POWER INTEGRATED CIRCUIT

Switching Regulator 5 Amp Positive and Negative Power Output Stages

PIC600
PIC601
PIC602
PIC610
PIC611
PIC612

FEATURES

- Designed and characterized for switching regulator applications
- Cost saving design reduces size, improves efficiency, reduces noise and RFI (See note 4.)
- High operating frequency (to > 100kHz) results in smaller inductor-capacitor filter and improved power supply response time
- High operating efficiency: Typical 2A circuit performance —
  Rise and Fall time <75ns
  Efficiency >85%
- No reverse recovery spike generated by commutating diode (See note 4. and Fig. 2.)
- Electrically isolated, 4-Pin, TO-66 hermetic case (500V, 1μA, all leads common)

DESCRIPTION

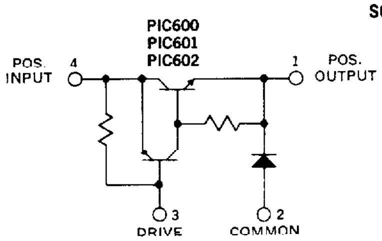
The Microsemi ESP Switching Regulator is a unique hybrid transistor circuit, specifically designed, constructed and specified for use in high current switching regulator applications. The designer is thus relieved of one of the most time consuming, tedious and critical aspects of switching regulator design: choosing the appropriate switching transistors and commutating diode and empirically determining the optimum drive and bias conditions.

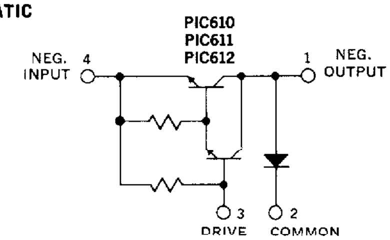
Switching regulators, when compared to conventional regulators, result in significant reductions in size, weight and internal power losses and a major decrease in overall cost. Using the Microsemi PIC600 series, the designer can achieve further improvements in size, weight, efficiency and costs. At the same time, because of the PIC600 series design and packaging, the designer is aided in overcoming two of the most significant drawbacks to switching regulators: noise generation and slow response time; there is, in fact, no diode reverse recovery spike (see note 4.).

The PIC600 series switching regulators are designed and characterized to be driven with standard integrated circuit voltage regulators. They are completely characterized over their entire operating range of -55°C to +125°C. The devices are enclosed in a special 4-pin TO-66 package, hermetically sealed for high reliability. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

Application Notes U-68 and U-76 provide a detailed description of the hybrid circuit and design guidance for specific circuit applications.

SCHEMATIC

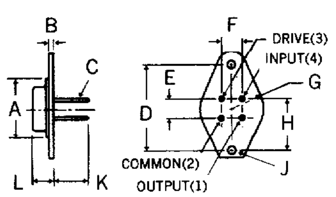




MECHANICAL SPECIFICATIONS

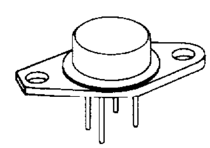
PIC600 PIC601 PIC602 PIC610 PIC611 PIC612

NOTES:
1. Case is electrically isolated.
2. Loads may be soldered to within 1/16" of base provided temperature-time exposure is less than 260°C for 10 seconds.



	ins.	mm
A	.620 MAX.	15.75 MAX.
B	.050-.075	1.27-1.91
C	.028-.034	0.71-0.86
D	.958-.962	24.33-24.43
E	.190-.210	4.83-5.33
F	.190-.210	4.83-5.33
G	.350 MAX. RAD.	8.89 MAX. RAD.
H	.570-.590	14.48-14.99
J	.142-.152 DIA.	3.61-3.86 DIA.
K	.360 MIN.	9.14 MIN.
L	.250-.340	6.35-8.64

4-Pin TO-66



Microsemi Corp.
Watertown
The diode experts

ABSOLUTE MAXIMUM RATINGS

	PIC600	PIC601	PIC602	PIC610	PIC611	PIC612
Input Voltage, V_{4-2}	60V	80V	100V	—60V	—80V	—100V
Output Voltage, V_{1-2}	60V	80V	100V	—60V	—80V	—100V
Drive-Input Reverse Voltage, V_{3-4}	5V	5V	5V	—5V	—5V	—5V
Output Current, I_1	5A	5A	5A	—5A	—5A	—5A
Drive Current, I_3	—0.2A	—0.2A	—0.2A	0.2A	0.2A	0.2A

Thermal Resistance
- Junction to Case, θ_{J-C}
  - Power Switch .... 4.0°C/W
  - Commutating Diode .... 4.0°C/W
- Case to Ambient, θ_{C-A} .... 60.0°C/W

Operating Temperature Range, T_C .... —55°C to +125°C

Maximum Junction Temperature, T_j .... +150°C

Storage Temperature Range .... —65°C to +150°C

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ELECTRICAL SPECIFICATIONS (at 25°C unless noted)

Test	Symbol	PIC600, 601, 602 Min.	Typ.	Max.	PIC610, 611, 612 Min.	Typ.	Max.	Units	Conditions
Current Delay Time	t_{di}	—	20	40	—	20	40	ns	V_{in} — 25V(—25V)
Current Rise Time	t_{ri}	—	50	75	—	50	75	ns	V_{out} = 5V(—5V)
Voltage Rise Time	t_{rv}	—	30	50	—	30	50	ns	I_{out} = 2A(—2A)
Voltage Storage Time	t_{sv}	—	700	—	—	700	—	ns	I_3 = —20mA(20mA) NOTE 5
Voltage Fall Time	t_{fv}	—	50	75	—	50	75	ns	See Figure 2.
Current Fall Time	t_{fi}	—	70	150	—	70	150	ns	See notes 1., 2., 4.
Efficiency (Notes 2. & 4.)	η	—	85	—	—	85	—	%	
On-State Voltage (Note 3.)	$V_{4-1(on)}$	—	1.0	1.5	—	—1.0	—1.5	V	I_4 = 2A(—2A), I_3 = —.02A(.02A) NOTE 5
On-State Voltage (Note 3.)	$V_{4-1(on)}$	—	2.5	3.5	—	—2.5	—3.5	V	I_4 = 5A(—5A), I_3 = —.02A(.02A) NOTE 5
Diode Forward Voltage (Note 3.)	$V_{2-1(on)}$	—	.8	1.0	—	—.8	—1.0	V	I_2 = 2A(—2A)
Diode Forward Voltage (Note 3.)	$V_{2-1(on)}$	—	1.0	1.5	—	—1.0	—1.5	V	I_2 = 5A(—5A)
Off-State Current	I_{4-1}	—	0.1	10	—	—0.1	—10	μA	V_4 = Rated input voltage
Off-State Current	I_{4-1}	—	10	—	—	—10	—	μA	V_4 = Rated input voltage, T_A = 100°C
Diode Reverse Current	I_{1-2}	—	1.0	10	—	—1.0	—10	μA	V_1 = Rated output voltage
Diode Reverse Current	I_{1-2}	—	500	—	—	500	—	μA	V_1 = Rated output voltage, T_A = 100°C

NOTES:
1. In switching an inductive load, the current will lead the voltage on turn on and lag the voltage on turn-off (see Figure 2.). Therefore, Voltage Delay Time (t_{DV}) ≅ t_{di} + t_{ri} and Current Storage Time (t_{si}) ≅ t_{sv} + t_{fv}.
2. The efficiency is a measure of internal power losses and is equal to Output Power divided by Input Power. The switching speed circuit of Figure 1., in which the efficiency is measured, is representative of typical operating conditions for the PIC600 switching regulators.
3. Pulse test: Duration = 300μs, Duty Cycle ≤ 2%.
4. As can be seen from the switching waveforms shown in Figure 2., no reverse of forward recovery spike is generated by the commutating diode during switching! This reduces self-generated noise, since no current spike is fed through the switching regulator. It also improves efficiency and reliabilty, since the power switch only carries current during turn-on.
5. To insure safe operation I_3 should be ≥|20mA| during T_{ON}. Operation at I_3 <|20mA| can permanently damage device.

POWER DISSIPATION CONSIDERATIONS

The total power losses in the switching regulator is the sum of the switching losses, and the power switch and diode D.C. losses. Once total power dissipation has been determined, the Power Dissipation curve, or thermal resistance data may be used to determine the allowable case or ambient temperature for any operating condition.

The switching losses curve presents data for a frequency of 20KHz. To find losses at any other frequency, multiply by f/20KHz.

The D.C. losses curve presents data for a duty cycle of .2. To find D.C. losses at any other duty cycle, multiply by D/.2 for the power switch and by (1-D)/.8 for the diode.

At frequencies much below 10KHz the above method for determining the allowable case or ambient temperature becomes invalid and a detailed transient thermal analysis must be performed.

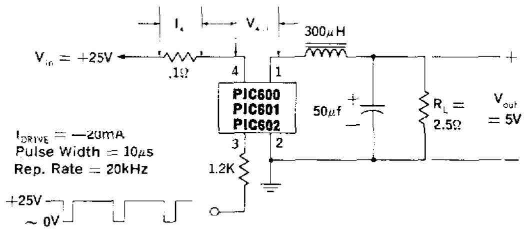

Figure 1. PIC600, 601, 602 Switching Speed Circuit

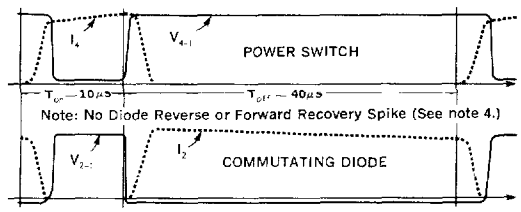

Figure 2. PIC600, PIC601, PIC602 Switching Waveforms

Note: PIC610, PIC611, PIC612 Test Circuit and waveforms are identical but of opposite polarity (V_{in} = −25V, V_{out} = −5V, I_{DRIVE} = +20mA).

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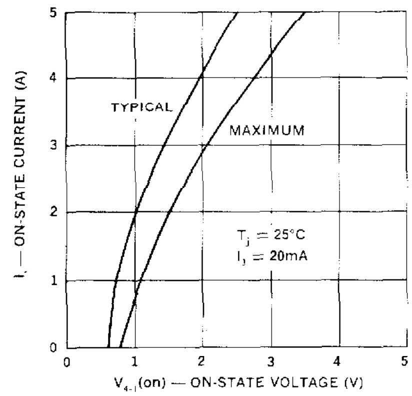
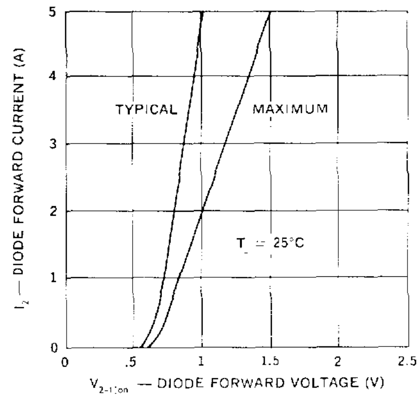
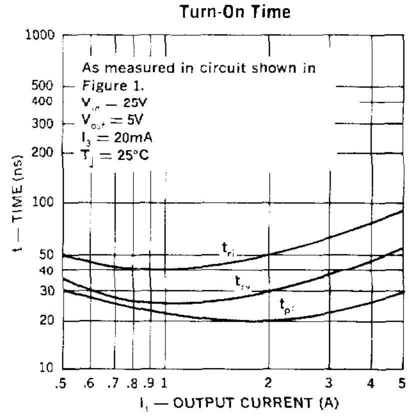
On-State Characteristics



Diode Forward Characteristics



Turn-On Time



Fall Time