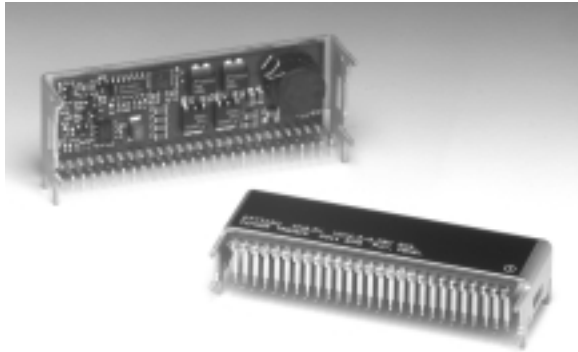




### Features

- 3.3V Input Voltage
- 20-A Output Current
- 5-bit Programmable:  
0.8V to 1.575V (25mV Steps)
- High Efficiency (85%)
- Differential Remote Sense
- Over-Current Protection
- 27-Pin Space-Saving Package
- Solderable Copper Case
- Compatible with PT7744  
20A "Current Booster"

### Description

The PT7714 Excalibur™ power module is a 20-A integrated switching regulator (ISR) housed a 27-pin space-saving copper package. Operating from a 3.3V-input bus, the PT7714 produces a tightly regulated supply voltage that is programmable over the range, 0.8V to 1.575V. The output voltage is selected via a 5-bit input code in incremental steps of 25mV.

This regulator is suitable for applications that employ the latest microprocessor and DSP products that require core supply voltages as low as 0.8V.

The PT7714 incorporates output short-circuit protection, and a differential remote sense to compensate for voltage drop between the regulator and load.

### Ordering Information

**PT7714□** = 0.8 to 1.575V

**PT7744□** = 20-A Booster \*

\* Consult the related application note for information on current booster operation.

### PT Series Suffix (PT1234 x)

| Case/Pin Configuration | Order Suffix | Package Code † |
|------------------------|--------------|----------------|
| Vertical               | <b>N</b>     | (ENE)          |
| Horizontal             | <b>A</b>     | (ENF)          |
| SMD                    | <b>C</b>     | (ENG)          |

† Previously known as package styles 1420 & 1430

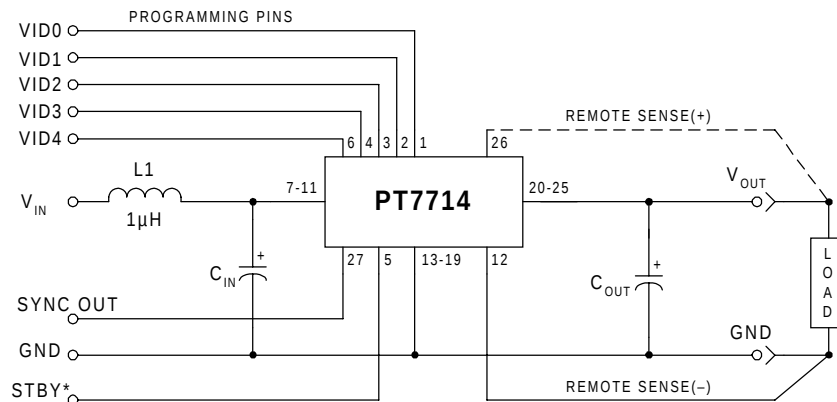
(Reference the applicable package code drawing for the dimensions and PC board layout)

### Pin-Out Information

| Pin | Function        | Pin | Function               |
|-----|-----------------|-----|------------------------|
| 1   | VID0            | 15  | GND                    |
| 2   | VID1            | 16  | GND                    |
| 3   | VID2            | 17  | GND                    |
| 4   | VID3            | 18  | GND                    |
| 5   | STBY*           | 19  | GND                    |
| 6   | VID4            | 20  | V <sub>out</sub>       |
| 7   | V <sub>in</sub> | 21  | V <sub>out</sub>       |
| 8   | V <sub>in</sub> | 22  | V <sub>out</sub>       |
| 9   | V <sub>in</sub> | 23  | V <sub>out</sub>       |
| 10  | V <sub>in</sub> | 24  | V <sub>out</sub>       |
| 11  | V <sub>in</sub> | 25  | V <sub>out</sub>       |
| 12  | Sense Gnd*      | 26  | Sense V <sub>out</sub> |
| 13  | GND             | 27  | Sync Out               |
| 14  | GND             |     |                        |

For STBY\* pin: open =output enabled  
ground =output disabled.

### Standard Application



C<sub>in</sub> = Required 1500µF electrolytic  
C<sub>out</sub> = Required 330µF electrolytic  
L<sub>1</sub> = Optional 1µH input choke

## Programming Information

| VID3 | VID2 | VID1 | VID0 | VID4=1<br>V <sub>out</sub> | VID4=0<br>V <sub>out</sub> |
|------|------|------|------|----------------------------|----------------------------|
| 1    | 1    | 1    | 1    | 0.800V                     | 1.200V                     |
| 1    | 1    | 1    | 0    | 0.825V                     | 1.225V                     |
| 1    | 1    | 0    | 1    | 0.850V                     | 1.250V                     |
| 1    | 1    | 0    | 0    | 0.875V                     | 1.275V                     |
| 1    | 0    | 1    | 1    | 0.900V                     | 1.300V                     |
| 1    | 0    | 1    | 0    | 0.925V                     | 1.325V                     |
| 1    | 0    | 0    | 1    | 0.950V                     | 1.350V                     |
| 1    | 0    | 0    | 0    | 0.975V                     | 1.375V                     |
| 0    | 1    | 1    | 1    | 1.000V                     | 1.400V                     |
| 0    | 1    | 1    | 0    | 1.025V                     | 1.425V                     |
| 0    | 1    | 0    | 1    | 1.050V                     | 1.450V                     |
| 0    | 1    | 0    | 0    | 1.075V                     | 1.475V                     |
| 0    | 0    | 1    | 1    | 1.100V                     | 1.500V                     |
| 0    | 0    | 1    | 0    | 1.125V                     | 1.525V                     |
| 0    | 0    | 0    | 1    | 1.150V                     | 1.550V                     |
| 0    | 0    | 0    | 0    | 1.175V                     | 1.575V                     |

Logic 0 = Pin 12 potential (Rem Sense Gnd)

Logic 1 = Open circuit (no pull-up resistors)

VID4 may not be changed while the unit is operating.

## PT7710 Product Family Comparison

| Product | Input Voltage | Description | Adjust Method | Output Range |
|---------|---------------|-------------|---------------|--------------|
| PT7711  | 5V            | VID         | 5-Bit         | 1.3V– 3.5V   |
| PT7712  | 3.3V          | VID         | 4-Bit         | 1.3V– 2.05V  |
| PT7713  | 3.3V          | VID         | 4-Bit         | 1.8V– 2.55V  |
| PT7714  | 3.3V          | VID         | 5-Bit         | 0.8V–1.575V  |
| PT7715  | 5V            | VID         | 5-Bit         | 1.075V–1.85V |
| PT7716  | 3.3V          | VID         | 5-Bit         | 1.075V–1.85V |
| PT7744  | 3.3V          | Booster     | —             | —            |
| PT7745  | 5V            | Booster     | —             | —            |

Specifications (Unless otherwise stated, T<sub>a</sub> = 25°C, V<sub>in</sub> = 3.3V, C<sub>in</sub> = 1.500μF, V<sub>out</sub> = 1.5V, C<sub>out</sub> = 330μF, and I<sub>o</sub> = I<sub>o</sub>max)

| Characteristics<br>(T <sub>a</sub> = 25°C unless noted) | Symbols                 | Conditions                                                                           | PT7714                                   |                   |                    | Units                           |
|---------------------------------------------------------|-------------------------|--------------------------------------------------------------------------------------|------------------------------------------|-------------------|--------------------|---------------------------------|
|                                                         |                         |                                                                                      | Min                                      | Typ               | Max                |                                 |
| Output Current                                          | I <sub>o</sub>          | T <sub>a</sub> = +25°C, Natural convection<br>T <sub>a</sub> = +60°C, 200 LFM, pkg N | 0.1 <sup>(1)</sup><br>0.1 <sup>(1)</sup> | —                 | 20<br>19           | A                               |
| Input Voltage Range                                     | V <sub>in</sub>         | Over I <sub>o</sub> range                                                            | 3.1                                      | —                 | 3.6                | V                               |
| Set-Point Voltage Tolerance                             | V <sub>o</sub> tol      | All output voltages                                                                  | —                                        | ±10               | ±25 <sup>(2)</sup> | mV                              |
| Temperature Variation                                   | Reg <sub>temp</sub>     | –40°C ≤ T <sub>a</sub> ≤ +85°C, I <sub>o</sub> = I <sub>o</sub> min                  | —                                        | ±0.75             | —                  | %V <sub>o</sub>                 |
| Line Regulation                                         | Reg <sub>line</sub>     | Over V <sub>in</sub> range                                                           | —                                        | ±5                | ±10                | mV                              |
| Load Regulation                                         | Reg <sub>load</sub>     | Over I <sub>o</sub> range                                                            | —                                        | ±5                | ±10                | mV                              |
| Total Output Voltage Variation                          | ΔV <sub>o</sub> tol     | Set-point, line, load<br>–40°C ≤ T <sub>a</sub> ≤ +85°C                              | —                                        | ±1                | ±3                 | %V <sub>o</sub>                 |
| Efficiency                                              | η                       | I <sub>o</sub> = 10A                                                                 | V <sub>o</sub> = 1.5V                    | —                 | 85                 | —                               |
|                                                         |                         |                                                                                      | V <sub>o</sub> = 1.2V                    | —                 | 82                 |                                 |
|                                                         |                         |                                                                                      | V <sub>o</sub> = 0.8V                    | —                 | 75                 |                                 |
|                                                         |                         | I <sub>o</sub> = 20A                                                                 | V <sub>o</sub> = 1.5V                    | —                 | 80                 | —                               |
|                                                         |                         |                                                                                      | V <sub>o</sub> = 1.2V                    | —                 | 77                 |                                 |
|                                                         |                         |                                                                                      | V <sub>o</sub> = 0.8V                    | —                 | 69                 |                                 |
| V <sub>o</sub> Ripple (pk-pk)                           | V <sub>r</sub>          | 20MHz bandwidth                                                                      | —                                        | 50                | —                  | mV <sub>pp</sub>                |
| Transient Response                                      | t <sub>tr</sub>         | 1A/μs load step, 50% to 100% I <sub>o</sub> max                                      | —                                        | 50                | —                  | μSec                            |
|                                                         | V <sub>os</sub>         | V <sub>o</sub> over/undershoot                                                       | —                                        | ±100              | —                  | mV                              |
| Short Circuit Threshold                                 | I <sub>sc</sub> (pk)    | Reset followed by auto-recovery                                                      | —                                        | 32                | —                  | A                               |
| Switching Frequency                                     | f <sub>o</sub>          | Over V <sub>in</sub> range                                                           | 300                                      | 350               | 400                | kHz                             |
| STBY* Input Requirements                                | Input High Voltage      |                                                                                      | V <sub>IH</sub>                          | Referenced to GND | 2.0                | Open <sup>(3)</sup><br>0.8<br>— |
|                                                         | Input Low Voltage       |                                                                                      | V <sub>IL</sub>                          |                   | –0.2               |                                 |
|                                                         | Input Low Current       |                                                                                      | I <sub>IL</sub>                          | Pin 5 to GND      | —                  | 0.3                             |
| Standby Input Current                                   | I <sub>in</sub> standby | pin 5 to GND                                                                         | —                                        | 30                | —                  | mA                              |
| External Capacitance                                    | C <sub>out</sub>        |                                                                                      | 330 <sup>(4)</sup>                       | —                 | 15,000             | μF                              |
| Operating Temperature Range                             | T <sub>a</sub>          | Over V <sub>in</sub> Range                                                           | –40                                      | —                 | +85 <sup>(5)</sup> | °C                              |
| Storage Temperature                                     | T <sub>s</sub>          | —                                                                                    | –40                                      | —                 | +125               | °C                              |
| Mechanical Shock                                        |                         | Per Mil-STD-883D, Method 2002.3<br>1 msec, Half Sine, mounted to a fixture           | —                                        | 500               | —                  | G's                             |
| Mechanical Vibration<br>Mil-STD-883D, 20–2000 Hz        | Through-Hole            |                                                                                      | —                                        | 20 <sup>(6)</sup> | —                  | G's                             |
|                                                         | SMD                     |                                                                                      | —                                        | 15 <sup>(6)</sup> | —                  |                                 |
| Weight                                                  | —                       | Vertical/Horizontal                                                                  | —                                        | 36                | —                  | grams                           |
| Flammability                                            | —                       | Materials meet UL 94V-0                                                              | —                                        | —                 | —                  | —                               |

**Notes:** (1) ISR-will operate down to no load with reduced specifications.

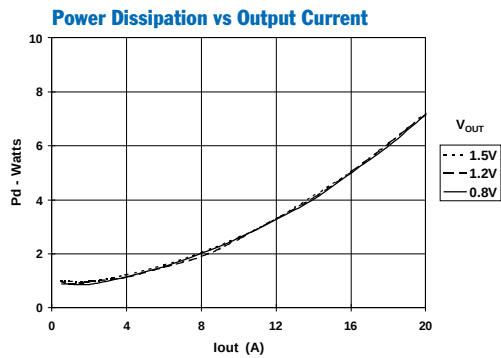
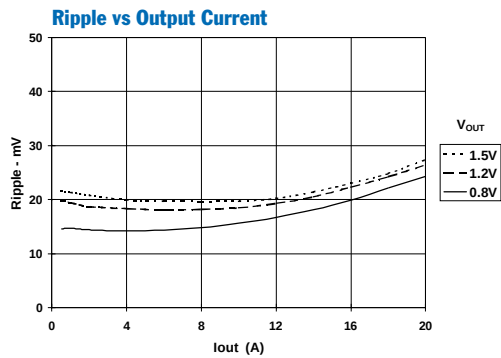
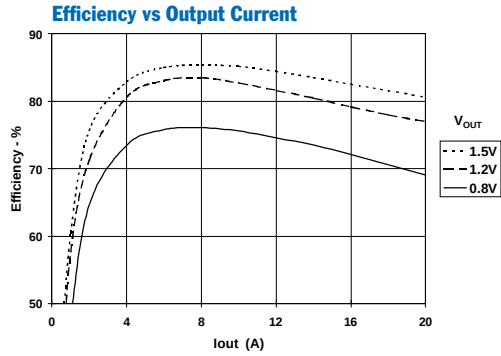
(2) If the remote sense ground is not used, pin 12 must be connected to pin 13 for optimum output voltage accuracy.

(3) The STBY\* control (pin 5) has an internal pull-up. If it is left open-circuit, the module will operate when input power is applied. A low-leakage (<1μA) MOSFET must be used to control this pin. The open-circuit voltage may be as high as V<sub>in</sub>.(4) For operation below 0°C, C<sub>in</sub> and C<sub>out</sub> must have stable characteristics. Use either low ESR tantalum or Oscon® capacitors.

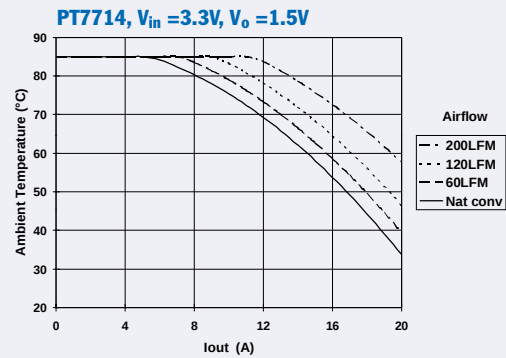
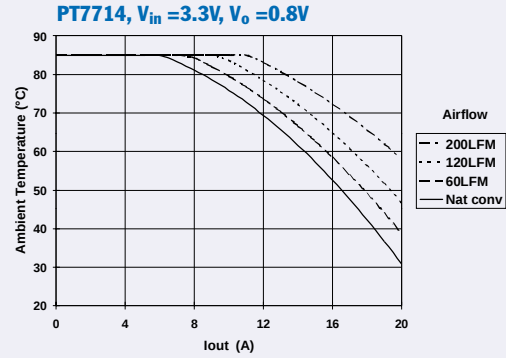
(5) See safe Operating Area curves or consult factory for the appropriate derating.

(6) The case pins on the through-hole package types (suffixes N &amp; A) must be soldered. For more information see the applicable package outline drawing.

**External Capacitors:** The PT7714 require a minimum output capacitance of 330μF for proper operation. The PT7714 also requires an input capacitance of 1500μF, which must be rated for a minimum of 1.4Arms of ripple current. For transient or dynamic load applications, additional capacitance may be required. For further information refer to the application note regarding capacitor selection for this product.**Input Filter:** An input filter inductor is optional for most applications. The inductor must be sized to handle 20ADC with a typical value of 1μH.

Performance Characteristics,  $V_{in} = 3.3V$  (See Note A)

## Safe Operating Area Curves (See Note B)



**Note A:** All characteristic data in the above graphs has been developed from actual products tested at  $25^{\circ}C$ . This data is considered typical for the ISR.

**Note B:** SOA curves represent operating conditions at which internal components are at or below manufacturer's maximum rated operating temperatures.

## Capacitor Recommendations for the PT7710 Series of Regulators and Current Boosters

### Input Capacitors

The recommended input capacitance is determined by the 1.4 ampere minimum ripple current rating and 1500 $\mu$ F minimum capacitance. Capacitors listed below must be rated for a minimum of twice (2 $\times$ ) the input voltage with +5V operation. Ripple current and  $\leq 100\text{m}\Omega$  Equivalent Series Resistance (ESR) values are the major considerations along with temperature when selecting the proper capacitor.

### Output Capacitors

The minimum required output capacitance is 330 $\mu$ F with a maximum ESR less than or equal to 100m $\Omega$ . Failure to observe this requirement may lead to regulator instability or oscillation. Electrolytic capacitors have poor ripple performance at frequencies greater than 400kHz, but excellent low frequency transient response. Above the ripple frequency ceramic decoupling capacitors are necessary to improve the transient response and reduce any microprocessor high frequency noise components apparent during higher current excursions. Preferred low ESR type capacitor part numbers are identified in the Table 1-1 below.

### Tantalum Characteristics

Tantalum capacitors with a minimum 10-V rating are recommended on the output bus, but only the AVX TPS Series, Sprague 594/595 Series, or Kemet T495/T510 Series. These AVX, Sprague, and Kemet capacitors are specified over other types due to their higher surge current, excellent power dissipation and ripple current ratings. As a caution, the TAJ Series by AVX is not recommended. This series exhibits considerably higher ESR, reduced power dissipation and lower ripple current capability. The TAJ series is also less reliable compared to the TPS series when determining power dissipation capability.

### Capacitor Table

Table 1-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The suggested minimum quantities per regulator for both the input and output buses are identified.

*This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. The RMS ripple current rating and ESR (Equivalent Series Resistance at 100kHz) are the critical parameters necessary to insure both optimum regulator performance and long capacitor life.*

**Table 1-1 Capacitors Characteristic Data**

| Capacitor Vendor/<br>Series        | Capacitor Characteristics |                 |                                                                         |                                    |                          | Quantity  |               | Vendor Number                                         |
|------------------------------------|---------------------------|-----------------|-------------------------------------------------------------------------|------------------------------------|--------------------------|-----------|---------------|-------------------------------------------------------|
|                                    | Working Voltage           | Value( $\mu$ F) | (ESR) Equivalent Series Resistance                                      | 105°C Maximum Ripple Current(Irms) | Physical Size(mm)        | Input Bus | Output Bus    |                                                       |
| Panasonic<br>FC (SMT)              | 16V                       | 2200            | 0.038 $\Omega$                                                          | 2000mA                             | 18x16.5                  | 1         | 1             | EEVFC1C222N                                           |
|                                    | 35V                       | 330             | 0.065 $\Omega$                                                          | 1205mA                             | 12.5x16.5                |           | 1             | EEVFC1V331LQ                                          |
|                                    | FC (Radial)               | 10V             | 0.090 $\Omega$                                                          | 755mA                              | 10x12.5                  |           | 1             | EEUFC1A561                                            |
| United<br>Chemi -Con<br>LFZ Series | 16V                       | 1800            | 0.032 $\Omega$                                                          | 2000mA                             | 18x15                    | 1         | 1             | EEUFC1C182S                                           |
|                                    | 25V                       | 330             | 0.090 $\Omega$                                                          | 760mA                              | 10x12.5                  |           | 1             | LXZ25VB331M10X12LL                                    |
|                                    | 16V                       | 1500            | 0.038 $\Omega$                                                          | 1660mA                             | 12.5x20                  | 1         | 1             | LXZ16VB222M12X20LL                                    |
| Nichicon<br>PL Series<br>PM Series | 16V                       | 470             | 0.090 $\Omega$                                                          | 760mA                              | 10x12.5                  |           | 1             | LXZ16VB471M10X12LL                                    |
|                                    | 10V                       | 680             | 0.090 $\Omega$                                                          | 770mA                              | 10x15                    |           | 1             | UPL1A681MHH6                                          |
|                                    | 10V                       | 1800            | 0.044 $\Omega$                                                          | 1420mA                             | 16x15                    | 1         | 1             | UPL1A182MHH6                                          |
| Oscon<br>SS (Radial)<br>SVP (SMT)  | 25V                       | 330             | 0.095 $\Omega$                                                          | 750mA                              | 10x15                    |           | 1             | UPL1E331MPH6                                          |
|                                    | 10V                       | 330             | 0.025 $\Omega \pm 4 = 0.006\Omega$<br>0.02 $\Omega \pm 4 = 0.005\Omega$ | >9800mA<br>>9800mA                 | 10x10.5<br>9x8.3         | 4<br>4    | N/R<br>(Note) | 10SS330M<br>10SVP330M                                 |
| AVX<br>Tantalum<br>TPS- Series     | 10V                       | 330             | 0.1 $\Omega \pm 5 = 0.02\Omega$<br>0.06 $\Omega$                        | 3500mA<br>1826mA                   | 7.3Lx<br>4.3Wx<br>4.1H   | 5<br>5    | 1<br>1        | TPSV337M010R0100<br>TPSV337M010R0060                  |
|                                    | 10V                       | 330             | 0.045 $\Omega \pm 4 = 0.011\Omega$<br>0.09 $\Omega$                     | >4500mA<br>>1660mA                 | 7.3L x<br>5.7W x<br>4.0H | 5<br>2    | 1<br>1        | 594D337X0010R2T<br>595D687X0010R2T<br>(Surface Mount) |
| Sprague<br>Tantalum<br>595D/594D   | 10V                       | 680             | 0.035 $\Omega$                                                          | 2000mA                             | 4.3Wx7.3L<br>x4.0H       | 5         | 1             | 510X337M010AS                                         |
|                                    | 10V                       | 220             | 0.07 $\Omega \pm 2 = 0.035\Omega$                                       | >2000mA                            |                          | 6         | 2             | T495X227M010AS<br>(Surface Mount)                     |
| Sanyo Poscap<br>TPB                | 10V                       | 220             | 0.04 $\Omega$                                                           | 3000mA                             | 7.2L x<br>4.3W x<br>3.1H | 6         | 2             | 10TPB220M<br>(Surface Mount)                          |

**Note:** (N/R) is not recommended for this application, due to extremely low Equivalent Series Resistance (ESR)

**Notes:**

1. Each booster requires the same amount of input and output capacitance as recommended for a stand-alone regulator. Consult the individual data sheet of the applicable regulator, and the related application note regarding capacitor selection for this product family.
2. The 1- $\mu$ H filter choke located at the input of each regulator and booster module ( $L_{in}$ ) is optional for most applications. If specified, each inductor must be sized to handle 20ADC at full output load.
3. The pin-out of the current booster modules include a number pins identified, “No Connect” (see Table 2-2). These pins are not connected internally to the module but must be soldered to a pad to preserve the unit’s mechanical integrity.
4. A similar PCB footprint and trace layout between the regulator and each booster will facilitate current sharing between all modules.

### Table 2-2; Booster Pin-Out Information

| Pin | Function        | Pin | Function        | Pin | Function         |
|-----|-----------------|-----|-----------------|-----|------------------|
| 1   | No Connect      | 10  | V <sub>in</sub> | 19  | GND              |
| 2   | No Connect      | 11  | V <sub>in</sub> | 20  | V <sub>out</sub> |
| 3   | No Connect      | 12  | No Connect      | 21  | V <sub>out</sub> |
| 4   | No Connect      | 13  | GND             | 22  | V <sub>out</sub> |
| 5   | No Connect      | 14  | GND             | 23  | V <sub>out</sub> |
| 6   | No Connect      | 15  | GND             | 24  | V <sub>out</sub> |
| 7   | V <sub>in</sub> | 16  | GND             | 25  | V <sub>out</sub> |
| 8   | V <sub>in</sub> | 17  | GND             | 26  | No Connect       |
| 9   | V <sub>in</sub> | 18  | GND             | 27  | Sync In          |

### Using the Standby Function on the PT7710 Excalibur™ Series of 20-A ISRs

For applications requiring On/Off control of the output voltage, the PT7710 family of Excalibur ISRs incorporate a standby function. This feature may be used for power-up/shutdown sequencing, or to change the output voltage while input power is applied. *See related notes:* “Pin-Coded Output Voltage Adjustment of the PT7710 Excalibur™ Series of 20-A 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<sup>1</sup> will set the regulator output to zero volts<sup>2</sup>. This places the regulator in standby mode, and reduces the input current to typically 30mA (60mA 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 3-1 gives the input requirements.

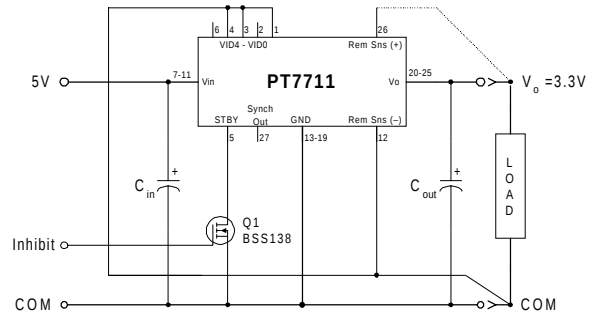
**Table 3-1 Standby Control Input Requirements<sup>(1, 2)</sup>**

| Parameter        | Min   | Typ      | Max                    |
|------------------|-------|----------|------------------------|
| Enable           | 2V    |          | Open Cct. <sup>1</sup> |
| Disable          | -0.2V |          | 0.8V                   |
| $I_{stby} (low)$ |       |          | 0.5mA                  |
| $V_{stby} (o/c)$ |       | $V_{in}$ |                        |

#### Notes:

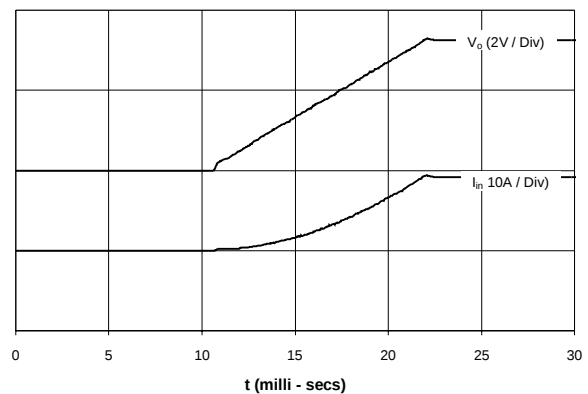
1. The Standby input on the PT7710 regulator family must be controlled using an open-collector (or open-drain) discrete transistor. *Do Not* use a pull-up resistor. The control input has an open-circuit voltage equal to  $V_{in}$ . To set the regulator output to zero, the control pin must be “pulled” to less than 0.8Vdc with a 0.5mA sink to ground.
2. When placed in the standby mode, the regulator output discharges the output capacitance with a low impedance to ground.
3. The turn-off time of  $Q_1$ , or rise time of the standby input is not critical with the PT7710 family. 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 3-1**



**Turn-On Time:** Turning  $Q_1$  in Figure 3-1 off, removes the low-voltage signal at pin 5 and enables the output. After a delay of approximately 10ms, the output voltage of a PT771x regulator rises to full regulation within 30ms<sup>3</sup>. Figure 3-2 shows the typical output voltage waveform of a PT7711 following the turn-off of  $Q_1$  at time  $t = 0$  secs. The output voltage in Figure 3-1 is set to 3.3V by connecting VID0 (pin 1), VID2 (pin 3), and VID3 (pin 4) to the ‘Rem Sense Gnd’ (pin 12)\*. The waveform was measured with a +5V input source voltage, and 10-A resistive load.

**Figure 3-2**



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

### Pin-Coded Output Voltage Adjustment of the PT7710 Excalibur™ Series of 20-A ISRs

The PT7710 Excalibur™ family of converters incorporate a pin-coded control to adjust the output voltage. This feature uses the control pins VID0–VID4 (pins 1–6). When the control pins are left open-circuit, the ISR output regulates at its default output voltage. Each control pin is internally connected to a precision resistor, which when grounded applies a weighted change to the output voltage. By selectively grounding VID0–VID4, the output voltage of these ISRs can be programmed in incremental steps over the specified output voltage range. The program codes and output voltage range offered by these ISRs are compatible with the Voltage ID specifications defined by Intel Corporation for VRMs (voltage regulator modules). The codes are used by both the Pentium® and Athlon® microprocessors. Refer to Figure 4-1 for the connection schematic, and the respective device Data Sheet for the programming code information.

#### Notes:

1. The programming convention is as follows:-  
Logic 0: Connect to pin 12 (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. 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 regulation of the product. If the remote sense ground is not used, pin 12 must be connected to pin 13 for optimum output voltage accuracy.

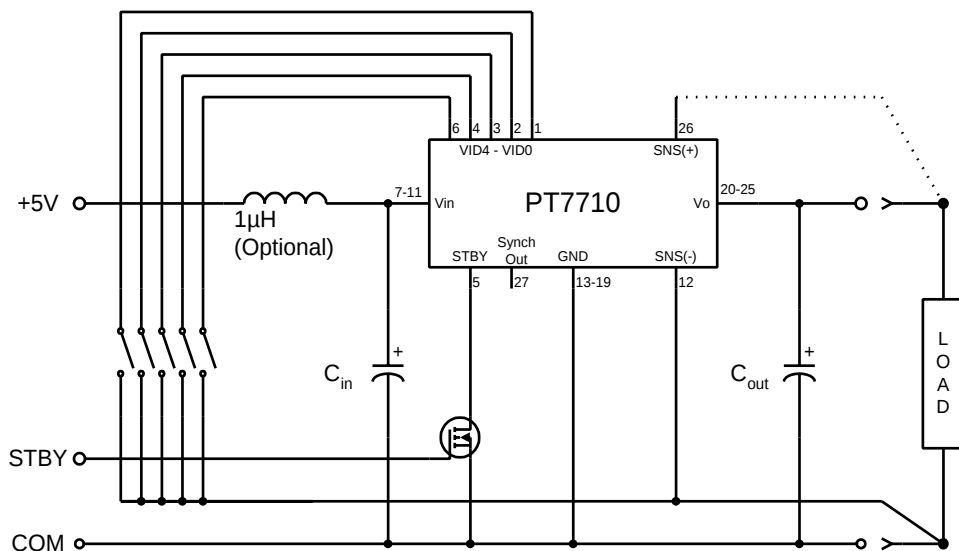
4. If active devices are used to ground the voltage control pins, low-level open drain MOSFET devices should be used over bipolar transistors. The inherent  $V_{ce(sat)}$  in bipolar devices introduces errors in the device's internal divider network. Discrete transistors such as the BSS138, 2N7002, or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

#### Active Voltage Programming:

Special precautions should be taken when making changes to the output voltage program code while the unit is powered. This activity can induce current transients through the device as a 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 or VID4 is discouraged.

When active devices are used to program the output voltage, their state should be asserted prior to the input power being applied. An alternative is to pull pin 5 (STBY) control to GND during the application of input voltage, then assert the required program code and release pin 5. The module will then initiate a soft-start power-up to the desired program voltage. For more information on the use of the Standby function, consult the related application note, “Using the Standby Function on the PT7710 Excalibur™ Series of 20-A ISRs.”

Figure 4-1



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