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19-2989; Rev 1; 4/06

EVALUATION KIT AVAILABLE

# 4-Channel RGB Video Filter with Asynchronous CVBS Input

MAX7448

## General Description

The MAX7448, 4-channel, buffered video reconstruction filter is ideal for anti-aliasing and digital-to-analog converter (DAC)-smoothing video applications or wherever analog video is reconstructed from a digital data stream (such as cable/satellite/terrestrial set-top boxes, DVD players, hard-disk recorders (HDRs), and personal video recorders (PVRs)). This device operates from a single +5V supply and has a flat passband out to 5MHz with a stopband attenuation of 43dB at 27MHz. This makes it ideal for use with NTSC, PAL, and standard-definition digital TV (SDTV) video systems. Each output is capable of driving two standard 150Ω video loads.

The MAX7448 processes RGB and asynchronous CVBS video signals. The output video buffers have a fixed gain of +6dB. The channel used for CVBS video has high-frequency boost circuitry, which provides picture sharpness with +1.2dB of gain boost without degradation in the stopband. The output video drivers can be disabled with an external pin.

The MAX7448 is available in a 14-pin TSSOP package with an exposed pad, and is specified over the -40°C to +85°C extended temperature range.

## Applications

Set-Top Boxes/HDRs
Game Consoles
Desktop Video Editors
DVD Players
Digital VCRs

## Features

- **4-Channel Filter and Buffer for RGB and CVBS Video Signals**
- **Filter Response Ideal for NTSC, PAL, and Interlaced SDTV Video Signals**
- **43dB (typ) Stopband Attenuation at 27MHz**
- **±0.75dB (max) Passband Ripple Out to 5MHz**
- **Blanking Level Voltage on Cable <1V**
- **Each Channel Drives Two 150Ω Video Loads**
- **+5V Single-Supply Voltage**
- **Small 14-Pin TSSOP Package**

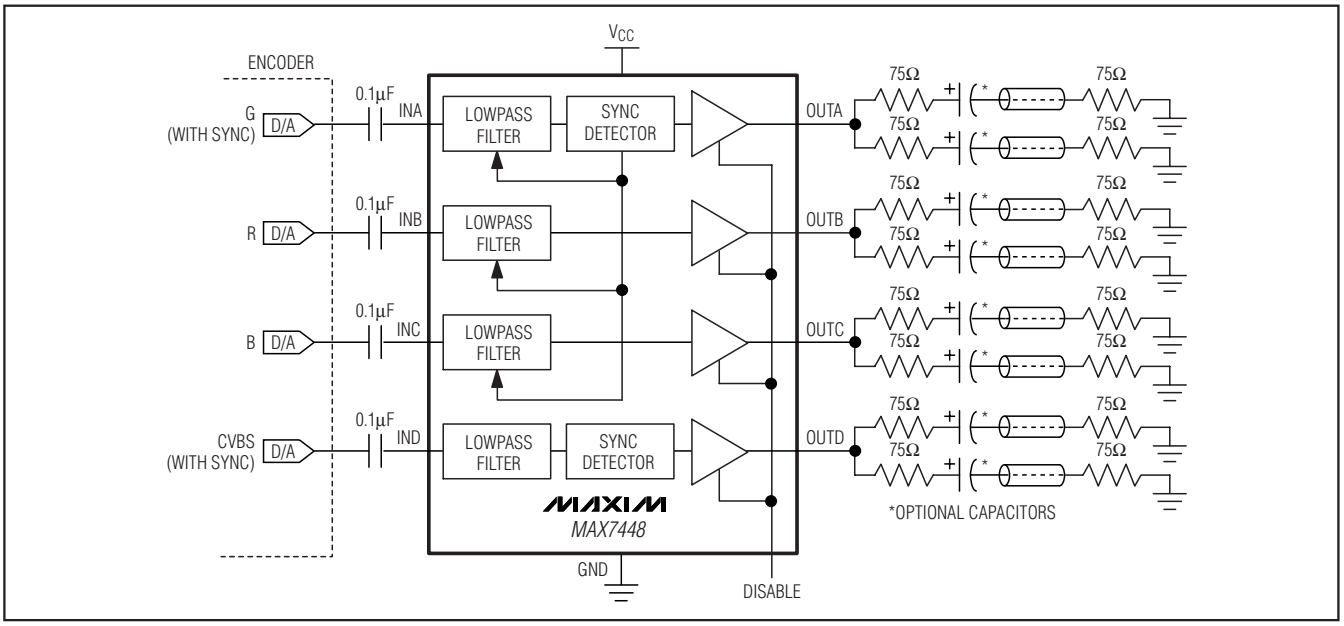
## Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE | PACKAGE CODE |
|---|---|---|---|
| MAX7448EUD | -40°C to +85°C | 14 TSSOP-EP* | U14E-3 |

*EP = Exposed pad.

***Pin Configuration appears at end of data sheet.***

## Functional Diagram



# 4-Channel RGB Video Filter with Asynchronous CVBS Input

## ABSOLUTE MAXIMUM RATINGS

$V_{CC}$ to GND .....+6V
All Other Pins to GND.....-0.3V to ($V_{CC}$ + 0.3V)
Maximum Current into Any Pin Except $V_{CC}$ and GND .....±50mA
Continuous Power Dissipation ($T_A$ = +70°C)
TSSOP-EP (derate 20.8mW/°C above +70°C).....1667mW
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Junction Temperature.....+150°C
Lead Temperature (soldering, 10s) .....+300°C

*Stresses beyond those listed under "Absolute Maximum Ratings" 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.*

## ELECTRICAL CHARACTERISTICS

($V_{CC}$ = +5V ±5%, $C_L$ = 0 to 20pF, $R_L$ = 75Ω to GND for DC-coupled load, $R_L$ = 75Ω to $V_{CC}$ / 2 for AC-coupled load, $C_{IN\_}$ = 0.1µF, GAIN = +6dB, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC}$ = +5V, $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Passband Response | | f = 100kHz to 5MHz, relative to 100kHz | Channels A, B, C | +0.75 | +0.15 | +0.75 | dB |
| | | | Channel D | +0.9 | +1.2 | +1.5 | |
| Stopband Attenuation | $A_{SB}$ | f ≥ 27MHz | | 39 | 43 | | dB |
| Differential Gain | dG | 5-step modulated staircase | | | 0.15 | 0.50 | % |
| Differential Phase | dθ | 5-step modulated staircase | | | 0.15 | 0.50 | Degrees |
| Signal-to-Noise Ratio | SNR | Peak signal ($2V_{P-P}$) to RMS noise, f = 100Hz to 50MHz | | | 80 | | dB |
| Group Delay Deviation | Δtg | Deviation from 100kHz to 4.1MHz | Channels A, B, C | | 11 | 20 | ns |
| | | | Channel D | | 17 | 30 | |
| Line-Time Distortion | $H_{DIST}$ | 18µs, 100 IRE bar | | | | 0.3 | % |
| Field-Time Distortion | $V_{DIST}$ | 130 lines, 18µs, 100 IRE bar | | | | 0.5 | % |
| Clamp Settling Time | $t_{CLAMP}$ | To ±1% | | | 430 | | Lines |
| Output DC Clamp Level | | Channels A, D | | 0.6 | 0.9 | 1.1 | V |
| | | Channels B, C | | 1.1 | 1.5 | 1.8 | |
| Low-Frequency Gain Accuracy | $A_V$ | f = 100kHz | | -3 | | +3 | % |
| Low-Frequency Gain Matching | $A_{V(MATCH)}$ | Low-frequency channel-to-channel matching, f = 100kHz | | | | 4 | % |
| Group Delay Matching | tg(MATCH) | Low-frequency channel-to-channel matching, f = 100kHz | | | 2 | | ns |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | f = 100kHz to 3.58MHz | | | 60 | | dB |
| Output Short-Circuit Current | $I_{SC}$ | OUT_ shorted to GND or $V_{CC}$ | | | 70 | | mA |
| Input Leakage Current | $I_{IN}$ | | | | | 10 | µA |
| Input Dynamic Swing | | Channels A, D | | | | 1.2 | $V_{P-P}$ |
| | | Channels B, C | | | | 0.9 | |
| **SUPPLY** | | | | | | | |
| Supply Voltage Range | $V_{CC}$ | | | 4.75 | | 5.25 | V |
| Supply Current | $I_{CC}$ | No load | | | 100 | 140 | mA |
| Power-Supply Rejection Ratio | PSRR | $V_{IN}$ = 100m$V_{P-P}$, f = 0 to 3.5MHz | | | 40 | | dB |

## ELECTRICAL CHARACTERISTICS (continued)

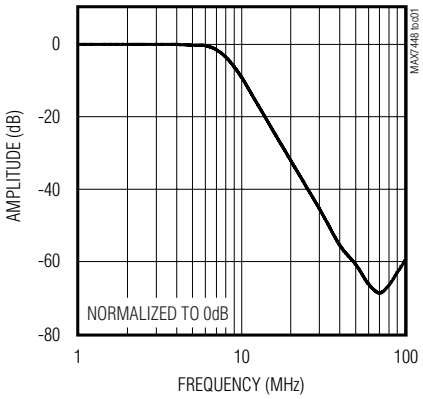
($V_{CC}$ = +5V ±5%, $C_L$ = 0 to 20pF, $R_L$ = 75Ω to GND for DC-coupled load, $R_L$ = 75Ω to $V_{CC}$ / 2 for AC-coupled load, $C_{IN\_}$ = 0.1µF, GAIN = +6dB, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CC}$ = +5V, $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **DISABLE** | | | | | | |
| Output Impedance during Disable | $Z_{DISABLE}$ | At 5MHz | | 2 | | kΩ |
| Disable Logic-Input High Voltage | $V_{IH}$ | | 2.0 | | | V |
| Disable Logic-Input Low Voltage | $V_{IL}$ | | | | 0.8 | V |
| Disable Logic-Input Current | $I_{DISABLE}$ | $V_{IL}$ = 0V (sink), $V_{IH}$ = $V_{CC}$ (source) | | | ±10 | µA |

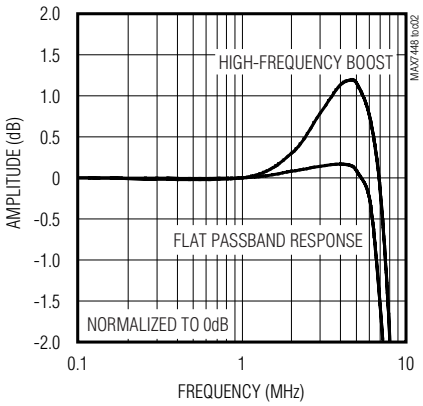
## Typical Operating Characteristics

($V_{CC}$ = +5V, $T_A$ = +25°C, unless otherwise noted.)

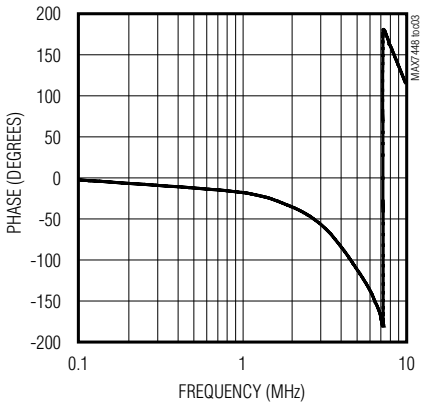
**AMPLITUDE vs. FREQUENCY**




**PASSBAND AMPLITUDE vs. FREQUENCY**




**PHASE RESPONSE vs. FREQUENCY**

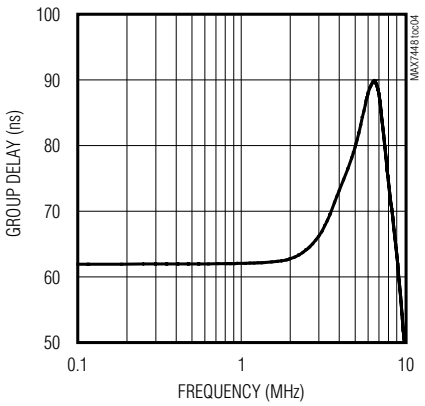


# 4-Channel RGB Video Filter with Asynchronous CVBS Input

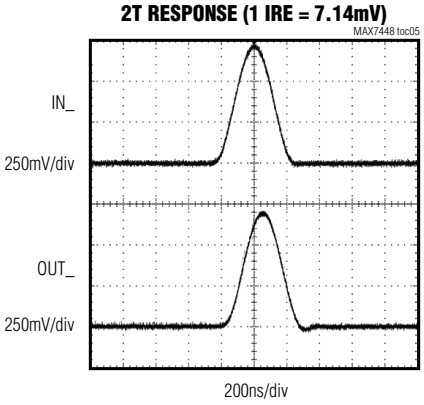
## Typical Operating Characteristics (continued)

($V_{CC}$ = +5V, $T_A$ = +25°C, unless otherwise noted.)

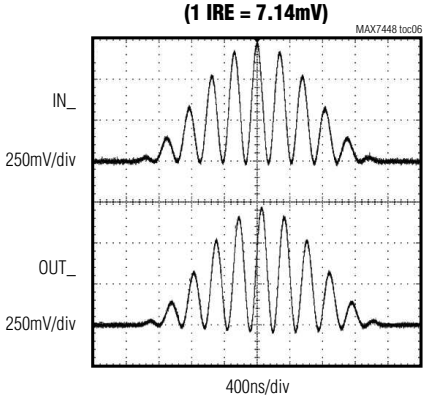
**GROUP DELAY vs. FREQUENCY**



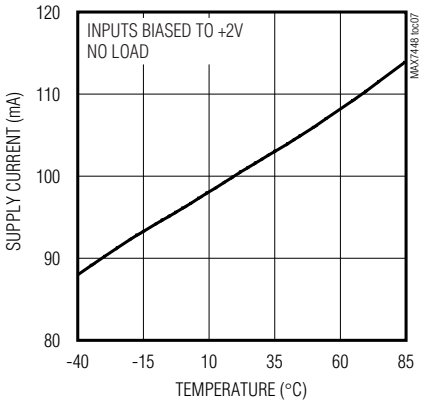

**2T RESPONSE (1 IRE = 7.14mV)**




**MODULATED 12.5T RESPONSE (1 IRE = 7.14mV)**

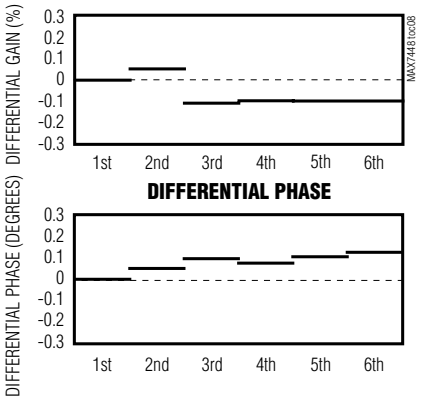



**SUPPLY CURRENT vs. TEMPERATURE**

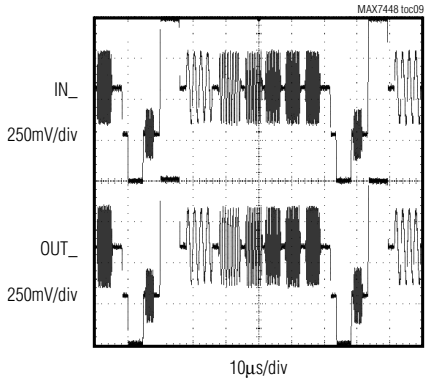



**DIFFERENTIAL GAIN**

**DIFFERENTIAL PHASE**




**MULTIBURST RESPONSE**



## Pin Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | INA | Channel A Video Input. Use channel A for the green (G with sync) video signal. AC-couple INA with a series 0.1µF capacitor. |
| 2 | INB | Channel B Video Input. Use channel B for the red (R) video signal. AC-couple INB with a series 0.1µF capacitor. |
| 3 | INC | Channel C Video Input. Use channel C for the blue (B) video signal. AC-couple INC with a series 0.1µF capacitor. |
| 4 | IND | Channel D Video Input. Use channel D for a CVBS (with sync) signal. AC-couple IND with a series 0.1µF capacitor. |
| 5 | DISABLE | Disable Logic Input. A logic-low on DISABLE enables the output buffers. A logic-high on DISABLE disables all buffer outputs and puts them in a high-impedance state. |
| 6–9 | GND | Ground |
| 10 | $V_{CC}$ | +5V Supply Input |
| 11 | OUTD | Channel D Buffer Output. This output can be either AC- or DC-coupled. |
| 12 | OUTC | Channel C Buffer Output. This output can be either AC- or DC-coupled. |

## Detailed Description

The MAX7448 filters and buffers video-encoder DAC outputs in applications such as set-top boxes, HDRs, DVD players, and digital VCRs. The MAX7448 reconstructs and cleans up analog video signals from the output of DAC video encoders. Each channel consists of a lowpass filter and an output video buffer that can drive two standard 150Ω video loads.

The MAX7448 is designed to process R, G (with sync), B, and $CVBS_{ASYNC}$ video signals. The video signal processed by channel A (G video signal) requires a sync pulse. This sync pulse provides the required timing for channels A, B, and C. Channel D allows an asynchronous video signal to be processed with its own local sync separator.

This device operates from a single +5V supply and has a nominal cutoff frequency of 5MHz optimized for NTSC, PAL, and SDTV.

### Filter

#### Filter Response

The reconstruction filter consists of two 2nd-order Sallen-Key stages. The Butterworth-type response features a maximally flat passband for NTSC and PAL bandwidths. The stopband offers at least 43dB (typ) of attenuation at a video-encoder DAC sampling frequency of 27MHz (see the *Typical Operating Characteristics*).

#### High-Frequency Boost

The +1.2dB high-frequency boost on channel D (CVBS video signal) increases image sharpness by compensating for signal degradation and rolloff in the video encoder. Channels A, B, and C do not boost high-frequency signals and have a flat response over the video bandwidth.

### Output Buffers

Each output buffer has a fixed gain of +6dB and can drive two 150Ω video loads with a $2V_{P-P}$ signal. The MAX7448 can drive an AC load or drive the video load directly without using a large output capacitor. The output buffers drive DC loads with an output blanking level of less than 1V.

# 4-Channel RGB Video Filter with Asynchronous CVBS Input

### Output Clamp Level

When a sync pulse is detected on channel A, the DC restore loop is activated for channel A, B, and C. Channel D's DC restore loop is activated by the sync pulse on channel D. The function of the loop is to set the DC level of the video signal to the specified level of the signal type (R, G, B, CVBS). See Table 1 for clamp levels and sync sources.

**Table 1. Output Clamp Level and Sync Source**

| CHANNEL | CLAMP LEVEL (V) | SYNC SOURCE |
|---|---|---|
| A | 0.9 | Channel A |
| B | 1.5 | Channel A |
| C | 1.5 | Channel A |
| D | 0.9 | Channel D |

## Applications Information

### Input Considerations

Use 0.1µF ceramic capacitors to AC-couple the inputs. These input capacitors store a DC level so the outputs are clamped to an appropriate DC voltage level.

### Output Considerations

The outputs are typically connected to a 75Ω series back-match resistor followed by the video cable. Because of the inherent divide-by-two of this configuration, the voltage on the video cable is always less than 1V, complying with industry-standard video requirements such as the European SCART standard (which allows up to 2V of DC on the video cable). The video buffer can also drive an AC-coupled video load. Good video performance is achieved with an output capacitor as low as 220µF.

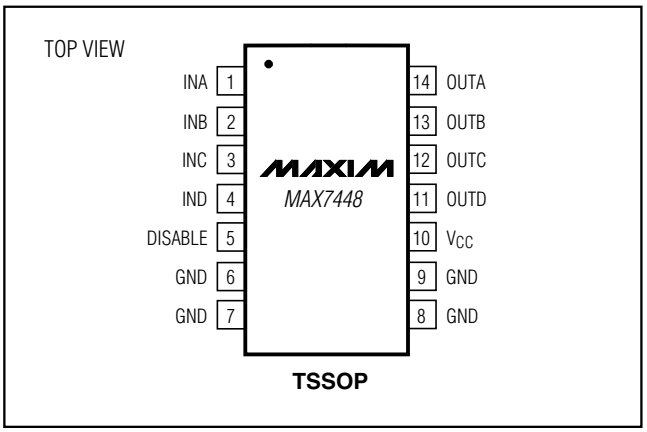
### Power-Supply Bypassing and Layout

The MAX7448 operates from a single +5V supply. Bypass $V_{CC}$ to GND with a 0.1µF capacitor. Place all external components as close to the device as possible.

### Exposed Pads

The TSSOP-EP package has an exposed pad on the bottom of the package. This pad is electrically connected to GND and should be connected to the ground plane for improved thermal conductivity. Do not route signals under this package.

## Pin Configuration




## Chip Information

TRANSISTOR COUNT: 6300

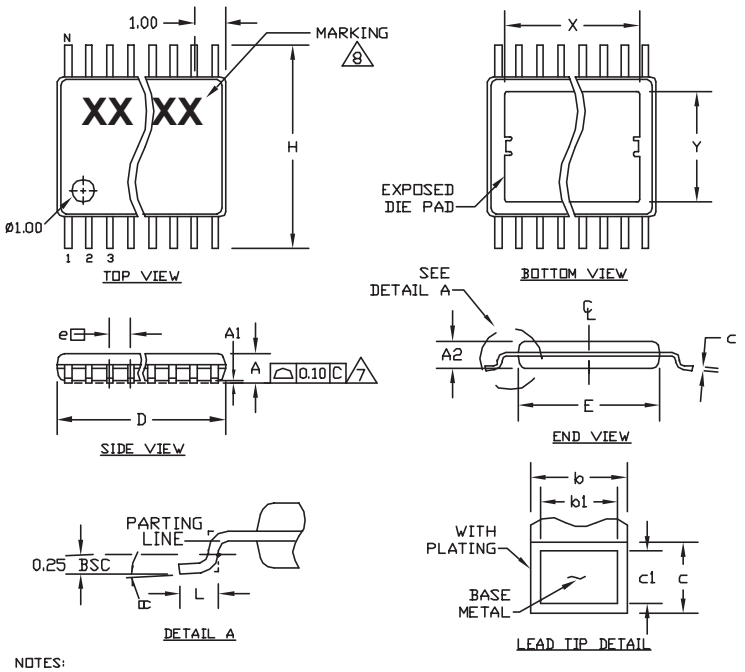
PROCESS: BiCMOS

# 4-Channel RGB Video Filter with Asynchronous CVBS Input

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

TSSOP 4.4mm BODY.EPS




| SYMBOL | COMMON DIMENSIONS | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | -- | 1.10 | -- | 0.043 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| A2 | 0.85 | 0.95 | 0.033 | 0.037 |
| b | 0.19 | 0.30 | 0.007 | 0.012 |
| b1 | 0.19 | 0.25 | 0.007 | 0.010 |
| c | 0.090 | 0.20 | 0.004 | 0.008 |
| c1 | 0.090 | 0.135 | 0.004 | 0.0053 |
| D | SEE VARIATIONS | | SEE VARIATIONS | |
| E | 4.30 | 4.50 | 0.169 | 0.177 |
| e | 0.65 BSC | | 0.026 BSC | |
| H | 6.25 | 6.50 | 0.246 | 0.256 |
| L | 0.50 | 0.70 | 0.020 | 0.028 |
| N | SEE VARIATIONS | | SEE VARIATIONS | |
| Y | 2.85 | 3.15 | 0.112 | 0.124 |
| α | 0° | 8° | 0° | 8° |

| JEDEC | | | VARIATIONS | | | |
|---|---|---|---|---|---|---|
| MO-153 | N | | MILLIMETERS | | INCHES | |
| | | | MIN. | MAX. | MIN. | MAX. |
| ABT-1 | 14 | D | 4.90 | 5.10 | 0.193 | 0.201 |
| | | X | 2.95 | 3.25 | 0.116 | 0.128 |
| ABT | 16 | D | 4.90 | 5.10 | 0.193 | 0.201 |
| | | X | 2.85 | 3.15 | 0.112 | 0.124 |
| ACT | 20 | D | 6.40 | 6.60 | 0.252 | 0.260 |
| | | X | 4.00 | 4.34 | 0.157 | 0.171 |
| AET | 28 | D | 9.60 | 9.80 | 0.378 | 0.386 |
| | | X | 5.35 | 5.65 | 0.211 | 0.222 |

NOTES:
1. DIMENSIONS D AND E DO NOT INCLUDE FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE.
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC OUTLINE MO-153. SEE JEDEC VARIATIONS TABLE.
5. "N" REFERS TO NUMBER OF LEADS.
6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
7. THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.
8. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
9. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, TSSOP, 4.40 MM BODY, EXPOSED PAD

| APPROVAL | DOCUMENT CONTROL NO. | REV. | |
|---|---|---|---|
| | 21-0108 | E | 1/1 |