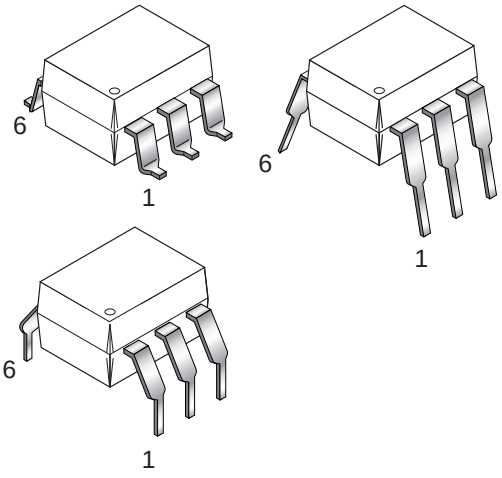
FAIRCHILD
SEMICONDUCTOR®

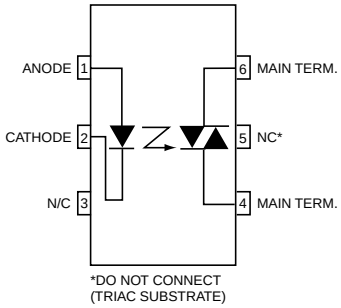
6-PIN DIP RANDOM-PHASE OPTOISOLATORS TRIAC DRIVER OUTPUT (250/400 VOLT PEAK)

MOC3010M MOC3011M MOC3012M MOC3020M MOC3021M MOC3022M MOC3023M

PACKAGE



SCHEMATIC



DESCRIPTION

The MOC301XM and MOC302XM series are optically isolated triac driver devices. These devices contain a GaAs infrared emitting diode and a light activated silicon bilateral switch, which functions like a triac. They are designed for interfacing between electronic controls and power triacs to control resistive and inductive loads for 115 VAC operations.

FEATURES

- Excellent I_{FT} stability—IR emitting diode has low degradation
- High isolation voltage—minimum 5300 VAC RMS
- Underwriters Laboratory (UL) recognized—File #E90700
- Peak blocking voltage
  - 250V-MOC301XM
  - 400V-MOC302XM
- VDE recognized (File #94766)
  - Ordering option V (e.g. MOC3023VM)

APPLICATIONS

- Industrial controls
- Traffic lights
- Vending machines
- Solid state relay
- Lamp ballasts
- Solenoid/valve controls
- Static AC power switch
- Incandescent lamp dimmers
- Motor control

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

Parameters	Symbol	Device	Value	Units
TOTAL DEVICE				
Storage Temperature	T_{STG}	All	-40 to +150	°C
Operating Temperature	T_{OPR}	All	-40 to +85	°C
Lead Solder Temperature	T_{SOL}	All	260 for 10 sec	°C
Junction Temperature Range	T_J	All	-40 to +100	°C
Isolation Surge Voltage(1) (peak AC voltage, 60Hz, 1 sec duration)	V_{ISO}	All	7500	Vac(pk)
Total Device Power Dissipation @ 25°C	P_D	All	330	mW
Derate above 25°C			4.4	mW/°C
EMITTER				
Continuous Forward Current	I_F	All	60	mA
Reverse Voltage	V_R	All	3	V
Total Power Dissipation 25°C Ambient	P_D	All	100	mW
Derate above 25°C			1.33	mW/°C
DETECTOR				
Off-State Output Terminal Voltage	V_{DRM}	MOC3010M/1M/2M MOC3020M/1M/2M/3M	250 400	V
Peak Repetitive Surge Current (PW = 1 ms, 120 pps)	I_{TSM}	All	1	A
Total Power Dissipation @ 25°C Ambient	P_D	All	300	mW
Derate above 25°C			4	mW/°C

Note

1. Isolation surge voltage, V_{ISO}, is an internal device dielectric breakdown rating. For this test, Pins 1 and 2 are common, and Pins 4, 5 and 6 are common.

ELECTRICAL CHARACTERISTICS (T_A = 25°C Unless otherwise specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

Parameters	Test Conditions	Symbol	Device	Min	Typ	Max	Units
EMITTER							
Input Forward Voltage	I_F = 10 mA	V_F	All		1.15	1.5	V
Reverse Leakage Current	V_R = 3 V, T_A = 25°C	I_R	All		0.01	100	µA
DETECTOR							
Peak Blocking Current,Either Direction	Rated V_{DRM}, I_F = 0 (note 1)	I_{DRM}	All		10	100	nA
Peak On-State Voltage,Either Direction	I_{TM} = 100 mA peak, I_F = 0	V_{TM}	All		1.8	3	V

TRANSFER CHARACTERISTICS (T_A = 25°C Unless otherwise specified.)

DC Characteristics	Test Conditions	Symbol	Device	Min	Typ	Max	Units
LED Trigger Current	Voltage = 3V (note 3)	I_{FT}	MOC3020M			30	mA
			MOC3010M			15	
			MOC3021M				
			MOC3011M			10	
			MOC3022M				
			MOC3012M			5	
			MOC3023M				
Holding Current, Either Direction		I_H	All		100		µA

Note

1. Test voltage must be applied within dv/dt rating.
2. This is static dv/dt. See Figure 5 for test circuit. Commutating dv/dt is a function of the load-driving thyristor(s) only.
3. All devices are guaranteed to trigger at an I_F value less than or equal to max I_{FT}. Therefore, recommended operating I_F lies between max I_{FT} (30 mA for MOC3020M, 15 mA for MOC3010M and MOC3021M, 10 mA for MOC3011M and MOC3022M, 5 mA for MOC3012M and MOC3023M) and absolute max I_F (60 mA).

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Fig. 1 LED Forward Voltage vs. Forward Current

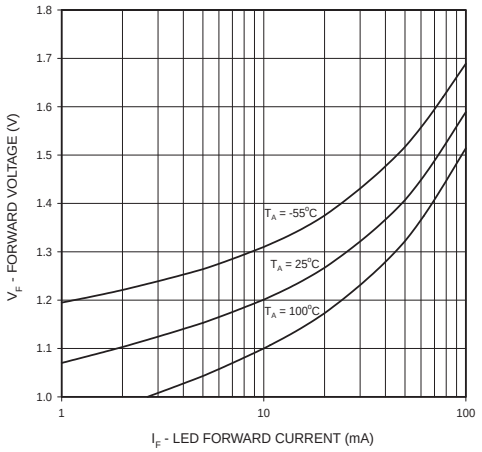


Fig. 2 On-State Characteristics

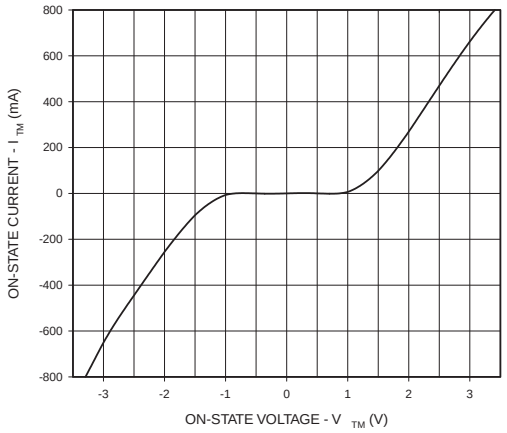


Fig. 3 Trigger Current vs. Ambient Temperature

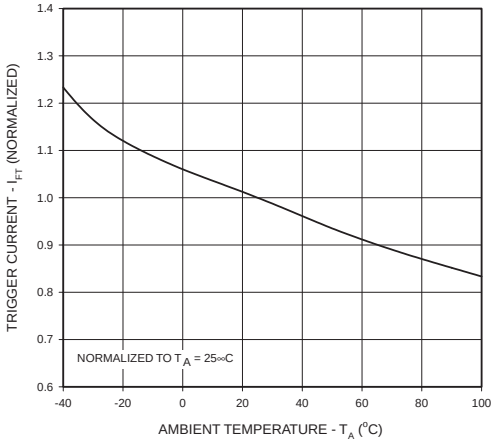


Fig. 4 LED Current Required to Trigger vs. LED Pulse Width

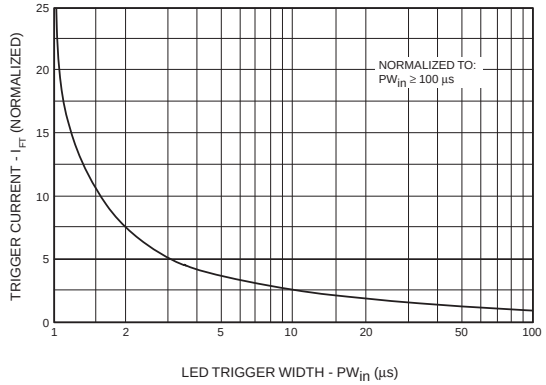


Fig. 5 dv/dt vs. Temperature

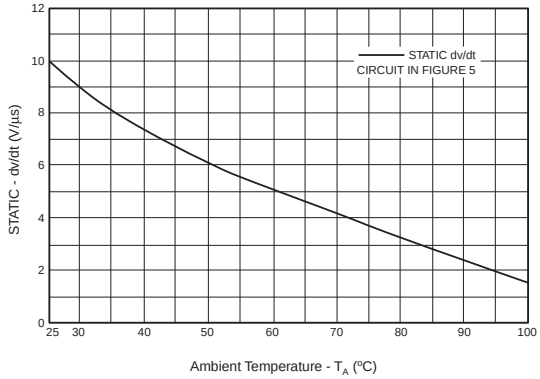
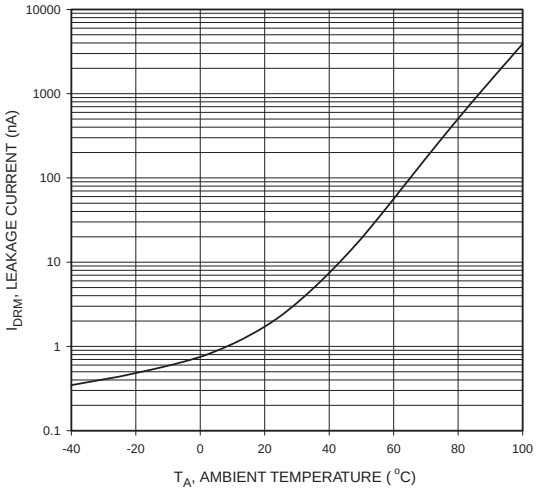
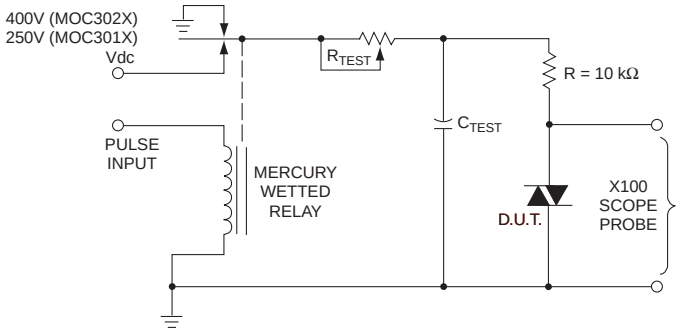


Fig. 6 Leakage Current, I_{DRM} vs. Temperature





1. The mercury wetted relay provides a high speed repeated pulse to the D.U.T.
2. 100x scope probes are used, to allow high speeds and voltages.
3. The worst-case condition for static dv/dt is established by triggering the D.U.T. with a normal LED input current, then removing the current. The variable R_{TEST} allows the dv/dt to be gradually increased until the D.U.T. continues to trigger in response to the applied voltage pulse, even after the LED current has been removed. The dv/dt is then decreased until the D.U.T. stops triggering. τ_{RC} is measured at this point and recorded.

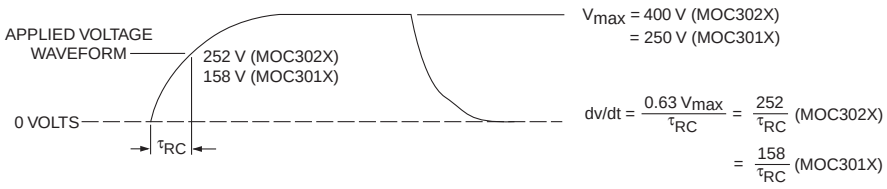


Figure 5. Static dv/dt Test Circuit

Note: This optoisolator should not be used to drive a load directly. It is intended to be a trigger device only.

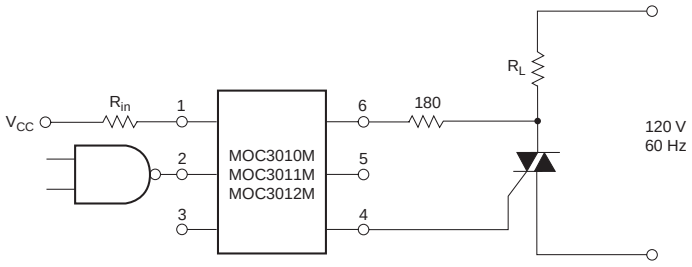


Figure 6. Resistive Load

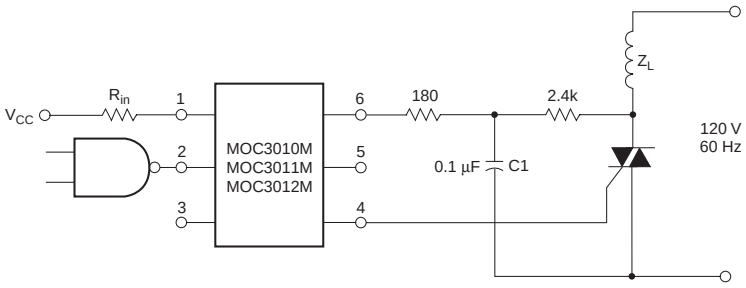


Figure 7. Inductive Load with Sensitive Gate Triac ($I_{GT} \leq 15$ mA)

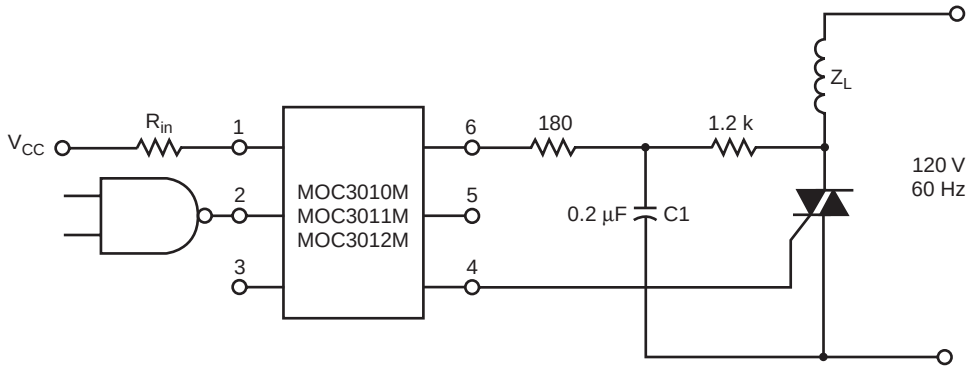
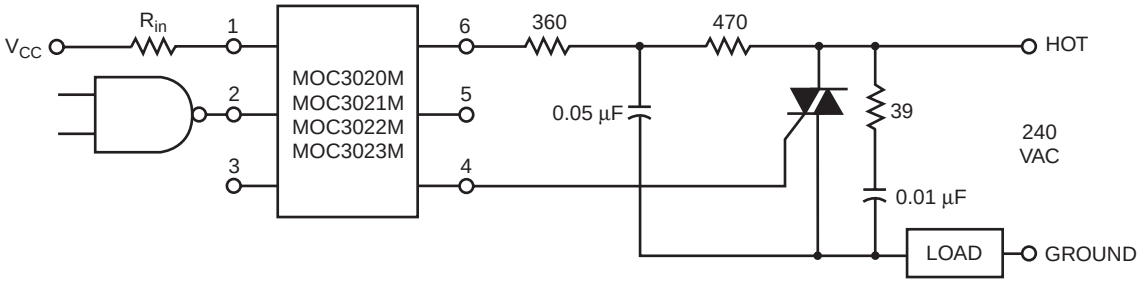


Figure 8. Inductive Load with Sensitive Gate Triac ($I_{GT} \leq 15$ mA)



In this circuit the “hot” side of the line is switched and the load connected to the cold or ground side.

The 39 ohm resistor and 0.01µF capacitor are for snubbing of the triac, and the 470 ohm resistor and 0.05 µF capacitor are for snubbing the coupler. These components may or may not be necessary depending upon the particular and load used.

Figure 9. Typical Application Circuit

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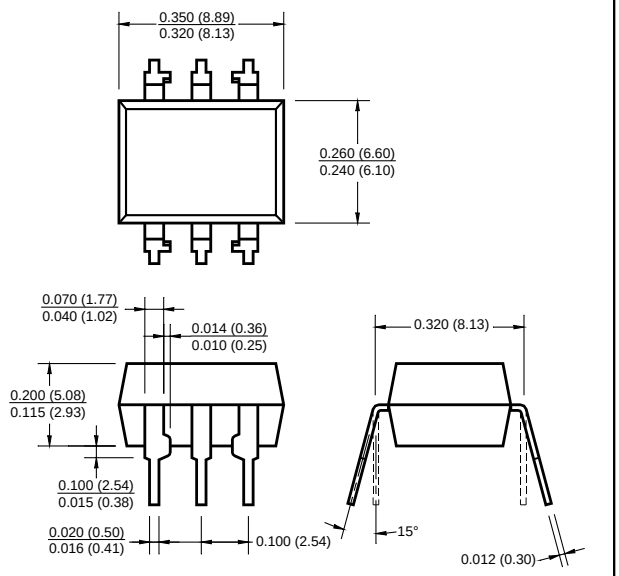
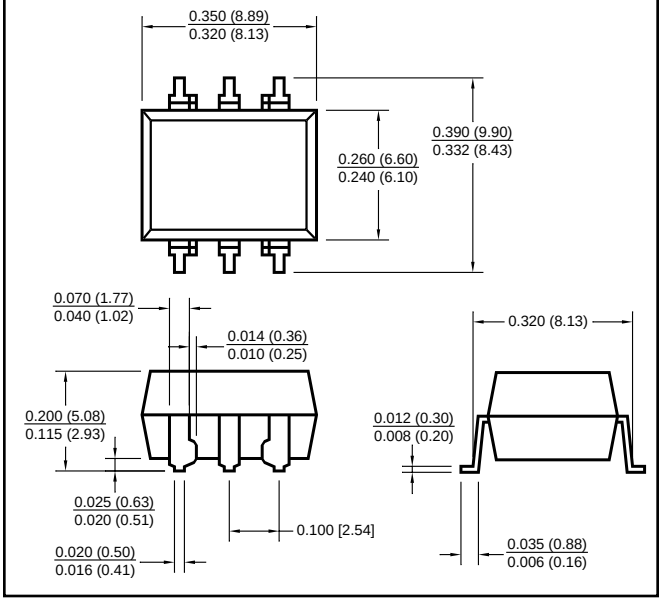
MOC3010M MOC3011M MOC3012M MOC3020M MOC3021M MOC3022M MOC3023M

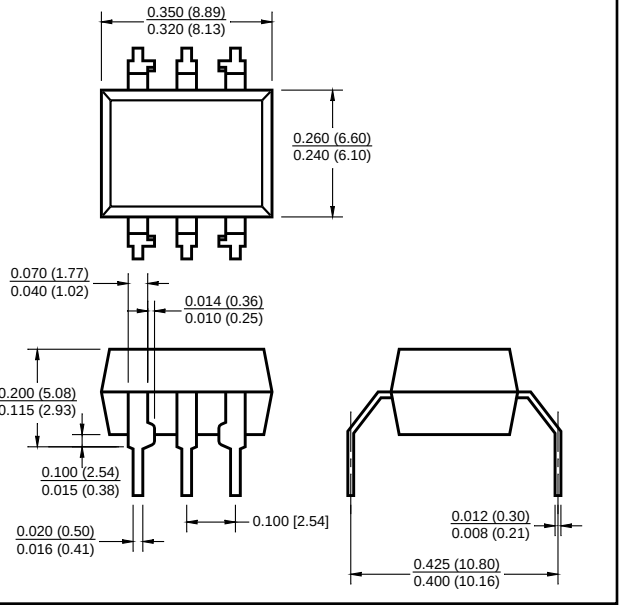
Package Dimensions (Through Hole)



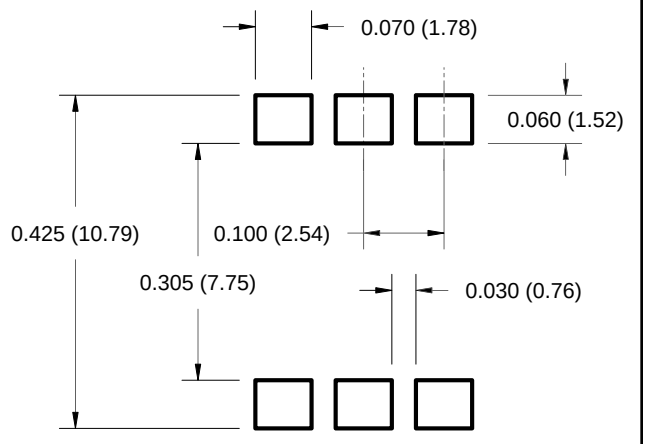
Package Dimensions (Surface Mount)



Package Dimensions (0.4” Lead Spacing)



Recommended Pad Layout for Surface Mount Leadform



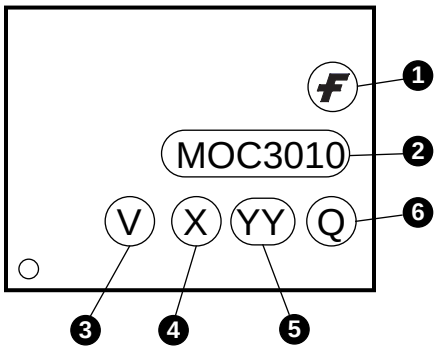
NOTE
All dimensions are in inches (millimeters)

6-PIN DIP RANDOM-PHASE OPTOISOLATORS TRIAC DRIVER OUTPUT (250/400 VOLT PEAK)

ORDERING INFORMATION

Option	Order Entry Identifier	Description
S	S	Surface Mount Lead Bend
SR2	SR2	Surface Mount; Tape and reel
T	T	0.4" Lead Spacing
V	V	VDE 0884
TV	TV	VDE 0884, 0.4" Lead Spacing
SV	SV	VDE 0884, Surface Mount
SR2V	SR2V	VDE 0884, Surface Mount, Tape & Reel

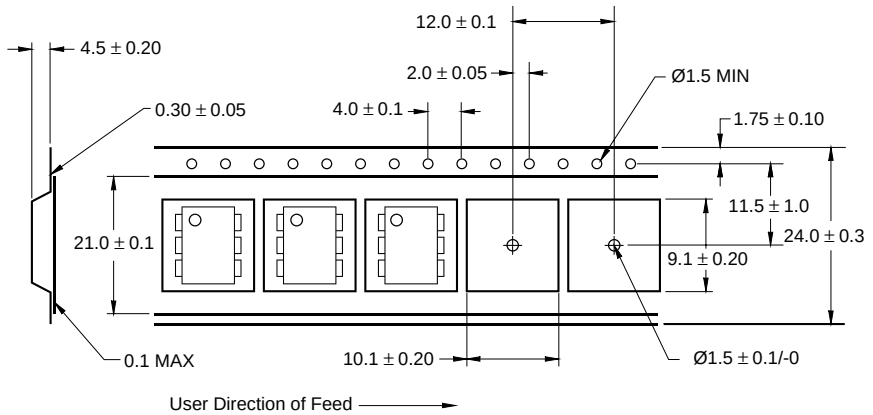
MARKING INFORMATION



Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	One digit year code, e.g., ‘3’
5	Two digit work week ranging from ‘01’ to ‘53’
6	Assembly package code

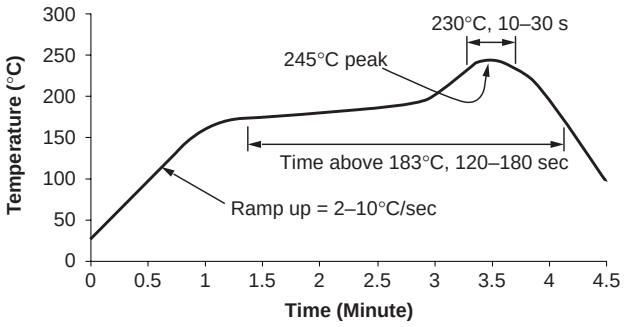
*Note – Parts that do not have the ‘V’ option (see definition 3 above) that are marked with date code ‘325’ or earlier are marked in portrait format.

Carrier Tape Specifications



NOTE
All dimensions are in inches (millimeters)

Reflow Profile (White Package, -M Suffix)



- Peak reflow temperature: 245°C (package surface temperature)
- Time of temperature higher than 183°C for 120–180 seconds
- One time soldering reflow is recommended

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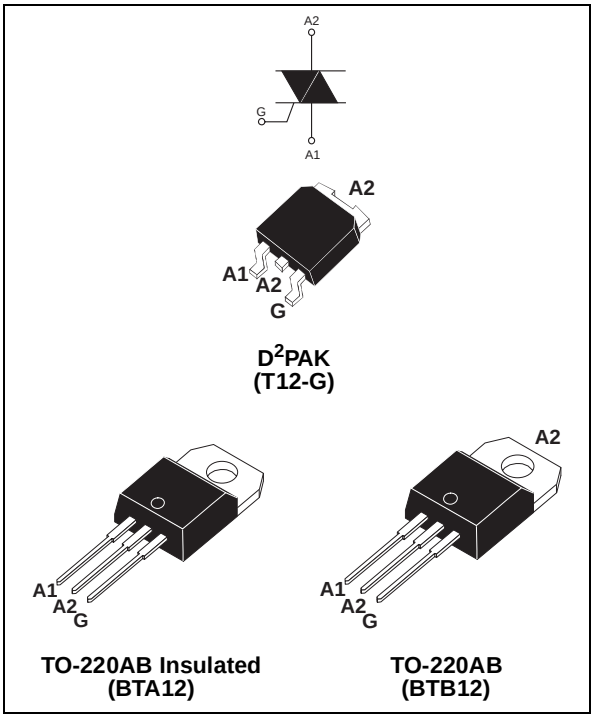
1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
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.

BTA/BTB12 and T12 Series

SNUBBERLESS™, LOGIC LEVEL & STANDARD 12A TRIACs

MAIN FEATURES:

Symbol	Value	Unit
$I_{T(RMS)}$	12	A
V_{DRM}/V_{RRM}	600 and 800	V
$I_{GT\ (Q_1)}$	5 to 50	mA



DESCRIPTION

Available either in through-hole or surface-mount packages, the BTA/BTB12 and T12 triac series is suitable for general purpose AC switching. They can be used as an ON/OFF function in applications such as static relays, heating regulation, induction motor starting circuits... or for phase control operation in light dimmers, motor speed controllers,...

The snubberless versions (BTA/BTB...W and T12 series) are specially recommended for use on inductive loads, thanks to their high commutation performances. Logic level versions are designed to interface directly with low power drivers such as microcontrollers. By using an internal ceramic pad, the BTA series provides voltage insulated tab (rated at 2500V RMS) complying with UL standards (File ref.: E81734)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Value	Unit
$I_{T(RMS)}$	RMS on-state current (full sine wave)	D^2PAK/TO-220AB	Tc = 105°C	12	A
		TO-220AB Ins.	Tc = 90°C		
I_{TSM}	Non repetitive surge peak on-state current (full cycle, Tj initial = 25°C)	F = 50 Hz	t = 20 ms	120	A
		F = 60 Hz	t = 16.7 ms	126	
I^2t	I^2t Value for fusing	tp = 10 ms		78	A^2s
dI/dt	Critical rate of rise of on-state current I_G = 2 x I_{GT} , tr ≤ 100 ns	F = 120 Hz	Tj = 125°C	50	A/µs
V_{DSM}/V_{RSM}	Non repetitive surge peak off-state voltage	tp = 10 ms	Tj = 25°C	V_{DRM}/V_{RRM} + 100	V
I_{GM}	Peak gate current	tp = 20 µs	Tj = 125°C	4	A
$P_{G(AV)}$	Average gate power dissipation		Tj = 125°C	1	W
T_{stg} T_j	Storage junction temperature range Operating junction temperature range			- 40 to + 150 - 40 to + 125	°C

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise specified)

■ **SNUBBERLESS™ and LOGIC LEVEL (3 Quadrants)**

Symbol	Test Conditions	Quadrant		T12		BTA/BTB12			Unit
				T1235	TW	SW	CW	BW	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III	MAX.	35	5	10	35	50	mA
V_{GT}		I - II - III	MAX.	1.3					V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	I - II - III	MIN.	0.2					V
I_H (2)	I_T = 100 mA		MAX.	35	10	15	35	50	mA
I_L	I_G = 1.2 I_{GT}	I - III	MAX.	50	10	25	50	70	mA
		II		60	15	30	60	80	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	500	20	40	500	1000	V/µs
(dI/dt)c (2)	(dV/dt)c = 0.1 V/µs Tj = 125°C		MIN.	-	3.5	6.5	-	-	A/ms
	(dV/dt)c = 10 V/µs Tj = 125°C			-	1	2.9	-	-	
	Without snubber Tj = 125°C			6.5	-	-	6.5	12	

■ **STANDARD (4 Quadrants)**

Symbol	Test Conditions	Quadrant		BTA/BTB12		Unit
				C	B	
I_{GT} (1)	V_D = 12 V R_L = 30 Ω	I - II - III IV	MAX.	25 50	50 100	mA
V_{GT}		ALL	MAX.	1.3		V
V_{GD}	$V_D = V_{DRM}$ R_L = 3.3 kΩ Tj = 125°C	ALL	MIN.	0.2		V
I_H (2)	I_T = 500 mA		MAX.	25	50	mA
I_L	I_G = 1.2 I_{GT}	I - III - IV	MAX.	40	50	mA
		II		80	100	
dV/dt (2)	V_D = 67 %V_{DRM} gate open Tj = 125°C		MIN.	200	400	V/µs
(dV/dt)c (2)	(dI/dt)c = 5.3 A/ms Tj = 125°C		MIN.	5	10	V/µs

STATIC CHARACTERISTICS

Symbol	Test Conditions			Value	Unit
V_T (2)	I_{TM} = 17 A tp = 380 µs	Tj = 25°C	MAX.	1.55	V
V_{to} (2)	Threshold voltage	Tj = 125°C	MAX.	0.85	V
R_d (2)	Dynamic resistance	Tj = 125°C	MAX.	35	mΩ
I_{DRM}	$V_{DRM} = V_{RRM}$	Tj = 25°C	MAX.	5	µA
I_{RRM}		Tj = 125°C		1	mA

Note 1: minimum IGT is guaranted at 5% of IGT max.

Note 2: for both polarities of A2 referenced to A1

THERMAL RESISTANCES

Symbol	Parameter			Value	Unit
$R_{th(j-c)}$	Junction to case (AC)		D^2PAK/TO-220AB	1.4	°C/W
			TO-220AB Insulated	2.3	
$R_{th(j-a)}$	Junction to ambient	S = 1 cm^2	D^2PAK	45	°C/W
			TO-220AB TO-220AB Insulated	60	

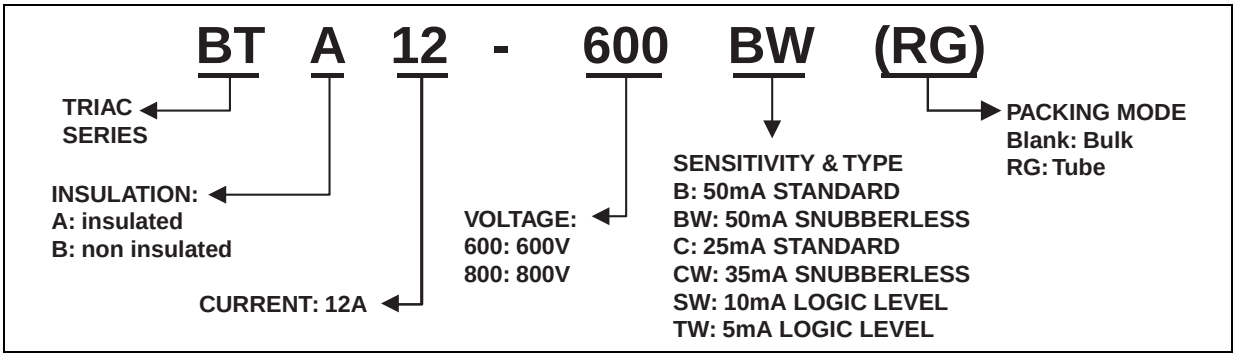
S = Copper surface under tab

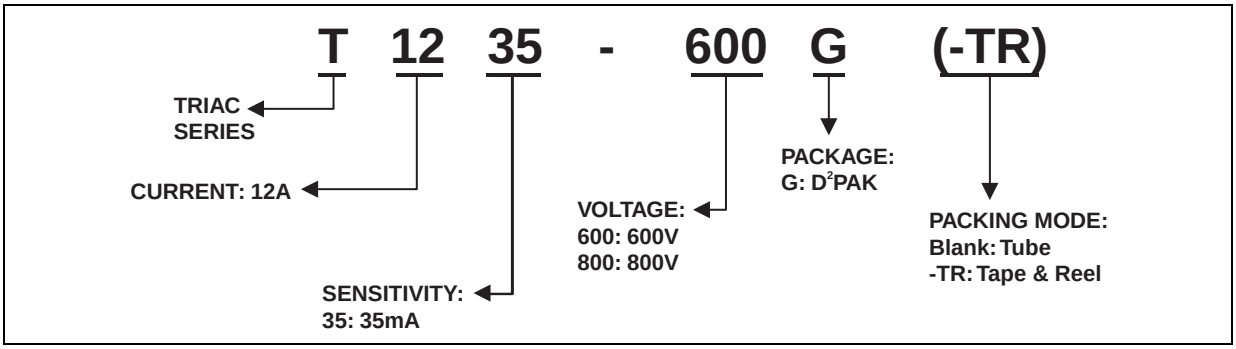
PRODUCT SELECTOR

Part Number	Voltage (xxx)		Sensitivity	Type	Package
	600 V	800 V			
BTA/BTB12-xxxB	X	X	50 mA	Standard	TO-220AB
BTA/BTB12-xxxBW	X	X	50 mA	Snubberless	TO-220AB
BTA/BTB12-xxxC	X	X	25 mA	Standard	TO-220AB
BTA/BTB12-xxxCW	X	X	35 mA	Snubberless	TO-220AB
BTA/BTB12-xxxSW	X	X	10 mA	Logic level	TO-220AB
BTA/BTB12-xxxTW	X	X	5 mA	Logic Level	TO-220AB
T1235-xxxG	X	X	35 mA	Snubberless	D^2PAK

BTB: non insulated TO-220AB package

ORDERING INFORMATION





OTHER INFORMATION

Part Number	Marking	Weight	Base quantity	Packing mode
BTA/BTB12-xxxyz	BTA/BTB12-xxxyz	2.3 g	250	Bulk
BTA/BTB12-xxxyzRG	BTA/BTB12-xxxyz	2.3 g	50	Tube
T1235-xxxG	T1235xxxG	1.5 g	50	Tube
T1235-xxxG-TR	T1235xxxG	1.5 g	1000	Tape & reel

Note: xxx = voltage, yy = sensitivity, z = type

Fig. 1: Maximum power dissipation versus RMS on-state current (full cycle).

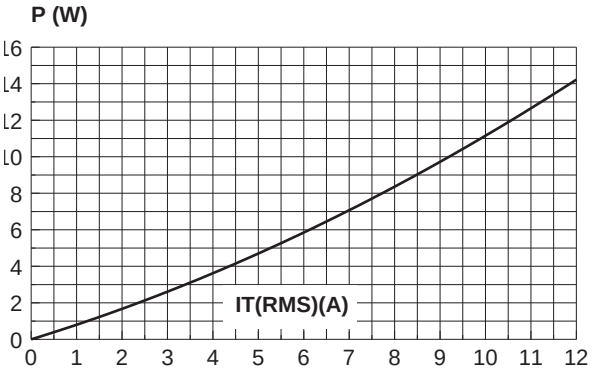


Fig. 2-1: RMS on-state current versus case temperature (full cycle).

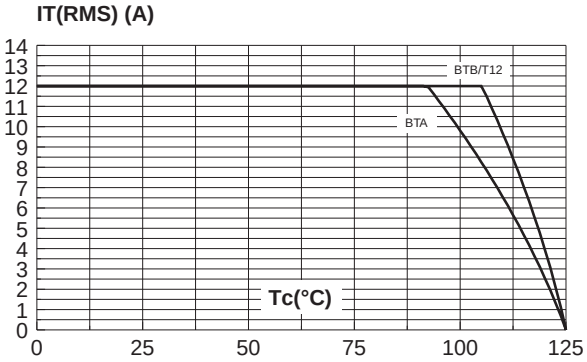


Fig. 2-2: RMS on-state current versus ambient temperature (printed circuit board FR4, copper thickness: 35µm),full cycle.

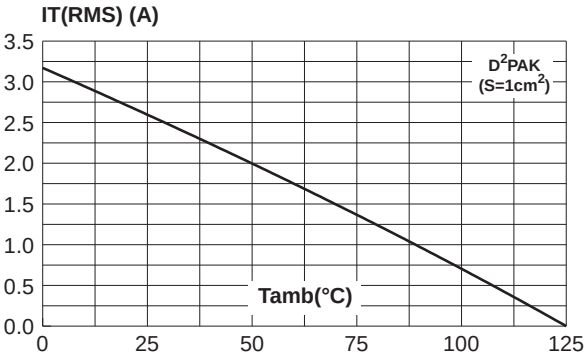


Fig. 3: Relative variation of thermal impedance versus pulse duration.

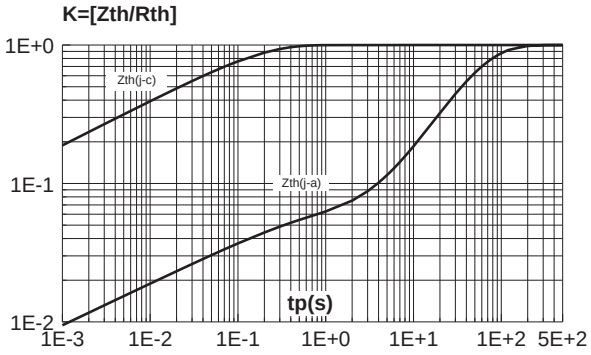


Fig. 4: On-state characteristics (maximum values).

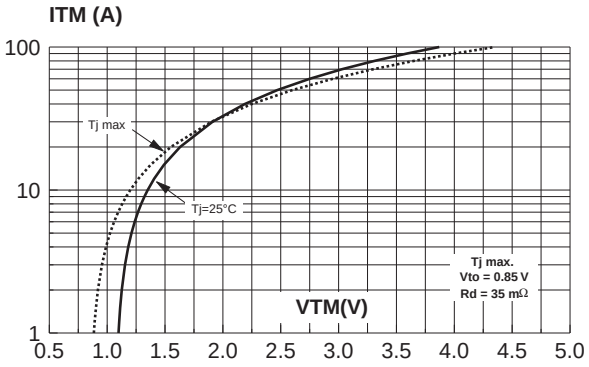


Fig. 5: Surge peak on-state current versus number of cycles.

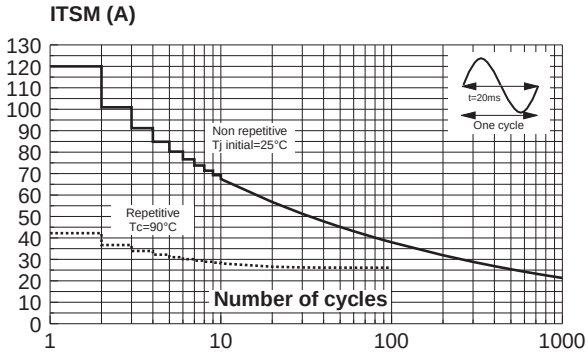


Fig. 6: Non-repetitive surge peak on-state current for a sinusoidal pulse with width tp < 10ms, and corresponding value of I^2t.

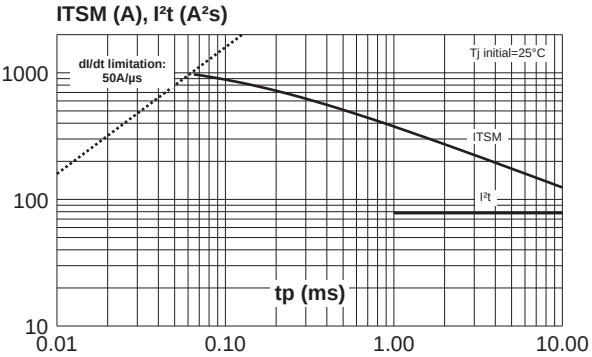


Fig. 7: Relative variation of gate trigger current, holding current and latching current versus junction temperature (typical values).

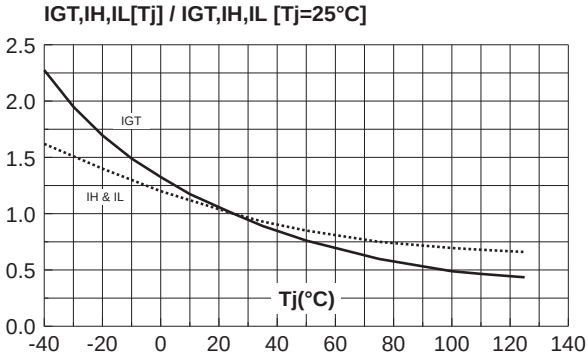


Fig. 8-1: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values) (BW/CW/T1235).

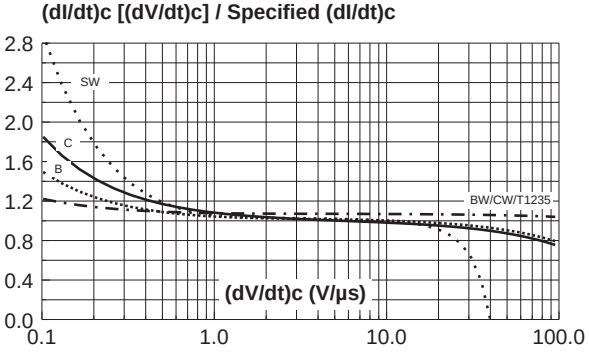


Fig. 8-2: Relative variation of critical rate of decrease of main current versus (dV/dt)c (typical values) (TW).

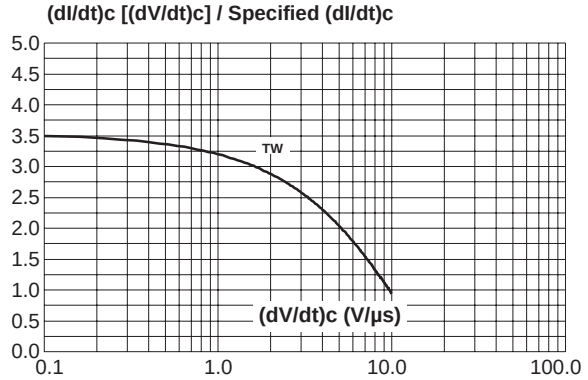


Fig. 9: Relative variation of critical rate of decrease of main current versus junction temperature.

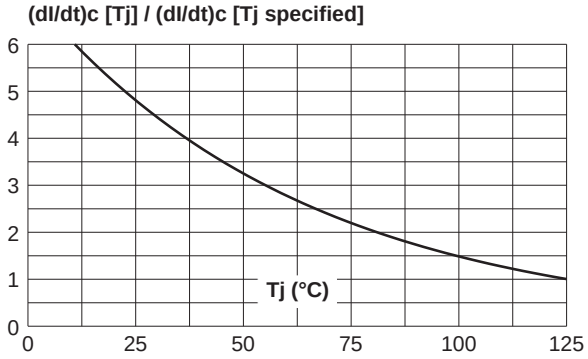
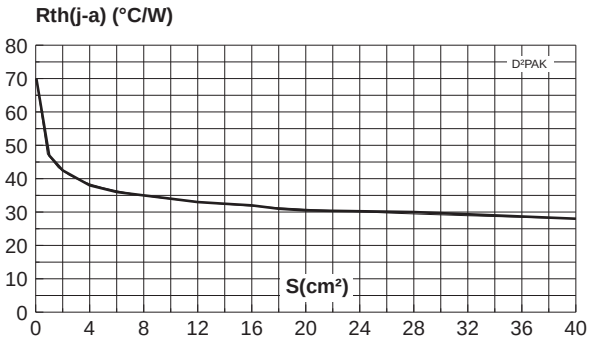
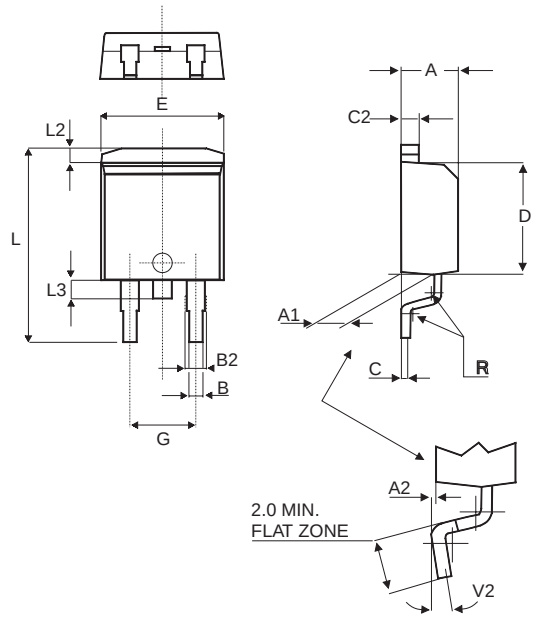


Fig. 10: D²PAK Thermal resistance junction to ambient versus copper surface under tab (printed circuit board FR4, copper thickness: 35 µm).



PACKAGE MECHANICAL DATA

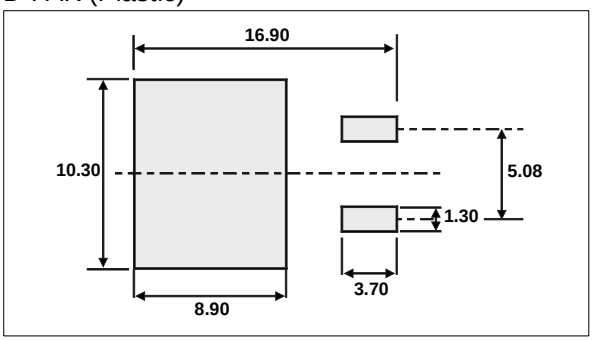
D²PAK (Plastic)



REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.30		4.60	0.169		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.70		0.93	0.027		0.037
B2	1.25	1.40		0.048	0.055	
C	0.45		0.60	0.017		0.024
C2	1.21		1.36	0.047		0.054
D	8.95		9.35	0.352		0.368
E	10.00		10.28	0.393		0.405
G	4.88		5.28	0.192		0.208
L	15.00		15.85	0.590		0.624
L2	1.27		1.40	0.050		0.055
L3	1.40		1.75	0.055		0.069
R		0.40			0.016	
V2	0°		8°	0°		8°

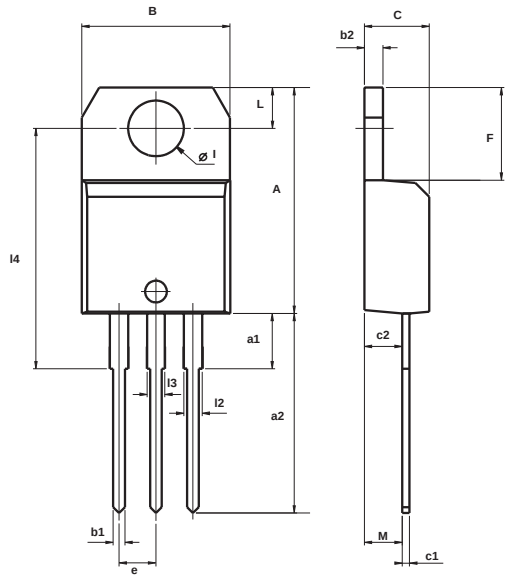
FOOTPRINT DIMENSIONS (in millimeters)

D²PAK (Plastic)



PACKAGE MECHANICAL DATA

TO-220AB / TO-220AB Ins.



REF.	DIMENSIONS					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	15.20		15.90	0.598		0.625
a1		3.75			0.147	
a2	13.00		14.00	0.511		0.551
B	10.00		10.40	0.393		0.409
b1	0.61		0.88	0.024		0.034
b2	1.23		1.32	0.048		0.051
C	4.40		4.60	0.173		0.181
c1	0.49		0.70	0.019		0.027
c2	2.40		2.72	0.094		0.107
e	2.40		2.70	0.094		0.106
F	6.20		6.60	0.244		0.259
I	3.75		3.85	0.147		0.151
l4	15.80	16.40	16.80	0.622	0.646	0.661
L	2.65		2.95	0.104		0.116
l2	1.14		1.70	0.044		0.066
l3	1.14		1.70	0.044		0.066
M		2.60			0.102	

TOSHIBA PHOTOCOUPLER GaAs IRED & PHOTO-TRANSISTOR

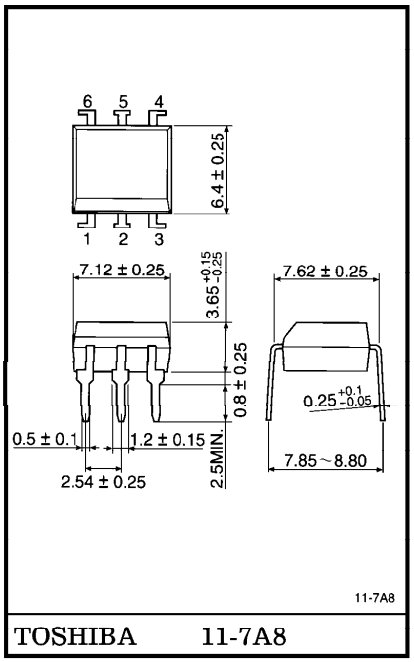
4N25(Short), 4N25A(Short), 4N26(Short), 4N27(Short), 4N28(Short)

AC LINE / DIGITAL LOGIC ISOLATOR.
DIGITAL LOGIC / DIGITAL LOGIC ISOLATOR.
TELEPHONE LINE RECEIVER.
TWISTED PAIR LINE RECEIVER.
HIGH FREQUENCY POWER SUPPLY FEEDBACK CONTROL.
RELAY CONTACT MONITOR.

The TOSHIBA 4N25 (Short) through 4N28 (Short) consists of a gallium arsenide infrared emitting diode coupled with a silicon phototransistor in a dual in-line package.

- Switching Speeds : 3μs (Typ.)
- DC Current Transfer Ratio : 100% (Typ.)
- Isolation Resistance : $10^{11}\Omega$ (Min.)
- Isolation Voltage : 2500Vrms (Min.)
- UL Recognized : UL1577, File No. E67349

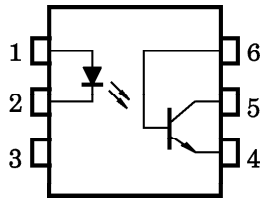
Unit in mm



TOSHIBA 11-7A8

Weight : 0.4g

PIN CONFIGURATIONS (Top view)



1 : ANODE
2 : CATHODE
3 : N.C.
4 : EMITTER
5 : COLLECTOR
6 : BASE

961001EBC2

MAXIMUM RATINGS (Ta = 25°C)

	CHARACTERISTIC	SYMBOL	RATING	UNIT
LED	Forward Current (Continuous)	I_F	80	mA
	Forward Current Derating	ΔI_F / °C	1.07 (*)	mA / °C
	Peak Forward Current (Note 1)	I_{PF}	3	A
	Power Dissipation	P_D	150	mW
	Power Dissipation Derating	ΔP_D / °C	2.0 (*)	mW / °C
	Reverse Voltage	V_R	3	V
DETECTOR	Collector-Emitter Voltage	BV_{CEO}	30	V
	Collector-Base Voltage	BV_{CBO}	70	V
	Emitter-Collector Voltage	BV_{ECO}	7	V
	Collector Current (Continuous)	I_C	100	mA
	Power Dissipation	P_C	150	mW
	Power Dissipation Derating	ΔP_C / °C	2.0 (*)	mW / °C
COUPLED	Storage Temperature Range	T_{stg}	−55~150	°C
	Operating Temperature Range	T_{opr}	−55~100	°C
	Lead Soldering Temperature (10s)	T_{sol}	260	°C
	Total Package Power Dissipation	P_T	250	mW
	Total Package Power Dissipation Derating	ΔP_T / °C	3.3 (*)	mW / °C

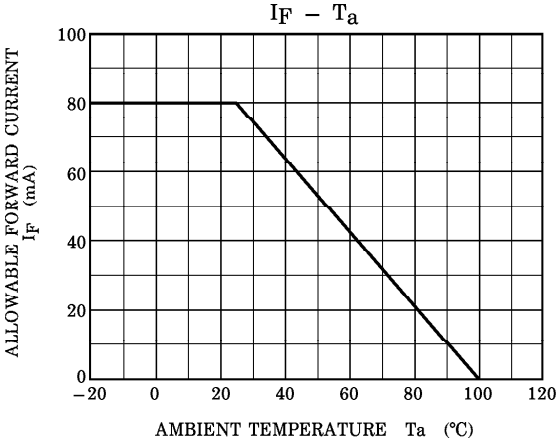
(Note 1) Pulse width 300μs, 2% duty cycle.
(*) Above 25°C ambient.

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

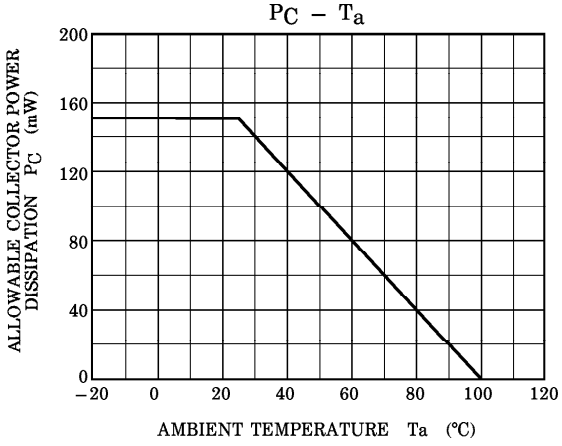
	CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
LED	Forward Voltage		V_F	I_F=10mA	—	1.15	1.5	V
	Reverse Current		I_R	V_R=3V	—	—	100	μA
	Capacitance		C_D	V=0, f=1MHz	—	30	—	pF
DETECTOR	DC Forward Current Gain		h_{FE}	V_{CE}=5V, I_C=500μA	—	200	—	—
	Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$	I_C=1mA, I_F=0	30	—	—	V
	Collector-Base Breakdown Voltage		$V_{(BR)CBO}$	I_C=100μA	70	—	—	V
	Emitter-Collector Breakdown Voltage		$V_{(BR)ECO}$	I_E=100μA	7	—	—	V
	Collector Dark Current		I_{CEO}	V_{CE}=10V	—	1	50	nA
	Collector Dark Current		I_{CBO}	V_{CB}=10V	—	0.1	20	nA
	Collector-Emitter Capacitance		C_{CE}	V=0, f=1MHz	—	10	—	pF
COUPLED	Current Transfer Ratio		I_C / I_F	I_F=10mA, V_{CE}=10V	20	100	—	%
	Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	I_F=50mA, I_C=2mA	—	0.1	0.5	V
	Capacitance Input to Output		C_S	V_S=0, f=1MHz	—	0.8	—	pF
	Isolation Resistance		R_S	V_S=500V, R.H.≦60%	10^{11}	—	—	Ω
	Isolation Voltage		BV_S	AC, 1 minute	2500	—	—	Vrms
		4N25, 4N25A	BV_S (*)	AC, Peak	2500	—	—	Vpk
		4N26, 4N27			1500	—	—	
		4N28			500	—	—	
		4N25A		AC, 1 second	1775	—	—	Vrms
	Rise / Fall Time		t_r / t_f	V_{CE}=10V, I_C=2mA R_L=100Ω	—	2	—	μs
	Rise / Fall Time		t_r / t_f	V_{CB}=10V, I_{CB}=50μA R_L=100Ω	—	200	—	ns

(*) JEDEC registered minimum BV_S, however, TOSHIBA specifies a minimum BV_S of 2500Vrms, 1 minute.

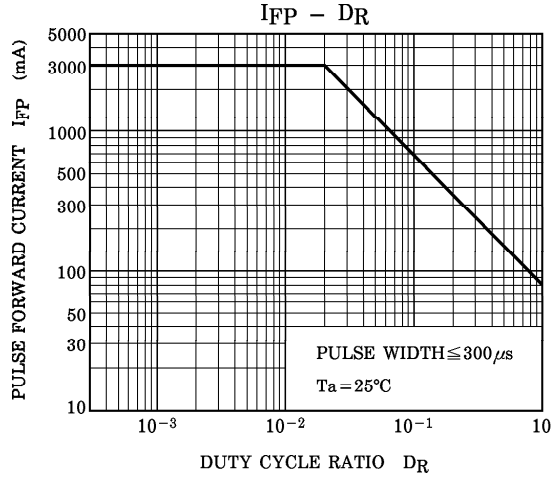
$I_F - T_a$



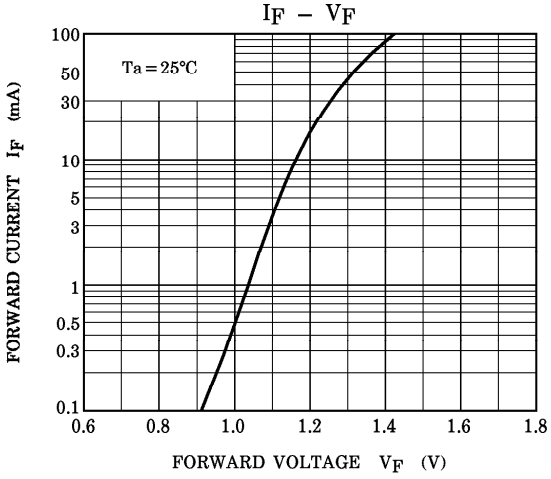
$P_C - T_a$



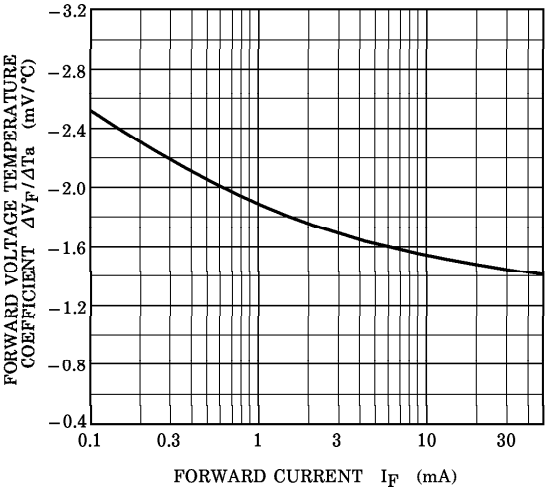
$I_{FP} - D_R$



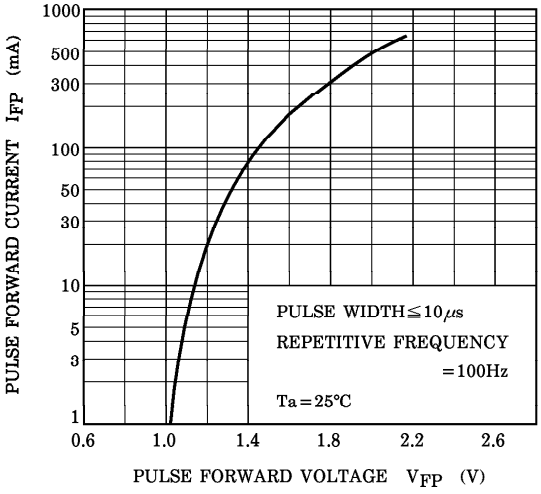
$I_F - V_F$



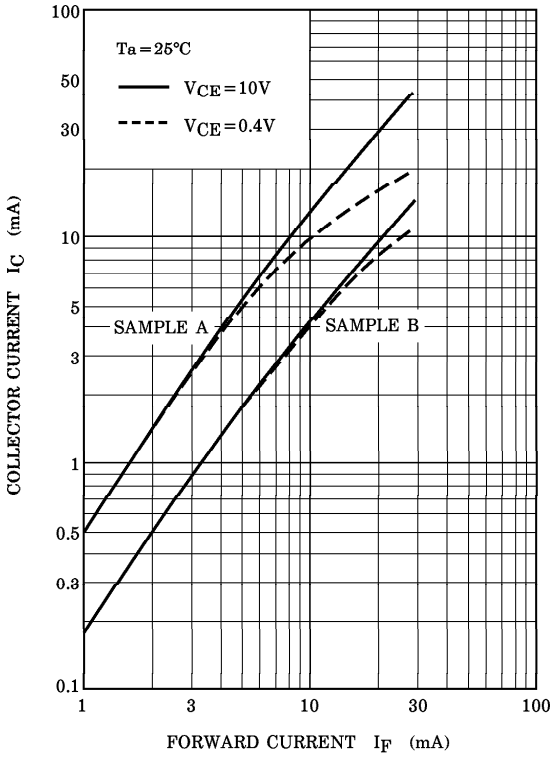
$\Delta V_F / \Delta Ta - I_F$



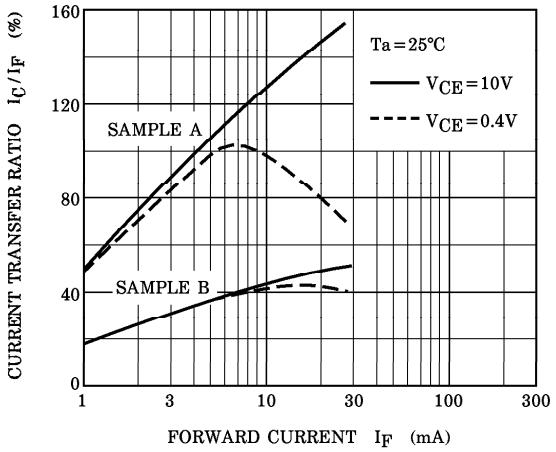
$I_{FP} - V_{FP}$



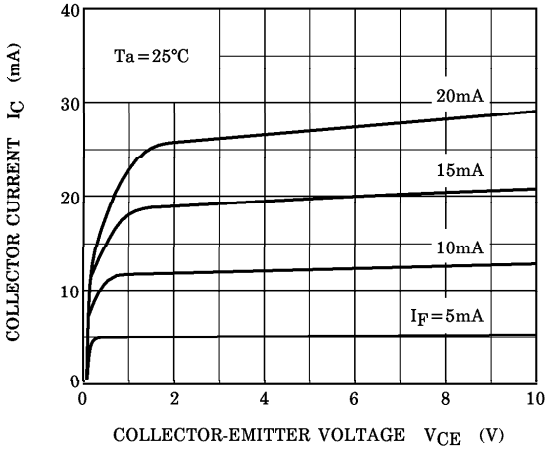
$I_C - I_F$



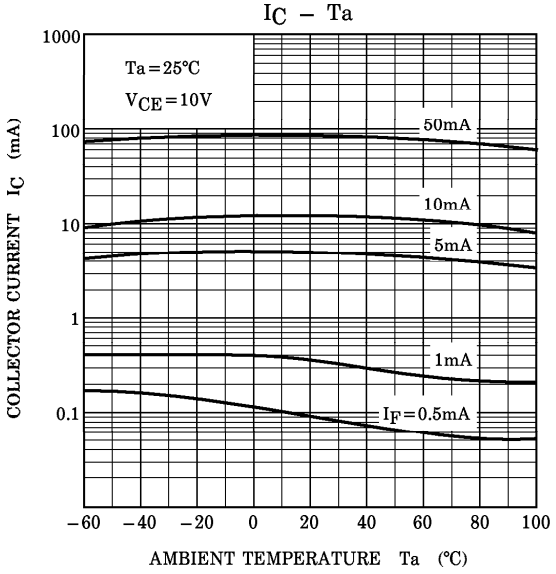
$I_C / I_F - I_F$



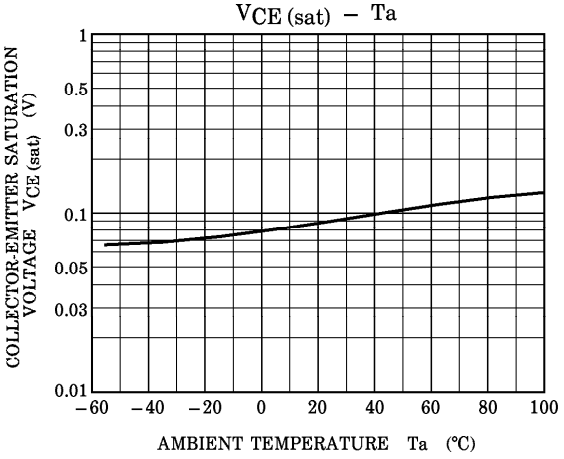
$I_C - V_{CE}$



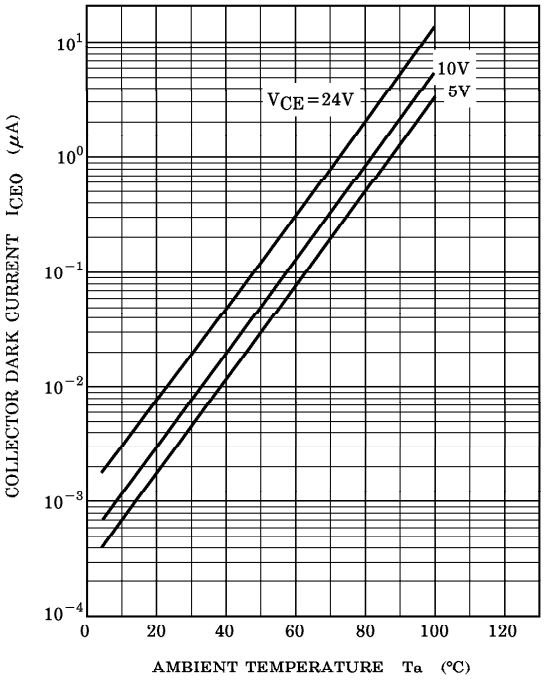
$I_C - Ta$



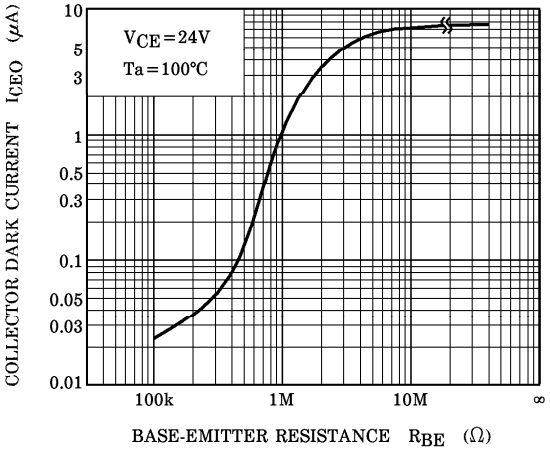
$V_{CE\,(sat)} - Ta$



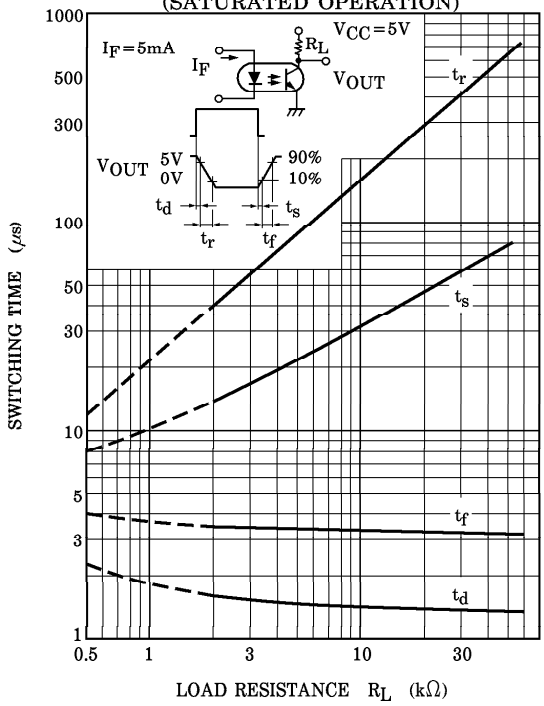
I_{CEO} – Ta



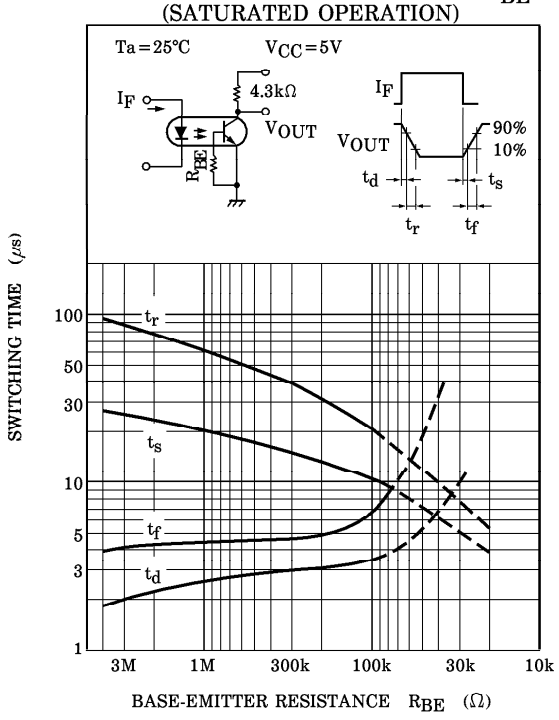
I_{CEO} – R_{BE}



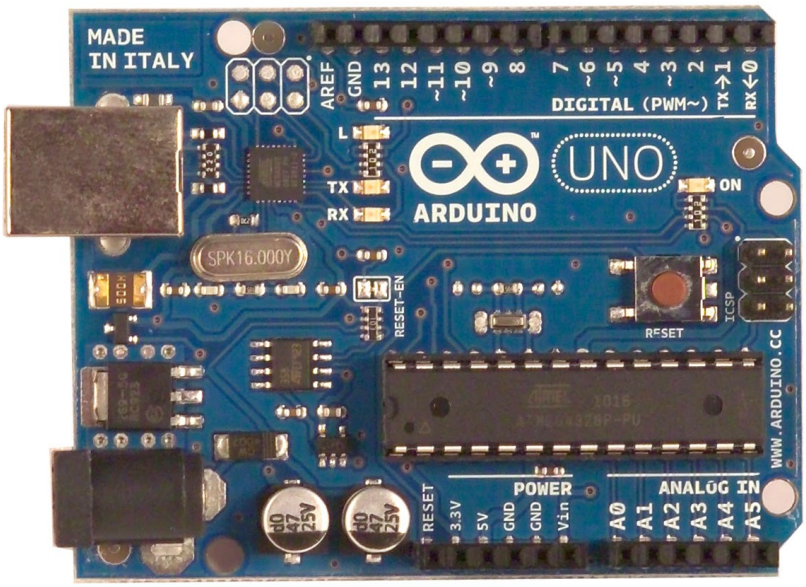
SWITCHING CHARACTERISTICS – R_L
(SATURATED OPERATION)



SWITCHING CHARACTERISTICS – R_{BE}
(SATURATED OPERATION)



Arduino UNO



Product Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Index

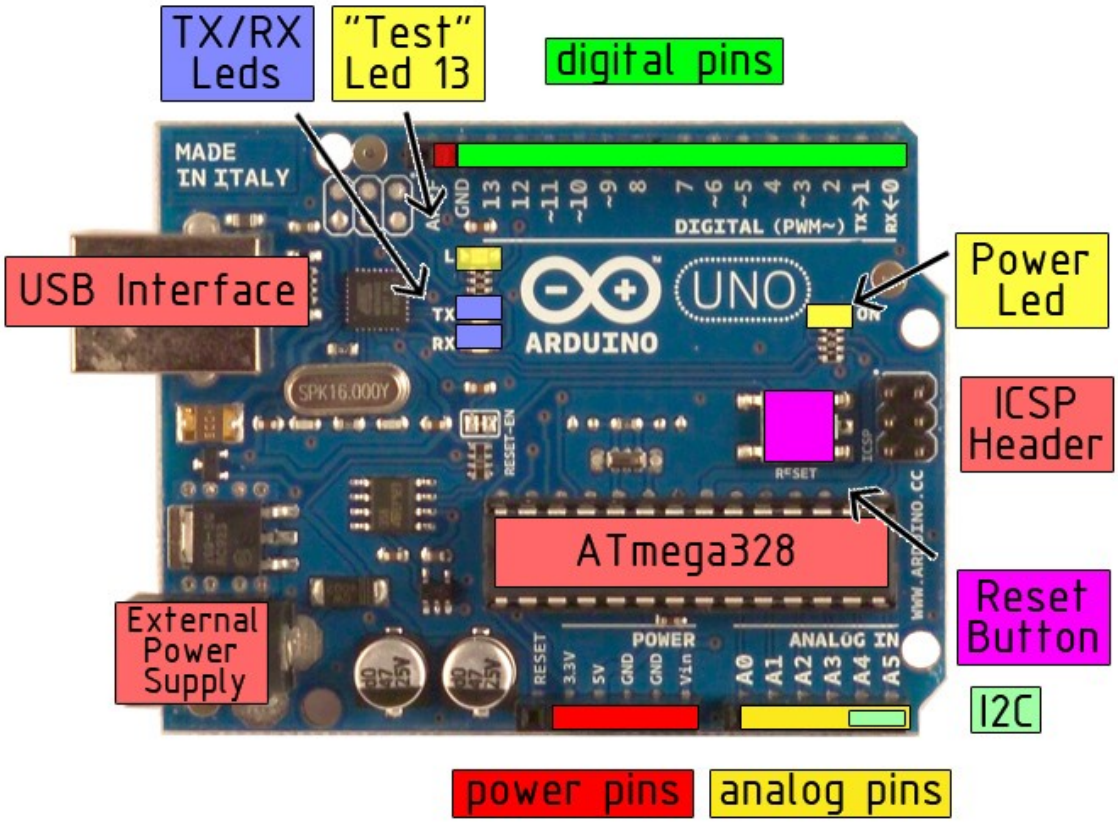
Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board



Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. TThese pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I²C: 4 (SDA) and 5 (SCL).** Support I²C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and Atmega328 ports.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an *.inf file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno w/ ATmega328" from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

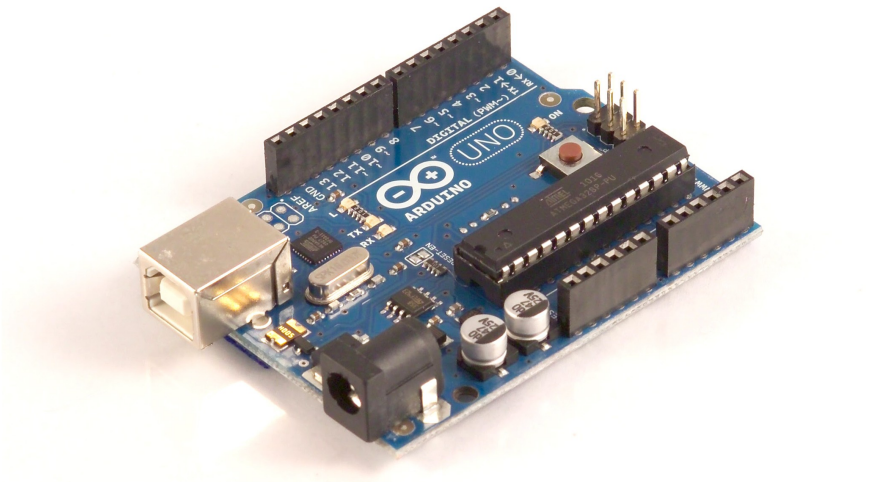
The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



How to use Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platoform program. You'll have to follow different instructions for your personal OS. Check on the Arduino site for the latest instructions. *http://arduino.cc/en/Guide/HomePage*

Linux Install Windows Install Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

Blink led

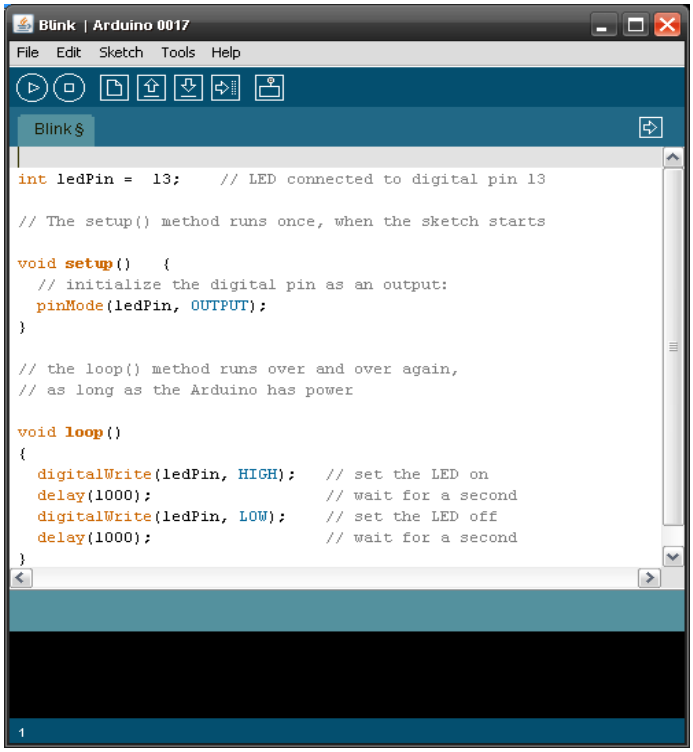
Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

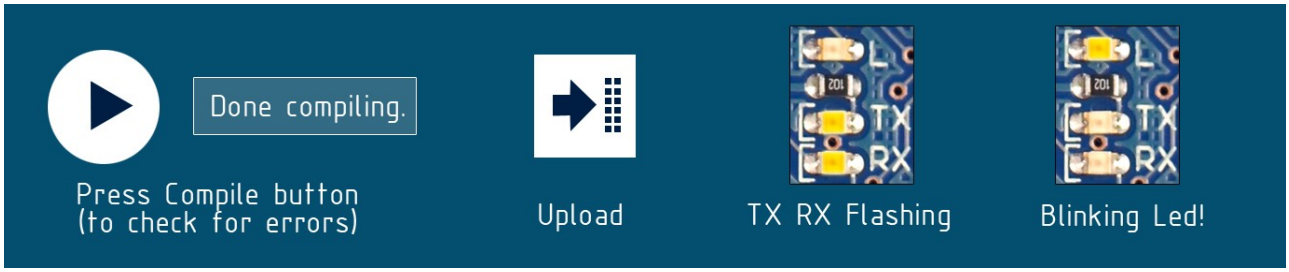
File>Sketchbook>
Arduino-0017>Examples>
Digital>Blink

Once you have your skecth you'll see something very close to the screenshot on the right.

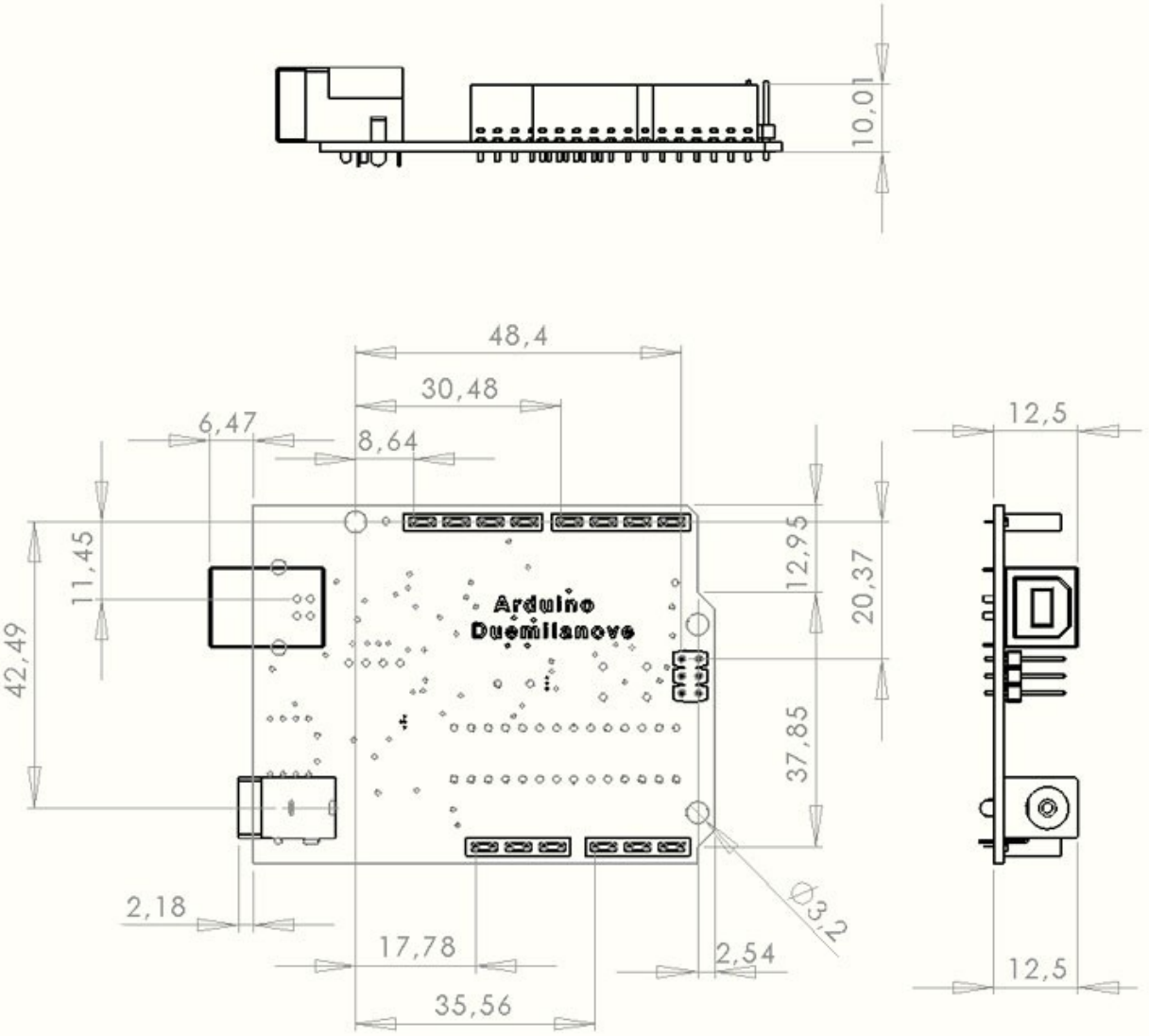
In **Tools>Board** select

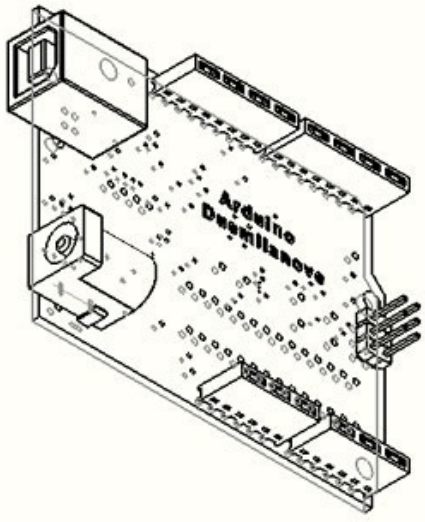
Now you have to go to
Tools>SerialPort
and select the right serial port, the one arduino is attached to.





Dimensioned Drawing





Terms & Conditions

1. Warranties

1.1 The producer warrants that its products will conform to the Specifications. This warranty lasts for one (1) years from the date of the sale. The producer shall not be liable for any defects that are caused by neglect, misuse or mistreatment by the Customer, including improper installation or testing, or for any products that have been altered or modified in any way by a Customer. Moreover, The producer shall not be liable for any defects that result from Customer's design, specifications or instructions for such products. Testing and other quality control techniques are used to the extent the producer deems necessary.

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1.6 Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products and any use of Arduino™ products in Customer's applications, notwithstanding any applications-related information or support that may be provided by the producer.

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4. Changes to specifications

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Enviromental Policies

The producer of Arduino™ has joined the Impatto Zero® policy of LifeGate.it. For each Arduino board produced is created / looked after half squared Km of Costa Rica's forest's.

Guangzhou HC Information Technology Co., Ltd.

Product Data Sheet

Module Data Sheet

Rev 1

1．0	2.0	2.1	2.2				
2006/6/18	2006/9/6	2010/4/22	2011/4/6				

DRAWN BY :	Ling Xin		**MODEL :** HC-06	
CHECKED BY :	Eric Huang		**Description::** BC04 has external 8M Flash and EDR module HC-06 is industrial, and compatible with civil HC-04	
APPD. BY：	Simon Mok		**REV: 2.0**	**Page :**
Former version introduction	HC-06 is the higher version of LV_BC_2.0. Linvor is the former of wavesen.			

www.wavesen.com Phone: 020-84083341 Fax: 020-84332079 QQ:1043073574
Address: Room 527, No.13, Jiangong Road, Tianhe software park, Tianhe district, Guangzhou Post: 510660
Technology consultant: support@wavesen.com Business consultant:sales@wavesen.com
Complaint and suggestion: sunbirdit@hotmail.com

Contents

1. Product's picture

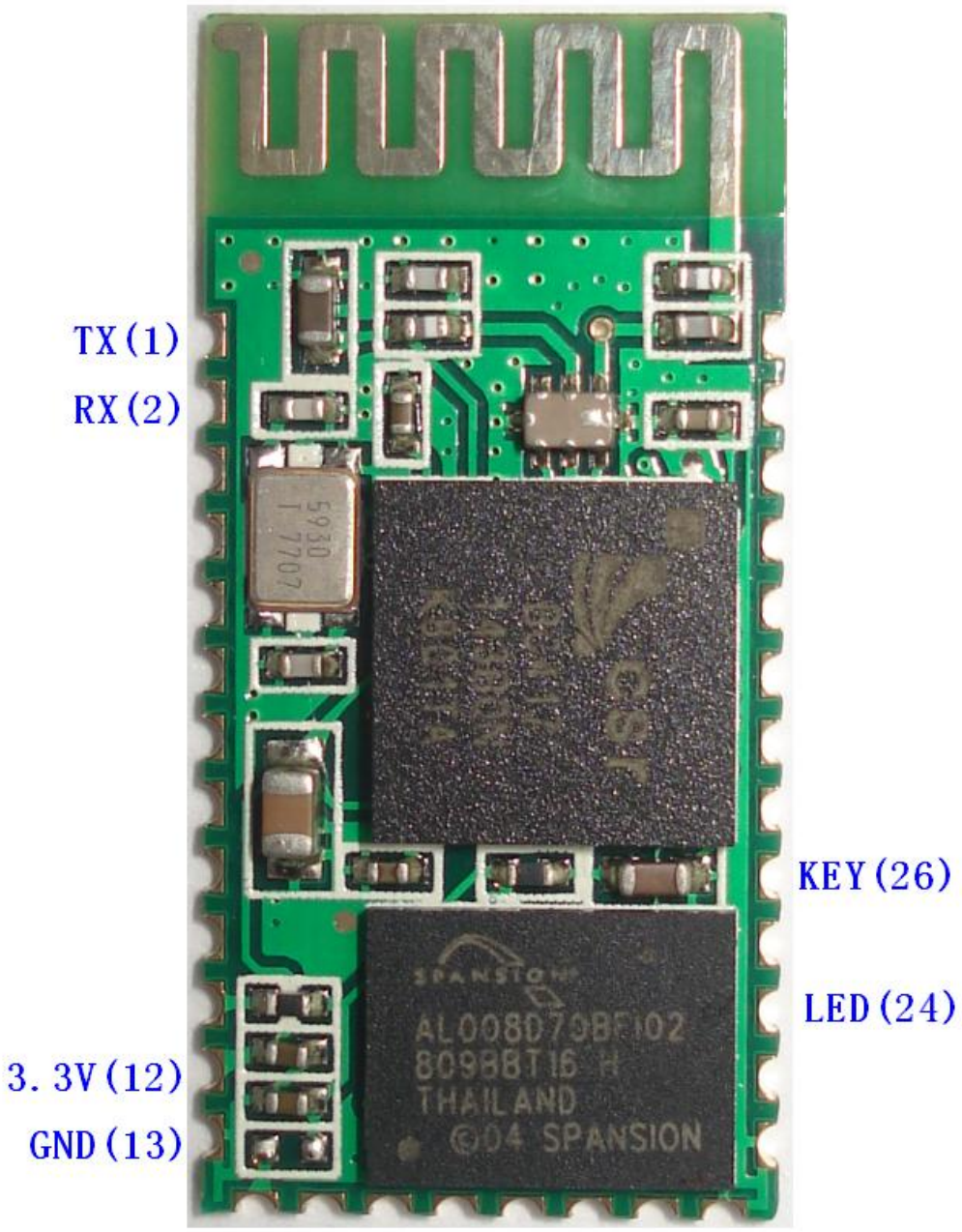

Figure 1 A Bluetooth module

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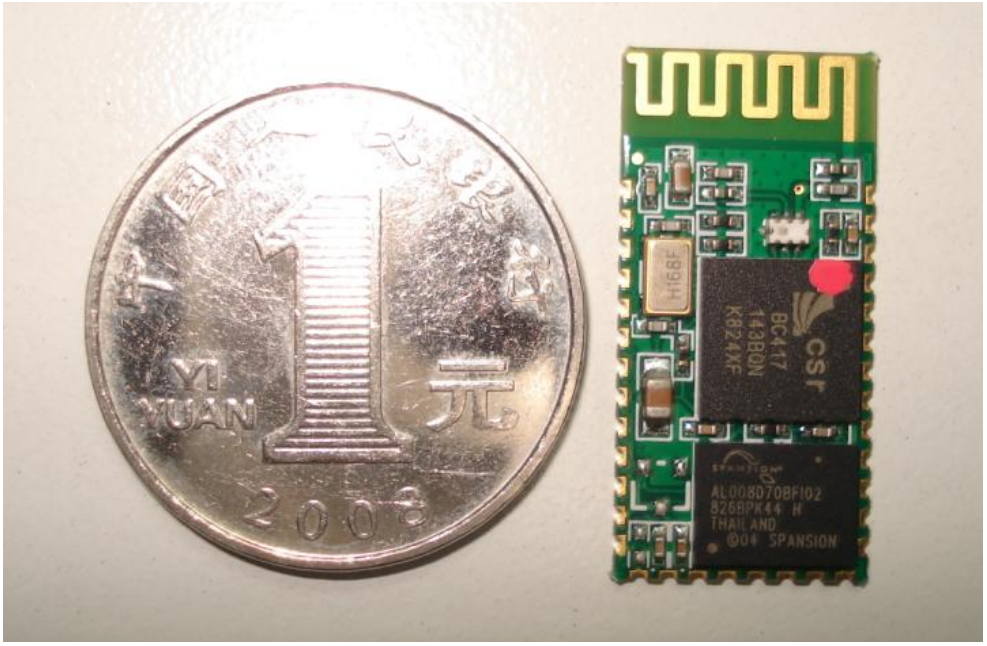

Figure 2. A Bluetooth module size

Figure 3 50 pieces chips in an anti-static blister package.

2. Feature

- Wireless transceiver
  - Sensitivity (Bit error rate) can reach -80dBm.
  - The change range of output's power: -4 - +6dBm.
- Function description (perfect Bluetooth solution)
  - Has an EDR module; and the change range of modulation depth: 2Mbps - 3Mbps.
  - Has a build-in 2.4GHz antenna; user needn't test antenna.
  - Has the external 8Mbit FLASH
  - Can work at the low voltage (3.1V~4.2V). The current in pairing is in the range of 30～40mA. The current in communication is 8mA.
  - Standard HCI Port (UART or USB)
  - USB Protocol: Full Speed USB1.1, Compliant With 2.0
  - This module can be used in the SMD.
  - It's made through RoHS process.
  - The board PIN is half hole size.
  - Has a 2.4GHz digital wireless transceiver.
  - Bases at CSR BC04 Bluetooth technology.
  - Has the function of adaptive frequency hopping.
  - Small (27mm×13mm×2mm)
  - Peripherals circuit is simple.
  - It's at the Bluetooth class 2 power level.
  - Storage temperature range: -40 ℃ - 85℃， work temperature range: -25 ℃ - +75℃
  - Any wave inter Interference: 2.4MHz， the power of emitting: 3 dBm.
  - Bit error rate: 0. Only the signal decays at the transmission link, bit error may be produced. For example, when RS232 or TTL is being processed, some signals may decay.

- Low power consumption
- Has high-performance wireless transceiver system
- Low Cost

- Application fields:
  - Bluetooth Car Handsfree Device
  - Bluetooth GPS
  - Bluetooth PCMCIA , USB Dongle
  - Bluetooth Data Transfer
- Software
  - CSR

3. PINs description

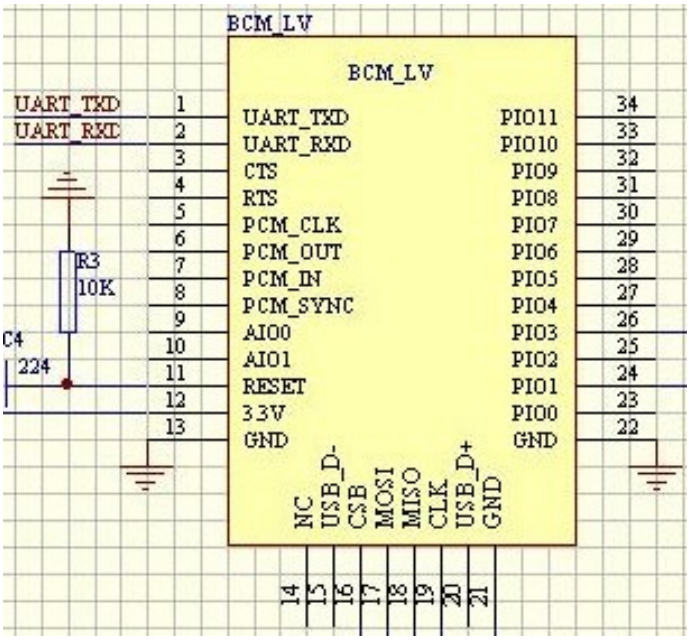

Figure 3 PIN configuration

The PINs at this block diagram is as same as the physical one.

PIN Name	PIN #	Pad type	Description	Note
GND	13 21 22	VSS	Ground pot	
1V8	14	VDD	Integrated 1.8V (+) supply with On-chip linear regulator output within 1.7-1.9V	
VCC	12	3.3V		
AIO0	9	Bi-Directional	Programmable input/output line	
AIO1	10	Bi-Directional	Programmable input/output line	

PIO0	23	Bi-Directional RX EN	Programmable input/output line, control output for LNA(if fitted)	
PIO1	24	Bi-Directional TX EN	Programmable input/output line, control output for PA(if fitted)	
PIO2	25	Bi-Directional	Programmable input/output line	
PIO3	26	Bi-Directional	Programmable input/output line	
PIO4	27	Bi-Directional	Programmable input/output line	
PIO5	28	Bi-Directional	Programmable input/output line	
PIO6	29	Bi-Directional	Programmable input/output line	CLK_REQ
PIO7	30	Bi-Directional	Programmable input/output line	CLK_OUT
PIO8	31	Bi-Directional	Programmable input/output line	
PIO9	32	Bi-Directional	Programmable input/output line	
PIO10	33	Bi-Directional	Programmable input/output line	
PIO11	34	Bi-Directional	Programmable input/output line	
RESETB	11	CMOS Input with weak intemal pull-down		
UART_RTS	4	CMOS output, tri-stable with weak internal pull-up	UART request to send, active low	
UART_CTS	3	CMOS input with weak internal pull-down	UART clear to send, active low	
UART_RX	2	CMOS input with weak internal pull-down	UART Data input	
UART_TX	1	CMOS output, Tri-stable with weak internal pull-up	UART Data output	
SPI_MOSI	17	CMOS input with weak internal pull-down	Serial peripheral interface data input	
SPI_CSB	16	CMOS input with weak internal	Chip select for serial peripheral interface, active low	

		pull-up		
SPI_CLK	19	CMOS input with weak internal pull-down	Serial peripheral interface clock	
SPI_MISO	18	CMOS input with weak internal pull-down	Serial peripheral interface data Output	
USB_-	15	Bi-Directional		
USB_+	20	Bi-Directional		
1.8V	14		1.8V external power supply input	Default : 1.8V internal power supply.
PCM_CLK	5	Bi-Directional		
PCM_OUT	6	CMOS output		
PCM_IN	7	CMOS Input		
PCM_SYNC	8	Bi-Directional		

4. The parameters and mode of product

LINVOR BLUE T

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Bluetooth Module

Bluetooth

CSR,BC417143B

V 2.0

2006/09/6

蓝牙 **RF** 模块

1. 采用 CSR BC4 +8M FLASH 方案
2. 具有 PIO0-PIO11、AIO0、AIO1、USB、PCM、UART 及 SPI 接口，模块内置 8MFLASH，功能强大，用户可定制软件,适用于各种蓝牙设备，内置 RF 天线,便于调试。

蓝牙协议版本	Bluetooth Specifcation V2.0 With EDR
USB 协议 USB Protocol	Full Speed USB V1.1 Compliant With USB V2.0
频率	2.4Ghz ISM band
调制方式	GFSK(Gaussian Frequency Shift Keying)
发射功率	-4 ->4 dBm, Class 2
灵敏度	≤-80dBm at 0.1% BER
通讯速率	Asynchronous:2Mbps(Max)
供电电源	3.3V
工作温度	-20~+55 Centigrade
封装尺寸	27mmX13mmX2mm

If you want more information, please visit www.wavesen.com.

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Complaint and suggestion: sunbirdit@hotmail.com

LINVOR BLUE T

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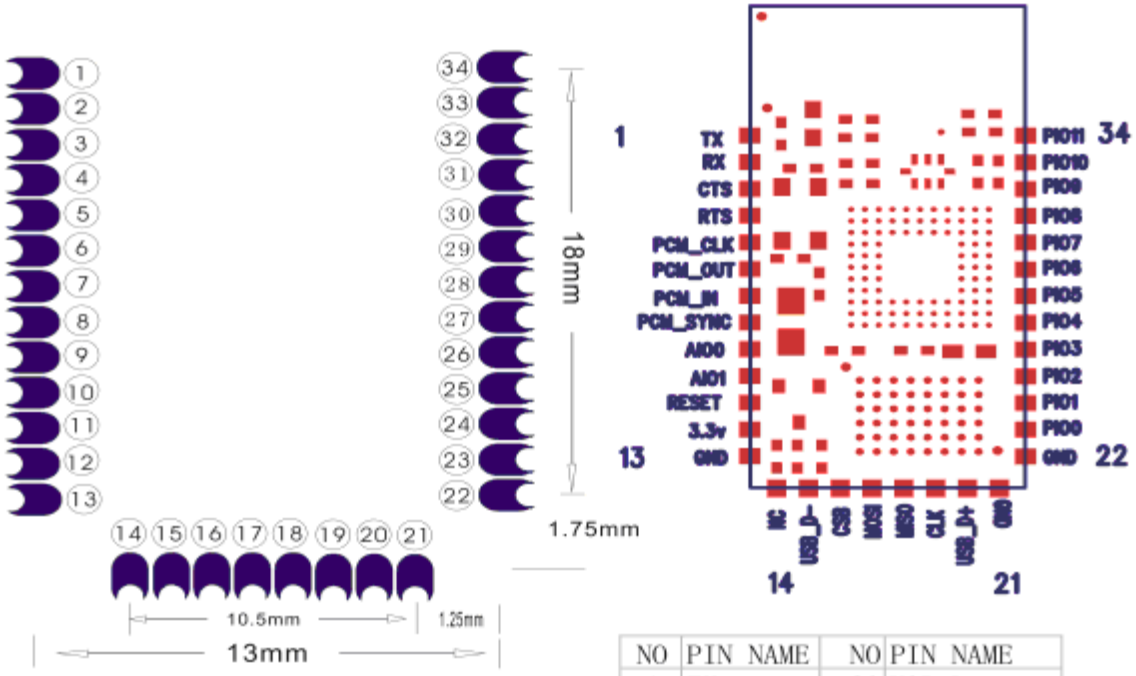
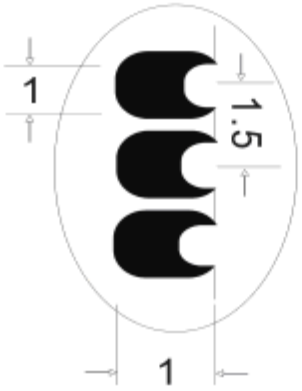
LV-BC-2.0

单位： mm





PCB Layout 请参考实物

NO	PIN NAME	NO	PIN NAME
1	TX	20	USB D+
2	RX	21	GND
3	CTS	22	GND
4	RTS	23	PIO0
5	PCM CLK	24	PIO1
6	PCM OUT	25	PIO2
7	PCM IN	26	PIO3
8	PCM SYNC	27	PIO4
9	AIO0	28	PIO5
10	AIO1	29	PIO6
11	RESET	30	PIO7
12	3.3V	31	PIO8
13	GND	32	PIO9
14	NC	33	PIO10
15	USB D-	34	PIO11
16	CSB		
17	MOSI		
18	MISO		
19	CLK		

5. Block diagram

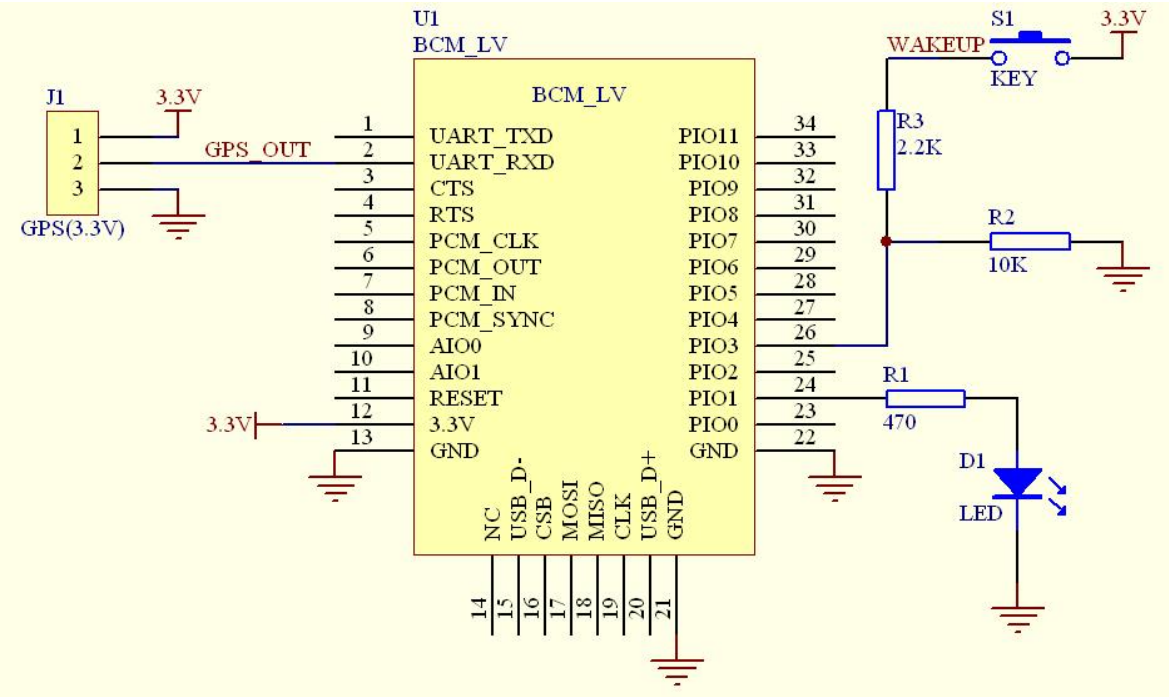


Figure 5 Block diagram 1

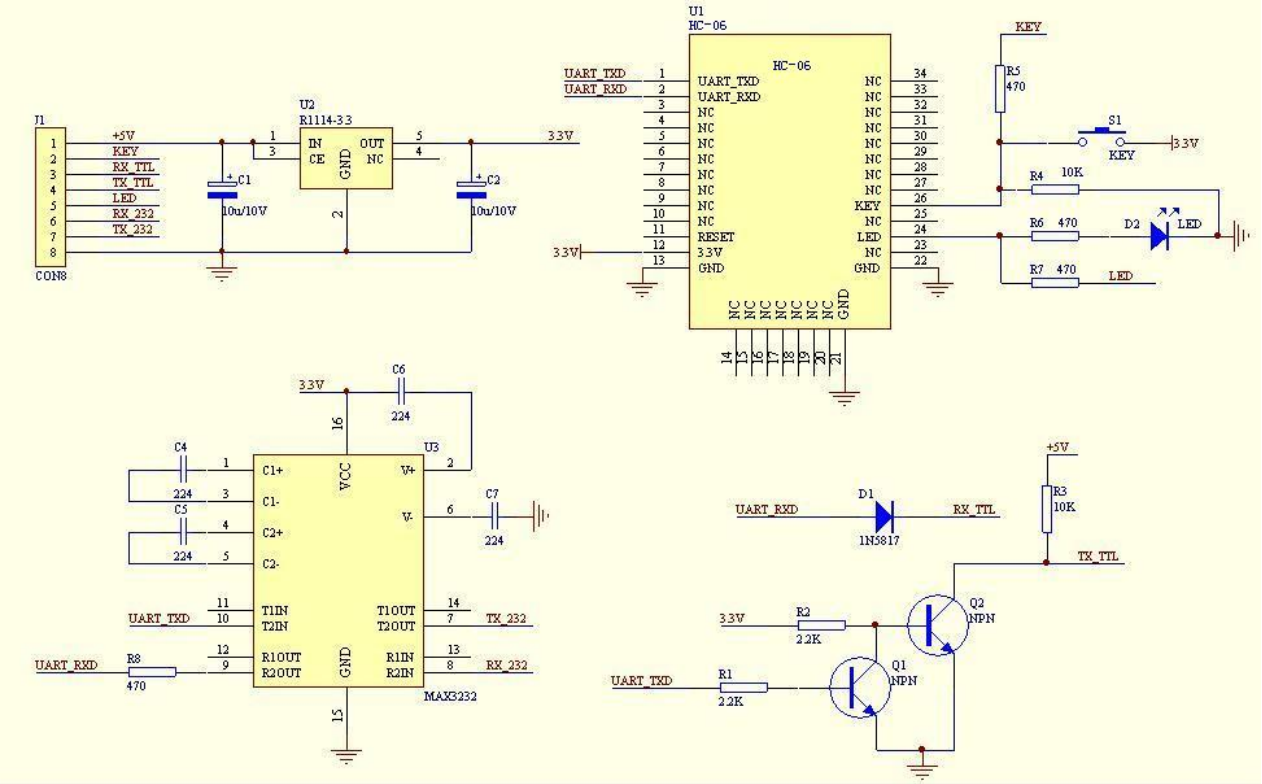


Figure 5 Block diagram 2

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HC-04/06 master device has a function of remembering the last paired slave device. As a master device, it will search the last paired salve device until the connection is built. But if the WAKEUP bottom is pressed, HC-04/06 will lose the memory and research the new slave device.

6. Debugging device

6.1 Device

PC, hardware, 3G，3G Frequency Counter (SP3386), 3.15V DC power supply, Shielding，Bluetooth Test box.

6.2 Software

7. Characteristic of test

Test Condition 25℃ RH 65%

		Min	Typ	Max	Unit
1.	Carrier Freq. (*ISM Band*)	2.4		2.4835	MHz
2.	RF O/P Power	-6	2	4	dBm
3.	Step size of Power control	2		8	dB
4.	Freq. Offset (*Typical Carrier freq.*)	-75		75	KHz
5.	Carrier Freq. drift (*Hopping on, drift rate/50uS*)	-20		20	KHz
	1 slot packet	-25		25	KHz
	3 slot packet	-40		-40	KHz
6.	Average Freq. Deviations (*Hopping off, modulation*)	140		175	KHz
	Freq. Deviation	115			KHz
	Ratio of Freq. Deviation	0.8			
7 .	Receive Sensitivity @< 0.1% BER*(Bit error rate*)	-83			dBm

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8. Test diagram

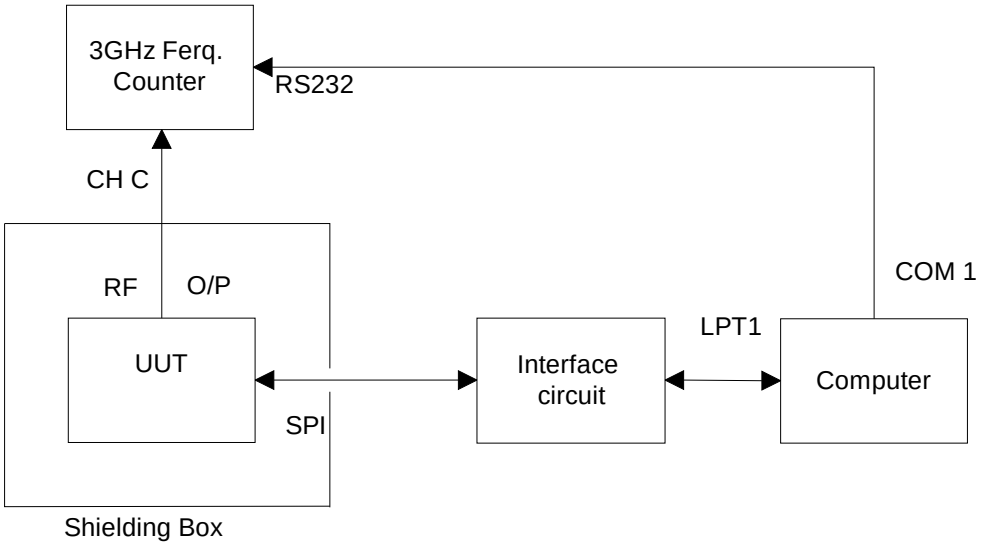

Fig 1. Programming and Freq. Alignment

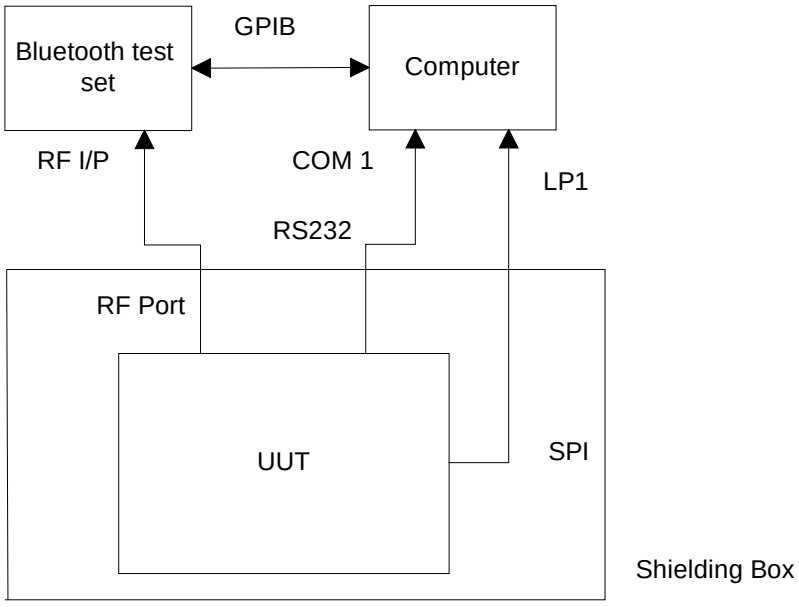

Fig 2 RF parameter Test Procedure

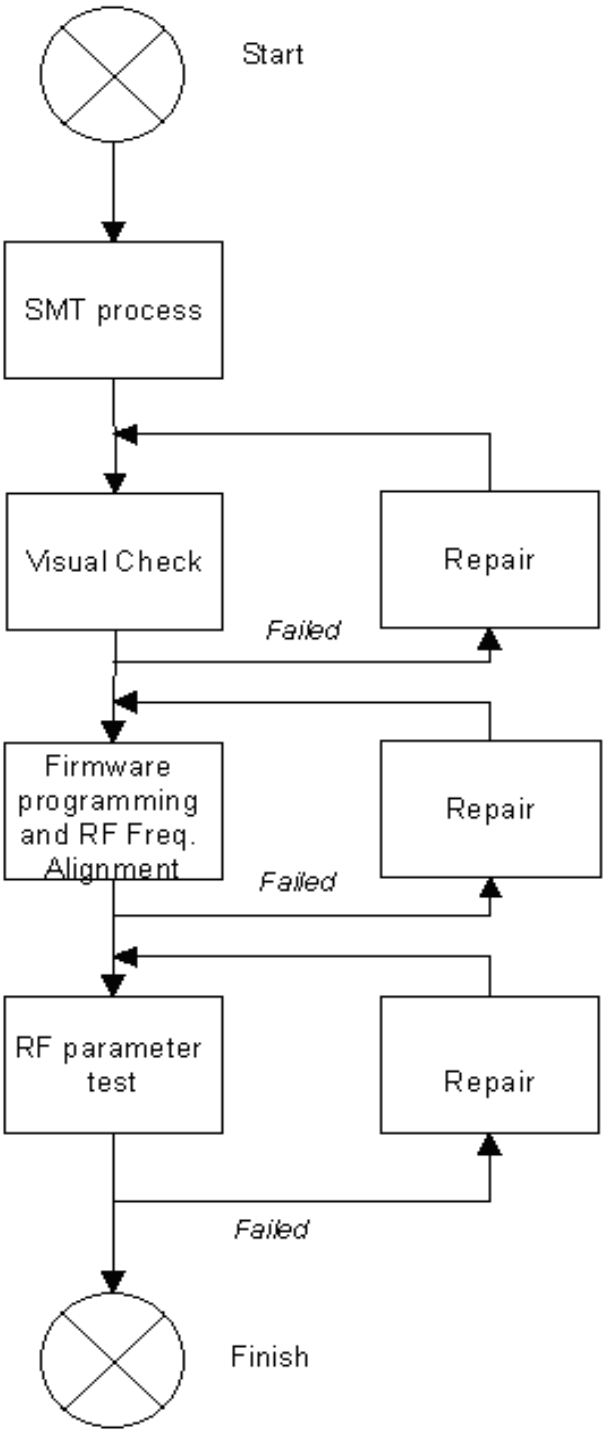

Fig 3 Assemble/Alignment/Testing Flow Chart

9. AT command set

The way to the AT command mode: supply power to the module, it will enter to the AT mode if it needn't pair. The interval of command is about 1 second.

Default parameter: Baud rate:9600N81, ID: linvor, Password:1234

1. Test communication

Send: AT (please send it every second)

Back: OK

2. Reset the Bluetooth serial baud rate

Send: AT+BAUD1

Back: OK1200

Send: AT+BAUD2

Back: OK2400

……

1---------1200

2---------2400

3---------4800

4---------9600 (Default)

5---------19200

6---------38400

7---------57600

8---------115200

9---------230400

A---------460800

B---------921600

C---------1382400

PC can't support the baud rate lager than 115200. The solution is: make the MCU have higher baud rate (lager than 115200) through programming, and reset the baud rate to low level through the AT command.

The baud rate reset by the AT command can be kept for the next time even though the power is cut off.

3. Reset the Bluetooth name

Send: AT+NAMEname

Back: OKname

Parameter name: Name needed to be set (20 characters limited)
Example:
Send: AT+NAMEbill_gates
Back: OKname

Now, the Bluetooth name is reset to be “bill_gates”

The parameter can be kept even though the power is cut off. User can see the new Bluetooth name in PDA refresh service. (Note: The name is limited in 20 characters.)

4. change the Bluetooth pair password
Send: AT+PINxxxx
Back:OKsetpin

Parameter xxxx: The pair password needed to be set, is a 4-bits number. This command can be used in the master and slave module. At some occasions, the master module may be asked to enter the password when the master module tries to connect the slave module (adapter or cell-phone). Only if the password is entered, the successful connection can be built. At the other occasions, the pair can be finish automatically if the master module can search the proper slave module and the password is correct. Besides the paired slave module, the master can connect the other devices who have slave module, such as Bluetooth digital camera, Bluetooth GPS, Bluetooth serial printer etc.
Example:
Send: AT+PIN8888
Back: OKsetpin
Then the password is changed to be 8888, while the default is 1234.
This parameter can be kept even though the power is cut off.

5. No parity check (The version, higher than V1.5, can use this command)
Send: AT+PN (This is the default value)
Back: OK NONE

6. Set odd parity check (The version, higher than V1.5, can use this command)
Send: AT+PO
Back: OK ODD

7. Set even parity check(The version, higher than V1.5, can use this command)
Send: AT+PE
Back: OK EVEN

8. Get the AT version

Send: AT+VERSION

Back: LinvorV1.n

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