# PT6940 Series

**6-A Dual Output 5-V/3.3-V Input Integrated Switching Regulator**

EXCALIBUR

**SLTS155B**

***Revised (4/8/2002)***

## Features

- High Efficiency Dual Output *(See Ordering Information)*
- Ideal Power Source for DSPs
- 5V/3.3V Input
- 6A Rated (Both Outputs)
- Internal Power-up Sequencing
- Single On/Off Control
- Independent Adjust/Trim
- Remote Sensing ($Vo_1$ & $Vo_2$)
- Soft-Start
- Short-Circuit Protection (coordinated shutdown)
- 27-pin Space-Saving Package
- Solderable Copper Case

## Description

The PT6940 Excalibur™ power modules are a series of high-efficiency dual-output regulators, housed in a solderable space-saving package. The dual output is ideal for DSP applications that require a second voltage source for a processor core.

Both outputs from the PT6940 regulator modules are rated to deliver a full 6A load current simultaneously, and are internally sequenced to comply with the power-up requirements of popular DSP ICs.

Each output can be independently adjusted with a single external resistor, and incorporates an output sense to compensate for voltage drop between the regulator and load. A short-circuit load fault at either output will result in the coordinated shutdown of both voltages.

## Ordering Information

**PT6941❑** = +3.3/2.5 Volts
**PT6942❑** = +3.3/1.8 Volts
**PT6943❑** = +3.3/1.5 Volts
**PT6944❑** = +3.3/1.2 Volts
**† PT6946❑** = +2.5/1.8 Volts
**† PT6947❑** = +2.5/1.5 Volts
**† PT6948❑** = +2.5/1.2 Volts

*† -Denotes models that will also operate off 3.3V input bus.*

## PT Series Suffix (PT1234x)

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

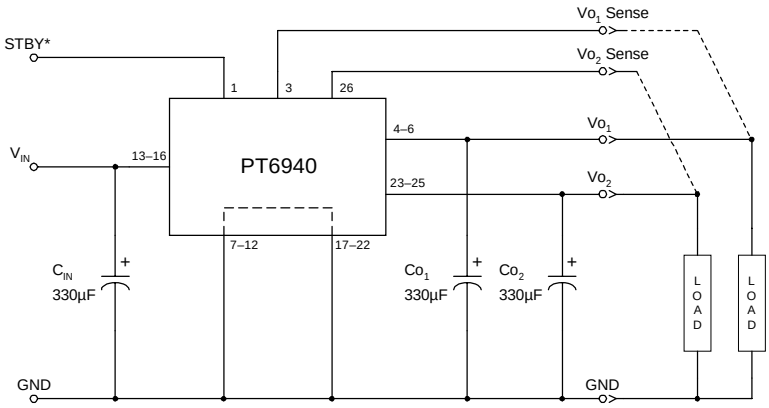
*(Reference the applicable package code drawing for the dimensions and PC layout)*

## Pin-Out Information

| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | STBY* † | 15 | $V_{in}$ |
| 2 | $Vo_1$ Adjust | 16 | $V_{in}$ |
| 3 | $Vo_1$ Sense | 17 | GND |
| 4 | $Vo_1$ | 18 | GND |
| 5 | $Vo_1$ | 19 | GND |
| 6 | $Vo_1$ | 20 | GND |
| 7 | GND | 21 | GND |
| 8 | GND | 22 | GND |
| 9 | GND | 23 | $Vo_2$ |
| 10 | GND | 24 | $Vo_2$ |
| 11 | GND | 25 | $Vo_2$ |
| 12 | GND | 26 | $Vo_2$ Sense |
| 13 | $V_{in}$ | 27 | $Vo_2$ Adjust |
| 14 | $V_{in}$ | | |

*† STBY* pin: Open = Outputs enabled*
*Ground = Outputs disabled*

## Standard Application




$C_{in}$ = Req'd 330µF * electrolytic
$Co_1/Co_2$ = Req'd 330µF * electrolytic

*300µF for Oscon® or low ESR tantalum (see application notes)

## General Specifications (Unless otherwise stated, $T_a$ =25°C, $V_{in}$ =5V, $C_{in}$ =330µF, $Co_1$ =330µF, $Co_2$ =330µF, and $Io_1/Io_2$ =Iomax)

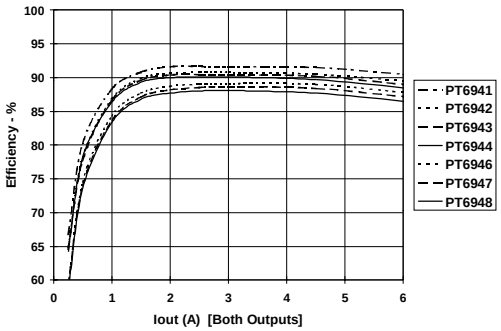
| Characteristic | Symbol | Conditions | | PT6940 Series Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Output Current | $I_o$ (1) | $T_a$ =25°C, natural convection<br>$T_a$ =60°C, 200LFM airflow | | 0.1 (2)<br>0.1 (2) | —<br>— | 6<br>6 | A |
| Input Voltage Range | $V_{in}$ | Over $I_o$ Range | $Vo_1$ ≤2.5V<br>$Vo_1$ >2.5V | 3.1<br>4.5 | —<br>— | 5.5<br>5.5 | V |
| Set Point Voltage Tolerance | $V_o$ tol | | | — | ±0.5 | ±2 | %$V_o$ |
| Temperature Variation | $Reg_{temp}$ | –40° ≤$T_a$ ≤ +85°C, $I_o$ =$I_o$min | | — | ±0.5 | — | %$V_o$ |
| Line Regulation | $Reg_{line}$ | Over $V_{in}$ range | | — | ±5 | ±10 | mV |
| Load Regulation | $Reg_{load}$ | Over $I_o$ range | | — | ±5 | ±10 | mV |
| Total Output Voltage Variation | $\Delta V_o$tot | Includes set-point, line, load,<br>–40° ≤$T_a$ ≤ +85°C | $V_o$ =3.3V<br>$V_o$ =2.5V<br>$V_o$ =1.8V<br>$V_o$ =1.5V<br>$V_o$ =1.2V | —<br>—<br>—<br>—<br>— | ±43<br>±35<br>±28<br>±25<br>±22 | ±100<br>±75<br>±54<br>±45<br>±36 | mV |
| Efficiency | η | $V_{in}$ =5V, $Io_1$ = $Io_2$ =4A | PT6941<br>PT6942<br>PT6943<br>PT6944<br>PT6946<br>PT6947<br>PT6948 | —<br>—<br>—<br>—<br>—<br>—<br>— | 92<br>91<br>90<br>90<br>89<br>88<br>87 | —<br>—<br>—<br>—<br>—<br>—<br>— | % |
| $V_o$ Ripple (pk-pk) | $V_r$ | 20MHz bandwidth | | — | 35 | — | $mV_{pp}$ |
| Transient Response | $t_{tr}$ | 1A/µs load step, 50% to 100% $I_o$max | | — | 60 | — | µs |
| | $\Delta V_{tr}$ | $V_o$ over/undershoot | | — | ±70 | — | mV |
| Short Circuit Threshold | $I_{sc}$(pk) | Reset followed by auto-recovery | | — | 13 (3) | — | A |
| Switching Frequency | $f_o$ | Over $V_{in}$ range | | 300 | 350 | 400 | kHz |
| STBY* (Pin 1)<br>Input High Voltage<br>Input Low Voltage | <br>$V_{IH}$<br>$V_{IL}$ | Referenced to GND (pin 7) | | <br>—<br>–0.1 | <br>—<br>— | <br>Open (4)<br>+0.4 | V |
| Input Low Current | $I_{IL}$ | | | — | -0.5 | – | mA |
| Quiescent Current | $I_{in}$ standby | pin 1 to GND | | — | 10 | 20 | mA |
| External Output Capacitance | | Both outputs | | 330 | — | TBD | µF |
| Operating Temperature Range | $T_a$ | Over $V_{in}$ Range | | –40 (5) | — | +85 (6) | °C |
| Storage Temperature | $T_s$ | — | | –40 | — | +125 | °C |
| Mechanical Shock | | Per Mil-STD-883D, Method 2002.3<br>1 msec, ½ Sine, mounted | | — | TBD | — | G's |
| Mechanical Vibration | | Mil-STD-883D Method 2007.2,<br>20-2000 Hz | Vertical<br>Horizontal | —<br>— | TBD (7)<br>TBD (7) | —<br>— | G's |
| Weight | — | Vertical/Horizontal | | — | 34 | — | grams |
| Flammability | — | Meets UL 94V-O | | | | | |

**Notes:** *(1) The outputs, $Vo_1$ and $Vo_2$, have similar characteristics. The applicable performance parameters are defined according to output voltage.*
*(2) The minimum output current applies to each output. The module will operate at no load with reduced specifications.*
*(3) A short-circuit load fault at either output causes the module to continuously reset, affecting both outputs.*
*(4) The STBY* control (pin 1) has an internal pull-up, and if it is left open circuit the module will operate when input power is applied. The open-circuit voltage is approximately the input voltage, $V_{in}$. Refer to the application notes for interface considerations.*
*(5) For operating temperatures below 0°C, Cin, $Co_1$, and $Co_2$ must have stable characteristics. Use either tantalum or Oscon® capacitors.*
*(6) See Safe Operating Area curves for the specific output voltage combination, or contact the factory for the appropriate derating.*
*(7) Only the case pins on through-hole pin configurations (N & A) must be soldered. For more information see the applicable package outline drawing.*

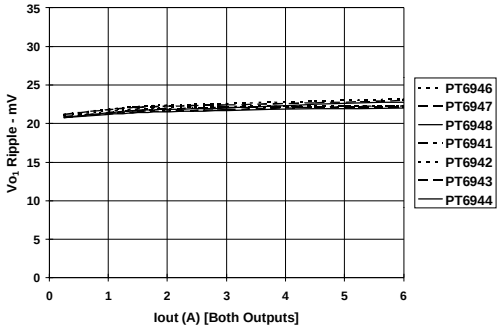
**Input/Output Capacitors:** *The PT6940 series requires a 330µF electrolytic capacitor at the input and both outputs for proper operation (300µF for Oscon® or low ESR tantalum). In addition, the input capacitance must be rated for a minimum of 1.0Arms ripple current. For transient or dynamic load applications, additional capacitance may be required. Refer to the application notes for more information.*

## Performance Characteristics; $V_{in}$ =5V (See Note A)

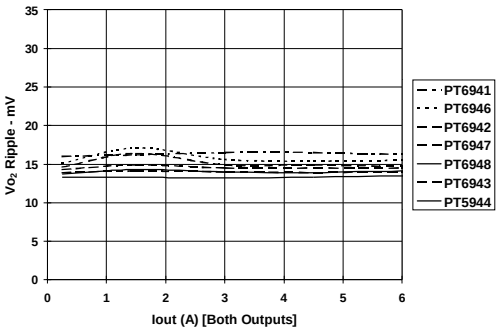
### Efficiency vs. $Io_1$ & $Io_2$ Load Currents



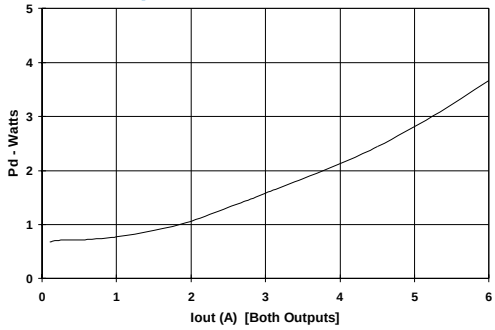

### $Vo_1$ Ripple vs. $Io_1$ & $Io_2$ Load Currents




### $Vo_2$ Ripple vs. $Io_1$ & $Io_2$ Load Currents

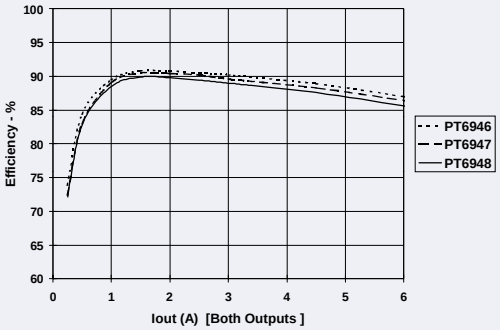



### Power Dissipation Vs. $Io_1$ & $Io_2$ Load Currents

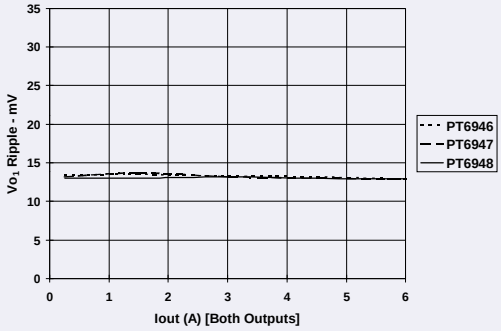



## Performance Characteristics; $V_{in}$ =3.3V (See Note A)

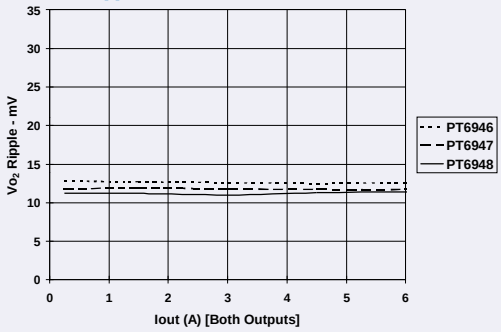
### Efficiency vs. $Io_1$ & $Io_2$ Load Currents



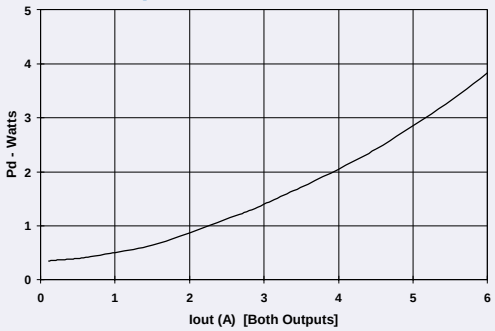

### $Vo_1$ Ripple vs. $Io_1$ & $Io_2$ Load Currents




### $Vo_2$ Ripple vs. $Io_1$ & $Io_2$ Load Currents



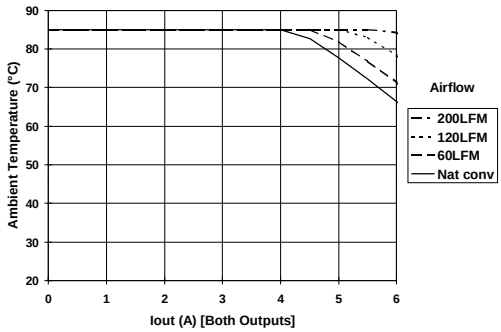

### Power Dissipation vs. $Io_1$ & $Io_2$ Load Currents



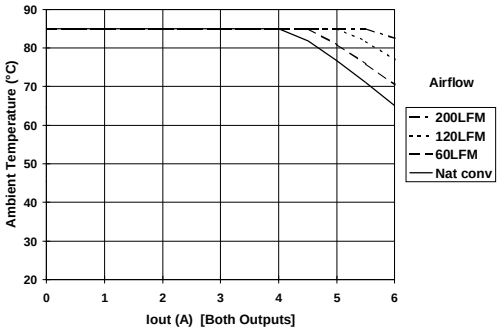

**Note A:** *Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.*

## Safe Operating Area Curves; $V_{in}$ =5V (See Note B)

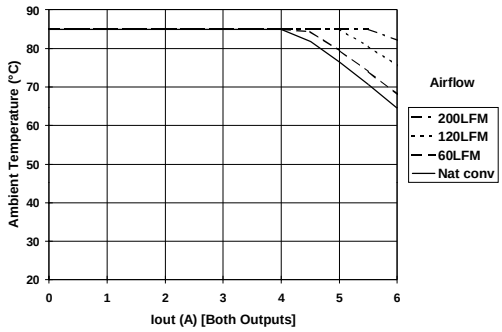
### PT6941 (3.3V/2.5V)



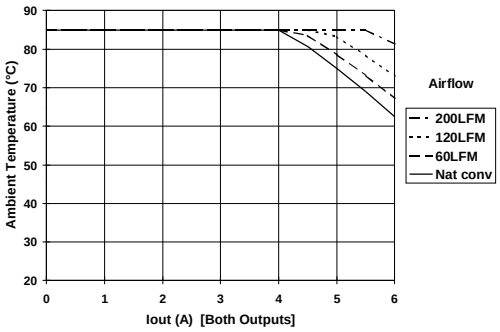

### PT6942 (3.3V/1.8V)




### PT6943 (3.3V/1.5V)

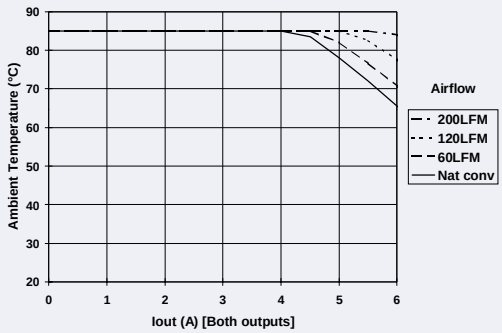



### PT6944 (3.3V/1.2V)

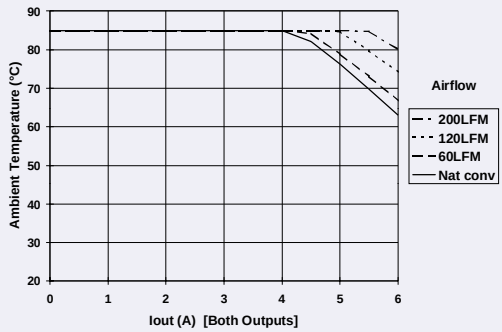



## Safe Operating Area Curves; $V_{in}$ =3.3V/5V (See Note B)

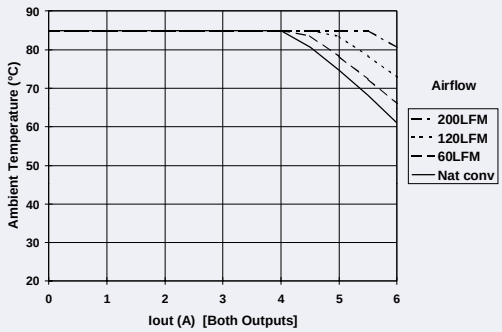
### PT6946 (2.5V/1.8V)




### PT6947 (2.5V/1.5V)




### PT6948 (2.5V/1.2V)




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

## Operating Features of the PT6940 Series of Dual-Output Voltage Regulators

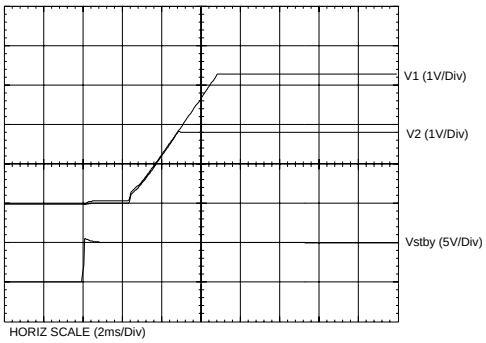
### Over-Current Protection

The PT6940 series of regulators incorporate independent current limit protection at both outputs ($Vo_1$ & $Vo_2$) with a periodic shutdown of both outputs. Applying a load current, in excess of the current limit threshold to either output, results in the shutdown of both voltages after a short period; typically 15ms. Following shutdown the module periodically attempts to recover by executing a soft start power-up at intervals of approximately 100ms. If the over-current fault persists, each attempted restart will result in a corresponding over-current trip and shutdown. During the 15ms period prior to each successive shutdown, the output with the load fault may not reach full regulation.

### Power-Up Voltage Sequencing

The output voltages from the PT6940 series regulators are independently regulated, and internally sequenced to meet the power-up requirements of popular microprocessors and DSP chipsets. Figure 1 shows the output voltage waveforms of a PT6942 (3.3V/1.8V) after either input power is applied, or the regulator is enabled. In this example turning $Q_1$ off in Figure 2, removes the low-voltage signal at pin 1 and enables the regulator. Following a delay of about 3–5ms, $Vo_1$ and $Vo_2$ rise together until the lower voltage, $Vo_2$, reaches its regulation voltage. $Vo_1$ then continues to rise until both outputs reach full regulation. The total power-up time is less than 15ms, and is relatively independent of load, temperature, and output capacitance. The turn-off of $Q_1$ corresponds to the rise in $V_{STBY}$. The waveforms were measured with a 5V input voltage, and with resistive loads of 4A at both the $Vo_1$ and $Vo_2$ outputs.

***Figure 1***

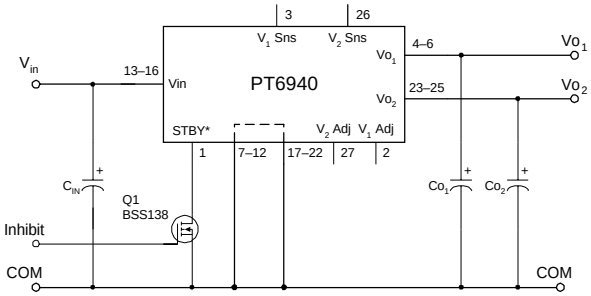



### Standby Control

The output voltages from the PT6940 may be disabled using the regulator's *Standby* control. The standby function is provided by the "*STBY**" control (pin 1). If pin 1 is left open-circuit the regulator operates normally, and provides a regulated output at both $Vo_1$ (pins 4–6) and $Vo_2$ (pins 23–25) whenever a valid input source voltage is applied to $V_{in}$ (pins 13–16) with respect to GND (pins 7-12 & 17–22). Applying a low-impedance sink to ground[1] at pin 1, simultaneously disables both regulated outputs. This places the regulator in standby mode, and reduces the input current drawn by the ISR to typically 10mA. The *Standby* control may also be used to maintain both regulator outputs at zero volts during the period that input power is applied.

The standby pin is ideally controlled using an open-collector (or open-drain) discrete transistor (See Figure 2). The open-circuit voltage is the input voltage, $V_{in}$.

***Figure 2***




**Notes:**

1. The standby control input is <u>*Not*</u> compatible with TTL or other devices that incorporate a totem-pole output drive. Use only a true open-collector device, preferably a discrete bipolar transistor (or MOSFET). To ensure the regulator output is disabled, the control pin must be pulled to less than 0.4Vdc with a low-level 0.5mA sink to ground.

2 <u>Do not</u> use an an external pull-up resistor. The control pin has its own internal pull-up. Adding an external pull-up could disable the over-current protection. The open-circuit voltage of the "*STBY**" pin is the input voltage, $V_{in}$.

## Capacitor Recommendations for the Dual-Output PT6940 Regulator Series

### Input Capacitor:

The recommended input capacitance is determined by 1.0 ampere minimum ripple current rating and 330µF minimum capacitance (300µF for Oscon® or low ESR tantalum). Ripple current and <100mΩ equivalent series resistance (ESR) values are the major considerations, along with temperature, when designing with different types of capacitors. Tantalum capacitors have a recommended minimum voltage rating of twice the maximum DC voltage + AC ripple. This is necessary to insure reliability for input voltage bus applications

### Output Capacitors: $Co_1/Co_2$

The ESR of the required capacitors, $Co_1$ & $Co_2$ must not be greater than 150mΩ. Electrolytic capacitors have poor ripple performance at frequencies greater than 400kHz but excellent low frequency transient response. Above the ripple frequency, ceramic capacitors are necessary to improve the transient response and reduce any high frequency noise components apparent during higher current excursions. Preferred low ESR type capacitor part numbers are identified in Table 1.

### Tantalum Capacitors

Tantalum type capacitors can be used for the output but only the AVX TPS series, Sprague 593D/594/595 series or Kemet T495/T510 series. These capacitors are recommended over many other tantalum types due to their higher rated surge, power dissipation, and ripple current capability. As a caution the TAJ series by AVX is not recommended. This series has considerably higher ESR, reduced power dissipation, and lower ripple current capability. The TAJ series is less reliable than the AVX TPS series when determining power dissipation capability. Tantalum or Oscon® types are recommended for applications where ambient temperatures fall below 0°C.

### Capacitor Table

Table 1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The number of capacitors required at both the input and output buses is identified for each capacitor type.

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

***Table 1: Input/Output Capacitors***

| Capacitor Vendor/ Component Series | Capacitor Characteristics | | | | | Quantity | | |
|---|---|---|---|---|---|---|---|---|
| | Working Voltage | Value(µF) | (ESR) Equivalent Series Resistance | 85°C Maximum Ripple Current(Irms) | Physical Size(mm) | Input Bus | Output Bus | Vendor Number |
| Panasonic FC | 25V<br>35V<br>35V | 560µF<br>390µF<br>330µF | 0.0065Ω<br>0.065Ω<br>0.117Ω | 1205mA<br>1205mA<br>555mA | 12.5x15<br>12.5x15<br>8x11.5 | 1<br>2<br>N/R | 1<br>1<br>1 | EEUFC1E561S<br>EEUFC1V391S<br>EEUFC1C331 |
| United Chemi-Con LXV/FS/ LXZ | 16V<br>35V<br>10V<br>20V | 330µF<br>470µF<br>330µF<br>150µF | 0.120Ω<br>0.052Ω<br>0.025Ω<br>0.030÷2 Ω | 555mA<br>1220mA<br>3500mA<br>3200mA | 8x12<br>10x20<br>10x10.5<br>10x10.5 | N/R<br>1<br>1<br>2 | 1<br>1<br>1<br>2 | LXZ16VB331M8X12LL<br>LXZ35VB471M10X20LL<br>10FS330M<br>20FS150M |
| Nichicon PL/ PM | 35V<br>35V<br>50V | 560µF<br>330µF<br>470µF | 0.048Ω<br>0.065÷2 Ω<br>0.046Ω | 1360mA<br>1020mA<br>1470mA | 16x15<br>12.5x15<br>18x15 | 1<br>1<br>1 | 1<br>1<br>1 | UPL1V561MHH6<br>UPL1V331MHH6<br>UPM1H4711MHH6 |
| Panasonic FC (Surface Mtg) | 10V<br>35V<br>16V | 1000µF<br>330µF<br>330µF | 0.043Ω<br>0.065Ω<br>0.150Ω | 1205mA<br>1205mA<br>670mA | 12x16.5<br>12.5x16<br>10x10.2 | 1<br>1<br>N/R | 1<br>1<br>1 | EEVFC1A102LQ<br>EEVFC1V331LQ<br>EEVFC1C331P |
| Oscon- SS SV | 10V<br>10V<br>20V | 330µF<br>330µF<br>150µF | 0.025Ω<br>0.025Ω<br>0.024÷2 Ω | >3500mA<br>>3800mA<br>3600mA | 10.0x10.5<br>10.3x10.3<br>10.3x10.3 | 1<br>1<br>2 | 1<br>1<br>2 | 10SS330M<br>10SV300M<br>20SV150M<br>SV= Surface Mount |
| AVX Tantalum TPS | 10V<br>10V<br>10V | 330µF<br>330µF<br>220µF | 0.100÷2 Ω<br>0.100÷2 Ω<br>0.095Ω | >2500mA<br>>3000mA<br>>2000mA | 7.3Lx<br>4.3Wx<br>4.1H | 2<br>2<br>2 | 1<br>1<br>2 | TPSV337M010R0100<br>TPSV337M010R0060<br>TPSV227M0105R0100 |
| Kemet T510/ T495 | 10V<br>10V | 330µF<br>220µF | 0.033Ω<br>0.07Ω÷2 =0.035Ω | 1400mA<br>>2000mA | 7.3Lx5.7W<br>x 4.0H | 2<br>2 | 1<br>2 | T510X337M010AS<br>T495X227M010AS |
| Sprague 594D | 10V<br>10V | 330µF<br>220µF | 0.045Ω<br>0.065Ω | 2350mA<br>>2000mA | 7.3Lx<br>6.0Wx<br>4.1H | 2<br>2 | 1<br>2 | 4D337X0010R2T<br>594D227X0010D2T |

N/R –Not recommended. The voltage rating does not meet the minimum operating limits.

## Adjusting the Output Voltages of the PT6940 Dual-Output ISRs

Each output voltage from the PT6940 series of integrated switching regulators (ISRs) can be independently adjusted higher or lower than the factory trimmed pre-set voltage. The voltages, $Vo_1$ and $Vo_2$ may each be adjusted either up or down using a single external resistor [1]. Table 1 gives the adjustment range for both $Vo_1$ and $Vo_2$ for each model in the series as $V_a$(min) and $V_a$(max). Note that $Vo_2$ must always be lower than $Vo_1$ [2].

**$Vo_1$ Adjust Up:** To increase the output, add a resistor $R_2$ between pin 2 ($Vo_1$ Adjust) and pins 7-12 (GND) [3].

**$Vo_1$ Adjust Down:** Add a resistor ($R_1$), between pin 2 ($Vo_1$ Adjust) and pin 3 ($Vo_1$ Sense).

**$Vo_2$ Adjust Up:** Add a resistor $R_4$ between pin 27 ($Vo_2$ Adjust) and pins 17–22 (GND).

**$Vo_2$ Adjust Down:** Add a resistor ($R_3$) between pin 27 ($Vo_2$ Adjust) and pin 26 ($Vo_2$ Sense).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor.

The adjust up and adjust down resistor values can also be calculated using the following formulas. Be sure to select the correct formula parameter from Table 1 for the output and model being adjusted.

$$(R_1) \text{ or } (R_3) = \frac{10\,(V_a - 0.9)}{V_o - V_a} - R_s \quad k\Omega$$

$$R_2 \text{ or } R_4 = \frac{9}{V_a - V_o} - R_s \quad k\Omega$$

Where: $V_o$ = Original output voltage, ($Vo_1$ or $Vo_2$)
$V_a$ = Adjusted output voltage
$R_s$ = The series resistance from Table 1

**Notes:**

1. Use only a single 1% resistor in either the ($R_1$) or $R_2$ location to adjust $Vo_1$, and in the ($R_3$) or $R_4$ location to adjust $Vo_2$. Place the resistor as close to the module as possible.
2. $Vo_2$ must always be at least 0.3V lower than $Vo_1$.
3. When adjusting $Vo_1$ higher than the factory pre-set output voltage the minimum input voltage must be revised as follows.

   **$Vo_1$ =3.3V:**
   $V_{in}$(min) = ($Vo_1$ + 1)V or 4.5V, whichever is greater.

   **$Vo_1$ =2.5V:**
   $Vo_1$ =2.5V is the maximum output voltage allowed for operation off a 3.3V input bus. If $Vo_1$ is adjusted above 2.5V, the input voltage must be a minimum of 4.5V.
4. $Vo_1$ and $Vo_2$ may be adjusted down to an alternative bus voltage by making, ($R_1$) or ($R_3$) respectively, a zero ohm link. Refer to the Table 1 footnotes for guidance.
5. Never connect capacitors to either the $Vo_1$ Adjust or $Vo_2$ Adjust pins. Any capacitance added to these control pins will affect the stability of the respective regulated output.

***Figure 1***

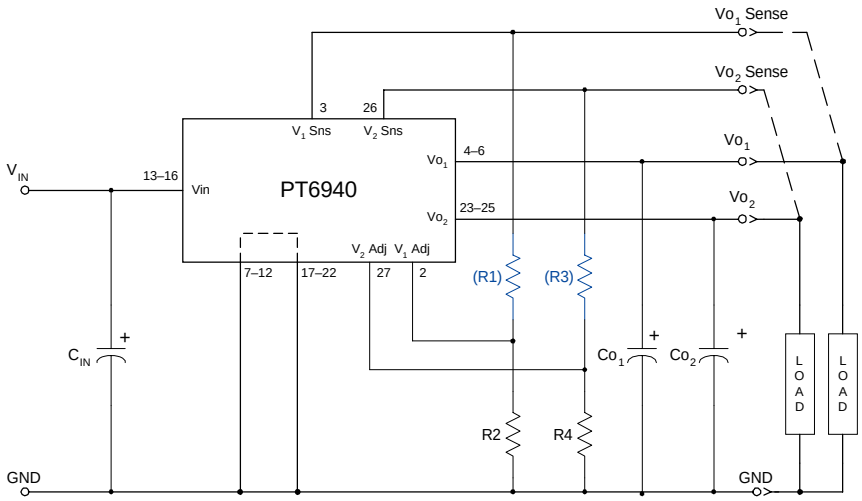


*Table 1*

**ADJUSTMENT RANGE AND FORMULA PARAMETERS**

| $Vo_1$ Bus | | | $Vo_2$ Bus (2) | | | |
|---|---|---|---|---|---|---|
| **Series Pt #** | **PT6941/42/43/44** | **PT6946/47/48** | **PT6941** | **PT6942/46** | **PT6943/47** | **PT6944/48** |
| **Adj. Resistor** | **(R1)/R2** | **(R1)/R2** | **(R3)/R4** | **(R3)/R4** | **(R3)/R4** | **(R3)/R4** |
| **$V_o$(nom)** | 3.3V | 2.5V | 2.5V | 1.8V | 1.5V | 1.2V |
| **Va(min)** | 2.5V * | 1.8V * | 1.8V * | 1.5V * | 1.2V * | 1.15V |
| **Va(max)** | 3.5V | 2.5V | 3.1V | 2.2V | 2.4V | 1.5V † |
| **$R_s$ (kΩ)** | 20.0 | 13.0 | 13.0 | 20.0 | 10.0 | 29.4 |

Ref. Note 4: * (R1) = Zero-ohm link
†(R3) = Zero-ohm link

*Table 2*

**ADJUSTMENT RESISTOR VALUES**

| $Vo_1$ Bus | | | $Vo_2$ Bus | | | |
|---|---|---|---|---|---|---|
| **Series Pt #** | **PT6941/42/43/44** | **PT6946/47/48** | **Series Pt #** | **PT6941** | **PT6942/46** | **PT6943/47** | **PT6944/48** |
| **Adj. Resistor** | **(R1)/R2** | **(R1)/R2** | **Adj. Resistor** | **(R3)/R4** | **(R3)/R4** | **(R3)/R4** | **(R3)/R4** |
| **$V_o$(nom)** | 3.3V | 2.5V | **$V_o$(nom)** | 2.5V | 1.8V | 1.5V | 1.2V |
| **$V_a$(req'd)** | | | **$V_a$(req'd)** | | | | |
| 1.8 | | (0.0) | 1.15 | | | | (20.6)kΩ |
| 1.85 | | (1.6)kΩ | 1.2 | | | (0.0)kΩ | |
| 1.9 | | (3.7)kΩ | 1.25 | | | (4.0)kΩ | 151.0kΩ |
| 1.95 | | (6.1)kΩ | 1.3 | | | (10.0)kΩ | 60.6kΩ |
| 2.0 | | (9.0)kΩ | 1.35 | | | (20.0)kΩ | 30.6kΩ |
| 2.05 | | (12.6)kΩ | 1.4 | | | (40.0)kΩ | 15.6kΩ |
| 2.1 | | (17.0)kΩ | 1.45 | | | (100.0)kΩ | 6.6kΩ |
| 2.15 | | (22.7)kΩ | 1.5 | | (0.0)kΩ | | 0.0kΩ |
| 2.2 | | (30.3)kΩ | 1.55 | | (6.0)kΩ | 170.0kΩ | |
| 2.25 | | (41.0)kΩ | 1.6 | | (15.0)kΩ | 80.0kΩ | |
| 2.3 | | (57.0)kΩ | 1.65 | | (30.0)kΩ | 50.0kΩ | |
| 2.35 | | (83.7)kΩ | 1.7 | | (60.0)kΩ | 35.0kΩ | |
| 2.4 | | (137.0)kΩ | 1.75 | | (150.0)kΩ | 26.0kΩ | |
| 2.45 | | (297.0)kΩ | 1.8 | (0.0)kΩ | | 19.6kΩ | |
| 2.5 | (0.0)kΩ | | 1.85 | (1.6)kΩ | 160.0kΩ | 15.7kΩ | |
| 2.55 | (2.0)kΩ | 167.0kΩ # | 1.9 | (3.7)kΩ | 70.0kΩ | 12.5kΩ | |
| 2.6 | (4.3)kΩ | 77.0kΩ # | 1.95 | (6.1)kΩ | 40.0kΩ | 10.0kΩ | |
| 2.65 | (6.9)kΩ | 47.0kΩ # | 2.0 | (9.0)kΩ | 25.0kΩ | 8.0kΩ | |
| 2.7 | (10.0)kΩ | 32.0kΩ # | 2.05 | (12.6)kΩ | 16.0kΩ | 6.4kΩ | |
| 2.75 | (13.6)kΩ | 23.0kΩ # | 2.1 | (17.0)kΩ | 10.0kΩ | 5.0kΩ | |
| 2.8 | (18.0)kΩ | | 2.15 | (22.7)kΩ | 5.7kΩ | 3.9kΩ | |
| 2.85 | (23.3)kΩ | | 2.2 | (30.3)kΩ | 2.5kΩ | 2.9kΩ | |
| 2.9 | (30.0)kΩ | | 2.25 | (41.0)kΩ | | 2.0kΩ | |
| 2.95 | (38.6)kΩ | | 2.3 | (57.0)kΩ | | 1.3kΩ | |
| 3.0 | (50.0)kΩ | | 2.35 | (83.7)kΩ | | 0.6kΩ | |
| 3.1 | (90.0)kΩ | | 2.4 | (137.0)kΩ | | 0.0kΩ | |
| 3.2 | (210.0)kΩ | | 2.45 | (297.0)kΩ | | | |
| 3.3 | | | 2.5 | | | | |
| 3.4 | 70.0kΩ | | 2.55 | 167.0kΩ | | | |
| 3.5 | 25.0kΩ | | 2.6 | 77.0kΩ | | | |
| 3.6 | 10.0kΩ | | 2.65 | 47.0kΩ | | | |
| 3.7 | 2.5kΩ | | 2.7 | 32.0kΩ | | | |
| | | | 2.75 | 23.0kΩ | | | |
| | | | 2.8 | 17.0kΩ | | | |
| | | | 2.85 | 12.7kΩ | | | |
| | | | 2.9 | 9.5kΩ | | | |
| | | | 2.95 | 7.0kΩ | | | |
| | | | 3.0 | 5.0kΩ | | | |
| | | | 3.1 | 2.0kΩ | | | |

$R_1/R_3$ = (Blue), $R_2/R_4$ = Black
# See Note 3

## PACKAGING INFORMATION

| Orderable Device | Status [1] | Package Type | Package Drawing | Pins | Package Qty | Eco Plan [2] | Lead/Ball Finish | MSL Peak Temp [3] |
|---|---|---|---|---|---|---|---|---|
| PT6941A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6941C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |
| PT6941N | ACTIVE | SIP MOD ULE | ENE | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6942A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6942C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |
| PT6942N | ACTIVE | SIP MOD ULE | ENE | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6943A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6943C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |
| PT6943N | ACTIVE | SIP MOD ULE | ENE | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6944A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6944C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |
| PT6944N | ACTIVE | SIP MOD ULE | ENE | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6946A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6946C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |
| PT6946N | ACTIVE | SIP MOD ULE | ENE | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6947A | ACTIVE | SIP MOD ULE | ENF | 27 | 10 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT6947C | ACTIVE | SIP MOD ULE | ENG | 27 | 10 | Pb-Free (RoHS) | Call TI | Level-3-215C-168HRS |

[1] The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame

retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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