

## Dual Output LNB Supply and Control Voltage Regulator with I<sup>2</sup>C Interface for Advanced Satellite Set-Top Box Designs

The ISL6422 is a highly integrated voltage regulator and interface IC, specifically designed for supplying power and control signals from advanced satellite set-top box (STB) modules to the low noise blocks (LNBs) of two antenna ports. The device consists of two independent current-mode boost PWMs and two low-noise linear regulators along with the circuitry required for 22kHz tone generation, modulation and I<sup>2</sup>C device interface. The device makes the total LNB supply design simple, efficient and compact with low external component count.

Two independent current-mode boost converters provide the linear regulators with input voltages that are set to the final output voltages, plus typically 0.8V to insure minimum power dissipation across each linear regulator. This maintains constant voltage drops across each linear pass element while permitting adequate voltage range for tone injection.

The final regulated output voltages are available at two output terminals to support simultaneous operation of two antenna ports for dual tuners. The outputs for each PWM can be controlled in two ways:

- Full control from I<sup>2</sup>C using the VTOP1, VTOP2, VBOT1, and VBOT12 bits, or
- Set the I<sup>2</sup>C to the lower range (13V/14V) and switch to the higher range (18V/19V) with the SELVTOP1 or SELVTOP2 pin.

All the functions on this IC are controlled via the I<sup>2</sup>C bus by writing 8-bit words onto the System Registers (SR). The same register can be read back, and 4-bits per output will report the diagnostic status. Separate enable commands sent on the I<sup>2</sup>C bus provide independent standby mode control for each PWM and linear combination, disabling the output into shutdown mode. Each output channel is capable of providing 750mA of continuous current. The overcurrent limit can be digitally programmed.

The External modulation input EXTM1, EXTM2 can accept a modulated DiseqC command and transfer it symmetrically to the output. Alternatively, the EXTM1 or EXTM2 pin can be used to modulate the continuous internal tone.

The  $\overline{\text{FLT}}$  pin serves as an interrupt for the processor when an over temperature, overcurrent or backwards overcurrent fault conditions is detected by the LNB controller or when both channels are disabled by the I<sup>2</sup>C EN bits set low. The nature of the fault can be read of the I<sup>2</sup>C registers.

## Features

- Single Chip Power Solution
  - True Dual Operation for 2-Tuner/2-Dish Applications
  - Both Outputs May be Enabled Simultaneously at Maximum Power
  - Integrated DC/DC Converter and I<sup>2</sup>C Interface
- Switch-Mode Power Converter for Lowest Dissipation
  - Boost PWMs with >92% Efficiency
  - Selectable 13.3V or 18.3V Outputs
  - Digital Cable Length Compensation (1V)
  - I<sup>2</sup>C and Pin controllable output
- Output Back Bias Capability of 28V
- I<sup>2</sup>C Compatible Interface for Remote Device Control
- Four level Slave Address 0001 00XX
- 2.5V, 3.3V, 5V Logic Compatible
- External Pins to Toggle Between V and H Polarization.
- Supports DiSEqC 2.0 Protocol
- Built-In Tone Oscillator Factory Trimmed to 22kHz
  - Facilitates DiSEqC (EUTELSAT) Encoding
  - External Modulation Input
- Internal Over-Temperature Protection and Diagnostics
- Internal OV, UV, Overload and Over-Temperature Flags (Visible on I<sup>2</sup>C)
- $\overline{\text{FLT}}$  Signal
- LNB Short-Circuit Protection and Diagnostics
- QFN, EPTSSOP Packages
- Pb-Free Plus Anneal Available (RoHS Compliant)

## Applications

- LNB Power Supply and Control for Satellite Set-Top Box

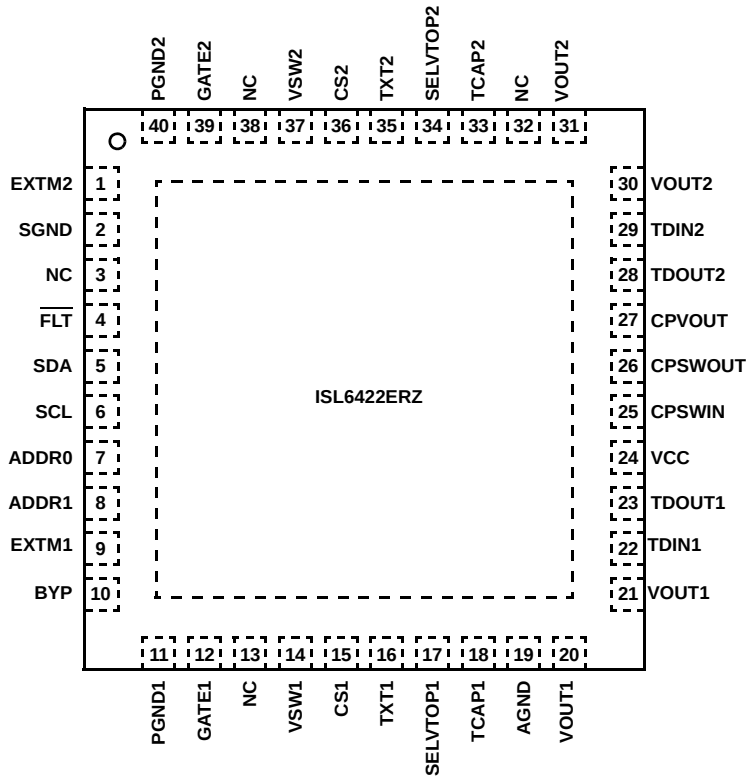
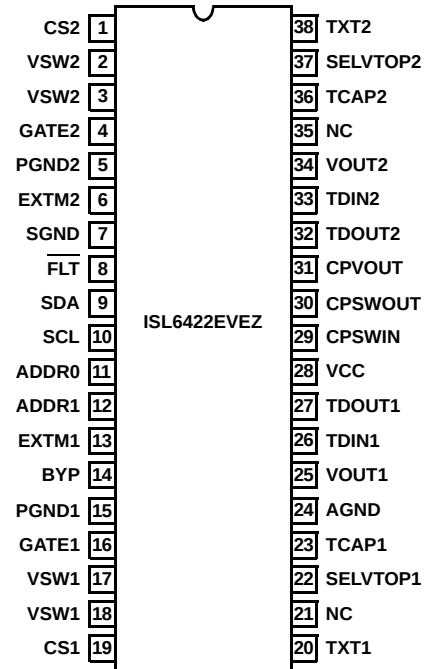
## Ordering Information

| PART NUMBER<br>(Note) | PART<br>MARKING | TEMP.<br>RANGE<br>(°C) | PACKAGE<br>(Pb-free) | PKG.<br>DWG. # |
|-----------------------|-----------------|------------------------|----------------------|----------------|
| ISL6422ERZ*           | ISL6422 ERZ     | -20 to +85             | 40 Ld 6x6 QFN        | L40.6x6        |
| ISL6422EVEZ*          | ISL6422 EVEZ    | -20 to + 85            | 38 Ld EPTSSOP        | M38.173B       |

\*Add "-T" suffix for tape and reel.

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

## Pinouts

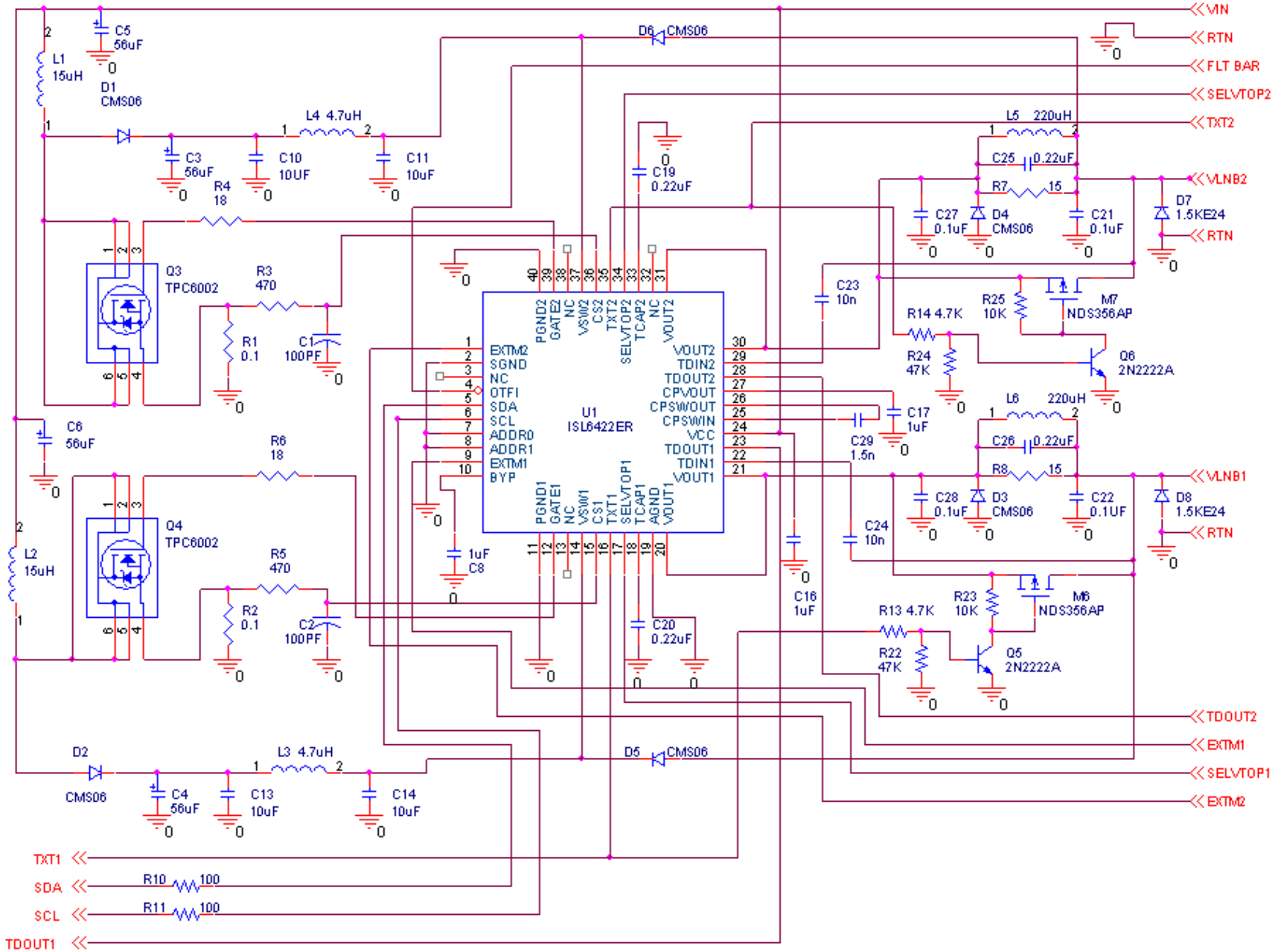
ISL6422  
(40 LD QFN)  
TOP VIEWISL6422  
(38 LD EPTSSOP)  
TOP VIEW

## 3 intersi



1. Pinouts shown are for the QFN package.

# Typical Application Schematic QFN



ISL6422

**Absolute Maximum Ratings**

Supply Voltage,  $V_{CC}$  ..... 8.0V to 18.0V  
 Logic Input Voltage Range  
 (SDA, SCL, ENT, DSQIN1 and DSQIN2,  
 SEL18V1 and SEL18V2) ..... -0.5V to 7V

**Thermal Information**

Thermal Resistance (Typical, Notes 2, 3)  $\theta_{JA}$  (°C/W)  $\theta_{JC}$  (°C/W)  
 EPTSSOP Package ..... 29 4  
 QFN Package ..... 34 6  
 Maximum Junction Temperature (Note 4) ..... +150°C  
 Maximum Storage Temperature Range ..... -40°C to +150°C  
 Pb-free reflow profile ..... see link below  
<http://www.intersil.com/pbfree/Pb-FreeReflow.asp>  
 Operating Temperature Range ..... -20°C to +85°C

**CAUTION:** Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

**NOTES:**

- $\theta_{JA}$  is measured in free air with the component mounted on a high effective thermal conductivity test board with "direct attach" features. See Tech Brief TB379.
- For  $\theta_{JC}$ , the "case temp" location is the center of the exposed metal pad on the package underside.
- The device junction temperature should be kept below +150°C. Thermal shut-down circuitry turns off the device if junction temperature exceeds +150°C typically.

**Electrical Specifications**  $V_{CC} = 12V$ ,  $T_A = -20^\circ C$  to  $+85^\circ C$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ . EN1 = EN2 = H, VTOP1 = VTOP2 = L, ENT1 = ENT2 = L, DCL = L, DSQIN1 = DSQIN2 = L,  $I_{OUT} = 12mA$ , unless otherwise noted. See "ISL6422 Software Description" on page 12 for I<sup>2</sup>C access to the system.

| PARAMETER                      | SYMBOL                       | TEST CONDITIONS                                                      | MIN   | TYP  | MAX   | UNITS  |
|--------------------------------|------------------------------|----------------------------------------------------------------------|-------|------|-------|--------|
| Operating Supply Voltage Range |                              |                                                                      | 8     | 12   | 14    | V      |
| Standby Supply Current         |                              | EN1 = EN2 = L                                                        |       | 1.5  | 3.0   | mA     |
| Supply Current                 | $I_{IN}$                     | EN1 = EN2 = VTOP1 = VTOP2 = VBOT1 = VBOT2 = ENT1 = ENT2 = H, No Load |       | 4.0  | 8.0   | mA     |
| <b>UNDERVOLTAGE LOCKOUT</b>    |                              |                                                                      |       |      |       |        |
| Start Threshold                |                              |                                                                      | 7.5   |      | 7.95  | V      |
| Stop Threshold                 |                              |                                                                      | 7.0   |      | 7.55  | V      |
| Start to Stop Hysteresis       |                              |                                                                      | 350   | 400  | 500   | mV     |
| <b>SOFT-START</b>              |                              |                                                                      |       |      |       |        |
| COMP Rise Time (Note 5)        |                              | (Note 5)                                                             |       | 8196 |       | Cycles |
| Output Voltage (Note 5)        | $V_{OUT1}$                   | (Refer to Table 11)                                                  | 13.04 | 13.3 | 13.56 | V      |
|                                | $V_{OUT1}$                   | (Refer to Table 11)                                                  | 14.02 | 14.3 | 14.58 | V      |
|                                | $V_{OUT1}$                   | (Refer to Table 11)                                                  | 17.94 | 18.3 | 18.66 | V      |
|                                | $V_{OUT1}$                   | (Refer to Table 11)                                                  | 19.00 | 19.3 | 19.68 | V      |
|                                | $V_{OUT2}$                   | (Refer to Table 15)                                                  | 13.04 | 13.3 | 13.56 | V      |
|                                | $V_{OUT2}$                   | (Refer to Table 15)                                                  | 14.02 | 14.3 | 14.58 | V      |
|                                | $V_{OUT2}$                   | (Refer to Table 15)                                                  | 17.94 | 18.3 | 18.66 | V      |
|                                | $V_{OUT2}$                   | (Refer to Table 15)                                                  | 19.00 | 19.3 | 19.68 | V      |
| Line Regulation                | $DV_{OUT1}$ ,<br>$DV_{OUT2}$ | $V_{IN} = 8V$ to $14V$ ; $V_{OUT1}$ , $V_{OUT2} = 13V$               |       | 4.0  | 40.0  | mV     |
|                                |                              | $V_{IN} = 8V$ to $14V$ ; $V_{OUT1}$ , $V_{OUT2} = 18V$               |       | 4.0  | 60.0  | mV     |
| Load Regulation                | $DV_{OUT1}$ ,<br>$DV_{OUT2}$ | $I_O = 12mA$ to $350mA$                                              |       | 50   | 80    | mV     |
|                                |                              | $I_O = 12mA$ to $750mA$                                              |       | 100  | 200   | mV     |

**Electrical Specifications**  $V_{CC} = 12V$ ,  $T_A = -20^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}C$ . EN1 = EN2 = H, VTOP1 = VTOP2 = L, ENT1 = ENT2 = L, DCL = L, DSQIN1 = DSQIN2 = L,  $I_{OUT} = 12mA$ , unless otherwise noted. See "ISL6422 Software Description" on page 12 for I<sup>2</sup>C access to the system. **(Continued)**

| PARAMETER                                                | SYMBOL         | TEST CONDITIONS                                                                    | MIN  | TYP  | MAX  | UNITS      |
|----------------------------------------------------------|----------------|------------------------------------------------------------------------------------|------|------|------|------------|
| Dynamic Output Current Limiting<br>(Note 8)              | $I_{MAX}$      | DCL = 0, ISEL1H and ISEL2H = 0,<br>ISEL1L and ISEL2L = 0,<br>ISEL1R and ISEL2R = 0 | 270  | 305  | 345  | mA         |
|                                                          |                | DCL = 0, ISEL1H and ISEL2H = 0,<br>ISEL1L and ISEL2L = 0,<br>ISEL1R and ISEL2R = 1 | 350  | 388  | 422  | mA         |
|                                                          |                | DCL = 0, ISEL1H and ISEL2H = 0,<br>ISEL1L and ISEL2L = 1,<br>ISEL1R and ISEL2R = 1 | 515  | 570  | 630  | mA         |
|                                                          |                | DCL = 0, ISEL1H and ISEL2H = 1,<br>ISEL1L and ISEL2L = 0,<br>ISEL1R and ISEL2R = 1 | 635  | 705  | 775  | mA         |
|                                                          |                | DCL = 0, ISEL1H and ISEL2H = 1,<br>ISEL1L and ISEL2L = 1,<br>ISEL1R and ISEL2R = 1 | 800  | 890  | 980  | mA         |
| Dynamic Overload Protection Off Time                     | $t_{OFF}$      | DCL = L, Output Shorted (Note 8)                                                   |      | 900  |      | ms         |
| Dynamic Overload Protection On Time                      | $t_{ON}$       |                                                                                    |      | 20   |      | ms         |
| Static Output Current Limiting                           | $I_{MAX}$      | DCL = 1 (Note 8)                                                                   |      | 990  |      | mA         |
| Cable Fault CABF Asserted High                           | $I_{CAB}$      | EN1 and EN2 = 1;                                                                   | 2    | 10   | 20   | mA         |
| <b>tone oscillator</b>                                   |                |                                                                                    |      |      |      |            |
| Tone Frequency                                           | $f_{tone}$     | ENT1 and ENT2 = H                                                                  | 20.0 | 22.0 | 24.0 | kHz        |
| Tone Amplitude                                           | $V_{tone}$     | ENT1 and ENT2 = H, $I_{OUT} = 5mA$                                                 | 500  | 680  | 800  | mV         |
| Tone Duty Cycle                                          | $dc_{tone}$    | ENT1 and ENT2 = H                                                                  | 40   | 50   | 60   | %          |
| Tone Rise or Fall Time                                   | $t_r, t_f$     | ENT1 and ENT2 = H                                                                  | 5    | 10   | 14   | $\mu s$    |
| <b>tone decoder</b>                                      |                |                                                                                    |      |      |      |            |
| Input Amplitude                                          | $V_{tdin}$     |                                                                                    | 200  |      | 1000 | mV         |
| Frequency Capture Range                                  | $F_{tdin}$     |                                                                                    | 17.5 |      | 26.5 | kHz        |
| Input Impedance                                          | $Z_{DET}$      |                                                                                    |      | 8.6  |      | k $\Omega$ |
| Detector Output Voltage                                  | $V_{TDOUT\_L}$ | Tone Present, $I_{LOAD} = 3mA$                                                     |      |      | 0.4  | V          |
| Detector Output Leakage                                  | $I_{TDOUT\_H}$ | Tone absent, $V_O = 6V$                                                            |      |      | 10   | $\mu A$    |
| Tone Decoder Rx Threshold                                | $V_{RXth}$     | TXT1 and TXT2 = L                                                                  | 100  | 150  | 200  | mV         |
| Tone Decoder Tx Threshold                                | $V_{TXth}$     | TXT1 and TXT2 = H                                                                  | 400  | 450  | 500  | mV         |
| <b>linear regulator</b>                                  |                |                                                                                    |      |      |      |            |
| Drop-out Voltage                                         |                | $I_{OUT} = 750mA$                                                                  |      | 0.8  | 1.0  | V          |
| Output Backward Leakage Current                          | $I_{OBK}$      | EN1 and EN2 = 0; $V_{OBK} = 27V$                                                   |      | 2.0  | 3.0  | mA         |
| Output Backward Leakage Current                          | $I_{OBK}$      | EN1 and EN2 = 0; $V_{OBK} = 28V$                                                   |      | 15.0 | 17.0 | mA         |
| Output Backward Current Threshold                        | $I_{OBKTH}$    | EN1 and EN2 = 1; $V_{OFAULT} = 19V$ (Note 7)                                       |      | 125  |      | mA         |
| Output Backward Voltage                                  | $I_{OBK}$      | EN1 and EN2 = 0                                                                    |      |      | 27   | V          |
| Output Undervoltage<br>(Asserted high during soft-start) |                | OUVF1, OUVF2 bit is asserted high,<br>measured from the typ output set value       | -6   |      | 2    | %          |
| Output Overvoltage<br>(Asserted high during soft-start)  |                | OUVF1, OUVF2 bit is asserted high,<br>measured from the typ output set value       | +2   |      | +6   | %          |

**Electrical Specifications**  $V_{CC} = 12V$ ,  $T_A = -20^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}C$ .  $EN1 = EN2 = H$ ,  $VTOP1 = VTOP2 = L$ ,  $ENT1 = ENT2 = L$ ,  $DCL = L$ ,  $DSQIN1 = DSQIN2 = L$ ,  $I_{OUT} = 12mA$ , unless otherwise noted. See "ISL6422 Software Description" on page 12 for  $I^2C$  access to the system. **(Continued)**

| PARAMETER                                                                                         | SYMBOL     | TEST CONDITIONS                                  | MIN | TYP | MAX | UNITS       |
|---------------------------------------------------------------------------------------------------|------------|--------------------------------------------------|-----|-----|-----|-------------|
| <b>TXT1 AND TXT2, EXTM1 AND EXTM2, SELVTOP1 AND SELVTOP2, ADDR0 AND ADDR1 INPUT PINS (Note 8)</b> |            |                                                  |     |     |     |             |
| Asserted LOW                                                                                      |            |                                                  |     |     | 0.8 | V           |
| Asserted HIGH                                                                                     |            |                                                  | 1.7 |     |     | V           |
| Input Current                                                                                     |            |                                                  |     | 25  |     | $\mu A$     |
| <b>CURRENT SENSE (CS pin)</b>                                                                     |            |                                                  |     |     |     |             |
| Input Bias Current                                                                                | $I_{BIAS}$ |                                                  |     | 700 |     | nA          |
| Overcurrent Threshold                                                                             | $V_{CS}$   | Static current mode, $DCL = H$                   | 325 | 450 | 500 | mV          |
| <b>ERROR AMPLIFIER</b>                                                                            |            |                                                  |     |     |     |             |
| Open Loop Voltage Gain                                                                            | $A_{OL}$   |                                                  |     | 88  |     | dB          |
| Gain Bandwidth Product                                                                            | GBP        |                                                  |     | 14  |     | MHz         |
| <b>PWM</b>                                                                                        |            |                                                  |     |     |     |             |
| Maximum Duty Cycle                                                                                |            |                                                  | 90  | 93  |     | %           |
| Minimum Pulse Width                                                                               |            |                                                  |     | 20  |     | ns          |
| <b>OSCILLATOR</b>                                                                                 |            |                                                  |     |     |     |             |
| Oscillator Frequency                                                                              | $f_o$      | Fixed at (20) ( $f_{tone}$ )                     | 396 | 440 | 484 | kHz         |
| <b>Thermal Shutdown</b>                                                                           |            |                                                  |     |     |     |             |
| Temperature Shutdown Threshold                                                                    |            |                                                  |     | 150 |     | $^{\circ}C$ |
| Temperature Shutdown Hysteresis                                                                   |            |                                                  |     | 20  |     | $^{\circ}C$ |
| <b>FLT</b>                                                                                        |            |                                                  |     |     |     |             |
| $\overline{FLT}$ (released)                                                                       |            | $V_O = 6V$                                       |     |     | 10  | $\mu A$     |
| $\overline{FLT}$ (asserted)                                                                       |            | $I_{SINK} = 3.2mA$ (1.5k pull-up resistor to 5V) |     |     | 0.4 | V           |

**NOTES:**

- Internal digital soft-start.
- The EXTM1 and EXTM2, SELVTOP1 and SELVTOP2, TXT1 and TXT2, and ADDR0 and ADDR1 pins have 200k internal pull-downs.
- On exceeding this dynamic back current limit threshold for a period of 100 $\mu s$ , the device enters the dynamic current limit mode, and the BCF  $I^2C$  bit is set. The dynamic back current limit duty during a BCF is ON = 100 $\mu s$  or OFF = 5ms.
- In the dynamic back current limit mode, the output is ON for 20ms and OFF for 900ms, but remains continuously ON in the Static mode. When tone is ON, the minimum current limit is 50mA lower than the values indicated in the table. While in the dynamic mode of current limit, the trip level is momentarily increased to 990mA during the 20ms ON time to facilitate recovery from overload conditions.

## Tone Waveform

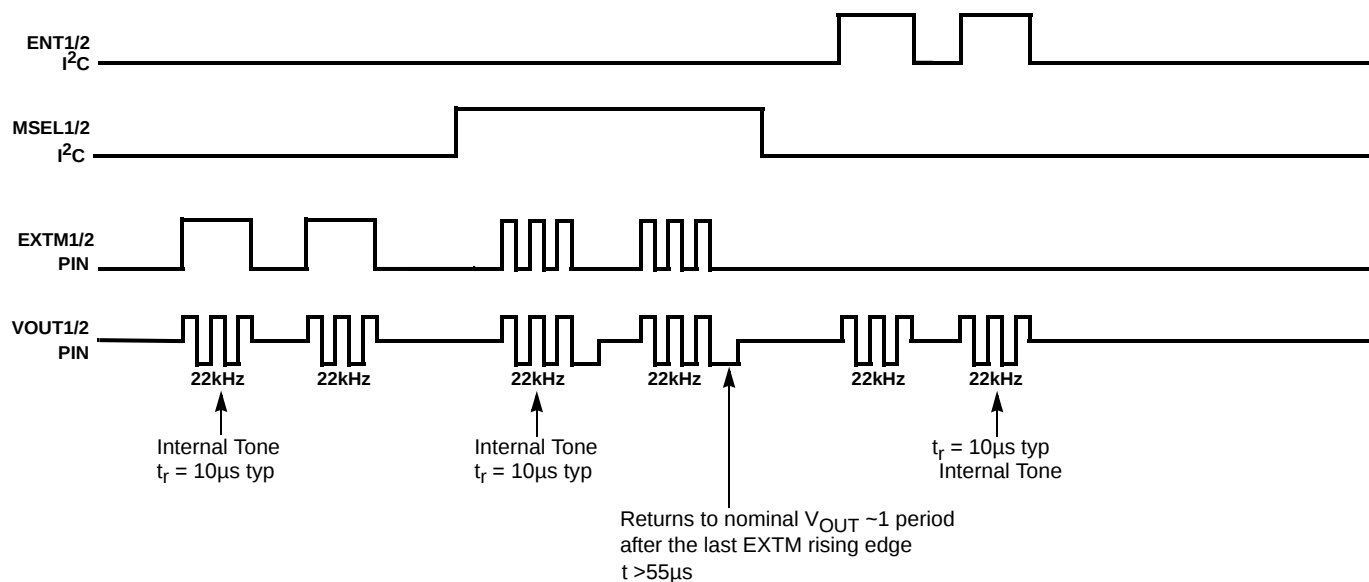


FIGURE 1. TONE WAVEFORM

### NOTES:

- The logic presented to the signal pins TXT1 and TXT2 changes the decoder threshold during tone Transmit and Receive. TTH1 and TTH2 allow threshold control through the I<sup>2</sup>C provided that TXT1 and TXT2 = 0.
- The tone rise and fall times are not shown due to resolution of graphics. It is 10µs typ for 22kHz.
- The EXTM1 and EXTM2 pins have input thresholds of  $V_{IL(max)} = 0.8V$  and  $V_{IH(min)} = 1.7V$

## Typical Performance Curves

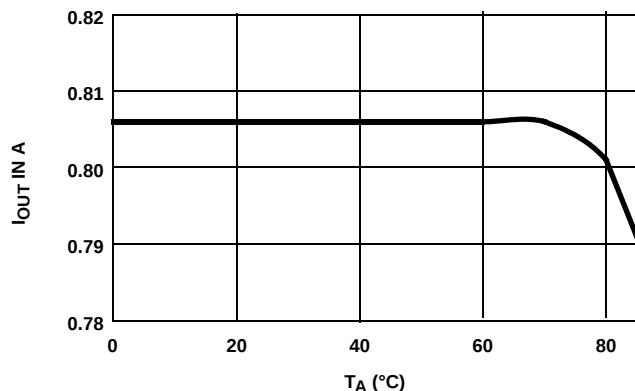


FIGURE 2. OUTPUT CURRENT DERATING 38 LD HTSSOP:  
 $I_{OUT\_max}$  vs  $T_A$

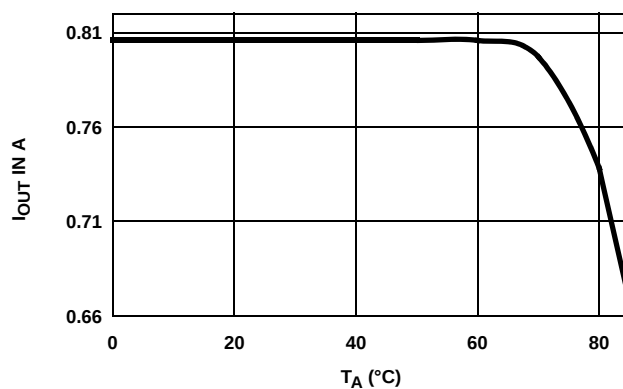


FIGURE 3. OUTPUT CURRENT DERATING 40 LD 6x6 QFN:  
 $I_{OUT\_max}$  vs  $T_A$

NOTE: With both channels in simultaneous operation at rated output.

## Functional Pin Descriptions

| SYMBOL                               | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SDA                                  | Bidirectional data from/to I <sup>2</sup> C bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| SCL                                  | Clock from I <sup>2</sup> C bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| VSW1 and VSW2                        | Input of the linear post-regulator.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| PGND1 and PGND2                      | Dedicated ground for the output gate driver of respective PWM.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| CS1 and CS2                          | Current sense input; connect the sense resistor R <sub>sc</sub> at this pin for desired overcurrent value for respective PWM.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| SGND                                 | Small signal ground for the IC.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| TCAP1 and TCAP2                      | Capacitor for setting rise and fall time of the output of LNB A and LNB B respectively. Typical value is 0.22μF.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| BYP                                  | Bypass capacitor for internal 5V.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| TXT1 and TXT2                        | TXT1 and TXT2 are the Tone Transmit signal inputs used to change the tone decoder threshold. The threshold is 200mV max for the Rx mode when the TXT1 and TXT2 are set low. The threshold is 400mV min in the Tx mode when TXT1 and TXT2 are set high. If Tx/Rx mode is set by I <sup>2</sup> C bit TTH(1, 2), when TTH(1, 2) = 1, then TXT(1, 2) will be driven high (5V) by an on-chip driver.                                                                                                                                                                                                         |
| VCC                                  | Main power supply to the chip.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| GATE1 and GATE2                      | These are the device outputs of PWM A and PWM B respectively. These high current driver outputs are capable of driving the gate of a power FET. These outputs are actively held low when V <sub>CC</sub> is below the UVLO threshold.                                                                                                                                                                                                                                                                                                                                                                    |
| VOUT1 and VOUT2                      | Output voltage for LNB A and LNB B respectively.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| ADDR0 and ADDR1                      | Address pins select four different device addresses per Table 19.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| EXTM1 and EXTM2                      | These pins can be used in two ways:<br>1. As an input for externally modulated DiSEqC tone signal that is transferred symmetrically onto V <sub>OUT</sub> .<br>2. Alternatively apply a DiSEqC modulation envelope that modulates an internal tone and then transfers it symmetrically onto V <sub>OUT</sub> .                                                                                                                                                                                                                                                                                           |
| FLT                                  | This is an open drain output from the controller. When the $\overline{\text{FLT}}$ goes low, it indicates that an Over-Temperature has occurred. The processor should then look at the I <sup>2</sup> C register to get the actual cause of the error. A high on the $\overline{\text{FLT}}$ indicates that the device is functioning normally.                                                                                                                                                                                                                                                          |
| CPVOUT, CPSWIN, CPSWOUT              | A 47nF charge pump cap is connected to CPVOUT. Connect a 1.5nF capacitor between CPSWIN and CPSWOUT.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| SELVTOP1 and SELVTOP2                | The following description applies to both pins and both bits.<br>When this pin is low, the V <sub>OUT</sub> is in the 13V/14V range selected by the I <sup>2</sup> C bit VBOT1 and VBOT2.<br>When this pin is high, the 18V/19V range is selected by the I <sup>2</sup> C bit VTOP1 and VTOP2.<br>The voltage select pin voltage VSPEN1 and VSPEN2 I <sup>2</sup> C bit must be set low for the SELVTOP1 and SELVTOP2 pins to be active. Setting VSPEN1 and VSPEN2 high disables these pins and voltage selection will be done using the I <sup>2</sup> C bits VBOT1 and VBOT2 and VTOP1 and VTOP2 only. |
| TDIN1 and TDIN2<br>TDOUT1 and TDOUT2 | TDIN1 and TDIN2 are the tone decoder inputs for Channels 1 and 2.<br>TDOUT1 and TDOUT2 are the tone detector outputs for Channels 1 and 2. TDOUT1 and TDOUT2 are open drain outputs.                                                                                                                                                                                                                                                                                                                                                                                                                     |
| AGND                                 | Analog ground for the IC.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Functional Description

The ISL6422 dual output voltage regulator makes an ideal choice for advanced satellite set-top box and personal video recorder applications. Both supply and control voltage outputs for two low-noise blocks (LNBs) are available simultaneously in any output configuration. The device utilizes built-in DC/DC step up converters that, from a single supply source ranging from 8V to 14V, generate the voltages that enable the linear post-regulators to work with a minimum of dissipated power. An undervoltage lockout circuit disables the device when VCC drops below a fixed threshold (7.5V typical).

### DiSEqC Encoding

The internal oscillator is factory-trimmed to provide a tone of 22kHz in accordance with DiSEqC (EUTELSAT) standards. No further adjustment is required. The tone oscillator can be controlled either by the I<sup>2</sup>C interface (ENT1 or ENT2 bit) or by a dedicated pin (EXTM1 or EXTM2) that allows immediate DiSEqC data encoding separately for each LNB. All the functions of this IC are controlled via the I<sup>2</sup>C bus by writing to the system registers. The same registers can be read back, and four bits will report the diagnostic status. The internal oscillator operates the converters at twenty times the 22k tone frequency. The device offers full I<sup>2</sup>C compatibility and supports 2.5V, 3.3V or 5V logic, and up to 400kHz operation.

If the Tone Enable bits (ENT1 and ENT2) are set LOW and the MSEL1 and MSEL2 bits set LOW through I<sup>2</sup>C, then the EXTM1 and EXTM2 terminal activates the internal tone signal, modulating the DC output with a 680mV<sub>P-P</sub> typ symmetrical tone waveform. The presence of this signal usually provides the LNB with information about the band to be received.

Burst coding of the tone can be accomplished due to the fast response of the EXTM1 and EXTM2 input and rapid tone response. This allows implementation of the DiSEqC (EUTELSAT) protocols.

When the ENT1 or ENT2 bit is set HIGH, a continuous 22kHz tone is generated regardless of the EXTM1 and EXTM2 pin logic status for the corresponding regulator channel (LNB-A or LNB-B). The ENT1 or ENT2 bit must be set LOW when the EXTM1 and/or EXTM2 pin is used for DiSEqC encoding.

The EXTM1 and EXTM2 pins also accept an externally modulated tone command when the MSEL1 or MSEL2 I<sup>2</sup>C bit is set high.

### DiSEqC Decoder

TDIN1 and TDIN2 are the inputs to the tone decoders of Channels 1 and 2 respectively. They accept the tone signal derived from the V<sub>OUT</sub> through the 10nF decoupling capacitor. The detector threshold can be set to 200mV maximum in the Receive mode and to 400mV minimum in the Transmit mode by means of the logic presented to the

TXT1 or TXT2 pin. If tone is detected, the open drain pin TDOUT1 or TDOUT2 is asserted low. This also enables the tone diagnostics to be performed, apart from the normal tone detection function.

### Linear Regulator

The output linear regulator will sink and source current. This feature allows full modulation capability into capacitive loads as high as 0.75μF. In order to minimize the power dissipation, the output voltage of the internal step-up converter is adjusted to allow the linear regulator to work at minimum dropout.

When the device is put in the shutdown mode (EN1 and EN2 = LOW), both PWM power blocks are disabled (that is, when EN1 = 0, PWM1 is disabled, and when EN2 = 0, PWM2 is disabled).

When the regulator blocks are active (EN1 and EN2 = HIGH, and VSPEN1 and VSPEN2 = LOW), the output can be controlled via I<sup>2</sup>C logic to be between 13V and 14V or between 18V and 19V (typical) by means of the Voltage Select bits (VTOP1, VTOP2, VBOT1, and VBOT2) for remote controlling of non-DiSEqC LNBs.

When the regulator blocks are active (EN1 and EN2 = HIGH, and VSPEN1 and VSPEN2 = HIGH), the VBOT1 and VBOT2 bits and the SELVTOP1 and SELVTOP2 pins will control the output between 13V and 14V and the VTOP1 and VTOP2 and the SELVTOP1 and SELVTOP2 pins will control the output between 18V and 19V.

### Output Timing

The output voltage rise and fall times can be set by an the external capacitor on the TCAP1 and TCAP2 pins. The output rise and fall times is given by Equation 1:

$$C = \frac{(270)t}{\Delta V} \quad (\text{EQ. 1})$$

where:

- C is the TCAP value in nF
- t is the required slew rate in ms, and
- ΔV is the differential transition voltage from low output voltage range to the high output range in Volts.

Rise and fall time will typically be the same.

The maximum recommended value for TCAP1 and TCAP2 would be the base on the maximum transition time allowed in the system application. Too small a value of TCAP1 and TCAP2 can cause high peak currents in the boost circuit. For example, a 10V/ms slew on a 80μF VSW capacitor with an inductor of 15μH can cause a peak inductor current of approximately 2.3A.

### Current Limiting

The dynamic back current limit block has five thresholds that can be selected by the following bits of the SR.

- ISEL1H and ISEL2H
- ISEL1L and ISEL2L
- ISEL1R and ISEL2R

See Table 8 and Table 9 for threshold selection using these bits. The DCL1 and DCL2 bits have to be set to low for this mode of operation. In this mode, the overcurrent protection circuit works dynamically 23 $\mu$ s after an overload is detected, and the output is shutdown for a time  $t_{OFF}$ , typically 900ms. Simultaneously, the OLF1 or OLF2 bit of the System Register is set to HIGH. After this time has elapsed, the output is resumed for a time  $t_{ON}$  = 20ms. During  $t_{ON}$ , the device output will be current limited to a 990mA typ level. If the overload is still detected, the protection circuit will cycle again through  $t_{OFF}$  and  $t_{ON}$ . At the end of a full  $t_{ON}$ , in which no overload is detected, normal operation is resumed and the OLF1 or OLF2 bit is reset to LOW. Typical  $t_{ON}$  +  $t_{OFF}$  time is 920ms as determined by an internal timer. This dynamic operation can greatly reduce the power dissipation in a short circuit condition, still ensuring excellent power-on start-up in most conditions.

However, there could be some cases in which a highly capacitive load on the output may cause a difficult start-up when the dynamic protection is chosen. This can be solved by initiating any power start-up in static mode (DCL = HIGH) and then switching to the dynamic mode (DCL = LOW) after a chosen amount of time. When in static mode, the OLF1 or OLF2 bit goes HIGH when the peak current sense threshold is reached and returns LOW when the overload condition is cleared. The OLF1, OLF2, BCF1, and BCF2 bits will be LOW at the end of initial power-on soft-start. In the static mode the output current through the linears is limited to 990mA typ.

When a 19.3V line is connected onto a VOUT1 or VOUT2 pin that has been set to 13.3V, the linear will then enter a dynamic back current limit state. When a dynamic back current limit of greater than 125mA typ is sensed at the lower FET of the linear for a period greater than 100 $\mu$ s, the output is disabled for a period of 5ms and the BCF1 and BCF2 bits are set. If the 19.3V remains connected, the output will cycle through the ON = 100 $\mu$ s/OFF = 5ms. The output will recover when the fault is removed.

### Thermal Protection

This IC is protected against overheating. When the junction temperature exceeds +150°C (typical), the step-up converter and the linear regulator are shut off and the OTF bit of the SR is set HIGH. Normal operation is resumed and the OTF bit is reset LOW when the junction is cooled down to +130°C (typical).

The  $\overline{FLT}$  pin serves as an interrupt for the processor when an over temperature, overcurrent or backwards overcurrent fault is detected by the LNB controller or when both channels are disabled by the I<sup>2</sup>C EN1 and EN2 bits being set low. Should the I<sup>2</sup>C lose power (for example by shorting BYP pin to ground), it is designed to power up with all control bits set to 0 (particularly the EN1 and EN2 bits). This prevents the device from coming back up in a state not desired by the host controller. If the host controller sees a  $\overline{FLT}$  low, it should read the I<sup>2</sup>C bits and find both EN1 and EN2 bits low. When it desires one or both to be high, it should re-write the I<sup>2</sup>C to the desired state.

### External Output Voltage Selection

The output voltage can be selected by the I<sup>2</sup>C bus. Additionally, the package offers two pins (SELVTOP1 and SELVTOP2) for independent 13 through 19V output voltage selection.

TABLE 1.

| VSPEN1,<br>VSPEN2 | VTOP1,<br>VTOP2 | VBOT1,<br>VBOT2 | SELVTOP1,<br>SELVTOP2 | VOUT1,<br>VOUT2 |
|-------------------|-----------------|-----------------|-----------------------|-----------------|
| 0                 | X               | 0               | 0                     | 13.3V           |
| 0                 | X               | 1               | 0                     | 14.3V           |
| 0                 | 0               | X               | 1                     | 18.3V           |
| 0                 | 1               | X               | 1                     | 19.3V           |
| 1                 | 0               | 0               | X                     | 13.3V           |
| 1                 | 0               | 1               | X                     | 14.3V           |
| 1                 | 1               | 0               | X                     | 18.3V           |
| 1                 | 1               | 1               | X                     | 19.3V           |

### I<sup>2</sup>C Bus Interface for ISL6422

(Refer to Phillips I<sup>2</sup>C Specification, Rev. 2.1)

Data transmission from the main microprocessor to the ISL6422 and vice versa takes place through the two-wire I<sup>2</sup>C bus interface, consisting of the two lines SDA and SCL. Both SDA and SCL are bidirectional lines. They are connected to a positive supply voltage via a pull-up resistor. (Pull-up resistors to positive supply voltage must be externally connected). When the bus is free, both lines are HIGH. The output stages of ISL6422 will have an open drain/open collector in order to perform the wired-AND function. Data on the I<sup>2</sup>C bus can be transferred up to 100kbps in the standard mode or up to 400kbps in the fast mode. The level of logic "0" and logic "1" depends on the value of  $V_{DD}$  as per the "Electrical Specifications" table on page 5. One clock pulse is generated for each data bit transferred.

### Data Validity

The data on the SDA line must be stable during the HIGH period of the clock. The HIGH or LOW state of the data line can change only when the clock signal on the SCL line is LOW. Refer to Figure 4.

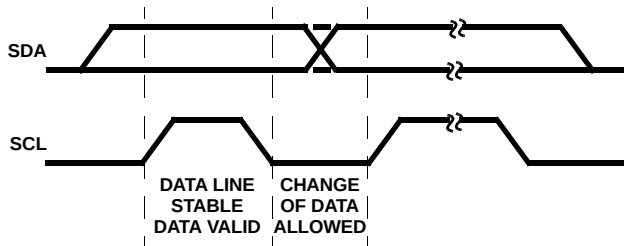


FIGURE 4. DATA VALIDITY

### START and STOP Conditions

As shown in Figure 5, the START condition is a HIGH to LOW transition of the SDA line while SCL is HIGH.

The STOP condition is a LOW to HIGH transition on the SDA line while SCL is HIGH. A STOP condition must be sent before each START condition.

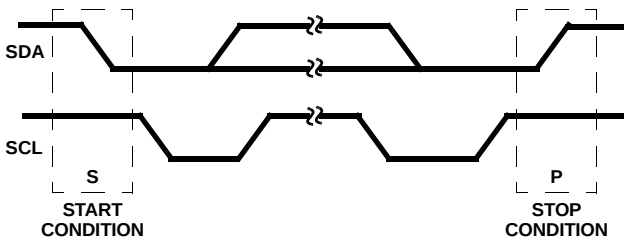


FIGURE 5. START AND STOP WAVEFORMS

### Byte Format

Every byte put on the SDA line must be eight bits long. The number of bytes that can be transmitted per transfer is unrestricted. Each byte has to be followed by an acknowledge bit. Data is transferred with the most significant bit first (MSB).

### Acknowledge

The master (microprocessor) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse (see Figure 6). The peripheral that acknowledges has to pull down (LOW) the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during this clock pulse. (Set-up and hold times must also be taken into account).

The peripheral which has been addressed has to generate an acknowledge after the reception of each byte, otherwise the SDA line remains at the HIGH level during the ninth clock pulse time. In this case, the master transmitter can generate the STOP information in order to abort the transfer.

The ISL6422 will not generate the acknowledge if the POWER OK signal from the UVLO is LOW.

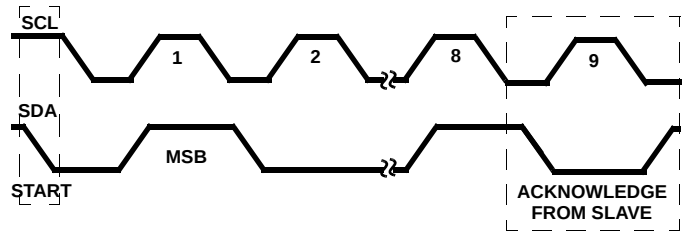


FIGURE 6. ACKNOWLEDGE ON THE I<sup>2</sup>C BUS

### Transmission Without Acknowledge

Avoiding detection of the acknowledgement, the microprocessor can use a simpler transmission; it waits one clock pulse without checking the slave acknowledging and sends the new data. Although, this approach is less protected from error and decreases the noise immunity.

## ISL6422 Software Description

### Interface Protocol

The interface protocol is comprised of the following, as shown in Table 2:

- Start condition (S)
- Chip address byte (MSB on left; the LSB bit determines read (1) or write (0) transmission) (the assigned I<sup>2</sup>C slave address for the ISL6422 is 0001 00XX)
- Sequence of data (1 byte + Acknowledge)
- Stop condition (P)

TABLE 2. INTERFACE PROTOCOL

|   |   |   |   |   |   |   |   |     |     |               |     |   |
|---|---|---|---|---|---|---|---|-----|-----|---------------|-----|---|
| S | 0 | 0 | 0 | 1 | 0 | 0 | 0 | R/W | ACK | Data (8 bits) | ACK | P |
|---|---|---|---|---|---|---|---|-----|-----|---------------|-----|---|

### System Register Format

- R, W = Read and Write bit
- R = Read-only bit
- X = Unused

All bits reset to 0 at Power-On

TABLE 3. STATUS REGISTER 1 (SR1)

| R, W | R, W | R, W | R   | R     | R     | R    | R    |
|------|------|------|-----|-------|-------|------|------|
| SR1H | SR1M | SR1L | OTF | CABF1 | OUVF1 | OLF1 | BCF1 |

TABLE 4. TONE REGISTER 2 (SR2)

| R, W | R, W | R, W | R, W | R, W  | R, W | R, W | R, W |
|------|------|------|------|-------|------|------|------|
| SR2H | SR2M | SR2L | ENT1 | MSEL1 | TTH1 | X    | X    |

TABLE 5. COMMAND REGISTER 3 (SR3)

| R, W | R, W | R, W | R, W | R, W   | R, W        | R, W   | R, W   |
|------|------|------|------|--------|-------------|--------|--------|
| SR3H | SR3M | SR3L | DCL1 | VSPEN1 | ISEL1R<br>X | ISEL1H | ISEL1L |

TABLE 6. CONTROL REGISTER 4 (SR4)

|      |      |      |      |      |      |       |       |
|------|------|------|------|------|------|-------|-------|
| R, W | R, W | R, W | R, W | R, W | R, W | R, W  | R, W  |
| SR4H | SR4M | SR4L | EN1  | X    | X    | VTOP1 | VBOT1 |

TABLE 7. STATUS REGISTER 5 (SR5)

|      |      |      |   |       |       |      |      |
|------|------|------|---|-------|-------|------|------|
| R, W | R, W | R, W | X | R     | R     | R    | R    |
| SR5H | SR5M | SR5L | X | CABF2 | OUVF2 | OLF2 | BCF2 |

TABLE 8. TONE REGISTER 6 (SR6)

|      |      |      |      |       |      |      |      |
|------|------|------|------|-------|------|------|------|
| R, W | R, W | R, W | R, W | R, W  | R, W | R, W | R, W |
| SR6H | SR6M | SR6L | ENT2 | MSEL2 | TTH2 | X    | X    |

TABLE 9. COMMAND REGISTER 7 (SR7)

|      |      |      |      |        |        |        |        |
|------|------|------|------|--------|--------|--------|--------|
| R, W | R, W | R, W | R, W | R, W   | R, W   | R, W   | R, W   |
| SR7H | SR7M | SR7L | DCL2 | VSPEN2 | ISEL2R | ISEL2H | ISEL2L |

TABLE 10. CONTROL REGISTER 8 (SR8)

|      |      |      |      |      |      |       |       |
|------|------|------|------|------|------|-------|-------|
| R, W | R, W | R, W | R, W | R, W | R, W | R, W  | R, W  |
| SR8H | SR8M | SR8L | EN2  | X    | X    | VTOP2 | VBOT2 |

**Transmitted Data (I<sup>2</sup>C bus WRITE mode)**

When the R/W bit in the chip is set to 0, the main microprocessor can write on the system registers (SR1 through SR8) of the ISL6422 via I<sup>2</sup>C bus. These will be written by the microprocessor as shown in the following. The spare bits of registers can be used for other functions.

TABLE 11. STATUS REGISTER SR1 CONFIGURATION

| SR1H | SR1M | SR1L | OTF | CABF1 | OUVF1 | OLF1 | BCF1 | FUNCTION                                                              |
|------|------|------|-----|-------|-------|------|------|-----------------------------------------------------------------------|
| 0    | 0    | 0    | X   | X     | X     | X    | X    | SR1 is selected                                                       |
| 0    | 0    | 0    | X   | X     | X     | 0    | X    | I <sub>OUT</sub> ≤ set limit, Normal Operation                        |
| 0    | 0    | 0    | X   | X     | X     | 1    | X    | I <sub>OUT</sub> > Static/Dynamic Limiting Mode/Power blocks disabled |
| 0    | 0    | 0    | X   | X     | X     | X    | 0    | I <sub>OBCK</sub> ≤ set limit, Normal Operation                       |
| 0    | 0    | 0    | X   | X     | X     | X    | 1    | I <sub>OBCK</sub> > Dynamic Limiting Mode/Power blocks disabled       |
| 0    | 0    | 0    | X   | X     | 0     | X    | X    | V <sub>IN</sub> /V <sub>OUT</sub> within specified range              |
| 0    | 0    | 0    | X   | X     | 1     | X    | X    | V <sub>IN</sub> /V <sub>OUT</sub> is not within specified range       |
| 0    | 0    | 0    | X   | 0     | X     | X    | X    | Cable is connected, I <sub>OUT</sub> is >20mA                         |
| 0    | 0    | 0    | X   | 1     | X     | X    | X    | Cable is open, I <sub>OUT</sub> <2mA                                  |
| 0    | 0    | 0    | 0   | X     | X     | X    | X    | T <sub>J</sub> ≤ +130°C, Normal operation                             |
| 0    | 0    | 0    | 1   | X     | X     | X    | X    | T <sub>J</sub> > +150°C, Power blocks disabled                        |

NOTE: X indicates "Read Only" and is a "Don't Care" for the Write mode.

TABLE 12. TONE REGISTER SR2 CONFIGURATION

| SR2H | SR2M | SR2L | ENT1 | MSEL1 | TTH1 | X | X | FUNCTION                                                                                     |
|------|------|------|------|-------|------|---|---|----------------------------------------------------------------------------------------------|
| 0    | 0    | 1    | X    | X     | X    | X | X | SR2 is selected                                                                              |
| 0    | 0    | 1    | 0    | 0     | X    | X | X | Internal Tone = 22kHz, modulated by EXTM1, t <sub>r</sub> , t <sub>f</sub> = 10μs typ        |
| 0    | 0    | 1    | 0    | 1     | X    | X | X | Ext 22k modulated input, t <sub>r</sub> , t <sub>f</sub> = 10μs typ                          |
| 0    | 0    | 1    | 1    | 0     | X    | X | X | Internal Tone = 22kHz, modulated by the ENT1 bit, t <sub>r</sub> , t <sub>f</sub> = 10μs typ |
| 0    | 0    | 1    | X    | X     | 0    | X | X | TXT = 0; Decoder Rx threshold is set at 200mV max                                            |
| 0    | 0    | 1    | X    | X     | 1    | X | X | TXT = 0; Decoder Tx threshold is set at 400mV min                                            |

NOTE: X is a "Don't Care" for the Write mode.

TABLE 13. COMMAND REGISTER SR3 CONFIGURATION

| SR3H | SR3M | SR3L | DCL1 | VSPEN1 | ISEL1R | ISEL1H | ISEL1L | FUNCTION                           |
|------|------|------|------|--------|--------|--------|--------|------------------------------------|
| 0    | 1    | 0    | X    | X      | X      | X      | X      | SR3 is selected                    |
| 0    | 1    | 0    | 0    | X      | 0      | X      | X      | $I_{OUT1} = 275\text{mA}$ maximum  |
| 0    | 1    | 0    | 0    | X      | 1      | 0      | 0      | $I_{OUT1} = 350\text{mA}$ maximum  |
| 0    | 1    | 0    | 0    | X      | 1      | 0      | 1      | $I_{OUT1} = 515\text{mA}$ maximum  |
| 0    | 1    | 0    | 0    | X      | 1      | 1      | 0      | $I_{OUT1} = 635\text{mA}$ maximum  |
| 0    | 1    | 0    | 0    | X      | 1      | 1      | 1      | $I_{OUT1} = 800\text{mA}$ maximum  |
| 0    | 1    | 0    | 1    | X      | X      | X      | X      | Dynamic current limit NOT selected |
| 0    | 1    | 0    | 0    | X      | X      | X      |        | Dynamic current limit selected     |
| 0    | 1    | 0    | X    | 0      | X      | X      | X      | SELVTOP H/W pin Enabled            |
| 0    | 1    | 0    | X    | 1      | X      | X      | X      | SELVTOP H/W pin Disabled           |

NOTE: X is a "Don't Care" for the Write mode.

TABLE 14. CONTROL REGISTER SR4 CONFIGURATION

| SR4H | SR4M | SR4L | EN1 | X | X | VTOP1 | VBOT1 | FUNCTION                                                                                                    |
|------|------|------|-----|---|---|-------|-------|-------------------------------------------------------------------------------------------------------------|
| 0    | 1    | 1    | 1   | X | X | 0     | 0     | SR4 is selected                                                                                             |
| 0    | 1    | 1    | 1   | X | X | 0     | 0     | $V_{SPEN1} = \text{SELVTOP1} = 0$ , $V_{OUT1} = 13\text{V}$ ,<br>$V_{BOOST1} = 13\text{V} + V_{DROP}$       |
| 0    | 1    | 1    | 1   | X | X | 0     | 1     | $V_{SPEN1} = \text{SELVTOP1} = 0$ , $V_{OUT1} = 14\text{V}$ ,<br>$V_{BOOST1} = 14\text{V} + V_{DROP}$       |
| 0    | 1    | 1    | 1   | X | X | 1     | 0     | $V_{SPEN1} = \text{SELVTOP1} = 0$ , $V_{OUT1} = 13\text{V}$ ,<br>$V_{BOOST1} = 13\text{V} + V_{DROP}$       |
| 0    | 1    | 1    | 1   | X | X | 1     | 1     | $V_{SPEN1} = \text{SELVTOP1} = 0$ , $V_{OUT1} = 14\text{V}$ ,<br>$V_{BOOST1} = 14\text{V} + V_{DROP}$       |
| 0    | 1    | 1    | 1   | X | X | 0     | 0     | $V_{SPEN1} = 0$ , $\text{SELVTOP1} = 1$ , $V_{OUT1} = 18\text{V}$ ,<br>$V_{BOOST1} = 18\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 0     | 1     | $V_{SPEN1} = 0$ , $\text{SELVTOP1} = 1$ , $V_{OUT1} = 18\text{V}$ ,<br>$V_{BOOST1} = 18\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 1     | 0     | $V_{SPEN1} = 0$ , $\text{SELVTOP1} = 1$ , $V_{OUT1} = 19\text{V}$ ,<br>$V_{BOOST1} = 19\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 1     | 1     | $V_{SPEN1} = 0$ , $\text{SELVTOP1} = 1$ , $V_{OUT1} = 19\text{V}$ ,<br>$V_{BOOST1} = 19\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 0     | 0     | $V_{SPEN1} = 1$ , $\text{SELVTOP1} = X$ , $V_{OUT1} = 13\text{V}$ ,<br>$V_{BOOST1} = 13\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 0     | 1     | $V_{SPEN1} = 1$ , $\text{SELVTOP1} = X$ , $V_{OUT1} = 14\text{V}$ ,<br>$V_{BOOST1} = 14\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 1     | 0     | $V_{SPEN1} = 1$ , $\text{SELVTOP1} = X$ , $V_{OUT1} = 18\text{V}$ ,<br>$V_{BOOST1} = 18\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 1   | X | X | 1     | 1     | $V_{SPEN1} = 1$ , $\text{SELVTOP1} = X$ , $V_{OUT1} = 19\text{V}$ ,<br>$V_{BOOST1} = 19\text{V} + V_{DROP}$ |
| 0    | 1    | 1    | 0   | X | X | X     | X     | PWM and Linear for Channel 1 disabled                                                                       |

NOTE: X is a "Don't Care" for the Write mode.

TABLE 15. STATUS REGISTER SR5 CONFIGURATION

| SR5H | SR5M | SR5L |   | CABF2 | OUVF2 | OLF2 | BCF2 | FUNCTION                                                       |
|------|------|------|---|-------|-------|------|------|----------------------------------------------------------------|
| 1    | 0    | 0    | X | X     | X     | X    | X    | SR5 is selected                                                |
| 1    | 0    | 0    | X | X     | X     | 0    | X    | $I_{OUT} \leq$ set limit, Normal Operation                     |
| 1    | 0    | 0    | X | X     | X     | 1    | X    | $I_{OUT} >$ Static/Dynamic Limiting Mode/Power blocks disabled |
| 1    | 0    | 0    | X | X     | X     | X    | 0    | $I_{OBACK} \leq$ set limit, Normal Operation                   |
| 1    | 0    | 0    | X | X     | X     | X    | 1    | $I_{OBACK} >$ Dynamic Limiting Mode/Power blocks disabled      |
| 1    | 0    | 0    | X | X     | 0     | X    | X    | $V_{IN}/V_{OUT}$ within specified range                        |
| 1    | 0    | 0    | X | X     | 1     | X    | X    | $V_{IN}/V_{OUT}$ is not within specified range                 |
| 1    | 0    | 0    | X | 0     | X     | X    | X    | Cable is connected, $I_{OUT}$ is $>20mA$                       |
| 1    | 0    | 0    | X | 1     | X     | X    | X    | Cable is open, $I_{OUT} <2mA$                                  |

NOTE: X indicates "Read Only" state.

TABLE 16. TONE REGISTER SR6 CONFIGURATION

| SR6H | SR6M | SR6L | ENT2 | MSEL2 | TTH2 | X | X | FUNCTION                                                             |
|------|------|------|------|-------|------|---|---|----------------------------------------------------------------------|
| 1    | 0    | 1    | X    | X     | X    | X | X | SR2 is selected                                                      |
| 1    | 0    | 1    | 0    | 0     | X    | X | X | Int Tone = 22kHz, modulated by EXTM2, $T_r$ , $T_f = 10\mu s$ typ    |
| 1    | 0    | 1    | 0    | 1     | X    | X | X | Ext 22k modulated input, $T_r$ , $T_f = 10\mu s$ typ                 |
| 1    | 0    | 1    | 1    | 0     | X    | X | X | Int Tone = 22kHz, modulated by ENT2 bit, $T_r$ , $T_f = 10\mu s$ typ |
| 1    | 0    | 1    | X    | X     | 0    | X | X | TXT2 = 0; Decoder Rx threshold is set at 200mV max                   |
| 1    | 0    | 1    | X    | X     | 1    | X | X | TXT2 = 0; Decoder Tx threshold is set at 400mV min                   |

NOTE: X is a "Don't Care" for the Write mode.

TABLE 17. COMMAND REGISTER SR7 CONFIGURATION

| SR7H | SR7M | SR7L | DCL2 | VSPEN2 | ISEL2R | ISEL2H | ISEL2L | FUNCTION                           |
|------|------|------|------|--------|--------|--------|--------|------------------------------------|
| 1    | 1    | 0    | X    | X      | X      | X      | X      | SR7 is selected                    |
| 1    | 1    | 0    | 0    | X      | 0      | X      | X      | $I_{OUT1} = 275mA$ max.            |
| 1    | 1    | 0    | 0    | X      | 1      | 0      | 0      | $I_{OUT1} = 350mA$ max.            |
| 1    | 1    | 0    | 0    | X      | 1      | 0      | 1      | $I_{OUT1} = 515mA$ max.            |
| 1    | 1    | 0    | 0    | X      | 1      | 1      | 0      | $I_{OUT1} = 635mA$ max.            |
| 1    | 1    | 0    | 0    | X      | 1      | 1      | 1      | $I_{OUT1} = 800mA$ max.            |
| 1    | 1    | 0    | 1    | X      | X      | X      | X      | Dynamic current limit NOT selected |
| 1    | 1    | 0    | 0    | X      | X      | X      | X      | Dynamic current limit selected     |
| 1    | 1    | 0    | X    | 0      | X      | X      | X      | SELVTOP H/W pin Enabled            |
| 1    | 1    | 0    | X    | 1      | X      | X      | X      | SELVTOP H/W pin Disabled           |

NOTE: X is a "Don't Care" for the Write mode.

TABLE 18. CONTROL REGISTER SR8 CONFIGURATION

| SR8H | SR8M | SR8L | EN2 | X | X | VTOP2 | VBOT2 | FUNCTION                                                                                         |
|------|------|------|-----|---|---|-------|-------|--------------------------------------------------------------------------------------------------|
| 1    | 1    | 1    | 1   | X | X | 0     | 0     | SR4 is selected                                                                                  |
| 1    | 1    | 1    | 1   | X | X | 0     | 0     | VSPEN2 = SELVTOP2 = 0, V <sub>OUT1</sub> = 13V, V <sub>BOOST1</sub> = 13V + V <sub>DROP</sub>    |
| 1    | 1    | 1    | 1   | X | X | 0     | 1     | VSPEN2 = SELVTOP2 = 0, V <sub>OUT1</sub> = 14V, V <sub>BOOST1</sub> = 14V + V <sub>DROP</sub>    |
| 1    | 1    | 1    | 1   | X | X | 1     | 0     | VSPEN2 = SELVTOP2 = 0, V <sub>OUT1</sub> = 13V, V <sub>BOOST1</sub> = 13V + V <sub>DROP</sub>    |
| 1    | 1    | 1    | 1   | X | X | 1     | 1     | VSPEN2 = SELVTOP2 = 0, V <sub>OUT1</sub> = 14V, V <sub>BOOST1</sub> = 14V + V <sub>DROP</sub>    |
| 1    | 1    | 1    | 1   | X | X | 0     | 0     | VSPEN2 = 0, SELVTOP2 = 1, V <sub>OUT1</sub> = 18V, V <sub>BOOST1</sub> = 18V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 0     | 1     | VSPEN2 = 0, SELVTOP2 = 1, V <sub>OUT1</sub> = 18V, V <sub>BOOST1</sub> = 18V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 1     | 0     | VSPEN2 = 0, SELVTOP2 = 1, V <sub>OUT1</sub> = 19V, V <sub>BOOST1</sub> = 19V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 1     | 1     | VSPEN2 = 0, SELVTOP2 = 1, V <sub>OUT1</sub> = 19V, V <sub>BOOST1</sub> = 19V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 0     | 0     | VSPEN2 = 1, SELVTOP2 = X, V <sub>OUT1</sub> = 13V, V <sub>BOOST1</sub> = 13V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 0     | 1     | VSPEN2 = 1, SELVTOP2 = X, V <sub>OUT1</sub> = 14V, V <sub>BOOST1</sub> = 14V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 1     | 0     | VSPEN2 = 1, SELVTOP2 = X, V <sub>OUT1</sub> = 18V, V <sub>BOOST1</sub> = 18V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 1   | X | X | 1     | 1     | VSPEN2 = 1, SELVTOP2 = X, V <sub>OUT1</sub> = 19V, V <sub>BOOST1</sub> = 19V + V <sub>DROP</sub> |
| 1    | 1    | 1    | 0   | X | X | X     | X     | PWM and Linear for channel 1 disabled                                                            |

NOTE: X is a "Don't Care" for the Write mode.

### Received Data (I<sup>2</sup>C bus READ MODE)

The ISL6422 can provide to the master a copy of the system register information via the I<sup>2</sup>C bus in read mode. The read mode is master-activated by sending the chip address with the R/W bit set to 1. At the following master-generated clock bits, the ISL6422 issues a byte on the SDA data bus line (MSB transmitted first).

At the ninth clock bit, the MCU master can:

- Acknowledge the reception, thus starting the transmission of another byte from the ISL6422.
- Not acknowledge, thus stopping the read mode communication.

While the whole register is read back by the microprocessor, the following read-only bits convey diagnostic information about the ISL6422.

- OUC1 and OUC2 (Over or Undercurrent bits)
- UV1 and UV2 (Over or Undervoltage bits)
- TPR1 and TPR2 (Tone present bits)
- OTF (Over-temperature fault bit).

### Power-On I<sup>2</sup>C Interface Reset

The I<sup>2</sup>C interface built into the ISL6422 is automatically reset at power-on. The I<sup>2</sup>C interface block will receive a Power OK logic signal from the UVLO circuit. This signal will go HIGH when chip power is OK. As long as this signal is LOW, the interface will not respond to any I<sup>2</sup>C commands and the system register SR1 and SR2 are initialized to all zeros, thus keeping the power blocks disabled. Once the V<sub>CC</sub> rises above UVLO, the POWER OK signal given to the I<sup>2</sup>C interface block will be HIGH, the I<sup>2</sup>C interface becomes operative and the SRs can be configured by the main microprocessor. About 400mV of hysteresis is provided in the UVLO threshold to avoid false triggering of the power-on reset circuit. (I<sup>2</sup>C comes up with EN = 0; EN goes HIGH at the same time as (or later than) all other I<sup>2</sup>C data for that PWM becomes valid).

**ADDR0 and ADDR1 Pins**

Connecting either ADDR0 or ADDR1 to GND, the chip I<sup>2</sup>C interface address is 0001000, but it is possible to choose between four different addresses simply by setting the logic as indicated in Table 19.

**TABLE 19. ADDRESS PIN CHARACTERISTICS**

| V <sub>ADDR</sub>                | ADDR1 | ADDR0 |
|----------------------------------|-------|-------|
| V <sub>ADDR-1</sub><br>"0001000" | 0     | 0     |
| V <sub>ADDR-2</sub><br>"0001001" | 0     | 1     |
| V <sub>ADDR-3</sub><br>"0001010" | 1     | 0     |
| V <sub>ADDR-4</sub><br>"0001011" | 1     | 1     |

**I<sup>2</sup>C Electrical Characteristics****TABLE 20. I<sup>2</sup>C SPECIFICATIONS**

| PARAMETER                | TEST CONDITION                             | MIN   | TYP    | MAX    |
|--------------------------|--------------------------------------------|-------|--------|--------|
| Input Logic High, VIH    | SDA, SCL                                   | 2.0V  |        |        |
| Input Logic Low, VIL     | SDA, SCL                                   |       |        | 0.8V   |
| Input Logic Current, IIL | SDA, SCL;<br>0.4V < V <sub>DD</sub> < 3.3V |       |        | 10μA   |
| Input Hysteresis         | SDA, SCL                                   | 165mV | 200mV  | 235mV  |
| SCL Clock Frequency      |                                            | 0     | 100kHz | 400kHz |

**I<sup>2</sup>C Bit Description****TABLE 21.**

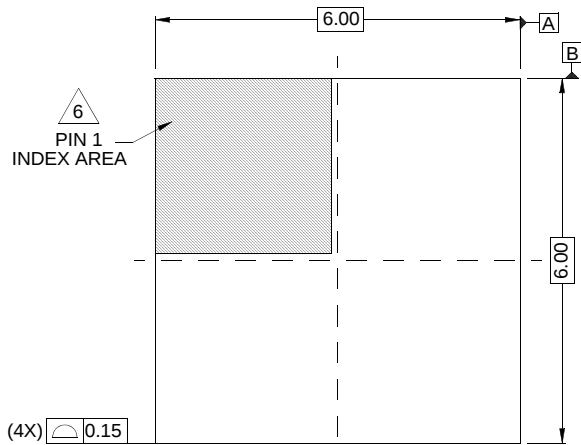
| BIT NAME                                                | DESCRIPTION                                                     |
|---------------------------------------------------------|-----------------------------------------------------------------|
| EN1 and EN2                                             | ENable Output for Channels 1 and 2                              |
| VTOP1 and VTOP2                                         | Voltage TOP Select (that is, 18V/19V for Channels 1 and 2)      |
| VBOT1 and VBOT2                                         | Voltage BOTtom Select (that is, 13V/14V for Channels 1 and 2)   |
| ENT1 and ENT2                                           | ENable Tone for Channels 1 and 2                                |
| MSEL1 and MSEL2                                         | Modulation SElect for Channels 1 and 2                          |
| TFR1 and TFR2                                           | Tone Frequency and Rise time select for Channels 1 and 2        |
| DCL1 and DCL2                                           | Dynamic Current Limit select for Channels 1 and 2               |
| VSPEN1 and VSPEN2                                       | Voltage Select Pin ENable for Channels 1 and 2                  |
| ISEL1H and ISEL2H, ISEL1L and ISEL2L, ISEL1R and ISEL2R | Current limit "I" SElect high and low bits for Channels 1 and 2 |
| OTF                                                     | Over-Temperature Fault bit                                      |
| CABF1, CABF2                                            | CABLE Fault or open status bit for Channels 1 and 2             |
| OUVF1, OUVF2                                            | Over and Undervoltage Fault status bit for Channels 1 and 2     |
| OLF1, OLF2                                              | Over Load Fault status bit for Channels 1 and 2                 |
| BCF1, BCF2                                              | Backward Current Fault Bit for Channels 1 and 2                 |
| TTH1, TTH2                                              | Tone THreshold is the OR of the signal pin TXT1 or TXT2         |

# Package Outline Drawing

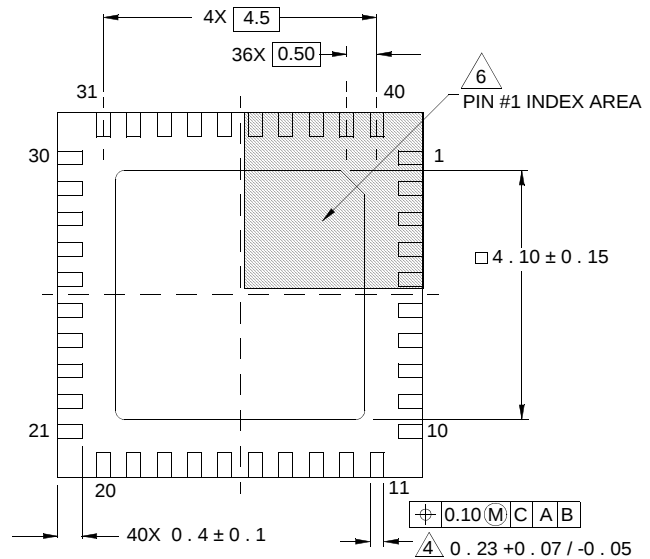
## L40.6x6

### 40 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE

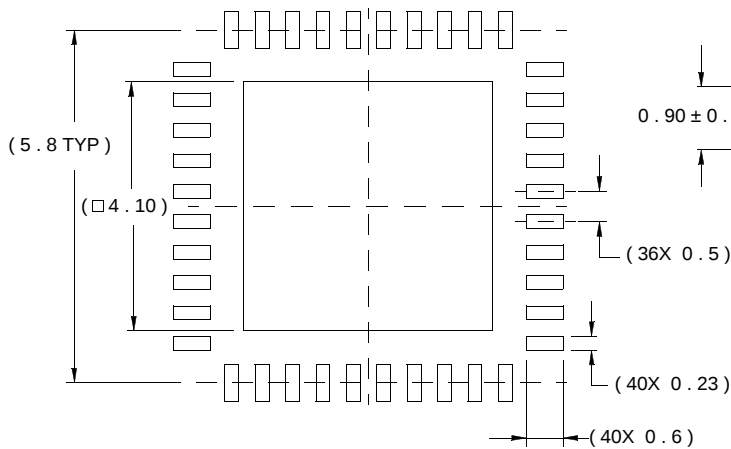
Rev 3, 10/06



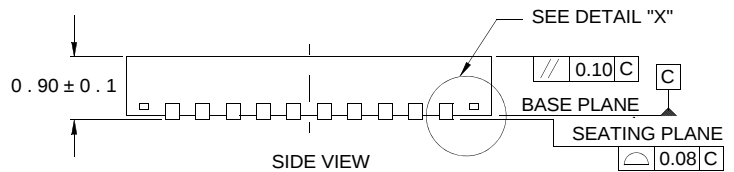
TOP VIEW



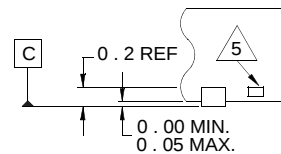
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW

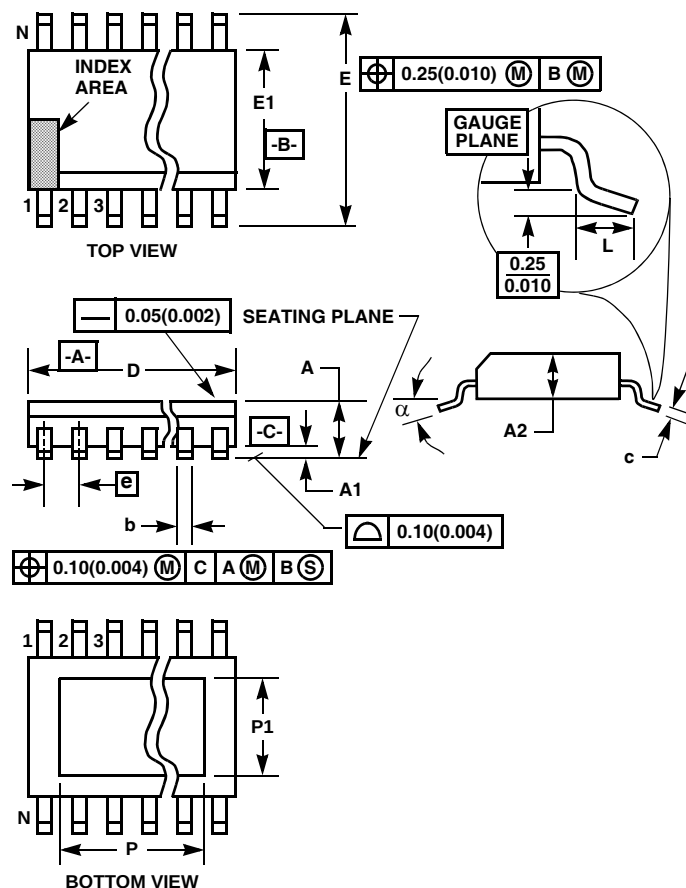


DETAIL "X"

#### NOTES:

1. Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal  $\pm 0.05$
4. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.

# Thin Shrink Small Outline Exposed Pad Plastic Packages (EPTSSOP)



## M38.173B

### 38 LEAD THIN SHRINK SMALL OUTLINE PLASTIC PACKAGE

| SYMBOL   | INCHES     |        | MILLIMETERS |      | NOTES |
|----------|------------|--------|-------------|------|-------|
|          | MIN        | MAX    | MIN         | MAX  |       |
| A        | -          | 0.047  | -           | 1.20 | -     |
| A1       | 0.002      | 0.006  | 0.05        | 0.15 | -     |
| A2       | 0.031      | 0.051  | 0.80        | 1.05 | -     |
| b        | 0.0075     | 0.0106 | 0.17        | 0.27 | 9     |
| c        | 0.0035     | 0.0079 | 0.09        | 0.20 | -     |
| D        | 0.378      | 0.386  | 9.60        | 9.80 | 3     |
| E1       | 0.169      | 0.177  | 4.30        | 4.50 | 4     |
| e        | 0.0197 BSC |        | 0.500 BSC   |      | -     |
| E        | 0.246      | 0.256  | 6.25        | 6.50 | -     |
| L        | 0.0177     | 0.0295 | 0.45        | 0.75 | 6     |
| N        | 38         |        | 38          |      | 7     |
| $\alpha$ | 0°         | 8°     | 0°          | 8°   | -     |
| P        | -          | 0.256  | -           | 6.5  | 11    |
| P1       | -          | 0.126  | -           | 3.2  | 11    |

Rev. 0 9/06

#### NOTES:

- These package dimensions are within allowable dimensions of JEDEC MO-153-BD-1, Issue F.
- Dimensioning and tolerancing per ANSI Y14.5M-1982.
- Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
- Dimension "E1" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.15mm (0.006 inch) per side.
- The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
- "L" is the length of terminal for soldering to a substrate.
- "N" is the number of terminal positions.
- Terminal numbers are shown for reference only.
- Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total in excess of "b" dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm (0.0027 inch).
- Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact. (Angles in degrees)
- Dimensions "P" and "P1" are thermal and/or electrical enhanced variations. Values shown are maximum size of exposed pad within lead count and body size.

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