## PT7705—5V

**18 Amp "Big-Hammer" Programmable
Integrated Switching Regulator**

**Power Trends Products
from Texas Instruments**

**SLTS045A**

*(Revised 6/30/2000)*

The PT7705 is a series of high-performance, 18 Amp Integrated Switching Regulators (ISRs) housed in a 27-pin SIP package. The 18A capability allows easy integration of the latest high-speed, low-voltage µPs and bus drivers into existing 5V systems.

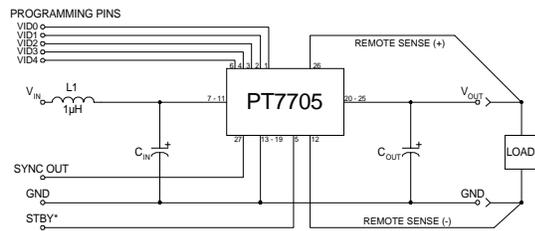The PT7705 series has been designed to work in parallel with one or more of the PT7749 - 18A current boosters for increased $I_{out}$ in increments of 18A.

The output voltage of the PT7705 can be easily programmed from 1.3V to 3.5V with a 5 bit input compatible with Intel's Pentium® II Processor. A differential remote sense is also provided which automatically compensates for any voltage drop from the ISR to the load.

1200µF of output capacitance are required for proper operation.

## Standard Application

PROGRAMMING PINS
VID0
VID1
VID2
VID3
VID4

$V_{IN}$
L1
1µH
PT7705
7 - 11
$C_{IN}$
27  13 - 19  5  12
SYNC OUT
GND
STBY*

REMOTE SENSE (+)
20 - 25
26
$V_{OUT}$
$C_{OUT}$
LOAD
GND
REMOTE SENSE (-)

$C_{in}$ = Required 1200µF electrolytic
$C_{out}$ = Required 1200µF electrolytic
L1 = Optional 1µH input choke

## Pin-Out Information

| Pin | Function | Pin | Function | Pin | Function |
|-----|----------|-----|----------|-----|----------|
| 1 | VID0 | 10 | $V_{in}$ | 18 | GND |
| 2 | VID1 | 11 | $V_{in}$ | 19 | GND |
| 3 | VID2 | 12 | Remote Sense Gnd | 20 | $V_{out}$ |
| 4 | VID3 | 13 | GND | 21 | $V_{out}$ |
| 5 | STBY* - Stand-by | 14 | GND | 22 | $V_{out}$ |
| 6 | VID4 | 15 | GND | 23 | $V_{out}$ |
| 7 | $V_{in}$ | 16 | GND | 24 | $V_{out}$ |
| 8 | $V_{in}$ | 17 | GND | 25 | $V_{out}$ |
| 9 | $V_{in}$ | | | 26 | Remote Sense $V_{out}$ |
| | | | | 27 | Sync Out |

For STBY* pin; open = output enabled
ground = output disabled.

## Specifications

| Characteristics ($T_a$ = 25°C unless noted) | Symbols | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Output Current | $I_o$ | $T_a$ = +60°C, 200 LFM, pkg N | | 0.1 (1) | — | 18 (2) | A |
| | | $T_a$ = +25°C, natural convection | | 0.1 (1) | — | 15 (2) | |
| Input Voltage Range | $V_{in}$ | $0.1A \leq I_o \leq 15A$ | | 4.5 (3) | — | 5.5 | V |
| Output Voltage Tolerance | $\Delta V_o$ | $V_{in}$ = +5V, $I_o$ = 15A  0°C ≤ $T_a$ ≤ +65°C | | $V_o$-0.03 | — | $V_o$+0.03 | V |
| Line Regulation | $Reg_{line}$ | 4.5V ≤ $V_{in}$ ≤ 5.5V, $I_o$ = 15A | | — | ±10 | — | mV |
| Load Regulation | $Reg_{load}$ | $V_{in}$ = +5V, 0.1 ≤ $I_o$ ≤ 15A | | — | ±10 | — | mV |
| $V_o$ Ripple/Noise | $V_n$ | $V_{in}$ = +5V, $I_o$ = 15A | | — | 50 | — | mV |
| Transient Response with $C_{out}$ = 1200µF | $t_{tr}$  $V_{os}$ | $I_o$ step between 7.5A and 15A  $V_o$ over/undershoot | | —  — | 100  200 | —  — | µSec  mV |
| Efficiency | η | $V_{in}$ = +5V, $I_o$ = 10A | $V_o$ = 3.3V  $V_o$ = 2.9V  $V_o$ = 2.5V  $V_o$ = 1.8V  $V_o$ = 1.5V | —  —  —  —  — | 89  87  85  79  77 | —  —  —  —  — | % |
| Switching Frequency | $f_o$ | 4.5V ≤ $V_{in}$ ≤ 5.5V  $0.1A \leq I_o \leq 15A$ | | 650 | 700 | 750 | kHz |
| Absolute Maximum Operating Temperature Range | $T_a$ | Over $V_{in}$ Range | | 0 | — | +85 (4) | °C |
| Storage Temperature | $T_s$ | — | | -40 | — | +125 | °C |
| Mechanical Shock | | Per Mil-STD-883D, Method 2002.3  1 msec, Half Sine, mounted to a fixture | | — | 500 | — | G's |
| Mechanical Vibration | | Per Mil-STD-883D, Method 2007.2,  20-2000 Hz, Soldered in a PC board | | — | 10 | — | G's |
| Weight | — | Vertical/Horizontal | | — | 31/41 | — | grams |

**Notes:** (1) ISR will operate down to no load with reduced specifications. Please note that this product is not short-circuit protected.
(2) The PT7705 series can be easily paralleled with one or more of the PT7749 Current Boosters to provide increased output current in increments of 18A.
(3) The minimum input voltage is 4.5V or $V_{out}$+1.2V, whichever is greater.
(4) See SOA curves or consult the factory for the appripriate derating.

**Output Capacitors:** *The PT7705 series requires a minimum ouput capacitance of 1200µF for proper operation. Do not use Oscon type capacitors. The maximum allowable output capacitance is 15,000µF. See Capacitor Application Note.*

**Input Filter:** *An input filter is optional for most applications. The input inductor must be sized to handle 15ADC with a typical value of 1µH. The input capacitance must be rated for a minimum of 1.3Arms of ripple current. For transient or dynamic load applications, additional capacitance may be required.*

# PT7705—5V

## 18 Amp "Big-Hammer" Programmable Integrated Switching Regulator

### Features

- Single-Device: +5V input
- 5-bit Programmable:
  1.3V to 3.5V@18A
- High Efficiency
- Input Voltage Range:
  4.5V to 5.5V
- Differential Remote Sense
- 27-pin SIP Package
- Parallelable with PT7749
  18A "Current Boosters"

### Programming Information

| VID3 | VID2 | VID1 | VID0 | VID4=1 Vout | VID4=0 Vout |
|------|------|------|------|-------------|-------------|
| 1 | 1 | 1 | 1 | 2.0V | 1.30V |
| 1 | 1 | 1 | 0 | 2.1V | 1.35V |
| 1 | 1 | 0 | 1 | 2.2V | 1.40V |
| 1 | 1 | 0 | 0 | 2.3V | 1.45V |
| 1 | 0 | 1 | 1 | 2.4V | 1.50V |
| 1 | 0 | 1 | 0 | 2.5V | 1.55V |
| 1 | 0 | 0 | 1 | 2.6V | 1.60V |
| 1 | 0 | 0 | 0 | 2.7V | 1.65V |
| 0 | 1 | 1 | 1 | 2.8V | 1.70V |
| 0 | 1 | 1 | 0 | 2.9V | 1.75V |
| 0 | 1 | 0 | 1 | 3.0V | 1.80V |
| 0 | 1 | 0 | 0 | 3.1V | 1.85V |
| 0 | 0 | 1 | 1 | 3.2V | 1.90V |
| 0 | 0 | 1 | 0 | 3.3V | 1.95V |
| 0 | 0 | 0 | 1 | 3.4V | 2.00V |
| 0 | 0 | 0 | 0 | 3.5V | 2.05V |

Logic 0 = Pin 12 potential (remote sense gnd)
Logic 1 = Open circuit (no pull-up resistors)
VID3 and VID4 may not be changed while the unit is operating.

### Ordering Information

**PT7705☐** = 1.3 to 3.5 Volts

*(For dimensions and PC board layout, see Package Styles 800 and 810.)*
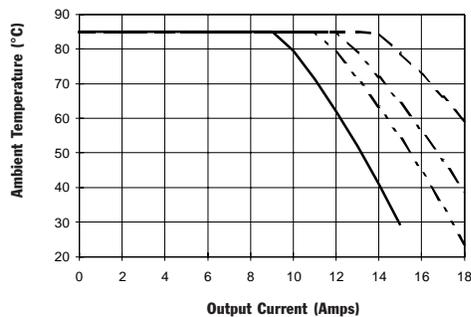
### PT Series Suffix (PT1234X)

**Case/Pin Configuration**

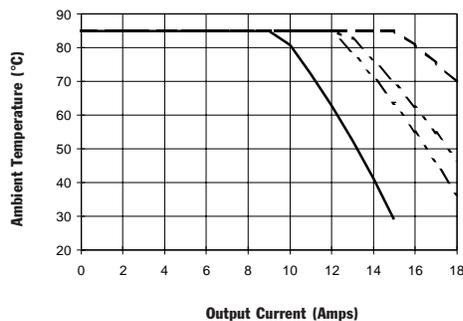| | |
|---|---|
| Vertical Through-Hole | **N** |
| Horizontal Through-Hole | **A** |
| Horizontal Surface Mount | **C** |

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# TYPICAL CHARACTERISTICS

## PT7705, $V_o$ = 3.3 VDC   (See Note B)

### Safe Operating Area Curves (@$V_{in}$=+5V)
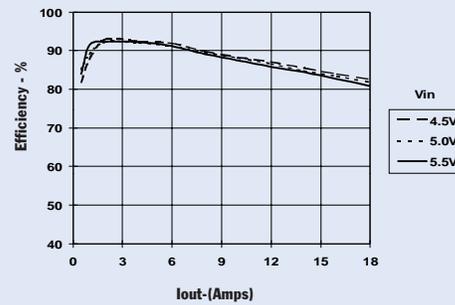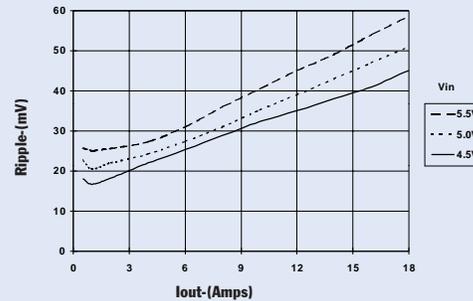
#### PKG SUFFIX N



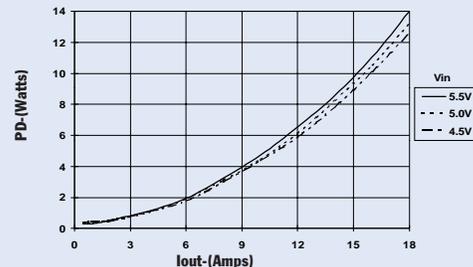#### PKG SUFFIX A, C



## PT7705, $V_o$ = 3.3 VDC   (See Note A)

### Efficiency vs Output Current



### Ripple vs Output Current



### Power Dissipation vs Output Current



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**Note A:** *All Characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.*
**Note B:** *SOA curves represent operating conditions at which internal components are at or below manufacturer's maximum rated operating temperatures.*

## Pin-Coded Output Voltage Adjustment on the "Big Hammer" Series ISRs

The ISRs related to Power Trends' PT7705 incorporate pin-coded voltage control to adjust the ouput voltage. The control pins are identified VID0 - VID4 (pins 1, 2, 3, 4, & 6) respectively. When the control pins are left open-circuit, the ISR output will regulate at its factory trimmed output voltage. Each pin is internally connected to a precision resistor, which when grounded changes the output voltage by a set amount. By selectively grounding VID0 -VID4, the output voltage these ISRs can be programmed in incremental steps over the specified output voltage range. In each case, the program code and output voltage range offered by these ISRs are compatible with the voltage ID specification defined by Intel Corporation for voltage regulator modules (VRMs) used to power Pentium® microprocessors. Refer to Figure 1 below for the connection schematic, and the respective device Data Sheet for the appropriate programming code information.

### Notes:

1. The programming convention is as follows:-

   Logic 0:   Connect to pin12 (Remote Sense Ground).
   Logic 1:   Open circuit/open drain (See notes 2, & 4)
2. Do not connect pull-up resistors to the voltage programming pins.
3. To minimize output voltage error, always use pin 12 (Remote Sense Ground) as the logic "0" reference. While the regular ground (pins 13-19) can also be used for programming, doing so will degrade the load reglation of the product.

4. If active devices are used to ground the voltage control pins, low-level open drain MOSFET devices should be used over bipolar transistors. The inherent $V_{ce}(sat)$ in bipolar devices introduces errors in the device's internal divider network. Discrete transistors such as the BSS138, 2N7002, IRLML2402, or the 74C906 hex open-drain buffer are examples of appropriate devices.

### Active Voltage Programming:

Special precautions should be taken when making changes to the voltage control progam code while the unit is powered. It is highly recommended that the ISR be either powered down or held in standby. Changes made to the program code while $V_{out}$ is enabled induces high current transients through the device. This is the result of the electrolytic output capacitors being either charged or discharged to the new output voltage set-point. The transient current can be minimized by making only incremental changes to the binary code, i.e. one LSB at a time. A minimum of 100μs settling time between each program state is also recommended. Making non-incremental changes to VID3 and VID4 with the output enabled is discouraged. If they are changed, the transients induced can overstress the device resulting in a permanent drop in efficiency. If the use of active devices prevents the program code being asserted prior to power-up, pull pin 5 (STBY) to the device GND during the period that the input voltage is applied to $V_{in}$. Releasing pin 5 will then allow the device output to execute a soft-start power-up to the programmed voltage.

*Figure 1*
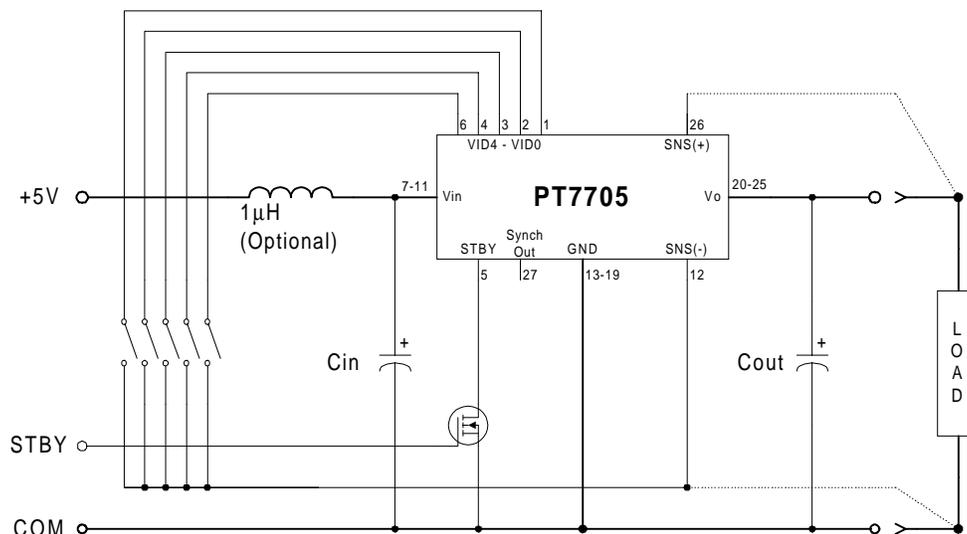
## Using the Standby Function on the "Big Hammer" Programmable ISR Series

For applications requiring output voltage On/Off control, the PT7705 "Big Hammer" ISRs incorporate a standby function[1] . This feature may be used for power-up/shutdown sequencing, and to change the output voltage while input power is applied. _See related notes:_ "Pin-coded Output Voltage Adjustment on the 'Big Hammer' Series ISRs."

The standby function is provided by the _STBY_* control, pin 5. If pin 5 is left open-circuit the regulator operates normally, providing a regulated output whenever a valid supply voltage is applied to $V_{in}$ (pins 7-11) with respect to GND (pins 13-19). Connecting pin 5 to ground[2] will set the regulator output to zero volts[3] . This places the regulator in standby mode, and reduces the input current to typcially 45mA (75mA max). If a ground signal is applied to pin 5 prior to power-up, the regulator output will be held at zero volts during the period that input power is applied.

The standby input must be controlled with an open-collector (or open-drain) discrete transistor (See Figure 1). Table 1 gives the threshold requirements.

_Table 1 Inhibit Control Threshold_[2]

| Parameter | Min | Max |
|---|---|---|
| Disable ($V_{IL}$) | –0.1V | 0.3V |

### Notes:

1. The Standby/Inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will be different. For specific information on this function for other regulator models, consult the applicable application note.
2. The Standby input on the PT7705 regulator series must be controlled using an open-collector (or open-drain) discrete transistor. _Do Not_ use a pull-up resistor. The control input has an open-circuit voltage of about 1.5Vdc. To set the regulator output to zero, the control pin must be "pulled" to less than 0.3Vdc with a low-level 0.1mA sink to ground.
3. When placed in the standby mode, the regulator output discharges the output capacitance with a low impedance to ground. If an external voltage is applied to the output, it will sink current and possibly over-stress the part.
4. The turn-off time of $Q_1$, or rise time of the standby input is not critical on the PT7705 series. Turning $Q_1$ off slowly, over periods up to 100ms, will not affect regulator operation. However, a slow turn-off time will increase both the initial delay and rise-time of the output voltage.

_Figure 1_
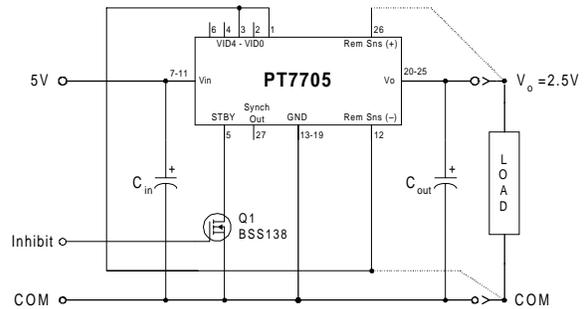


**Turn-On Time:** Turning $Q_1$ in Figure 1 off, removes the low-voltage signal at pin 5 and enables the output. Following a brief delay of 5-10ms, the output voltage of the PT7705 series regulators rise to full regulation within 15ms[4] . Figure 2 shows the typical output voltage waveform of a PT7705 following the prompt turn-off of $Q_1$ at time t =0 secs. The output voltage in Figure 1 is set to 2.5V by connecting VID0 (pin 1), and VID2 (pin 3) to the Remote Sense Gnd (pin 12)*. The waveform in Figure 2 was measured with a 5V input source voltage, and 10A resistive load.

_Figure 2_
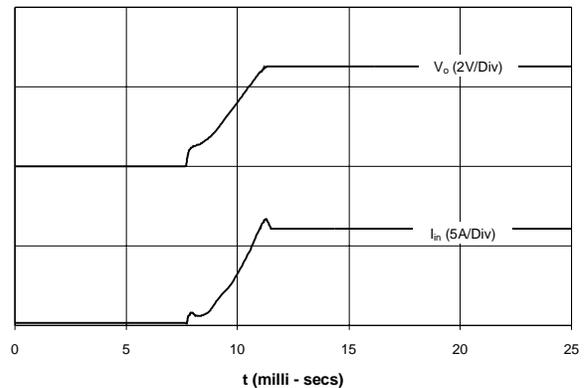


* Consult the data sheet for details on other VID codes.

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