# AS1357

## Programmable Triple LDO

**DataSheet**

## 1 General Description

The AS1357 is a high-performance triple CMOS low-dropout voltage regulator in a single QFN package. The efficient set of programmable power supplies is optimized to deliver the best compromise between quiescent current and regulator performance for mobile phones, PDAs, MP3 players, and other battery powered devices.

The one-time-programmable (OTP) function provides greater design flexibility by allowing for independent programming of the output voltage for each regulator on-site. The OTP function allows for fast prototyping reducing development times and costs significant. Factory trimmed versions for full-production are also available.

Stability is guaranteed with ceramic output capacitors of only 1µF (±20% – X5R) up to 4.7µF (±20% – X5R). The low equivalent series resistance (ESR) of these capacitors ensures low output impedance at high frequencies.

Regulation performance is excellent even under low dropout conditions, when the power transistor has to operate in linear mode.

The low-noise performance allows direct connection of noise sensitive circuits without additional filtering networks.

The AS1357 is available in a 12-pin QFN 4x4 or 16-pin QFN 3x3 package.

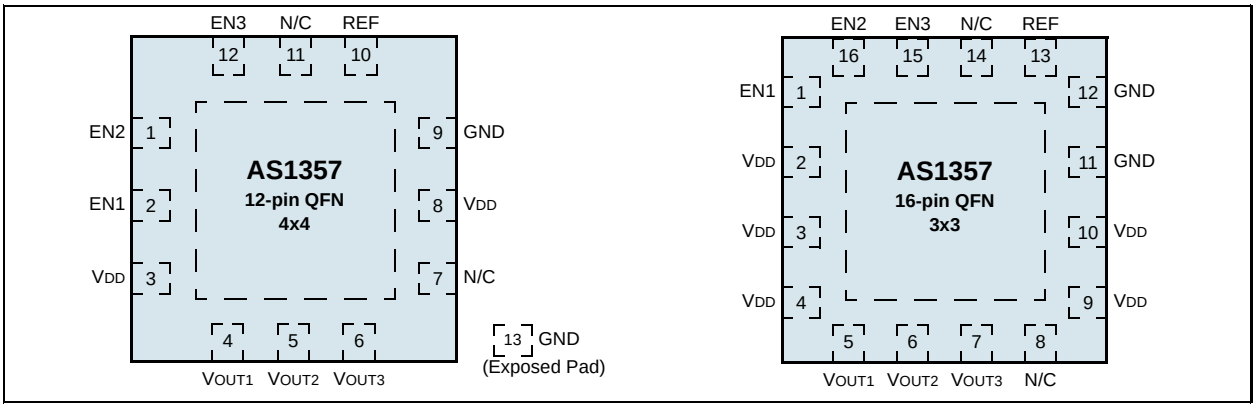
## 2 Key Features

- 3 Independent Voltage Regulators with Shutdown
- Output Current: 200mA each LDO
- One Time Programmable Output Voltage (User- or Factory-Trimmed)
- Programmable Output Voltage Range: 1.8 to 3.3V in 0.1V Steps
- Accuracy: ±1.5%
- PSRR: 70dB at 1kHz, 40dB at 100kHz
- Line Regulation: ±2mV
- Load Regulation: ±0.6mV
- Supply Range: 3 to 5.5V
- 0.2V Dropout Voltage @ I = 200mA
- Shutdown Current: ≤1µA
- Supply Current Without Load: 175µA (typ)
- Softstart for Low Inrush Current
- Stable with low ESR Ceramic Capacitors from 1 to 4.7µF
- Low Noise: 40µV rms @10Hz to 100kHz Bandwidth
- Thermal Protection
- Over-Current Protection
- Temperature Range: -40 to +85°C
- Package Types: 12-pin QFN 4x4 and 16-pin QFN 3x3

## 3 Applications

The AS1357 is ideal for cordless and mobile phones, MP3 players, CD and DVD players, PDAs, handheld computers, digital cameras, and any other hand-held battery-powered device.

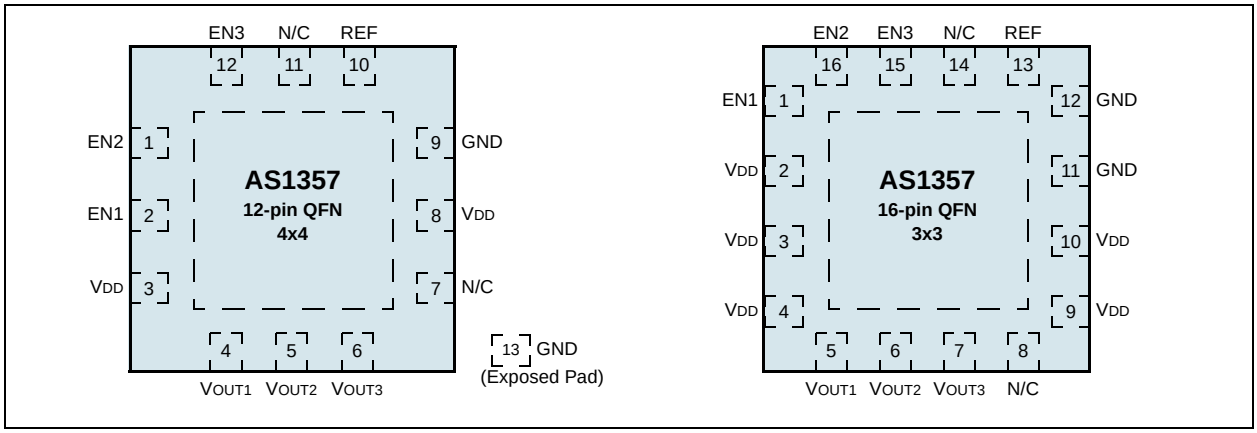
*Figure 1. Pinout Assignments (Top View)*



# 4 Pinout

## Pin Assignments

*Figure 2. Pin Assignments (Top View – Not To Scale)*




## Pin Descriptions

*Table 1. Pin Descriptions*

| 12-pin QFN 4x4 Pin Number | 16-pin QFN 3x3 Pin Number | Pin Name | Description |
|---|---|---|---|
| 2 | 1 | EN1 | **VOUT1 Digital Input Enable** |
| 1 | 16 | EN2 | **VOUT2 Digital Input Enable** |
| 12 | 15 | EN3 | **VOUT3 Digital Input Enable** |
| 9 | 11, 12 | GND | **Negative Supply Voltage**.<br>**Note:** All GND pins must be connected together externally. |
| 13 | - | GND | **Negative Supply Voltage**. This pin is the exposed pad.<br>**Note:** All GND pins must be connected together externally. |
| 10 | 13 | REF | **Analog Reference Voltage**.<br>**Note:** Connect to 100nF capacitor during normal operation. |
| 3, 8 | 2, 3, 4, 9, 10 | VDD | **Positive Supply Voltage**.<br>**Note:** All VDD pins must be connected together externally. |
| 4 | 5 | VOUT1 | **Regulated Analog Output Voltage 1** |
| 5 | 6 | VOUT2 | **Regulated Analog Output Voltage 2** |
| 6 | 7 | VOUT3 | **Regulated Analog Output Voltage 3** |
| 7,11 | 8, 14 | N/C | **Not connected.** |

# 5 Absolute Maximum Ratings

Stresses beyond those listed in Table 3 may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

*Table 2. Absolute Maximum Ratings*

| Parameter | Min | Max | Units | Comments |
|---|---|---|---|---|
| $V_{DD}$ to GND | -0.3 | 7 | V | |
| Any other pin to GND | -0.3 | $V_{DD}$ + 0.3 | V | |
| Continuous Power Dissipation QFN12 4x4mm | 1100 | 2800 | mW | Min value measured at $T_{AMB}$ = 85°C; max value measured at $T_{AMB}$ = 25°C. |
| Package-Body Peak Temperature | | 260 | °C | The reflow peak soldering temperature (body temperature) specified is in accordance with *IPC/JEDEC J-STD-020C "Moisture/Reflow Sensitivity Classification for non-hermetic Solid State Surface Mount Devices"*. |
| Operating Temperature | -40 | 85 | °C | |
| Storage Temperature | -65 | 150 | °C | |
| Electrostatic Discharge Protection (ESD) Level | 1 | | kV | HBM – Norm: *MIL 883 E method 3015*. |

# 6 Electrical Characteristics

*$V_{DD}$ = 4V; $T_{AMB}$ = -40 to +85°C (Typ values are for $T_{AMB}$ = 25°C); $C_{LOAD}$ = 1µF (Ceramic); unless otherwise specified.*

*Table 3. Electrical Characteristics*

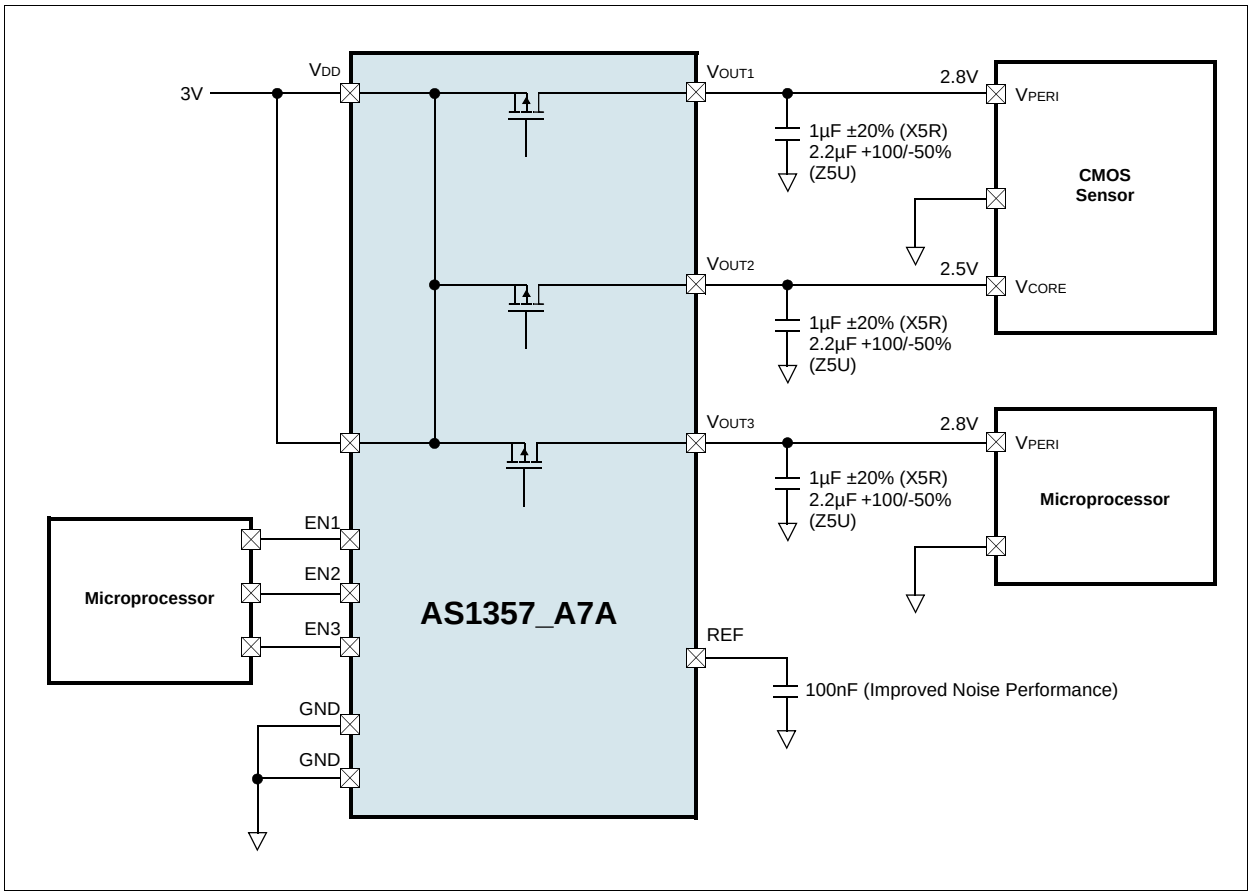
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Supply Voltage Range | | 3 | | 5.5 | V |
| $V_{OUT}$ | Output Voltage Range | | 1.8 | | 3.3 | V |
| $R_{ON}$ | On Resistance | | | | 1 | Ω |
| PSRR [1] | Power Supply Rejection Ratio | f = 1kHz, $C_{REF}$ = 100nF | 70 | | | dB |
| | | f = 100kHz, $C_{REF}$ = 100nF | 40 | | | |
| $I_{OFF}$ | Shut Down Current | ENx = Low | | | 1 | µA |
| $I_{VDD}$ | Supply Current | Without Load | | 175 | 275 | µA |
| $t_{set}$ [1] | Output Voltage Settling Time | $I_{LOAD}$ Switched from 0 to 100mA | | | 50 | µs |
| $t_{start}$ [1] | Start-up Time [2] | $C_{REF}$ = 100nF Pre-charged | | | 300 | µs |
| | | $C_{REF}$ = 0nF Uncharged | | 300 | | µs |
| | | $C_{REF}$ = 100nF Uncharged | | 15 | | ms |
| $V_{OUT}$ | Output Voltage Tolerance | $I_{LOAD}$ = 0mA, $T_{AMB}$ = 25°C | -1.5 | | 1.5 | % |
| | | $I_{LOAD}$ = 0 to 200mA | -2 | | 2 | % |
| $V_{LINEREG}$ | Line Regulation, Static | $V_{DD}$ = 5.5V | -1 | | 1 | % |
| | | $V_{DD}$ = 3 to 4.5V | -2 | | 2 | mV [1] |
| $V_{LOADREG}$ | Load Regulation, Static | $I_{LOAD}$ = 0 to 50 mA | | 0.3 | 2.5 | mV [1] |
| | | $I_{LOAD}$ = 0 to 200 mA (referenced to 100mA) | | 0.6 | 5 | mV [1] |
| $V_{IH}$ | Enable Input Voltage High | | 0.6 x $V_{DD}$ | | | V |
| $V_{IL}$ | Enable Input Voltage Low | | | | 0.8 | V |
| $I_{LOAD}$ | Output Current | | 0 | | 200 | mA |
| $I_{LIMIT}$ | Output Current Limitation | | | 400 | | mA |
| $V_{Noise}$ | Output Noise Voltage | 10 to 100kHz, $C_{REF}$ = 100nF | | 40 | | $\mu V_{RMS}$ |
| | Thermal Protection | | | 145 | | °C |

**Notes:**

1. Guaranteed by design and verified by lab evaluation.
2. Startup is performed if any EN pin goes high.

# 7 Typical Application

*Figure 3. Typical AS1357_uxy Application*

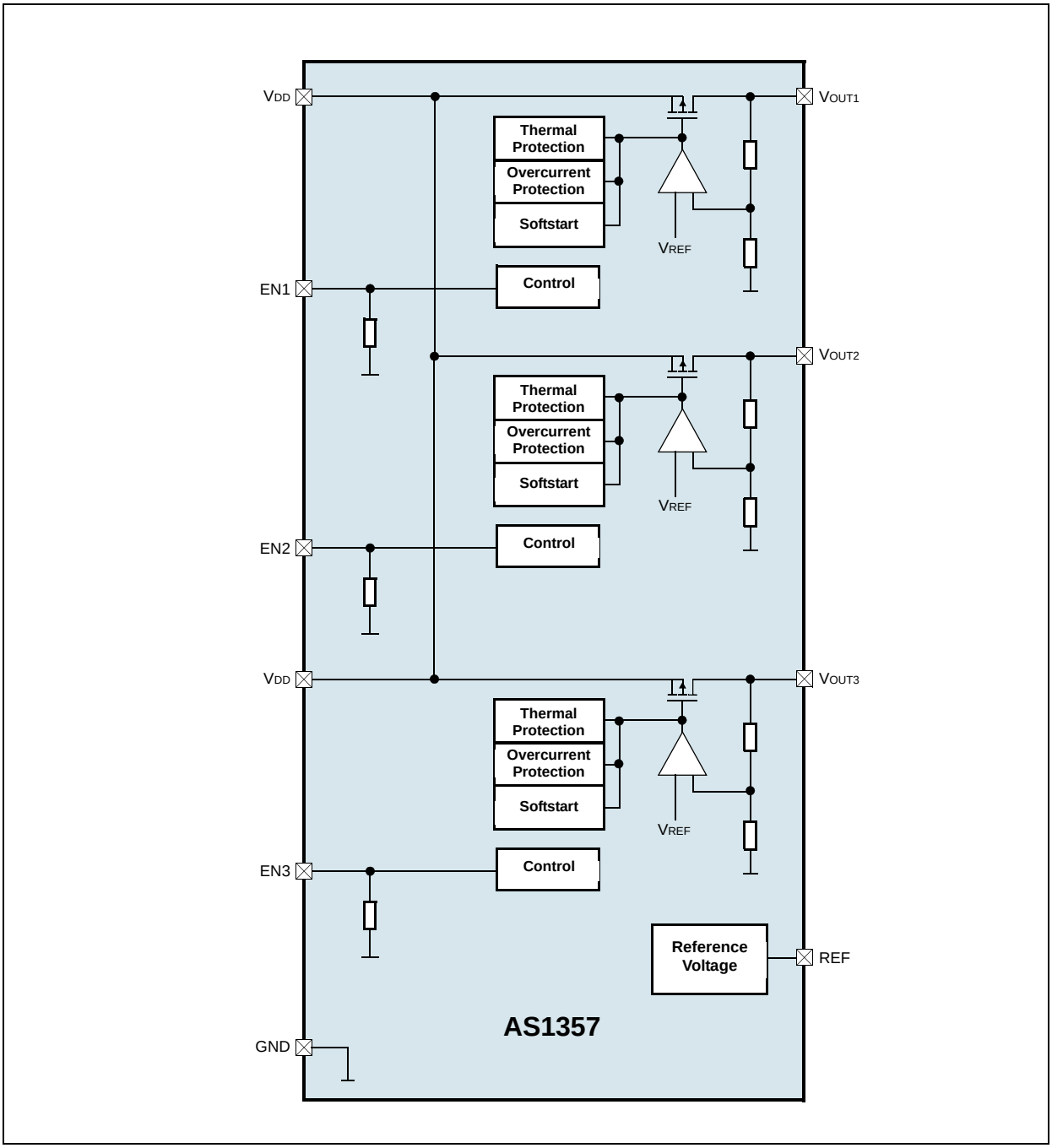



## One-Time Programming Procedure Output Voltages

The three LDOs can be programmed and burned to any output voltage between 1.8 and 3.3V in steps of 0.1V. Customers can burn the desired output voltages onsite using the austriamicrosystems programming board.

Furthermore, the AS1357 is available in pre-programmed versions with fixed output voltages (see Ordering Information on page 9.)

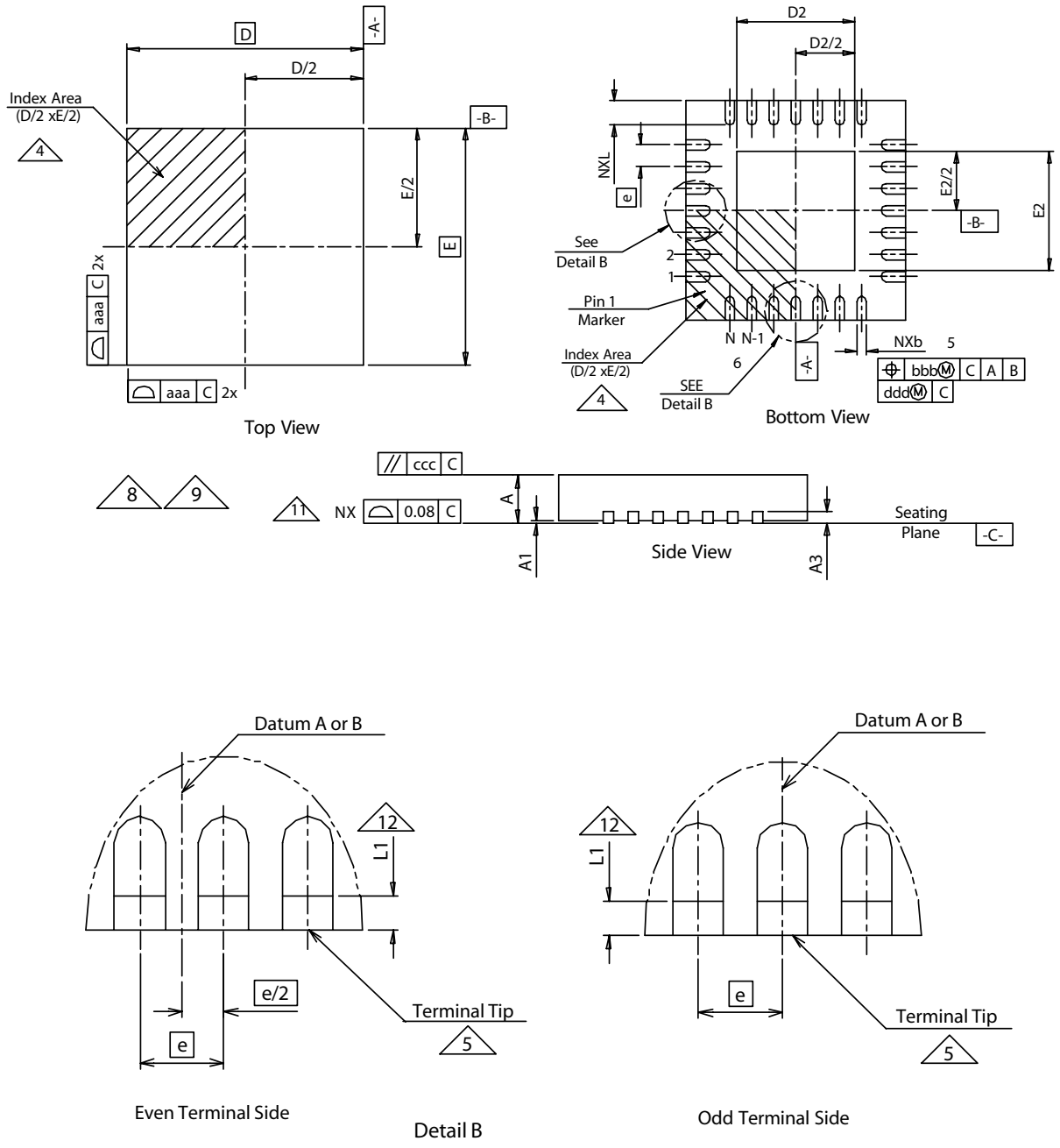
*Figure 4. AS1357 Block Diagram*



# 8 Package Drawings and Markings

The AS1357 is available in a 12-pin QFN 4x4 package and a 16-pin QFN 3x3 package.

*Figure 5. 12-pin QFN 4x4 and 16-pin QFN 3x3 Packages*




**Notes:**

1. Dimensioning and tolerancing conform to *ASME Y14.5M-1994*.
2. All dimensions are in millimeters; angles in degrees.

3. N is the total number of terminals.
4. The terminal #1 identifier and terminal numbering convention shall conform to *JEDEC 95 SPP-012*. Details of terminal #1 identifier are optional but must be located within the zone indicated. The terminal #1 identifier may be either a mold or marked feature.
5. Dimension b applies to metallized terminal and is measured between 0.15 and 0.30mm from terminal tip. If one end of the terminal has the optional radius, the b dimension should not be measured in that radius area.
6. Dimensions ND and NE refer to the number of terminals on each D and E side, respectively.
7. Depopulation is possible in a symmetrical fashion.
8. Figure 5 is shown for illustration only and does not represent any specific variation.
9. All variations may be constructed per Figure 5, however variations may alternately be constructed between square or rectangle shape per dimensions D and E.
10. Refer to the Dimensions Table for a complete set of dimensions.
11. Bilateral coplanarity zone applies to the exposed heat sink slug as well as the terminals.
12. Depending on the method of lead termination at the edge of the package, pullback (L1) may be present. L minus L1 to be ≥ 0.33mm.
13. For variations with more than one lead count for a given body size and terminal pitch, each lead count for that variation is denoted by a dash number (e.g., -1 or -2).

| 16-pin QFN 3x3 Dimensions | | | | |
|---|---|---|---|---|
| **Symbol** | **Min** | **Nom** | **Max** | **Notes** |
| aaa | | 0.15 | | 1, 2 |
| bbb | | 0.10 | | 1, 2 |
| ccc | | 0.10 | | 1, 2 |
| ddd | | 0.05 | | 1, 2 |
| b | 0.18 | 0.25 | 0.30 | 1, 2 |
| e | | 0.50 | | |
| A | 0.80 | 0.90 | 1.00 | 1, 2 |
| A1 | 0.00 | 0.02 | 0.05 | 1, 2 |
| A3 | | 0.20 REF | | 1, 2 |
| L1 | 0.03 | | 0.15 | 1, 2 |
| D BSC | | 3.00 | | 1, 2, 10 |
| E BSC | | 3.00 | | 1, 2, 10 |
| D2 | 1.30 | 1.45 | 1.55 | 1, 2, 10 |
| E2 | 1.30 | 1.45 | 1.55 | 1, 2, 10 |
| L | 0.30 | 0.40 | 0.50 | 1, 2, 10 |
| N | | 16 | | 1, 2, 10 |
| ND | | 4 | | 1, 2, 10 |
| NE | | 4 | | 1, 2, 10 |

| 12-pin QFN 4x4 Dimensions | | | | |
|---|---|---|---|---|
| **Symbol** | **Min** | **Nom** | **Max** | **Notes** |
| aaa | | 0.15 | | 1, 2 |
| bbb | | 0.10 | | 1, 2 |
| ccc | | 0.10 | | 1, 2 |
| ddd | | 0.05 | | 1, 2 |
| b | 0.25 | 0.30 | 0.35 | 1, 2 |
| e | | 0.80 | | |
| A | 0.80 | 0.90 | 1.00 | 1, 2 |
| A1 | 0.00 | 0.02 | 0.05 | 1, 2 |
| A3 | | 0.20 REF | | 1, 2 |
| L1 | 0.03 | | 0.15 | 1, 2 |
| D BSC | | 4.00 | | 1, 2, 10 |
| E BSC | | 4.00 | | 1, 2, 10 |
| D2 | 2.00 | 2.15 | 2.25 | 1, 2, 10 |
| E2 | 2.00 | 2.15 | 2.25 | 1, 2, 10 |
| L | 0.45 | 0.55 | 0.65 | 1, 2, 10 |
| N | | 12 | | 1, 2, 10 |
| ND | | 3 | | 1, 2, 10 |
| NE | | 3 | | 1, 2, 10 |

# 9 Ordering Information

The AS1357 is available with preset LDO output voltages or customer-specific versions (with a minimum order quantity of 30,000). Each customer-specific device is factory trimmed to the desired output voltage (see Table 9).

*Table 4. Ordering Information*

| Part | LDO Values | Delivery Form | Package |
|---|---|---|---|
| AS1357-T | User-programmable LDO values [1] | Tape and Reel | 12-pin QFN 4x4 |
| AS1357 | User-programmable LDO values [1] | Tray | 12-pin QFN 4x4 |
| AS1357V-T [2] | User-programmable LDO values [1] | Tape and Reel | 16-pin QFN 3x3 |
| AS1357V [2] | User-programmable LDO values [1] | Tray | 16-pin QFN 3x3 |
| AS1357_A7A-T | $V_{OUT1}$ = 2.8V, $V_{OUT2}$ = 2.5V, $V_{OUT3}$ = 2.8V | Tape and Reel | 12-pin QFN 4x4 |
| AS1357_*uxy*-T [3, 4] | Customer-specific LDO values | --- | 12-pin QFN 4x4 |
| AS1357V_*uxy*-T [2, 3, 4] | Customer-specific LDO values | --- | 16-pin QFN 3x3 |

1. The values are programmed via the AS1352/57 programming board.
2. Available upon request. Contact austriamicrosystems, AG for more information.
3. Customer-specific values are as follows:
   *u* = Customer-specific $V_{OUT1}$ value suffix.
   *x* = Customer-specific $V_{OUT2}$ value suffix.
   *y* = Customer-specific $V_{OUT3}$ value suffix.
4. “-T” suffix for tape and reel, no suffix for tray delivery form.

*Table 5. Output Voltages Suffix Guide*

| Part | Suffix | Output Voltage |
|---|---|---|
| AS1357_*uxy* | F | 3.3 V |
| | E | 3.2 V |
| | D | 3.1 V |
| | C | 3.0 V |
| | B | 2.9 V |
| | A | 2.8 V |
| | 9 | 2.7 V |
| | 8 | 2.6 V |
| | 7 | 2.5 V |
| | 6 | 2.4 V |
| | 5 | 2.3 V |
| | 4 | 2.2 V |
| | 3 | 2.1 V |
| | 2 | 2.0 V |
| | 1 | 1.9 V |
| | 0 | 1.8 V |

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