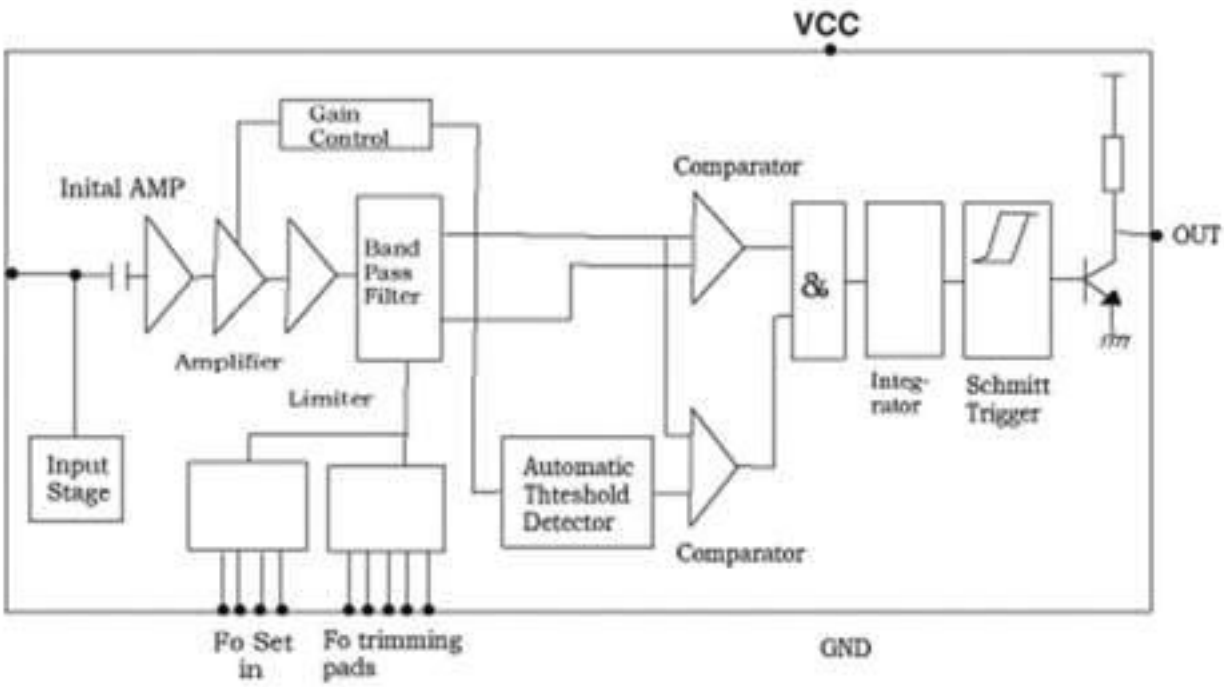
2. Dimensions and Pin Assignment



3. Application Circuit



4. Schematic Diagram



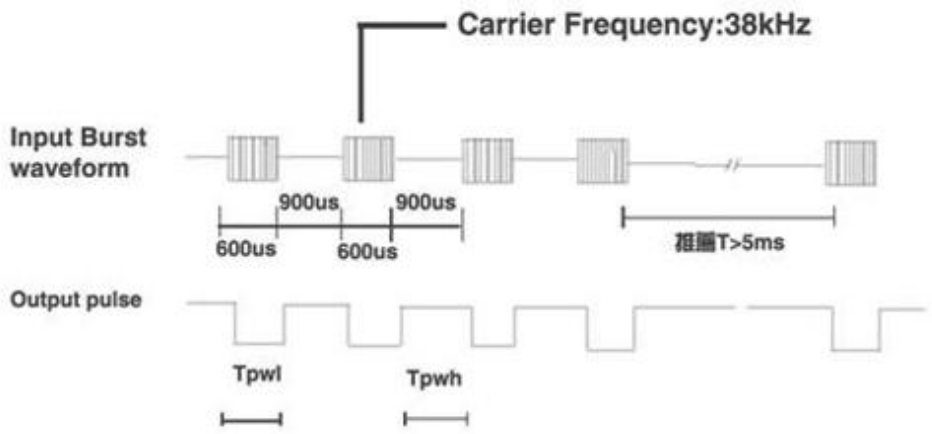
http://www.openimpulse.com

5. Optical Parameters (T = 25 ℃ Vcc = 5v f0 = 38KHZ)

Parameter	Symbol	Test Conditions	Min	Typ	Mnx	Unit
Operating Voltage	Vcc		2.7		5.5	V
Receiving distance	L	L5IR = 300MA (test signal)	10	15		M
Carrier Frequency	f0		38K			HZ
Acceptance angle	01/2	Distance attenuation 1/2		+ / -35		Deg
BMP width	FBW	-3Db andwidth	2	3.3	5	kHz
Quiescent Current	Icc	When there is no signal input	----	0.8	1.5	mA
Low output	VOL	Vin = 0V Vcc = 5V		0.2	0.4	V
High-level output	VOH	Vcc = 5V	4.5			V
The output pulse width	TPWL	Vin = 500μVp-p ※	500	600	700	μs
	TPWH	Vin = 50mVp-p ※	500	600	700	μs

※ testing on the optical axis to the transmit pulse width 600/900μs, 5CM within receiving range, the average value of the received pulse 50

6. Test Wave

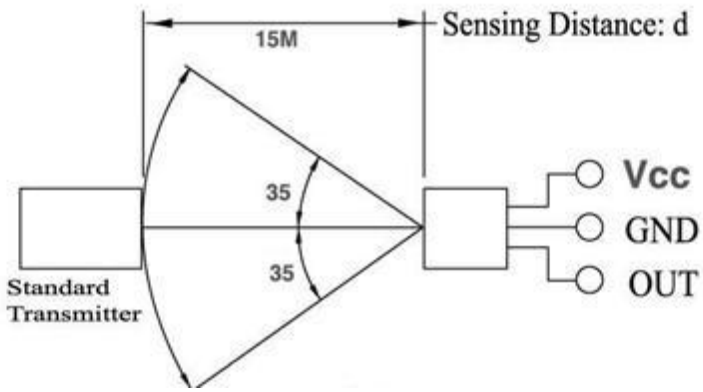


http://www.openimpulse.com

7. Limit Parameters

Project	Symbol	Specification	Unit
Supply Voltage	Vcc	6.0	v
Operating Temperature	Topr	-25-85	℃
Storage Temperature	Tstg	-40-125	℃
Soldering Temperature	Tsol	240	℃

8. Receiving Angle Diagram



9. Recommended Conditions of Use

Project	Symbol	Min	Typ	Mnx	Unit
Operating Voltage	Vcc	2.7	-----	5.5	V
Input Frequency	FM		38		kHz
Operating Temperature	Topr	-20			

EM-18 RFID Reader

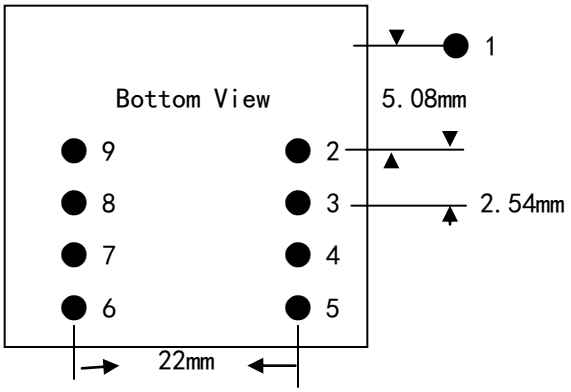
Tech parameter:

voltage: DC5V

electrical current: <50MA

operating frequence: 125KHZ

Read distance: 10CM。



Basal Specifications:

1	VCC	5V
2	GND	GND
3	BEEP	BEEP AND LED
4	ANT	NO USE
5	ANT	NO USE
6	SEL	HIGH IS RS232,LOW IS WEIGAND
7	RS232	RS232
8	D1	WEIGAND DATA 1
9	D0	WEIGAND DATA 0

Output format:

1. Wiegand26 (format)

Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Note	P	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	P
	P	E	E	E	E	E	E	E	E	E	E	E	E													
														0	0	0	0	0	0	0	0	0	0	0	0	P

Note: E: Summed for even parity O: Summed for odd parity P: parity(even or odd) D: Data code for card:the data will use the last 24 data bits of card

2. RS232 interface format:

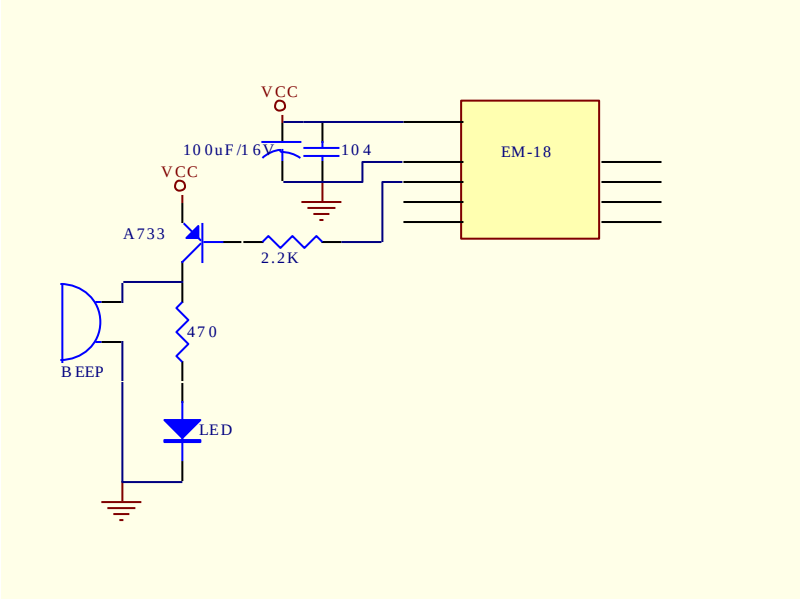
10 ASCII DATA (card no.) + 2 ASCII DATA (XOR result)

1. data baud rate:9600BPS 2. data bit: 8bits 3. Parity check: none 4. stop bit: 1

Description:

32mm(length) * 32mm(width) * 8mm(height)

applied circle:



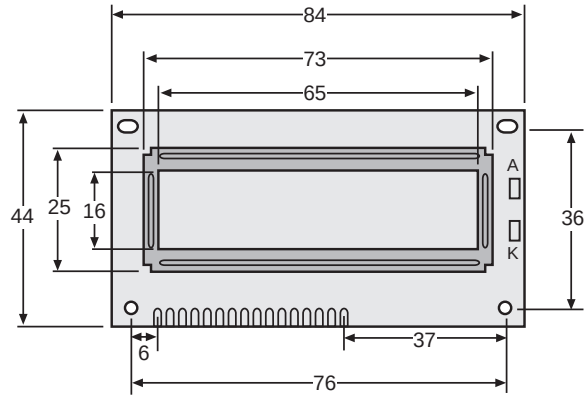
ALTRONIC DISTRIBUTORS pty. ltd.
ACN 008 801 161

Z 7000A
Z 7011

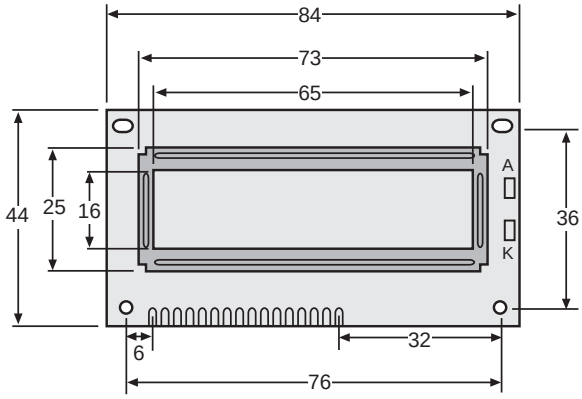
Specification Sheet
Alphanumeric LCD Modules

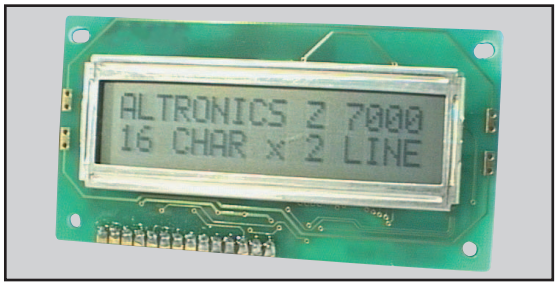
16 character x 2 line dot matrix LCD module.
• Powered by 5V DC • 96 inbuilt ASCII characters, 92 special characters and 8 custom characters
• Supertwist (Z 7000A) and backlit (Z 7011) versions available

Z 7000A Dimension



Z 7011 Dimension





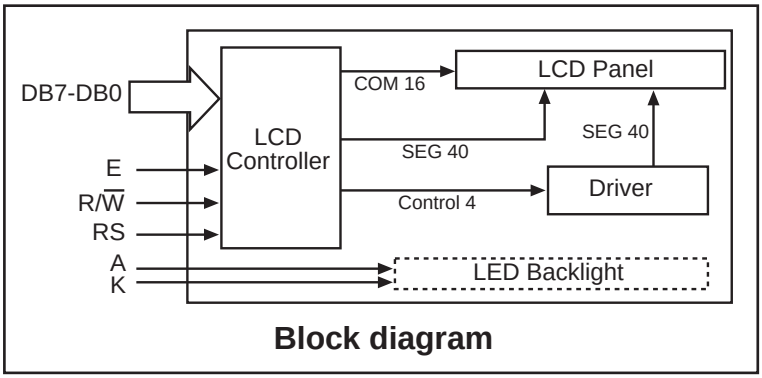
Pin Assignments

Pin No.	Label	Description
1	VSS	Ground
2	VDD	Supply Voltage
3	VO	Contrast adjustment voltage
4	RS	Register select signal
5	R/W	Read / write select signal
6	E	Operation (read/write) enable
7	DB0	Low byte data bit
8	DB1	Low byte data bit
9	DB2	Low byte data bit
10	DB3	Low byte data bit
11	DB4	High byte data bit
12	DB5	High byte data bit
13	DB6	High byte data bit
14	DB7	High byte data bit
15	A	Positive LED backlight (Anode)*
16	K	Negative LED backlight (Cathode)*

* Backlighting connections for Z 7011 Only

Characteristics

Overall Dimensions: Z 7000A 84 x 44 x 8.8mm
Z 7011 84 x 44 x 12.7mm
Viewing Area: .....66 x 16mm
Character Size: .....2.96 x 5.56mm
Character Pitch: .....3.55 x 5.94mm
Character Font:.....5x7 dots
Dot Size:.....0.56 x 0.66mm
Duty:.....1/16
Weight: .....Z 7000A 28g
Z 7011 36g



Block diagram

Parameter	Symbol	Condition	Pin	Min.	Typ.	Max	Unit
Supply voltage	VDD		VDD	4.75	5.00	5.25	V
Supply current	IDD	VDD = 5V	VDD	-	1.0	3.0	mA
High level input voltage	VIH1		DB0-DB7	2.0	-	VDD	V
Low level input voltage	VIL1		RS, R/W, E	VSS	-	0.8	V
High level output voltage	VOH1	IOH = 0.2mA	DB0-DB7	2.4	-	-	V
Low level output voltage	VOL1	IOL = 1.2mA	DB0-DB7	-	-	0.4	V
LCD driving voltage	VLCD	VDD = 5V		3.0	-	VDD	V
Backlight current (Z 7011)	ILED			20	-	80	mA
Internal clock speed	FOSC			245	250	255	kHz
Response time (rise)	Tr	T = 25°C		-	110	220	ms
Response time (fall)	Tf	T = 25°C		-	110	220	ms
Viewing angle (Lateral)		T = 25°C		60	-	120	degrees
Viewing angle (Longitudinal)		T = 25°C		50	-	80	degrees
Operating temperature	TOP			0	25	50	°C
Storage temperature	TST			-20	25	+60	°C

Specification Sheet

Alphanumeric LCD Module

Control and Display Commands

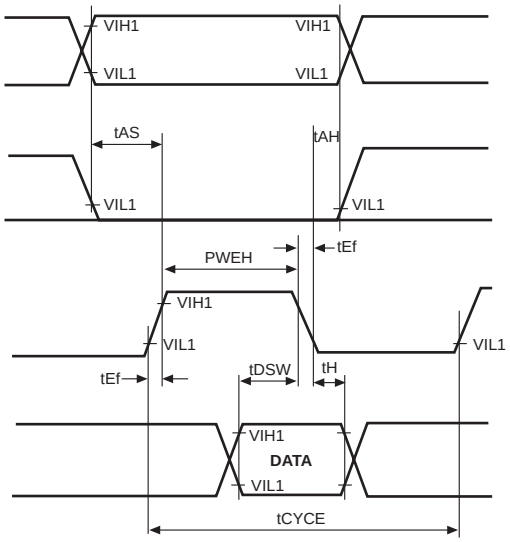
Command	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Remarks
Display Clear	0	0	0	0	0	0	0	0	0	1	Clears Display
Return Home	0	0	0	0	0	0	0	0	1	X	Cursor Moves to 1st Digit
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	I/D=0 Cursor moves left I/D=1 Cursor moves right SH=0 Display is not shifted SH=1 Display is shifted
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D=0 Display off, D=1 Display on C=0 Cursor on, C=1 Cursor off B=0 Blinking off, B=1 Blinking on
Display Shifting & Cursor Motion	0	0	0	0	0	1	S/C	R/L	X	X	SC=0 Cursor moves, SC=1 Display shifts R/L=0 Left shift, R/L=1 Right shift
Set Display Function	0	0	0	0	1	DL	N	F	X	X	DL=0 4 bit interface, DL=1 8 bit interface N=0 1 line display, N=1 2 line display F=0 5x7 dots, F=1 5x10 dots
Set CGRAM Address	0	0	0	1	CG5	CG4	CG3	CG2	CG1	CG0	DB5-DB0 : CGRAM Address CGRAM Add. corresponds to Cursor Add.
Set DDRAM Address	0	0	1	DD6	DD5	DD4	DD3	DD2	DD1	DD0	DB6-DB0 : DDRAM Address
Read Busy Flag & Address Ctr	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	DB6-DB0 : Address Counter (AC) BF=0 Ready, BF=1 Busy
Write Data to CGRAM / DDRAM	1	0	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0	DB7-DB0 : Data Bits for Write
Read Data CGRAM / DDRAM	1	1	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0	DB7-DB0 : Data Bits Read

Timing

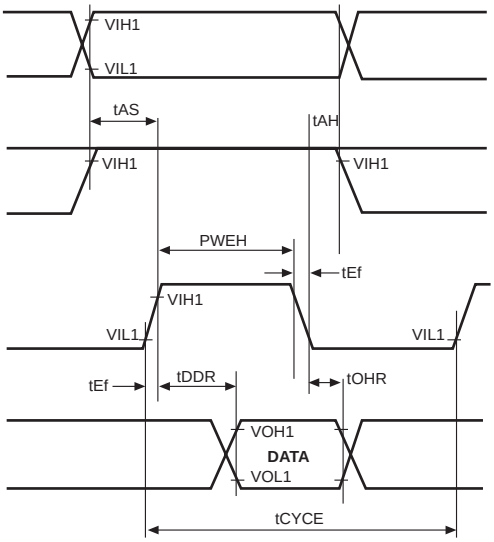
Item	Symbol	Value
Enable cycle time	tCYCE	500ns
Enable pulse width	PWEH	220ns
Enable rise/fall time	tEr, tef	25ns
Set up time	tAS	60ns
Address hold time	tAH	10ns

Item	Symbol	Value
Data set-up time	tDSW	100ns
Data delay time	tDDR	170ns
Data hold time (write)	tH	10ns
Data hold time (read)	tDHR	20ns
Clock frequency	tOSC	270kHz

Writing Timing



Reading Timing



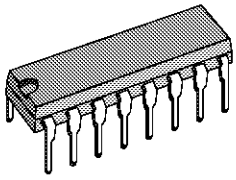
SGS-THOMSON MICROELECTRONICS

L293D

PUSH-PULL FOUR CHANNEL DRIVER WITH DIODES

PRELIMINARY DATA

- 600mA. OUTPUT CURRENT CAPABILITY PER CHANNEL
- 1.2A PEAK OUTPUT CURRENT (NON REPETITIVE) PER CHANNEL
- ENABLE FACILITY
- OVERTEMPERATURE PROTECTION
- LOGICAL "0" INPUT VOLTAGE UP TO 1.5v (HIGH NOISE IMMUNITY
- INTERNAL CLAMPS DIODES



Powerdip 12+2+2

ORDERING NUMBER : L293D

DESCRIPTION

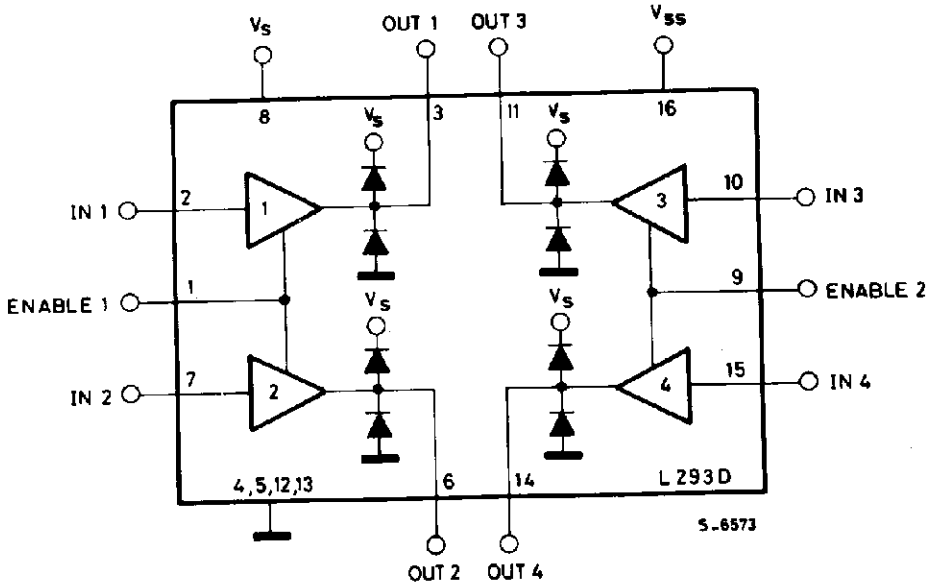
The L293D is a monolithic integrated high voltage, high current four channel vriver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoides, DC and stepping motors) and switching power transistors.

To simplify use as two bridges is pair of channels is equiped with an enable input. A separate supply innput is provited formthe logic, allowing operation at a low voltage and internal clamp diodes are included.

This device is suitable for use in switching applications at frequencies up to 5 KHz.

The L293D is assembled in a 16 lead plastic packege which has 4 center pins connected together and used for heatsinking.

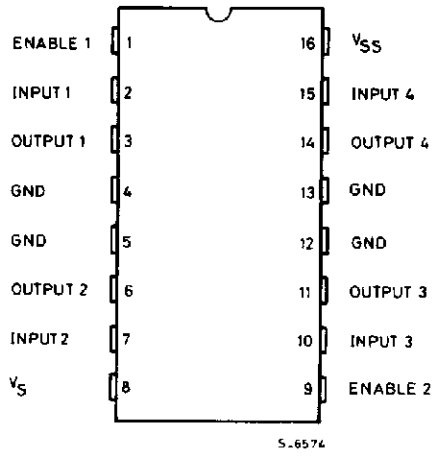
BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	36	V
V_{SS}	Logic Supply voltage	36	V
V_i	Input voltage	7	V
V_{en}	Enable voltage	7	V
I_o	Peak output current (100µs non repetitive)	1.2	A
P_{tot}	Total power dissipation at $T_{ground\text{-}pins}$ = 80°C	5	W
T_{stg}, Tj	Storage and junction temperature	-40 to 150	°C

CONNECTION DIAGRAM



THERMAL DATA

Symbol	Parameter		Value	Unit
Rth-j-case	Thermal resistance junction-case	max	14	°C/W
Rth j-case	Thermal resistance junction-ambient	max	80	°C/W

ELECTRICAL CHARACTERISTICS (For each channel, V_S = 24V, V_{SS} = 5V, T_{amb} = 25 °C, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s	Supply voltage		V_{ss}		36	V
V_{ss}	Logic supply voltage (pin 16)		4.5		36	V
I_s	Total quiescent supply current (pin 8)	V_i = L I_o = 0 V_{en} = H		2	6	mA
		V_i = H I_o = 0 V_{en} = H		16	24	
		V_{en} = L			4	
I_{ss}	Total quiescent logic supply current (pin 16)	V_i = L I_o = 0 V_{en} = H		44	60	mA
		V_i = H I_o = 0 V_{en} = H		16	22	
		V_{en} = L		16	24	
V_{IL}	Input low voltage (pin 2, 7, 10, 15)		-0.3		1.5	V
V_{IH}	Input high voltage (pin 2, 7, 10, 15)	$V_{ss} \leq$ 7V	2.3		V_{ss}	V
		V_{ss} > 7V	2.3		7	
I_{IL}	Low voltage input current (pin 2, 7, 10, 15)	V_{IL} = 1.5V			-10	µA
I_{IH}	High voltage input current (pin 2, 7, 10, 15)	2.3≤ $V_{IH} \leq V_{ss}$ -0.6V		30	100	µA
V_{enL}	Enable low voltage (pin 1, 9)		-0.3		1.5	V
V_{enH}	Enable high voltage (pin 1, 9)	$V_{ss} \leq$ 7V	2.3		V_{ss}	V
		V_{ss} 7V	2.3		7	
I_{enL}	Low voltage enable current (pin 1, 9)	V_{enL} = 1.5V		-30	-100	µA
i_{enH}	High voltage enable current (pin 1, 9)	2.3V ≤ $V_{enH} \leq V_{ss}$ -0.6V			± 10	µA
V_{CEsatH}	Source output saturation voltage (pin 3, 6, 11, 14)	I_o = -0.6A		1.4	1.8	V
V_{CEsatL}	Sink output saturation voltage (pins 3, 6, 11, 14)	I_o +0.6A			1.2	1.8
V_F	Clamp diode forward voltage	I_o = 600 mA		1.3		V
t_r	Rise time (*)	0.1 to 0.9 V_o		250		ns
t_f	Fall time (*)	0.9 to 0.1 V_o		250		ns
t_{on}	Turn-on delay (*)	0.5 V_i to 0.5 V_o		750		ns
t_{off}	Turn-off delay (*)	0.5 V_i to 0.5 V_o		200		ns

(*) See fig.1

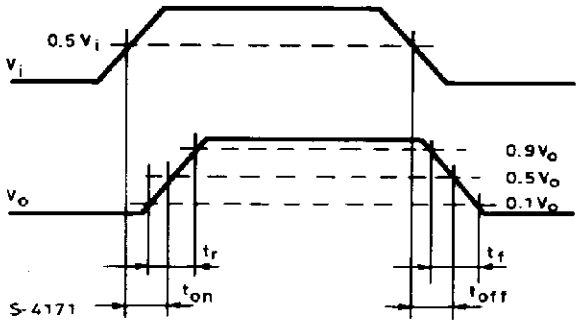
TRUTH TABLE (One channel)

INPUT	ENABLE (*)	OUTPUT
H	H	H
L	H	L
H	L	Z
L	L	Z

Z = High output impedance

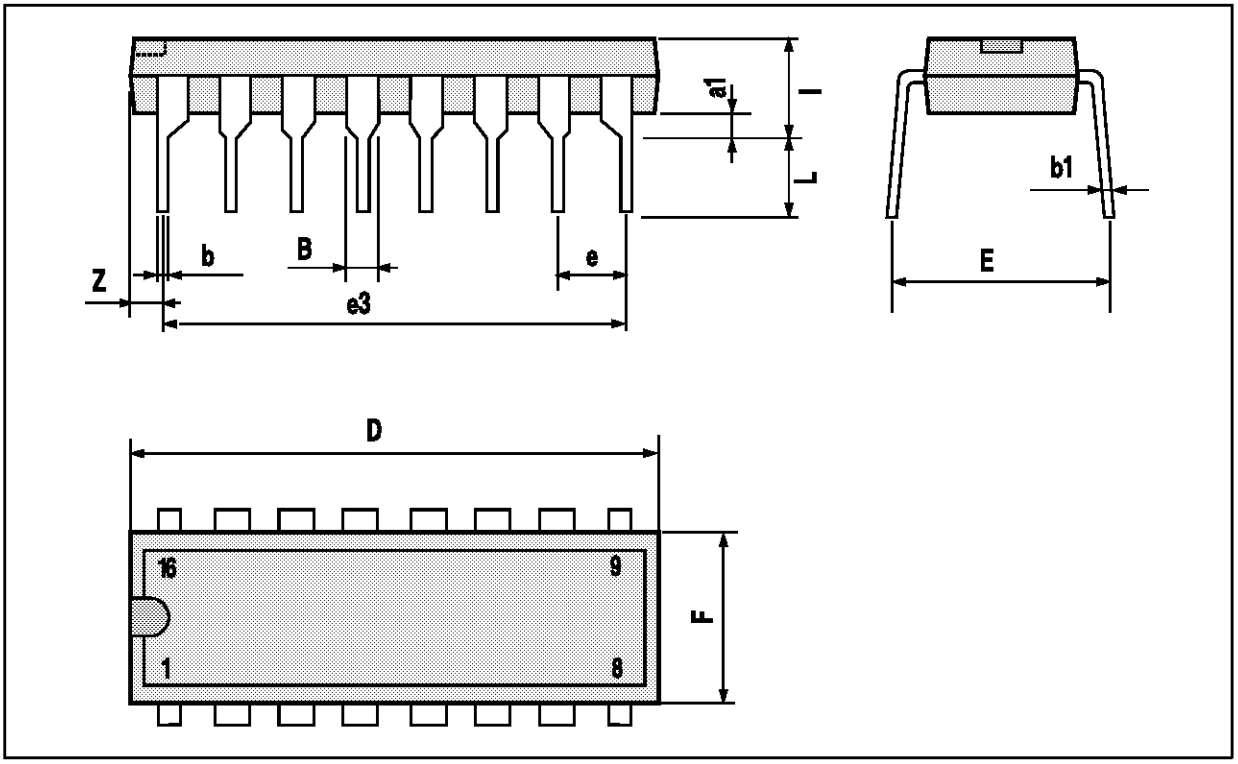
(*) Relative to the considered channel

Figure 1. Switching Times



POWERDIP PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.85		1.40	0.033		0.055
b		0.50			0.020	
b1	0.38		0.50	0.015		0.020
D			20.0			0.787
E		8.80			0.346	
e		2.54			0.100	
e3		17.78			0.700	
F			7.10			0.280
I			5.10			0.201
L		3.30			0.130	
Z			1.27			0.050



FAIRCHILD
SEMICONDUCTOR®

1N4001 - 1N4007

Features

- Low forward voltage drop.
- High surge current capability.

DO-41
COLOR BAND DENOTES CATHODE

General Purpose Rectifiers (Glass Passivated)

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value							Units
		4001	4002	4003	4004	4005	4006	4007	
V_{RRM}	Peak Repetitive Reverse Voltage	50	100	200	400	600	800	1000	V
$I_{F(AV)}$	Average Rectified Forward Current, .375 " lead length @ T_A = 75°C	1.0							A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms Single Half-Sine-Wave	30							A
T_{stg}	Storage Temperature Range	-55 to +175							°C
T_J	Operating Junction Temperature	-55 to +175							°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Thermal Characteristics

Symbol	Parameter	Value	Units
P_D	Power Dissipation	3.0	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

Electrical Characteristics

T_A = 25°C unless otherwise noted

Symbol	Parameter	Device							Units
		4001	4002	4003	4004	4005	4006	4007	
V_F	Forward Voltage @ 1.0 A	1.1							V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A = 75°C	30							µA
I_R	Reverse Current @ rated V_R T_A = 25°C T_A = 100°C	5.0 500							µA µA
C_T	Total Capacitance V_R = 4.0 V, f = 1.0 MHz	15							pF

General Purpose Rectifiers (Glass Passivated)
(continued)

Typical Characteristics

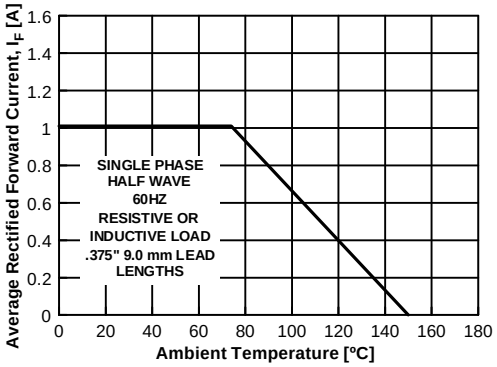


Figure 1. Forward Current Derating Curve

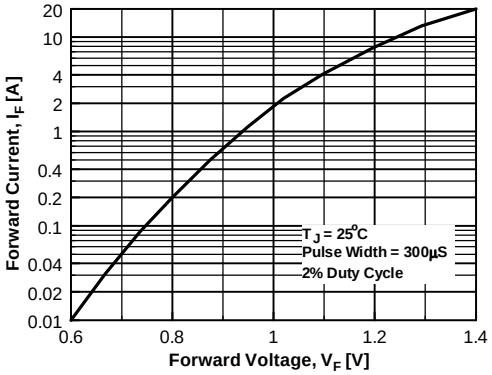


Figure 2. Forward Voltage Characteristics

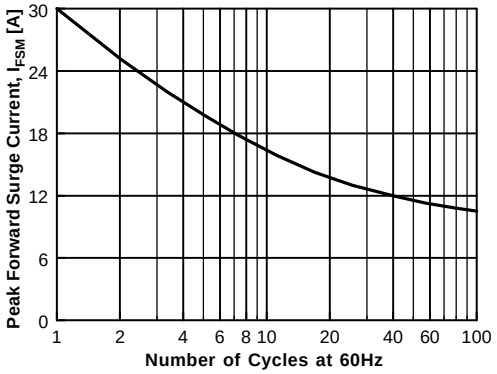


Figure 3. Non-Repetitive Surge Current

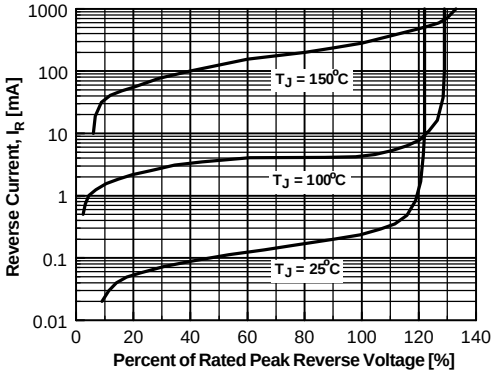


Figure 4. Reverse Current vs Reverse Voltage

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CoolFET™	FRFET™	PACMAN™	Stealth™	
CROSSVOLT™	GlobalOptoisolator™	POP™	SuperSOT™-3	
DenseTrench™	GTO™	Power247™	SuperSOT™-6	
DOME™	HiSeC™	PowerTrench®	SuperSOT™-8	
EcoSPARK™	ISOPLANAR™	QFET™	SyncFET™	
E^2CMOS™	LittleFET™	QS™	TinyLogic™	
EnSigna™	MicroFET™	QT Optoelectronics™	TruTranslation™	
FACT™	MicroPak™	Quiet Series™	UHC™	
FACT Quiet Series™	MICROWIRE™	SILENT SWITCHER®	UltraFET®	

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

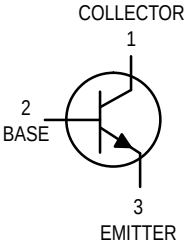
PRODUCT STATUS DEFINITIONS

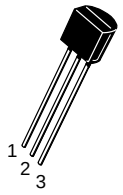
Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Amplifier Transistors
NPN Silicon

BC546, B
BC547, A, B, C
BC548, A, B, C





CASE 29–04, STYLE 17
TO–92 (TO–226AA)

MAXIMUM RATINGS

Rating	Symbol	BC 546	BC 547	BC 548	Unit
Collector–Emitter Voltage	V_{CEO}	65	45	30	Vdc
Collector–Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter–Base Voltage	V_{EBO}	6.0			Vdc
Collector Current — Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	BC546 BC547 BC548	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector–Base Breakdown Voltage (I_C = 100 μAdc)	BC546 BC547 BC548	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter–Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	BC546 BC547 BC548	$V_{(BR)EBO}$	6.0 6.0 6.0	— — —	— — —	V
Collector Cutoff Current (V_{CE} = 70 V, V_{BE} = 0) (V_{CE} = 50 V, V_{BE} = 0) (V_{CE} = 35 V, V_{BE} = 0) (V_{CE} = 30 V, T_A = 125°C)	 BC546 BC547 BC548 BC546/547/548	I_{CES}	 — — — —	 0.2 0.2 0.2 —	 15 15 15 4.0	 nA μA

REV 1

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC547A/548A		—	90	—	
	BC546B/547B/548B		—	150	—	
	BC548C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC546		110	—	450	
	BC547		110	—	800	
	BC548		110	—	800	
	BC547A/548A		110	180	220	
	BC546B/547B/548B		200	290	450	
	BC547C/BC548C		420	520	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC547A/548A		—	120	—	
	BC546B/547B/548B		—	180	—	
	BC548C		—	300	—	
Collector–Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.09	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.2	0.6	
(I_C = 10 mA, I_B = See Note 1)			—	0.3	0.6	
Base–Emitter Saturation Voltage		$V_{BE(sat)}$	—	0.7	—	V
(I_C = 10 mA, I_B = 0.5 mA)						
Base–Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
SMALL–SIGNAL CHARACTERISTICS						
Current–Gain — Bandwidth Product		f_T				MHz
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC546		150	300	—	
	BC547		150	300	—	
	BC548		150	300	—	
Output Capacitance		C_{obo}	—	1.7	4.5	pF
(V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)						
Input Capacitance		C_{ibo}	—	10	—	pF
(V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)						
Small–Signal Current Gain		h_{fe}				—
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC546		125	—	500	
	BC547/548		125	—	900	
	BC547A/548A		125	220	260	
	BC546B/547B/548B		240	330	500	
	BC547C/548C		450	600	900	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2 kΩ,	BC546		—	2.0	10	
f = 1.0 kHz, Δf = 200 Hz)	BC547		—	2.0	10	
	BC548		—	2.0	10	

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1.0 V.

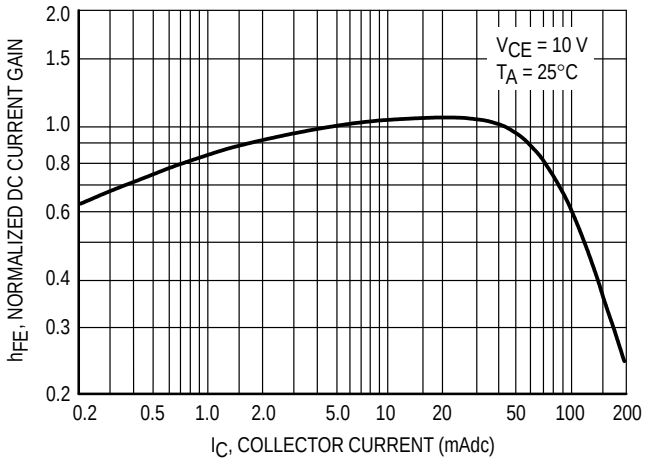


Figure 1. Normalized DC Current Gain

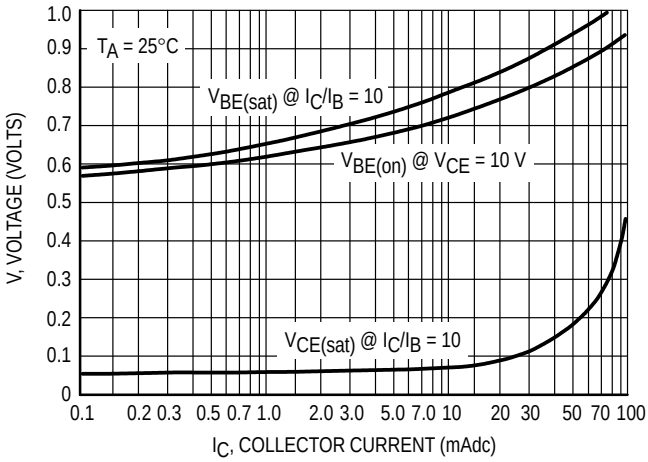


Figure 2. "Saturation" and "On" Voltages

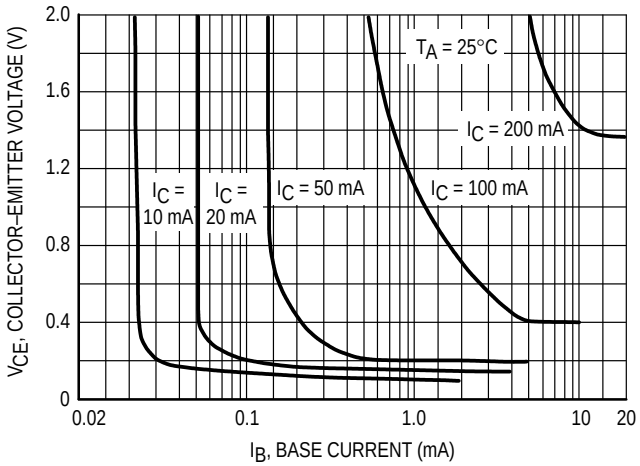


Figure 3. Collector Saturation Region

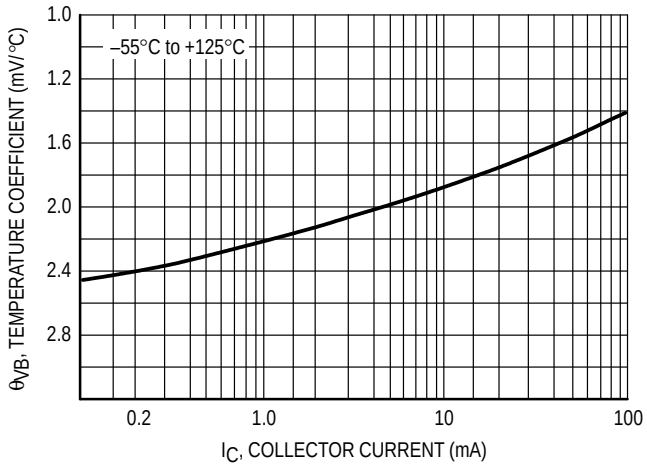


Figure 4. Base–Emitter Temperature Coefficient

BC547/BC548

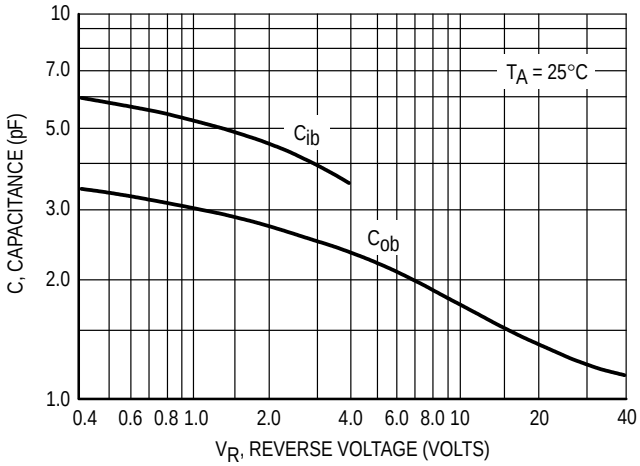


Figure 5. Capacitances

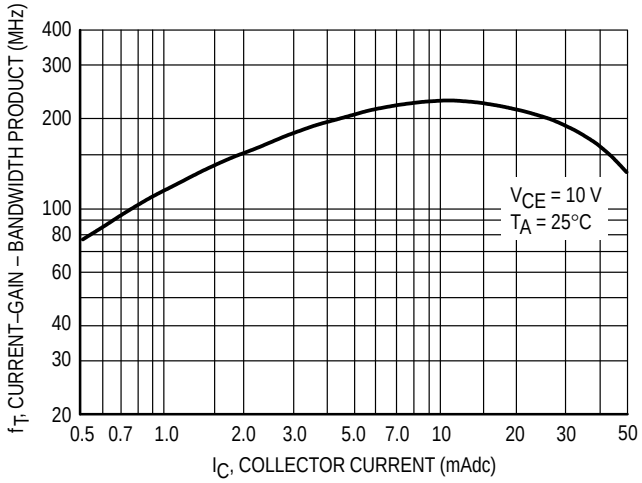


Figure 6. Current–Gain – Bandwidth Product

BC547/BC548

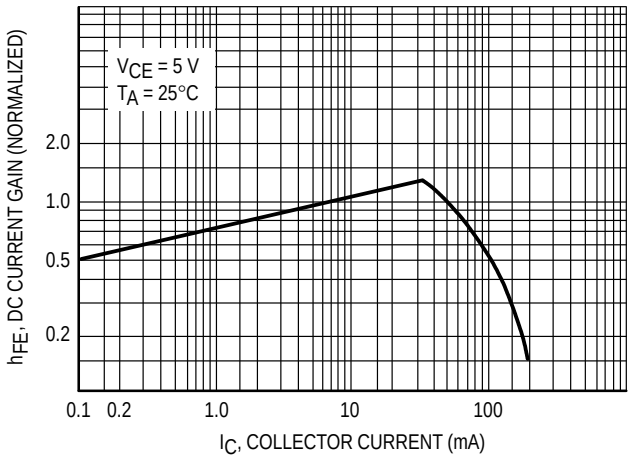


Figure 7. DC Current Gain

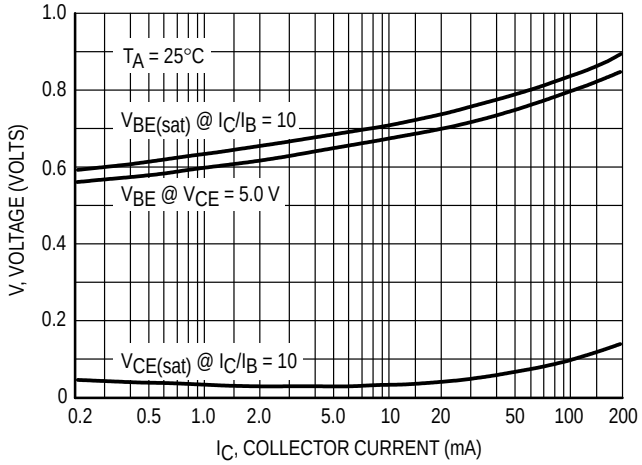


Figure 8. “On” Voltage

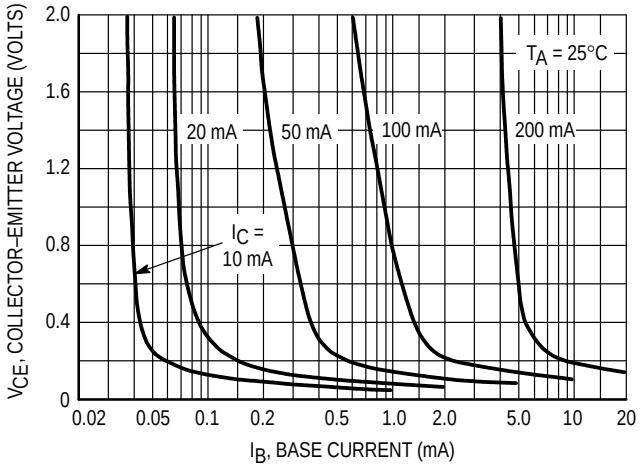


Figure 9. Collector Saturation Region

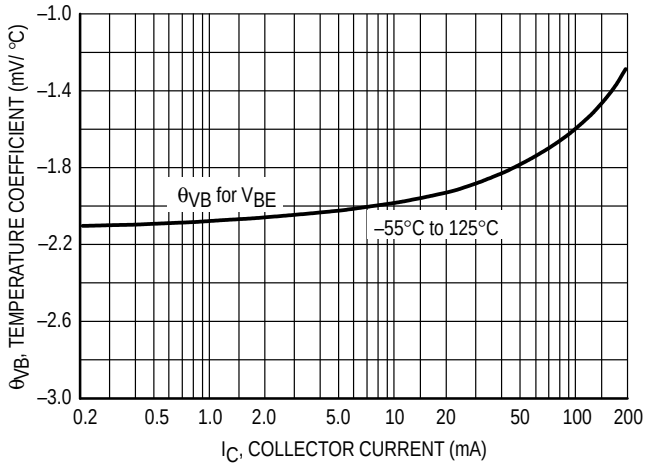


Figure 10. Base–Emitter Temperature Coefficient

BC546

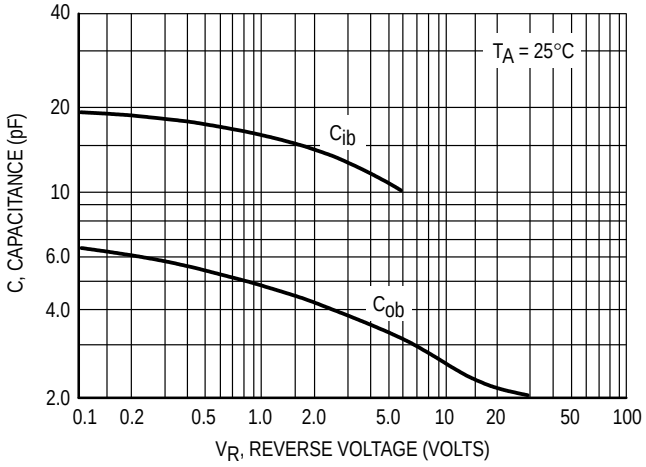


Figure 11. Capacitance

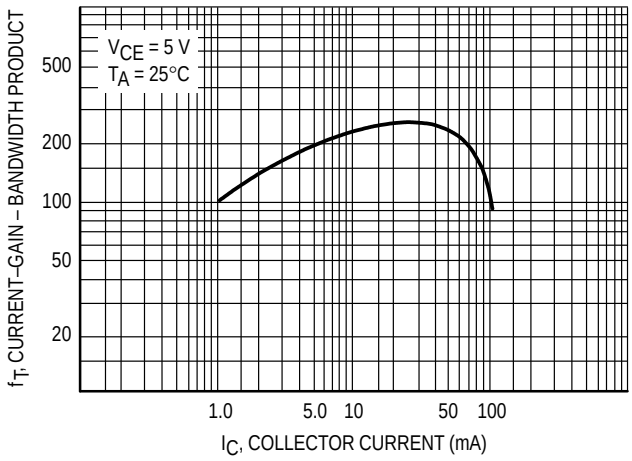
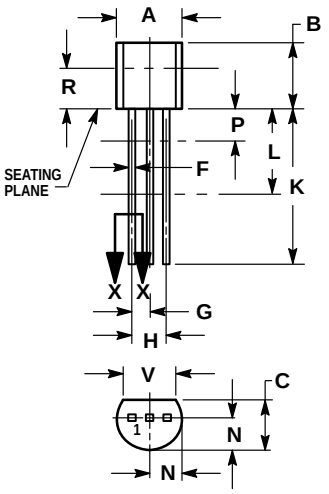
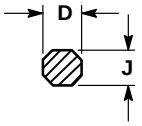


Figure 12. Current–Gain – Bandwidth Product

PACKAGE DIMENSIONS





SECTION X–X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.022	0.41	0.55
F	0.016	0.019	0.41	0.48
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.04	2.66
P	—	0.100	—	2.54
R	0.115	—	2.93	—
V	0.135	—	3.43	—

CASE 029–04
(TO–226AA)
ISSUE AD

STYLE 17:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

National Semiconductor

May 2000

LM78XX
Series Voltage Regulators

General Description

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.

Features

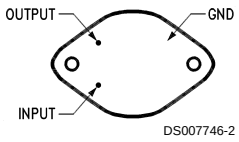
- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

Voltage Range

LM7805C	5V
LM7812C	12V
LM7815C	15V

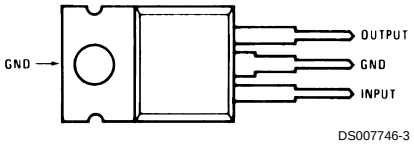
Connection Diagrams

Metal Can Package
TO-3 (K)
Aluminum



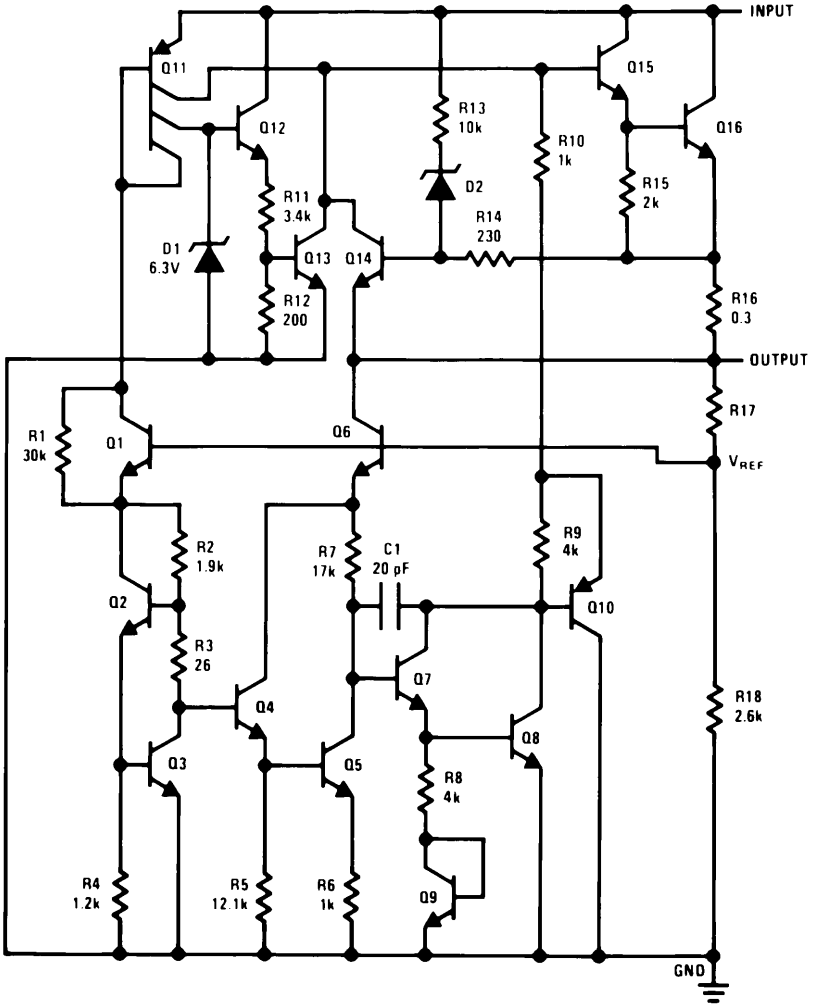
Bottom View
Order Number LM7805CK,
LM7812CK or LM7815CK
See NS Package Number KC02A

Plastic Package
TO-220 (T)



Top View
Order Number LM7805CT,
LM7812CT or LM7815CT
See NS Package Number T03B

Schematic



DS007746-1

Absolute Maximum Ratings (Note 3)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Input Voltage (V_O = 5V, 12V and 15V)	35V
Internal Power Dissipation (Note 1)	Internally Limited
Operating Temperature Range (T_A)	0˚C to +70˚C
Maximum Junction Temperature	
(K Package)	150˚C
(T Package)	150˚C
Storage Temperature Range	−65˚C to +150˚C
Lead Temperature (Soldering, 10 sec.)	
TO-3 Package K	300˚C
TO-220 Package T	230˚C

Electrical Characteristics LM78XXC (Note 2)

0˚C ≤ T_J ≤ 125˚C unless otherwise noted.

Output Voltage				5V			12V			15V			Units
Input Voltage (unless otherwise noted)				10V			19V			23V			
Symbol	Parameter	Conditions		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	Tj = 25˚C, 5 mA ≤ I_O ≤ 1A		4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A		4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA	Tj = 25˚C		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤ V_{IN} ≤ 25)			14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
			0˚C ≤ Tj ≤ +125˚C			50			120			150	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 20)			(15 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 1A	Tj = 25˚C			50			120			150	mV
			ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.6 ≤ V_{IN} ≤ 27)			(17.7 ≤ V_{IN} ≤ 30)			V
			0˚C ≤ Tj ≤ +125˚C			25			60			75	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	Tj = 25˚C	5 mA ≤ I_O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I_O ≤ 750 mA			25			60			75	mV
		5 mA ≤ I_O ≤ 1A, 0˚C ≤ Tj ≤ +125˚C				50			120			150	mV
I_Q	Quiescent Current	I_O ≤ 1A	Tj = 25˚C			8			8			8	mA
			0˚C ≤ Tj ≤ +125˚C			8.5			8.5			8.5	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A				0.5			0.5			0.5	mA
		Tj = 25˚C, I_O ≤ 1A				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN}≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 500 mA, 0˚C ≤ Tj ≤ +125˚C				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7 ≤ V_{IN} ≤ 25)			(14.5 ≤ V_{IN}≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A =25˚C, 10 Hz ≤ f ≤ 100 kHz			40			75			90		µV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection		I_O ≤ 1A, Tj = 25˚C or	62	80		55	72		54	70		dB
		f = 120 Hz	I_O ≤ 500 mA 0˚C ≤ Tj ≤ +125˚C	62			55			54			dB
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
R_O	Dropout Voltage	Tj = 25˚C, I_{OUT} = 1A			2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz			8			18			19		mΩ

Electrical Characteristics LM78XXC (Note 2) (Continued)

$0^{\circ}C \le T_J \le 125^{\circ}C$ unless otherwise noted.

Output Voltage			5V			12V			15V			Units
Input Voltage (unless otherwise noted)			10V			19V			23V			
Symbol	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
	Short-Circuit Current	Tj = 25˚C		2.1			1.5			1.2		A
	Peak Output Current	Tj = 25˚C		2.4			2.4			2.4		A
	Average TC of V_{OUT}	$0^{\circ}C \le Tj \le +125^{\circ}C$, I_O = 5 mA		0.6			1.5			1.8		mV/˚C
V_{IN}	Input Voltage Required to Maintain Line Regulation	Tj = 25˚C, $I_O \le 1A$		7.5		14.6			17.7			V

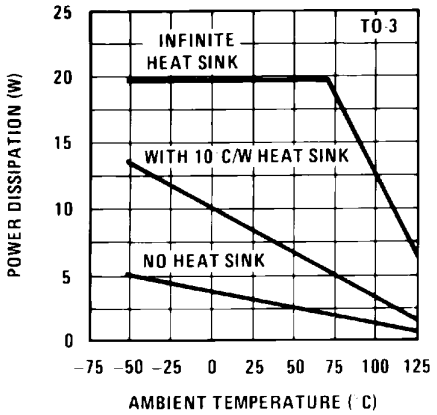
Note 1: Thermal resistance of the TO-3 package (K, KC) is typically 4˚C/W junction to case and 35˚C/W case to ambient. Thermal resistance of the TO-220 package (T) is typically 4˚C/W junction to case and 50˚C/W case to ambient.

Note 2: All characteristics are measured with capacitor across the input of 0.22 µF, and a capacitor across the output of 0.1µF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w \le 10$ ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

Note 3: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. For guaranteed specifications and the test conditions, see Electrical Characteristics.

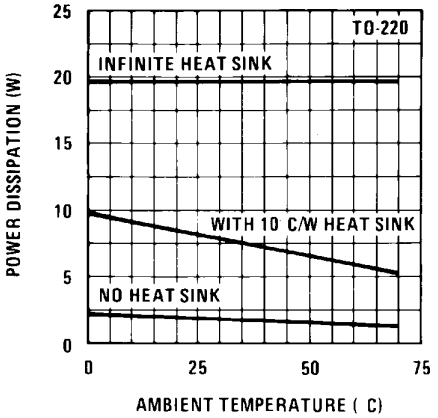
Typical Performance Characteristics

Maximum Average Power Dissipation



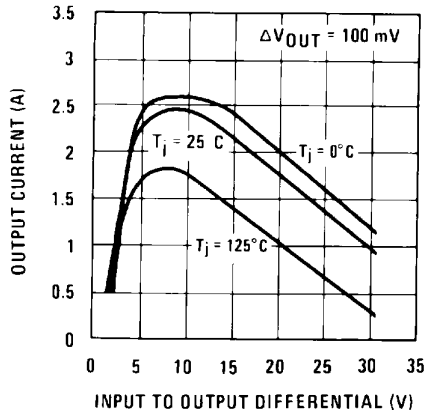
DS007746-5

Maximum Average Power Dissipation



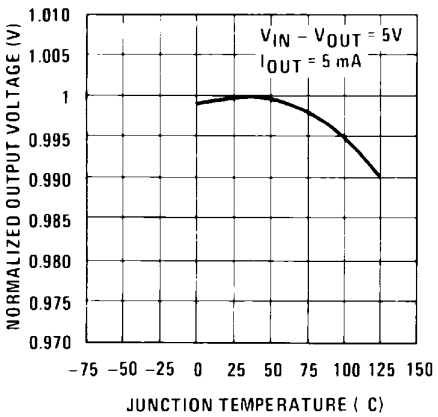
DS007746-6

Peak Output Current



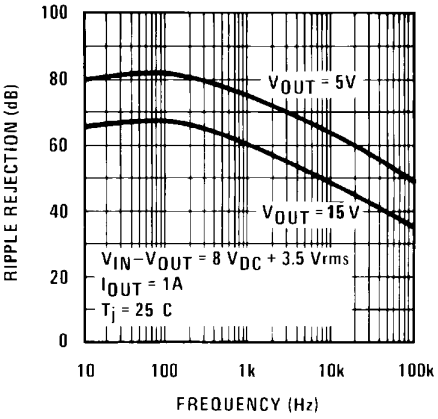
DS007746-7

Output Voltage (Normalized to 1V at T_J = 25°C)



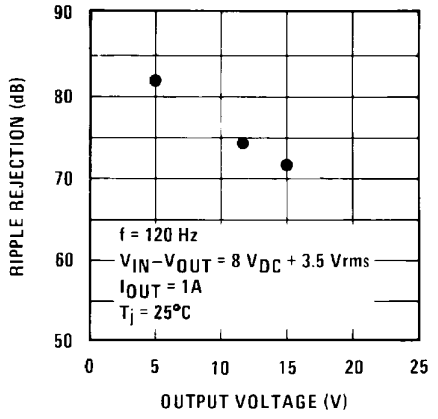
DS007746-8

Ripple Rejection



DS007746-9

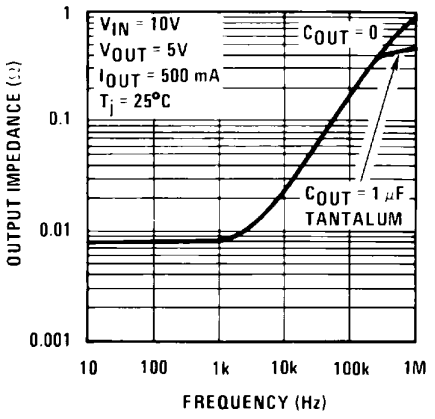
Ripple Rejection



DS007746-10

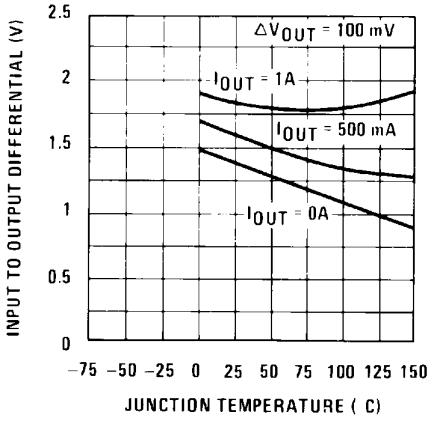
Typical Performance Characteristics (Continued)

Output Impedance



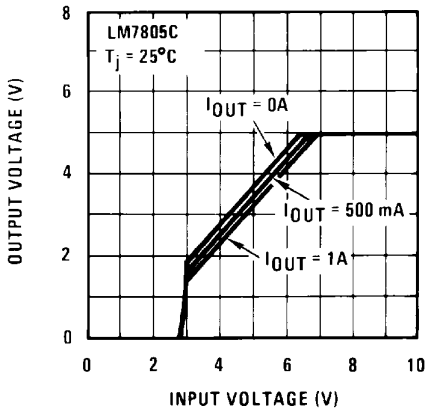
DS007746-11

Dropout Voltage



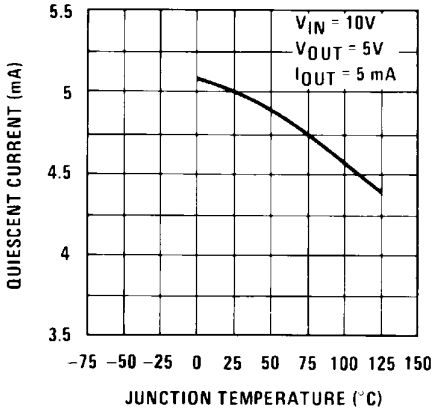
DS007746-12

Dropout Characteristics



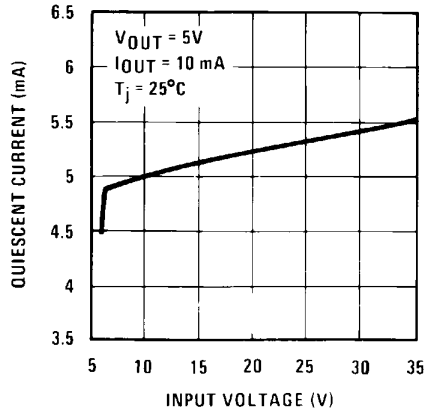
DS007746-13

Quiescent Current



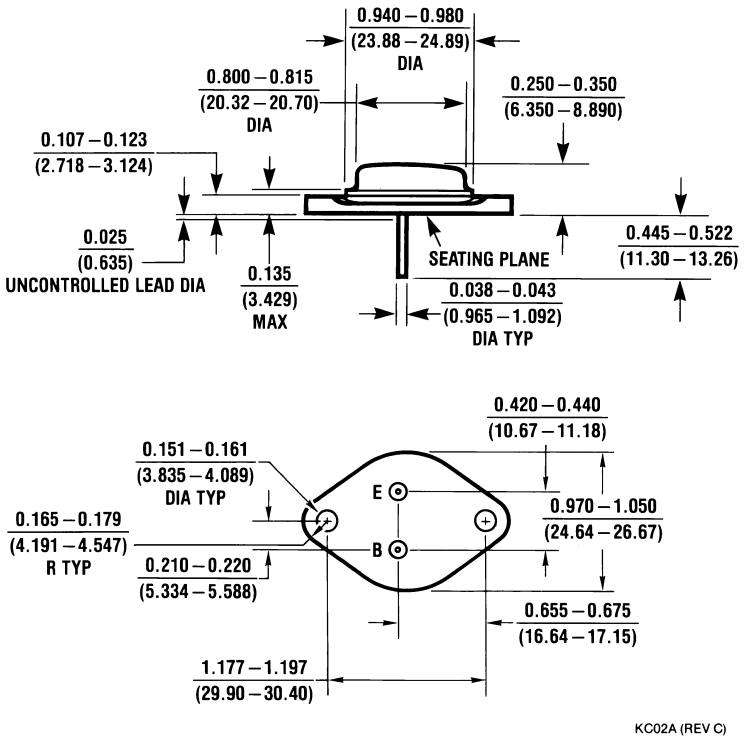
DS007746-14

Quiescent Current



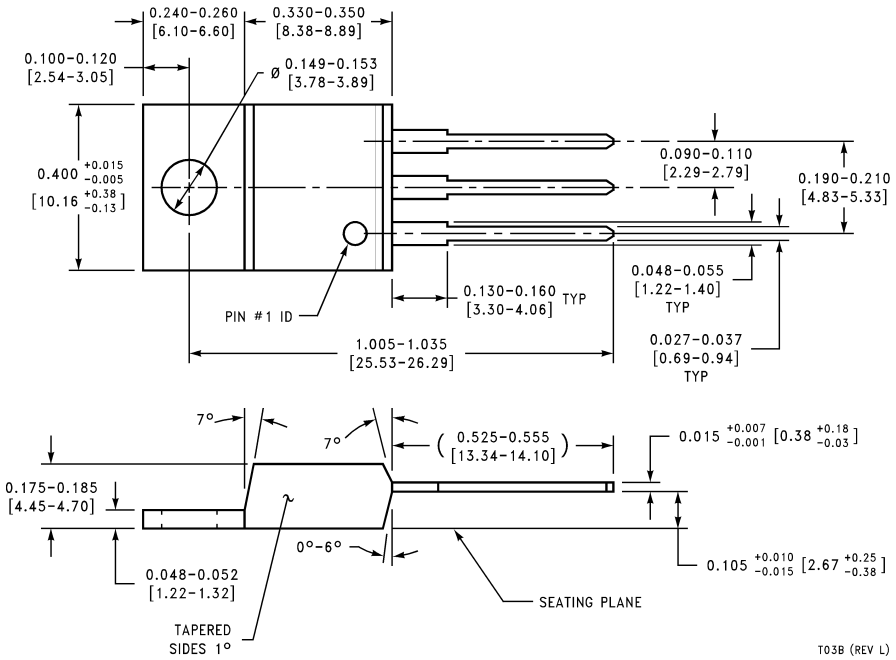
DS007746-15

Physical Dimensions inches (millimeters) unless otherwise noted



Aluminum Metal Can Package (KC)
Order Number LM7805CK, LM7812CK or LM7815CK
NS Package Number KC02A

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



TO-220 Package (T)
Order Number LM7805CT, LM7812CT or LM7815CT
NS Package Number T03B

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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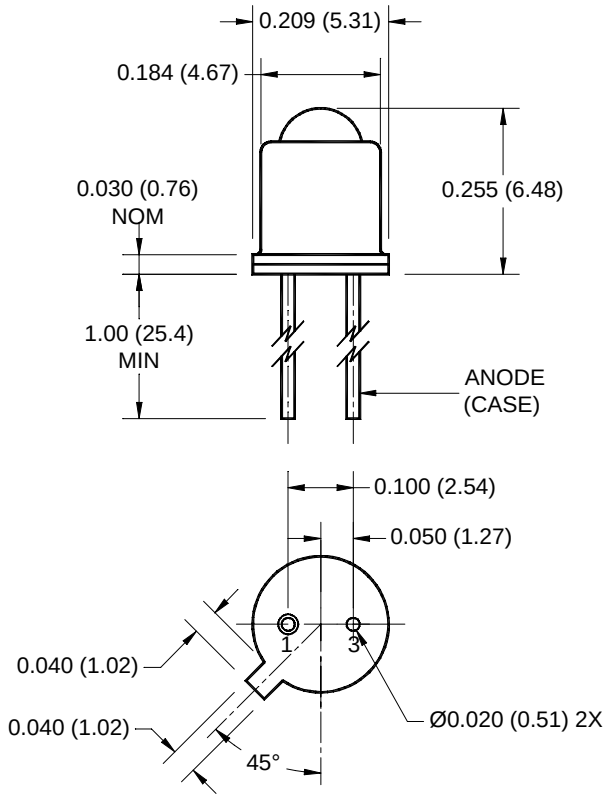
GaAs INFRARED EMITTING DIODE

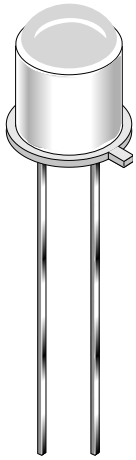
LED55B LED55C LED56

PACKAGE DIMENSIONS

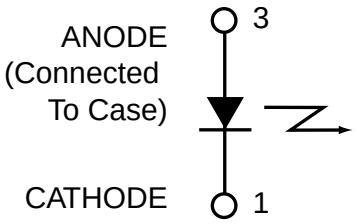


NOTES:

1. Dimensions for all drawings are in inches (mm).
2. Tolerance of ± .010 (.25) on all non-nominal dimensions unless otherwise specified.



SCHEMATIC



DESCRIPTION

The LED55B/LED55C/LED56 are 940 nm LEDs in a narrow angle, TO-46 package.

FEATURES

- Good optical to mechanical alignment
- Mechanically and wavelength matched to the TO-18 series phototransistor
- Hermetically sealed package
- High irradiance level

GaAs INFRARED EMITTING DIODE

LED55B LED55C LED56

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise specified)

Parameter	Symbol	Rating	Unit
Operating Temperature	T_{OPR}	-65 to +125	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Soldering Temperature (Iron)(3,4,5 and 6)	T_{SOL-I}	240 for 5 sec	°C
Soldering Temperature (Flow)(3,4 and 6)	T_{SOL-F}	260 for 10 sec	°C
Continuous Forward Current	I_F	100	mA
Forward Current (pw, 1µs; 200Hz)	I_F	10	A
Reverse Voltage	V_R	3	V
Power Dissipation (T_A = 25°C)(1)	P_D	170	mW
Power Dissipation (T_C = 25°C)(2)	P_D	1.3	W

NOTE:
1. Derate power dissipation linearly 1.70 mW/°C above 25°C ambient.
2. Derate power dissipation linearly 13.0 mW/°C above 25°C case.
3. RMA flux is recommended.
4. Methanol or isopropyl alcohols are recommended as cleaning agents.
5. Soldering iron tip 1/16" (1.6mm) minimum from housing.
6. As long as leads are not under any stress or spring tension
7. Total power output, P_O, is the total power radiated by the device into a solid angle of 2 π steradians.

ELECTRICAL / OPTICAL CHARACTERISTICS (T_A =25°C) (All measurements made under pulse conditions)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP	MAX	UNITS
Peak Emission Wavelength	I_F = 100 mA	λ_P	—	940	—	nm
Emission Angle at 1/2 Power	I_F = 100 mA	Θ	—	±8	—	Deg.
Forward Voltage	I_F = 100 mA	V_F	—	—	1.7	V
Reverse Leakage Current	V_R = 3 V	I_R	—	—	10	µA
Total Power LED55B(7)	I_F = 100 mA	P_O	3.5	—	—	mW
Total Power LED55C(7)	I_F = 100 mA	P_O	5.4	—	—	mW
Total Power LED56(7)	I_F = 100 mA	P_O	1.5	—	—	mW
Rise Time 0-90% of output		t_r	—	1.0	—	µs
Fall Time 100-10% of output		t_f	—	1.0	—	µs

TYPICAL PERFORMANCE CURVES

Figure 1. Power Output vs. Input Current

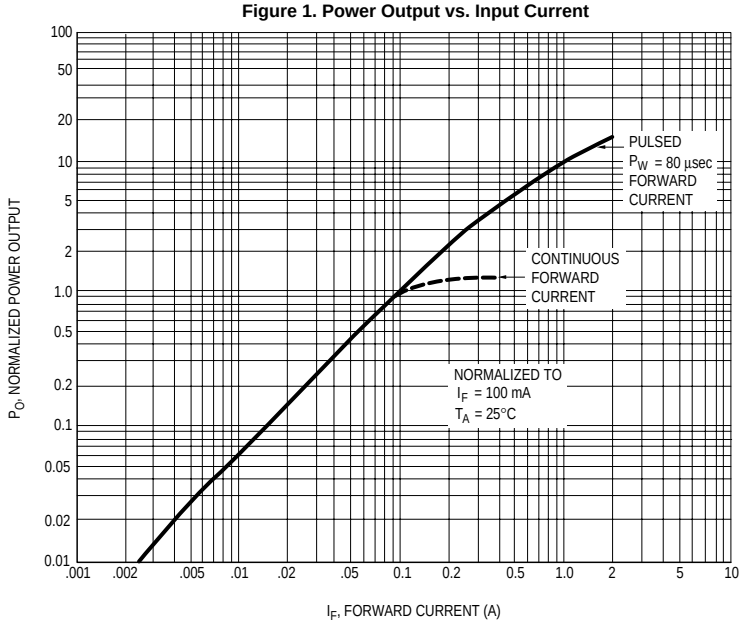


Figure 2. Power Output vs. Temperature

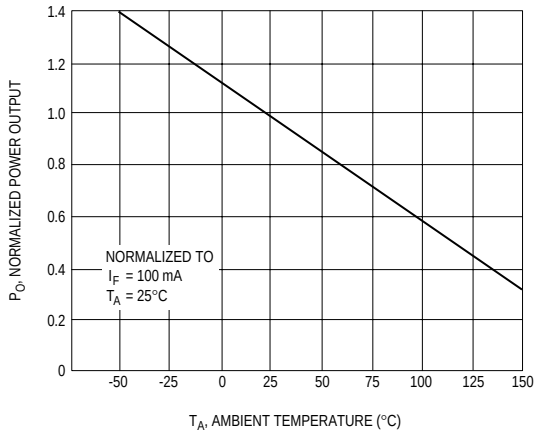


Figure 3. Forward Voltage vs. Forward Current

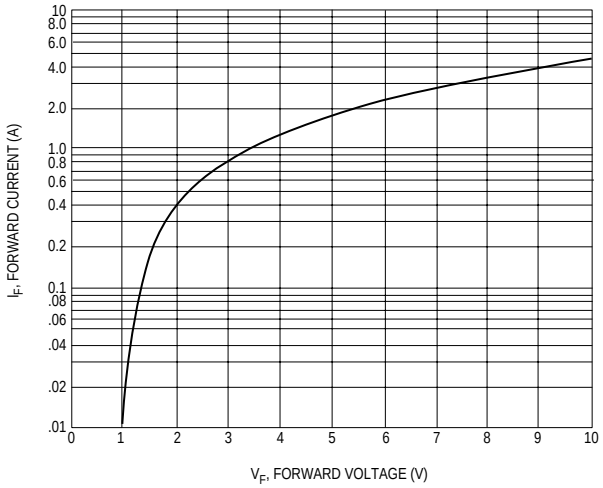


Figure 4. Forward Voltage vs. Forward Current

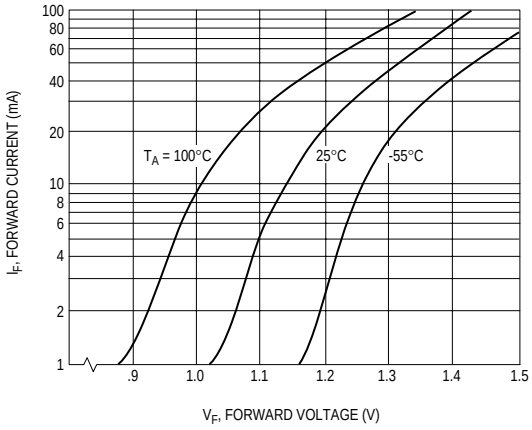
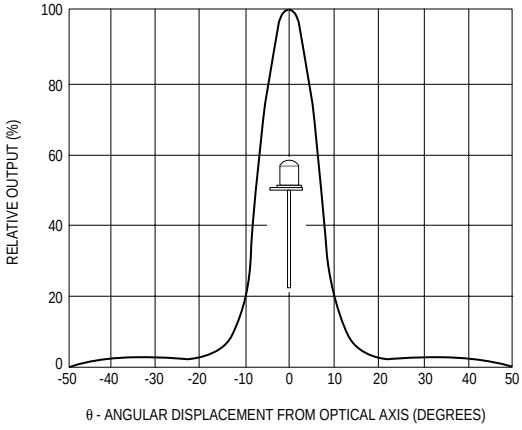


Figure 5. Typical Radiation Pattern



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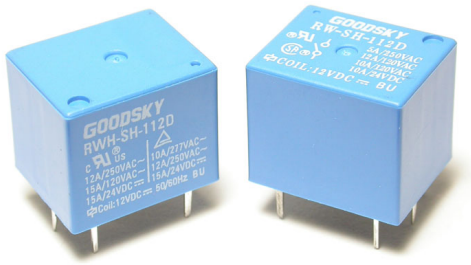
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

RW/RWH



Main Feature

1. RW Series Relay covers switching capacity by 10A is spite of miniature size to comply with user's wide selection.
2. RWH is approved C-UL & TÜV safety standard.
3. The employment of suitable plastic materials is applied under high temperature condition and various chemical solutions.
4. Complete protective construction is designed form dust and soldering flux. If required, plastic sealed type is available for washing procedure.
5. 12A at 120VAC for RW & 12A at 240VAC for RWH are UL approved.

Application

Domestic Appliances, Office Machines, Audio Equipment, Coffee-Pots, Control units, etc.

Contact Rating

- Nominal Load (Resistive Load Cos φ =1)
  Contact Capacity: RW ..... 12A at 120VAC.(UL)
  10A at 120VAC.
  10A at 24VDC.
  RWH ..... 12A at 250VAC.(UL)
  10A at 277VAC(TUV)
  TV-5 at 120VDC.
  15A at 24VDC.
  Rated Carrying Current ..... RW: 10A & RWH: 15A.
  Max. Allowable Current ..... RW: 10A & RWH: 15A.
  Max. Allowable Voltage ..... AC 240V, DC 110V.
  Max. Allowable Power Force. RW: 1500 VA, 240W.
  RWH: 1800VA, 360W.
  Min. Switching Load ..... RW: DC 5V, 10mA.
  RWH: DC5V, 15mA.
- Contact Material ..... RW: Ag Alloy.
  RWH: $AgSnO_2$.
- Contact Form ..... SPST & SPDT.

Performance (at Initial Value)

- Contact Resistance ..... 100mΩ Max.@1A,6VDC
- Operate Time ..... 10 mSec. Max.
- Release Time ..... 5 mSec. Max.
- Dielectric Strength :
  Between Coil & Contact ..... 1,000VAC at 50/60 Hz for one minute.
  Between Contacts ..... 500VAC at 50/60 Hz for one minute.
- Surge Resistance ..... 3,000V (between Coil & Contact 1.2x50μSec.)
- Insulation Resistance..... 100 MegaΩ Min. at 500VDC.
- Max. On/Off Switching :
  Electrical..... 30 Ops per Minute.
  Mechanical..... 300 Ops per Minute.
- Temperature Range ..... -30～55°C
- Humidity Range..... 45～85% RH.
- Coil Temperature Rise..... 35°C Max.
- Vibration :
  Endurance ..... 10 to 55 Hz dual amplitude width 1.5mm.
  Error Operation ..... 10 to 55 Hz dual amplitude width 1.5mm.
- Shock :
  Endurance ..... 1,000 m/S^2 Min.
  Error Operation ..... 100 m/S^2 Min.
- Life Expectancy :
  Mechanical ..... 10^7 Operations at No Load condition.
  Electrical ..... 10^5 Operations at Rated Resistive Load.
- Weight..... About 11 g.

Safety Standard & Its File Number :

- RW:
  UL..... E141060
  CSA..... LR76598
- RWH:
  C-UL..... E141060
  TÜV..... R9854380

Coil Specification (at 20°C)

Coil Sensitivity	Nominal Voltage (VDC)	Nominal Current (mA)	Coil Resistance (Ω±10%)	Power Consumption (W)	Pull-In Voltage (VDC)	Drop-Out Voltage (VDC)	Maximum Allowable Voltage (VDC)
RW/RWH	3	120	25	Abt. 0.36	75% Maximum	5% Minimum	130%
	5	73	70				
	6	60	100				
	9	40	225				
	12	30	400				
	18	20	900				
	24	15	1,600				
	48	7.5	6,400	Abt. 0.45	80% Max.		

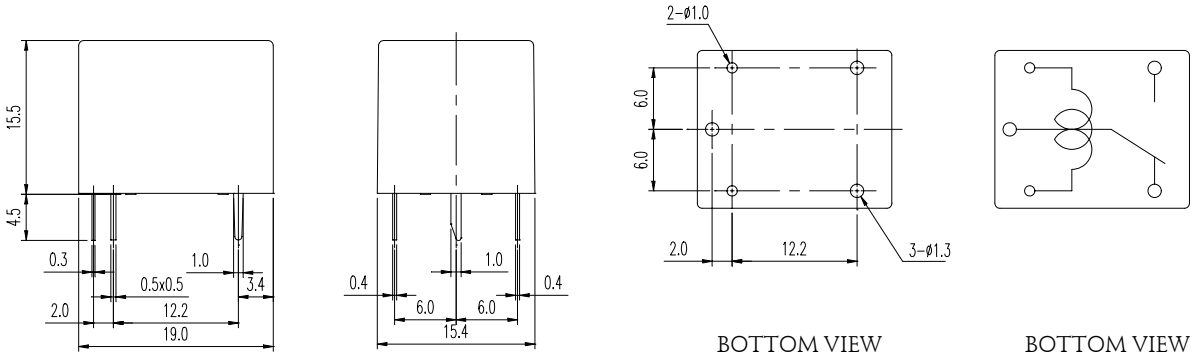
Ordering Information:

RW/RWH - SS - 1 12 D M

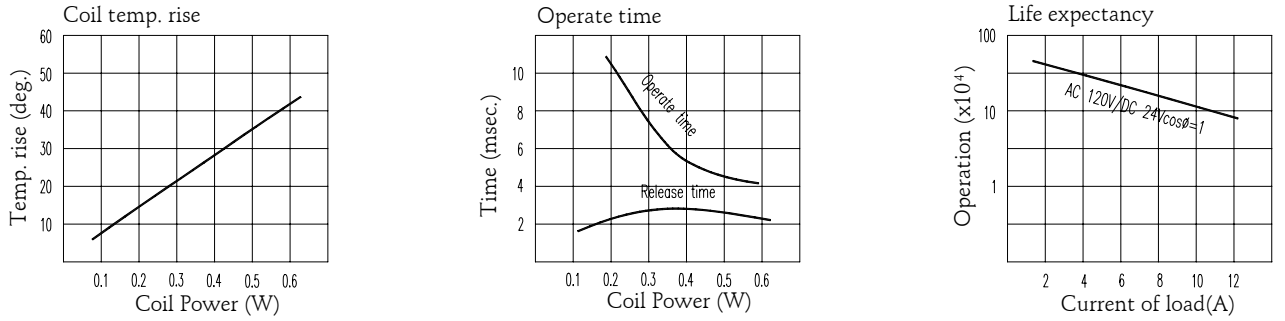
Type of Sealing	Number of Pole	Coil Voltage	Coil Type	Contact Form
SS - Flow Solder Type SH - Plastic Sealed Type	1 – One Pole	3V, 5V, 6V, 9V, 12V, 18V, 24V, 48V	D – Standard DC Coil	Nil - One Form C M - One Form A B - One Form B

Dimension:

RW-SS/SH
RWH-SS/SH



Reference Data:



Aluminum Capacitors
+ 105 °C, Tubular Radial Lead

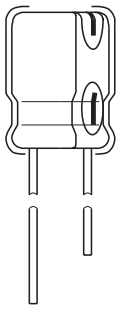


Fig.1 Component outline.

FEATURES

- Wide temperature range
- Radial design in two and three lead configuration
- Ideal SMPS output filter

Pb-free Available

QUICK REFERENCE DATA

DESCRIPTION	VALUE
Nominal case size ØD x L in mm	0.75" x 1.125" [1.905 x 28.575] to 1.0" x 3.626" [25.4 x 92.075]
Operating temperature	- 55 °C to + 105 °C
Rated Capacitance range, C_R	27 µF to 27000 µF
Tolerance on C_R	- 10 %, + 50 %
Rated voltage range, U_R	6.3 WVDC to 250 WVDC
Termination	Radial leads
Life validation test at + 105 °C	2000 hours: Δ CAP ≤ 15 % from initial measurement. Δ ESR ≤ 1.5 x initial specified limit. Δ DCL ≤ initial specified limit.
Shelf life at + 105 °C	500 hours: Δ CAP ≤ 10 % from initial measurement. Δ ESR ≤ 1.15 x initial specified limit. Δ DCL ≤ 2 x initial specified limit
DC leakage current at + 25 °C	$I = K \sqrt{CV}$ K = 0.5 I in µA, C in µF, V in Volts

RIPPLE CURRENT MULTIPLIERS

TEMPERATURE	
Ambient Temperature	**Multipliers**
+ 105 °C	0.4
+ 85 °C	1.0
+ 65 °C	1.4
+ 45 °C	1.7
+ 25 °C	2.0

FREQUENCY (Hz)					
Rated WVDC	**50 - 60**	**100 - 120**	**300 - 400**	**1000**	**20000**
0 - 60	0.60	0.75	0.80	0.90	1.0
61 - 250	0.43	0.54	0.75	0:85	1.0

LOW TEMPERATURE PERFORMANCE

CAPACITANCE RATIO $C^{-55\,°C}/C^{+25\,°C}$ MINIMUM AT 120 Hz			
Rated Voltage (WVDC)	6.3 - 25	40 - 100	150 - 250
Capacitance Remaining	75 %	80 %	65 %
ESR RATIO $ESR^{-55\,°C}/ESR^{+25\,°C}$ MAXIMUM AT 120 Hz			
Rated Voltage (WVDC)	0 - 12	13 - 40	41 - 250
Multipliers	8	10	16
ESL (TYPICAL VALUES AT 1 MHz TO 10 MHz)			
Nominal Diameter	0.75 [19.0.]	0.875 [22.0]	1.00 [25.0]
Typical ESL (nH)	10	11	13

DIMENSIONS in inches [millimeters]

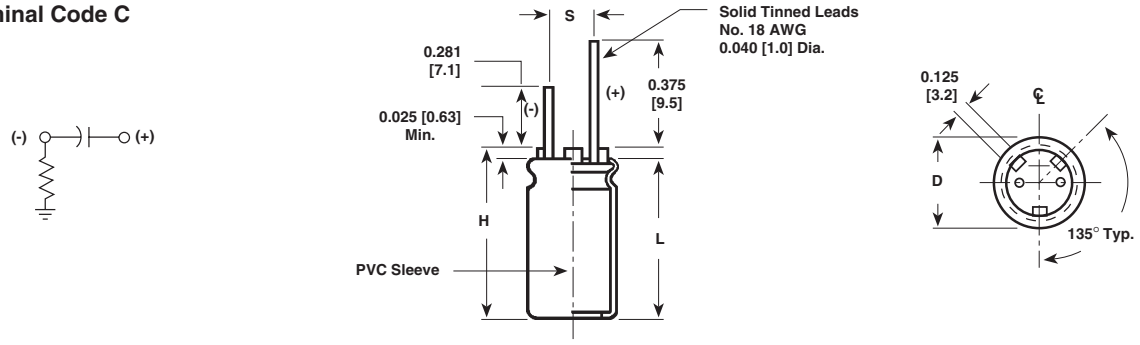
CASE CODE	STYLE 1 STYLE 7 D ± 0.015 [0.4]	STYLE 1 STYLE 7 L ± 0.062 [1.6]	OVERALL LENGTH H (Max.)	LEAD SPACING* S ± 0.015 [0.4]	TYPICAL WEIGHT Oz. (Grams)
GE	0.770 [19.6]	1.150 [29.2]	1.246 [31.6]	0.250 [6.4]	0.46 (13)
GJ	0.770 [19.6]	1.650 [41.9]	1.746 [44.3]	0.250 [6.4]	0.67 (19)
GL	0.770 [19.6]	2.150 [54.6]	2.246 [57.0]	0.250 [6.4]	0.74 (21)
GP	0.770 [19.6]	2.650 [67.3]	2.746 [69.7]	0.250 [6.4]	0.88 (25)
GS	0.770 [19.6]	3.150 [80.0]	3.246 [82.4]	0.250 [6.4]	1.16 (33)
GT	0.770 [19.6]	3.650 [92.7]	3.746 [95.1]	0.250 [6.4]	1.34 (38)
HE	0.895 [22.7]	1.150 [29.2]	1.246 [31.6]	0.300 [7.6]	0.63 (18)
HJ	0.895 [22.7]	1.650 [41.9]	1.746 [44.3]	0.300 [7.6]	0.95 (27)
HL	0.895 [22.7]	2.150 [54.6]	2.246 [57.0]	0.300 [7.6]	1.02 (29)
HP	0.895 [22.7]	2.650 [67.3]	2.746 [69.7]	0.300 [7.6]	1.37 (39)

DIMENSIONS in inches [millimeters]					
CASE CODE	**STYLE 1 STYLE 7**		**OVERALL LENGTH**	**LEAD SPACING***	**TYPICAL WEIGHT**
	D ± 0.015 [0.4]	**L ± 0.062 [1.6]**	**H (Max.)**	**S ± 0.015 [0.4]**	**Oz. (Grams)**
HS	0.895 [22.7]	3.150 [80.0]	3.246 [82.4]	0.300 [7.6]	1.73 (49)
HT	0.895 [22.7]	3.650 [92.7]	3.746 [95.1]	0.300 [7.6]	2.08 (59)
JE	1.020 [25.9]	1.150 [29.2]	1.246 [31.6]	0.400 [10.2]	0.81 (23)
JJ	1.020 [25.9]	1.650 [41.9]	1.746 [44.3]	0.400 [10.2]	1.02 (29)
JL	1.020 [25.9]	2.150 [54.6]	2.246 [57.0]	0.400 [10.2]	1.20 (34)
JP	1.020 [25.9]	2.650 [67.3]	2.746 [69.7]	0.400 [10.2]	1.87 (53)
JS	1.020 [25.9]	3.150 [80.0]	3.246 [82.4]	0.400 [10.2]	2.22 (63)
JT	1.020 [25.9]	3.650 [92.7]	3.746 [95.1]	0.400 [10.2]	2.54 (72)
* Type U673D only.					

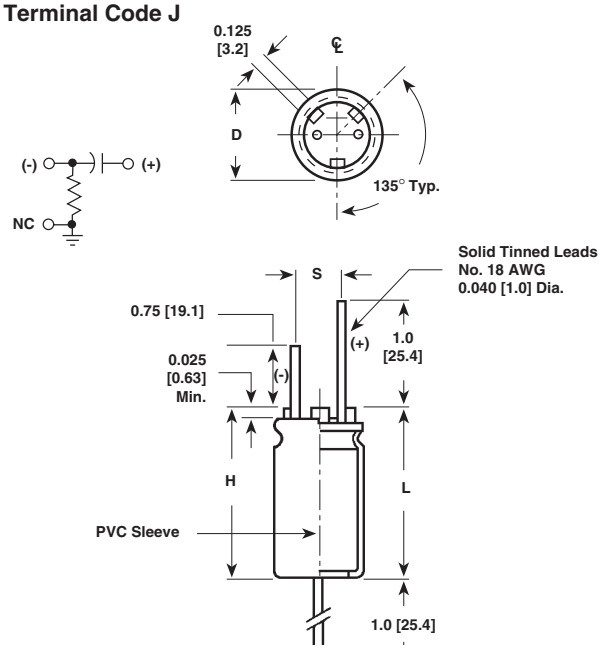
LEAD SPACING				
CASE DIAMETER	**A**	**B**	**C_1**	**C_2**
0.750 [19.1]	0.300 [7.6]	0.167 [4.23]	0.100 [2.5]	0.200 [5.1]
0.875 [22.2]	0.400 [10.2]	0.228 [5.79]	0.150 [3.8]	0.300 [7.6]
1.000 [25.4]	0.400 [10.2]	0.228 [5.79]	0.150 [3.8]	0.300 [7.6]

DIMENSIONS in inches [millimeters] AND AVAILABLE FORMS

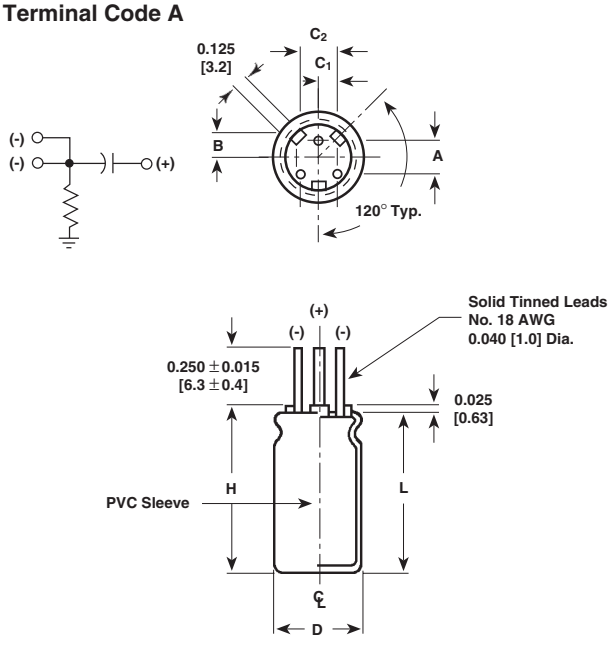
Terminal Code C



Terminal Code J



Terminal Code A



ELECTRICAL DATA

SYMBOL	DESCRIPTION
µF	rated capacitance
± %	F = - 10 %, + 50 %; H = - 10 %, + 100 %
DC	voltage rating at 105 °C
GE	see dimensions in millimeters table
1	PVC Sleeve
C	termination

ORDERING EXAMPLE*

Electrolytic capacitor U673D and U674D series

U673D 222 F 6R3 GE 1C

*Note: For lead (Pb)-free, add suffix E3 to part number.
Example: U673D222F6R3GE1CE3

STANDARD RATINGS in inches [millimeters]

CAPACITANCE (µF)	PART NUMBER	NOMINAL CASE SIZE D x L	Max. ESR at + 25 °C (mΩ)		Max. RIPPLE at + 105 °C (A)	Max. Z at 100 kHz (mΩ)
			120 Hz	20 kHz - 40 kHz	20 kHz - 40 kHz	
6.3 WVDC at 105 °C, SURGE = 9 V						
2200.0	U673D228F6R3GE1C	0.770 x 1.150 [19.6 x 29.2]	105.0	81.0	2.30	83.0
4700.0	U673D478F6R3GJ1C	0.770 x 1.650 [19.6 x 41.9]	53.0	41.0	3.70	43.0
6800.0	U673D688F6R3GL1C	0.770 x 2.150 [19.6 x 54.6]	36.0	28.0	4.95	30.0
8200.0	U673D828F6R3GP1C	0.770 x 2.650 [19.6 x 67.3]	28.0	22.7	6.11	25.0
10000.0	U673D109F6R3GS1C	0.770 x 3.150 [19.6 x 80.0]	23.0	19.0	7.20	21.0
12000.0	U673D129F6R3GT1C	0.770 x 3.650 [19.6 x 92.7]	21.0	17.0	8.14	19.0
3300.0	U673D338F6R3HE1C	0.895 x 1.150 [22.7 x 29.2]	74.0	58.0	3.00	60.0
6800.0	U673D688F6R3HJ1C	0.895 x 1.650 [22.7 x 41.9]	38.0	39.0	4.73	41.0
10000.0	U673D109F6R3HL1C	0.895 x 2.150 [22.7 x 54.6]	27.0	22.0	6.20	24.0
15000.0	U673D159F6R3HP1C	0.895 x 2.650 [22.7 x 67.3]	21.0	17.4	7.62	19.0
18000.0	U673D189F6R3HS1C	0.895 x 3.150 [22.7 x 80.0]	18.0	15.0	8.83	17.0
22000.0	U673D229F6R3HT1C	0.895 x 3.650 [22.7 x 92.7]	15.8	13.3	10.10	15.0
4700.0	U673D478F6R3JE1C	1.020 x 1.150 [25.9 x 29.2]	60.0	48.0	3.60	50.0
10000.0	U673D109F6R3JJ1C	1.020 x 1.650 [25.9 x 41.9]	32.0	26.0	5.54	28.0
15000.0	U673D159F6R3JL1C	1.020 x 2.150 [25.9 x 54.6]	22.6	18.8	7.30	21.0
18000.0	U673D189F6R3JP1C	1.020 x 2.650 [25.9 x 67.3]	18.0	15.2	8.81	17.0
22000.0	U673D229F6R3JS1C	1.020 x 3.150 [25.9 x 80.0]	15.4	13.0	10.20	14.0
27000.0	U673D279F6R3JT1C	1.020 x 3.650 [25.9 x 92.7]	13.4	11.5	11.60	13.0
7.5 WVDC at 105 °C, SURGE = 10 V						
1800.0	U673D188F7R5GE1C	0.770 x 1.150 [19.6 x 29.2]	110.0	82.0	2.30	84.0
3900.0	U673D398F7R5GJ1C	0.770 x 1.650 [19.6 x 41.9]	55.0	41.0	3.70	52.0
5600.0	U673D568F7R5GL1C	0.770 x 2.150 [19.6 x 54.6]	38.0	29.0	4.93	31.0
8200.0	U673D828F7R5GP1C	0.770 x 2.650 [19.6 x 67.3]	29.5	22.8	6.10	25.0
10000.0	U673D109F7R5GS1C	0.770 x 3.150 [19.6 x 80.0]	25.8	20.0	7.04	22.0
12000.0	U673D129F7R5GT1C	0.770 x 3.650 [19.6 x 92.7]	22.0	17.4	8.06	19.0
3300.0	U673D338F7R5HE1C	0.895 x 1.150 [22.7 x 29.2]	76.0	58.4	2.97	61.0
5600.0	U673D568F7R5HJ1C	0.895 x 1.650 [22.7 x 41.9]	39.5	30.6	4.72	33.0
8200.0	U673D828F7R5HL1C	0.895 x 2.150 [22.7 x 54.6]	27.7	21.8	6.23	24.0
12000.0	U673D129F7R5HP1C	0.895 x 2.650 [22.7 x 67.3]	22.0	17.6	7.58	20.0
15000.0	U673D159F7R5HS1C	0.895 x 3.150 [22.7 x 80.0]	18.7	15.0	8.82	17.0
18000.0	U673D189F7R5HT1C	0.895 x 3.650 [22.7 x 92.7]	16.4	13.5	9.97	15.0
3900.0	U673D398F7R5JE1C	1.020 x 1.150 [25.9 x 29.2]	62.0	48.0	3.55	50.0
8200.0	U673D828F7R5JJ1C	1.020 x 1.650 [25.9 x 41.9]	32.0	25.9	5.56	28.0
12000.0	U673D129F7R5JL1C	1.020 x 2.150 [25.9 x 54.6]	23.5	19.0	7.22	21.0
18000.0	U673D189F7R5JP1C	1.020 x 2.650 [25.9 x 67.3]	18.3	15.0	8.83	17.0
22000.0	U673D229F7R5JS1C	1.020 x 3.150 [25.9 x 80.0]	15.8	13.0	10.20	15.0
27000.0	U673D279F7R5JT1C	1.020 x 3.650 [25.9 x 92.7]	13.8	11.6	11.60	13.0

STANDARD RATINGS in inches [millimeters]						
CAPACITANCE (µF)	**PART NUMBER**	**NOMINAL CASE SIZE D x L**	**Max. ESR at + 25 °C (mΩ)**		**Max. RIPPLE at + 105 °C (A)**	**Max. Z at 100 kHz (mΩ)**
			120 Hz	**20 kHz - 40 kHz**	**20 kHz - 40 kHz**	
10 WVDC at + 105 °C, SURGE = 12 V						
1800.0	U673D188F010GE1C	0.770 x 1.150 [19.6 x 29.2]	123.0	89.0	2.20	91.0
3300.0	U673D338F010GJ1C	0.770 x 1.650 [19.6 x 41.9]	60.0	44.0	3.56	46.0
5600.0	U673D568F010GL1C	0.770 x 2.150 [19.6 x 54.6]	41.0	30.0	4.79	32.0
6800.0	U673D688F010GP1C	0.770 x 2.650 [19.6 x 67.3]	31.0	24.0	5.93	26.0
8200.0	U673D828F010GS1C	0.770 x 3.150 [19.6 x 80.0]	26.0	20.0	7.02	22.0
10000.0	U673D109F010GT1C	0.770 x 3.650 [19.6 x 92.7]	23.0	17.8	7.97	20.0
2700.0	U673D278F010HE1C	0.895 x 1.150 [22.7 x 29.2]	82.0	61.0	2.90	62.0
5600.0	U673D568F010HJ1C	0.895 x 1.650 [22.7 x 41.9]	42.0	32.0	4.61	34.0
8200.0	U673D828F010HL1C	0.895 x 2.150 [22.7 x 54.6]	29.6	22.0	6.11	24.0
10000.0	U673D109F010HP1C	0.895 x 2.650 [22.7 x 67.3]	24.0	18.0	7.33	20.0
12000.0	U673D129F010HS1C	0.895 x 3.150 [22.7 x 80.0]	19.9	15.8	8.63	17.0
15000.0	U673D159F010HT1C	0.895 x 3.650 [22.7 x 92.7]	17.3	13.8	9.85	16.0
3900.0	U673D398F010JE1C	1.020 x 1.150 [25.9 x 29.2]	66.6	50.0	3.47	52.0
6800.0	U673D688F010JJ1C	1.020 x 1.650 [25.9 x 41.9]	34.0	26.7	5.48	29.0
12000.0	U673D129F010JL1C	1.020 x 2.150 [25.9 x 54.6]	24.0	19.0	7.18	21.0
15000.0	U673D159F010JP1C	1.020 x 2.650 [25.9 x 67.3]	19.2	15.0	8.72	17.0
18000.0	U673D189F010JS1C	1.020 x 3.150 [25.9 x 80.0]	16.0	13.0	10.20	15.0
22000.0	U673D229F010JT1C	1.020 x 3.650 [25.9 x 92.7]	14.3	11.8	11.50	14.0
12 WVDC at + 105 °C, SURGE = 16 V						
1500.0	U673D158F012GE1C	0.770 x 1.150 [19.6 x 29.2]	119.0	83.0	2.26	85.0
3300.0	U673D338F012GJ1C	0.770 x 1.650 [19.6 x 41.9]	60.0	42.0	3.65	44.0
4700.0	U673D478F012GL1C	0.770 x 2.150 [19.6 x 54.6]	41.0	29.0	4.88	31.0
6800.0	U673D688F012GP1C	0.770 x 2.650 [19.6 x 67.3]	31.0	23.0	6.07	26.0
8200.0	U673D828F012GS1C	0.770 x 3.150 [19.6 x 80.0]	26.0	19.4	7.14	22.0
10000.0	U673D109F012GT1C	0.770 x 3.650 [19.6 x 92.7]	23.0	17.0	8.11	20.0
2200.0	U673D228F012HE1C	0.895 x 1.150 [22.7 x 29.2]	83.0	60.0	2.93	62.0
4700.0	U673D478F012HJ1C	0.895 x 1.650 [22.7 x 41.9]	42.0	31.0	4.69	33.0
6800.0	U673D688F012HL1C	0.895 x 2.150 [22.7 x 54.6]	29.0	22.0	6.20	25.0
10000.0	U673D109F012HP1C	0.895 x 2.650 [22.7 x 67.3]	24.0	18.3	7.43	21.0
12000.0	U673D129F012HS1C	0.895 x 3.150 [22.7 x 80.0]	19.7	15.0	8.82	18.0
15000.0	U673D159F012HT1C	0.895 x 3.650 [22.7 x 92.7]	17.0	13.3	10.10	16.0
3300.0	U673D338F012JE1C	1.020 x 1.150 [25.9 x 29.2]	66.0	49.0	3.53	52.0
6800.0	U673D688F012JJ1C	1.020 x 1.650 [25.9 x 41.9]	34.0	26.0	5.54	29.0
10000.0	U673D109F012JL1C	1.020 x 2.150 [25.9 x 54.6]	25.5	19.0	7.12	22.0
12000.0	U673D129F012JP1C	1.020 x 2.650 [25.9 x 67.3]	19.7	15.0	8.75	18.0
18000.0	U673D189F012JS1C	1.020 x 3.150 [25.9 x 80.0]	16.4	13.0	10.20	16.0
22000.0	U673D229F012JT1C	1.020 x 3.650 [25.9 x 92.7]	14.6	11.8	11.50	15.0
16 WVDC at 105 °C, SURGE = 20 V						
1200.0	U673D128F016GE1C	0.770 x 1.150 [19.6 x 29.2]	129.0	83.0	2.24	85.0
2700.0	U673D278F016GJ1C	0.770 x 1.650 [19.6 x 41.9]	65.0	43.0	3.62	45.0
3900.0	U673D398F016GL1C	0.770 x 2.150 [19.6 x 54.6]	44.0	30.0	4.84	32.0
5600.0	U673D568F016GP1C	0.770 x 2.650 [19.6 x 67.3]	34.0	23.5	6.01	26.0
6800.0	U673D688F016GS1C	0.770 x 3.150 [19.6 x 80.0]	28.0	19.7	7.09	23.0
8200.0	U673D828F016GT1C	0.770 x 3.650 [19.6 x 92.7]	24.0	17.0	8.16	21.0
2200.0	U673D228F016HE1C	0.895 x 1.150 [22.7 x 29.2]	89.0	59.0	2.93	61.0
3900.0	U673D398F016HJ1C	0.895 x 1.650 [22.7 x 41.9]	45.0	31.6	4.64	34.0
5600.0	U673D568F016HL1C	0.895 x 2.150 [22.7 x 54.6]	31.6	22.4	6.14	25.0

Standard Series of Values in a Decade for Resistances and Capacitances

E3-E192

According to IEC 60063

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48	E24	E12	E6	E3
100	100	100	178	178	178	316	316	316	562	562	562	10	10	10	10
101			180			320			569			11			
102	102		182	182		324	324		576	576		12	12		
104			184			328			583			13			
105	105	105	187	187	187	332	332	332	590	590	590	15	15	15	
106			189			336			597			16			
107	107		191	191		340	340		604	604		18	18		
109			193			344			612			20			
110	110	110	196	196	196	348	348	348	619	619	619	22	22	22	22
111			198			352			626			24			
113	113		200	200		357	357		634	634		27	27		
114			203			361			642			30			
115	115	115	205	205	205	365	365	365	649	649	649	33	33	33	
117			208			370			657			36			
118	118		210	210		374	374		665	665		39	39		
120			213			379			673			43			
121	121	121	215	215	215	383	383	383	681	681	681	47	47	47	47
123			218			388			690			51			
124	124		221	221		392	392		698	698		56	56		
126			223			397			706			62			
127	127	127	226	226	226	402	402	402	715	715	715	68	68	68	
129			229			407			723			75			
130	130		232	232		412	412		732	732		82	82		
132			234			417			741			91			
133	133	133	237	237	237	422	422	422	750	750	750				
135			240			427			759						
137	137		243	243		432	432		768	768					
138			246			437			777						
140	140	140	249	249	249	442	442	442	787	787	787				
142			252			448			796						
143	143		255	255		453	453		806	806					
145			258			459			816						
147	147	147	261	261	261	464	464	464	825	825	825				
149			264			470			835						
150	150		267	267		475	475		845	845					
152			271			481			856						
154	154	154	274	274	274	487	487	487	866	866	866				
156			277			493			876						
158	158		280	280		499	499		887	887					
160			284			505			898						
162	162	162	287	287	287	511	511	511	909	909	909				
164			291			517			920						
165	165		294	294		523	523		931	931					
167			298			530			942						
169	169	169	301	301	301	536	536	536	953	953	953				
172			305			542			965						
174	174		309	309		549	549		976	976					
176			312			556			988						