# DATA SHEET

## SA5775A
Differential air core meter driver

Product specification
Supersedes data of 1999 Sep 20

2000 Aug 10

Philips
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# Differential air-core meter driver SA5775A

## DESCRIPTION

The SA5775A is a monolithic driver for controlling air-core (or differential) meters typically used in automotive instrument cluster applications. The circuit interfaces with a microprocessor through a serial bus and directly drives the air-core meter. The SA5775A has 10-bit resolution (0.35 degree) and is guaranteed to be monotonic. Data can be shifted through the part, allowing several SA5775As to be cascaded with only one chip-select line. On-chip current shut down logic protects the circuit from external faults.

## FEATURES

- 10-Bit resolution (0.35 degrees)
- Exceptional accuracy (0.25 degrees, typical)
- High-torque capability
- Active differential drivers eliminate back-EMF issues
- No RFI/EMI generation issues
- Simple serial interface
- Simple cascading capability for multiple meters
- Internal fault protection
- Only one external component required (bypass capacitor)

## APPLICATION

- Instrumentation utilizing air-core meters

## PIN CONFIGURATION

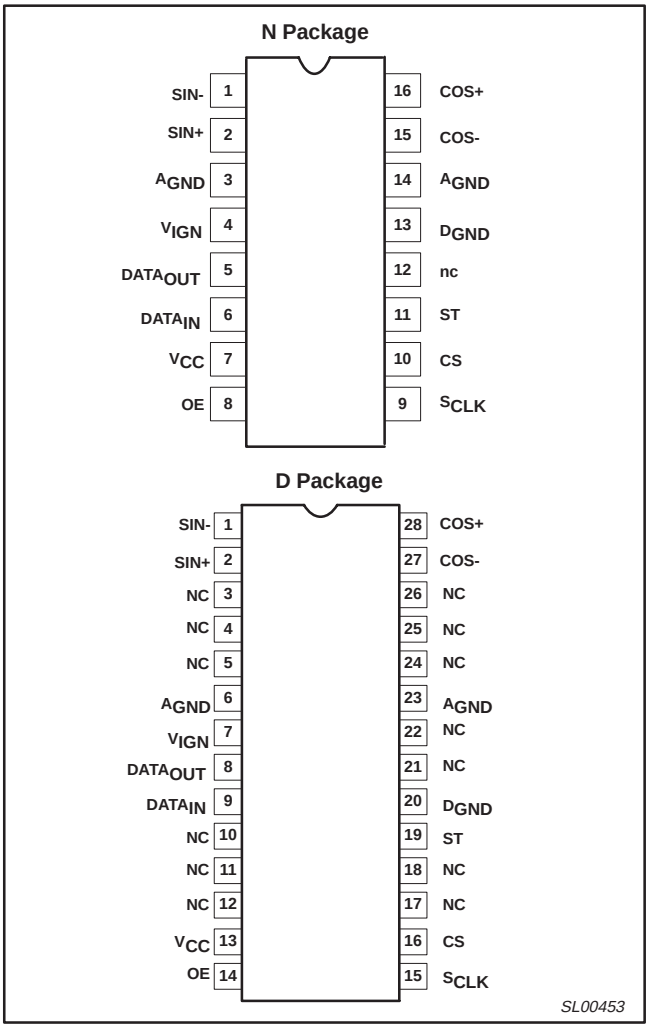



**Figure 1. Pin configuration**

## ORDERING INFORMATION

| DESCRIPTION | TEMPERATURE RANGE | ORDER CODE | DWG # |
|---|---|---|---|
| 16-Pin Plastic Dual In-Line Package (DIP) | -40 to +85°C | SA5775AN | SOT38-4 |
| 28-Pin Small Outline Package (SO) | -40 to +85°C | SA5775AD | SOT136-1 |

## BLOCK DIAGRAM

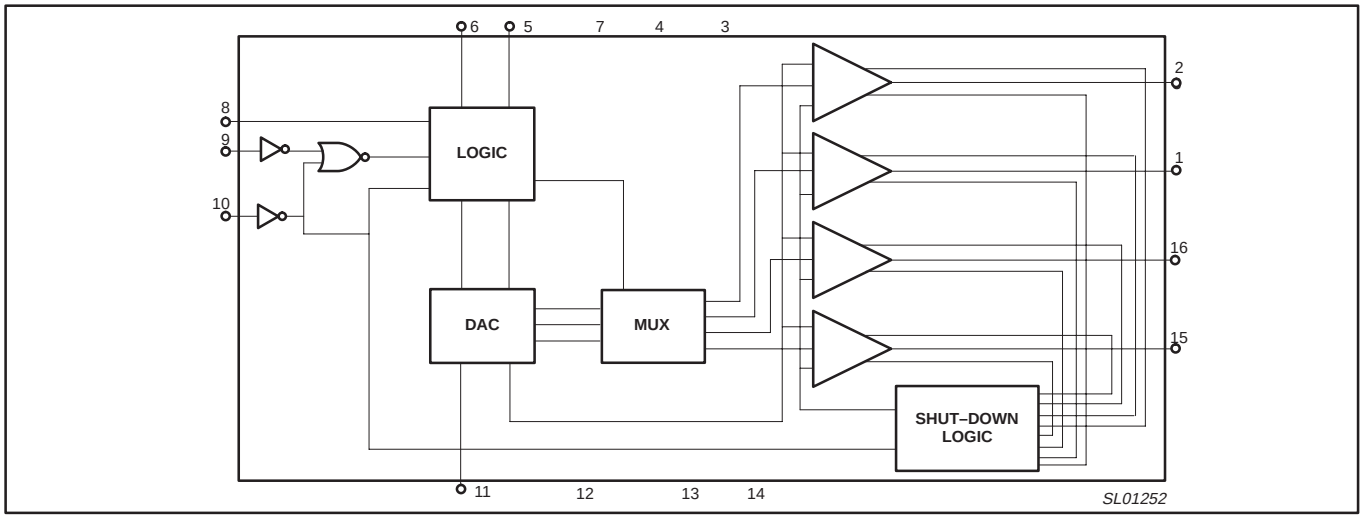



**Figure 2. Block diagram, pin numbers for DIL package**

### Table 1. SA5775A Pin Descriptions for the N Package (Dual In-Line)

| Pin # | Name | Function |
|---|---|---|
| 1. | SIN– | Negative output connection to the SIN coil of the gauge. |
| 2. | SIN+ | Positive output connection to the SIN coil of the gauge. |
| 3. | $A_{GND}$ | Ground for $V_{IGN}$ supply. Pins 3, 13 and 14 connected on the circuit board. |
| 4. | $V_{IGN}$ | Analog supply. Nominally 14.0 V. |
| 5. | $DATA_{OUT}$ | Serial data output. Output of the internal shift register. When a new data word is shifted in, the old word is shifted out the $DATA_{OUT}$ pin. |
| 6. | $DATA_{IN}$ | Serial data input. A new data word is serially shifted into the part on the rising edge of $S_{CLK}$. The data is shifted in MSB first. |
| 7. | $V_{CC}$ | 5 V logic supply. The internal latches and registers are set to zero on the rising edge of this signal. |
| 8. | OE | Output drivers are turned off when this input is low. Current draw is minimized. |
| 9. | $S_{CLK}$ | Serial clock input. Data is loaded into the part on the rising edge of $S_{CLK}$. |
| 10. | CS | Active high chip select input. When CS is high, the part is enabled to receive a new serial input word. The high-to-low transition of CS loads the new 10-bit word into the DAC registers and updates the output. |
| 11. | ST | Status output from this IC to indicate that the outputs have been disabled. The outputs may be disabled due to shorted outputs, over temperature conditions, power up reset, or output enable control pin .This output is an open drain output .Multiple status outputs may be wire OR'ed together .This output is low when the outputs are disabled due to a fault condition. |
| 12. | nc | Not connected |
| 13. | $D_{GND}$ | Ground for $V_{CC}$ supply. Connect to Pins 3 and 14. |
| 14. | $A_{GND}$ | Ground for $V_{BB}$ supply. Connect to Pins 3 and 13. |
| 15. | COS– | Negative output connection to the COS coil of the gauge. |
| 16. | COS+ | Positive output connection to the COS coil of the gauge. |

**Table 2. SA5775A Pin Descriptions for the D Package (Small Outline)**

| Pin # | Name | Function |
|---|---|---|
| 1. | SIN– | Negative output connection to the SIN coil of the gauge. |
| 2. | SIN+ | Positive output connection to the SIN coil of the gauge. |
| 3. | NC | No connect |
| 4. | NC | No connect |
| 5. | NC | No connect |
| 6. | $A_{GND}$ | Ground for $V_{IGN}$ supply. Pins 6, 20 and 23 connected on the circuit board. |
| 7. | $V_{IGN}$ | Analog supply. Nominally 14.0V. |
| 8. | $DATA_{OUT}$ | Serial data output. Output of the internal shift register. When a new data word is shifted in, the old word is shifted out the $DATA_{OUT}$ pin. |
| 9. | $DATA_{IN}$ | Serial data input. A new data word is serially shifted into the part on the rising edge of $S_{CLK}$. The data is shifted in MSB first. |
| 10. | NC | No connect |
| 11. | NC | No connect |
| 12. | NC | No connect |
| 13. | $V_{CC}$ | 5 V logic supply. The internal latches and registers are set to zero on the rising edge of this signal. |
| 14. | OE | Output drivers are turned off when this input is low. Current draw is minimized. |
| 15. | $S_{CLK}$ | Serial clock input. Data is loaded into the part on the rising edge of $S_{CLK}$. |
| 16. | CS | Active high chip select input. When CS is high, the part is enabled to receive a new serial input word. The high-to-low transition of CS loads the new 10-bit word into the DAC registers and updates the output. |
| 17. | NC | No connect |
| 18. | NC | No connect |
| 19. | ST | Status output from this IC to indicate that the outputs have been disabled. The outputs may be disabled due to shorted outputs, over temperature conditions, power up reset, or output enable control pin. This output is an open drain output. Multiple status outputs may be wire OR'ed together. This output is low when the outputs are disabled due to a fault condition. |
| 20. | $D_{GND}$ | Ground for $V_{CC}$ supply. Connect to Pins 6 and 23. |
| 21. | NC | No connect |
| 22. | NC | No connect |
| 23. | $A_{GND}$ | Ground for $V_{BB}$ supply. Connect to Pins 6 and 20. |
| 24. | NC | No connect |
| 25. | NC | No connect |
| 26. | NC | No connect |
| 27. | COS– | Negative output connection to the COS coil of the gauge. |
| 28. | COS+ | Positive output connection to the COS coil of the gauge. |

## ABSOLUTE MAXIMUM RATINGS

| SYMBOL | PARAMETER | RATING | UNIT |
|---|---|---|---|
| $V_{IGN}$ | Analog supply | -1 to +23 | V |
| $V_{CC}$ | Digital supply | -1 to +6 | V |
| $D_{GND}$ to $A_{GND}$ | Ground difference | -0.3 to +0.3 | V |
| $V_{IN}$ | Digital input voltage, Data In, OE, CS, $S_{CLK}$ | -1 to +7 | V |
| $P_D$ | Power dissipation ($T_A$ = 25°C)[1]<br>D and N packages | 1500 | mW |
| $T_A$ | Ambient operating temperature | –40 to +85 | °C |
| $T_J$ | Junction temperature | 150 | °C |
| $\theta_{JA}$ | DIP and SO packages | 90 | °C/W |

**NOTE:**
1. For power dissipation ratings in still air, derate above 25°C at the following rates:
D and N packages at 12mW/°C

## DC ELECTRICAL CHARACTERISTICS

$V_{IGN}$ = 7.5 to 18 V; $V_{CC}$ = 4.5 to 5.5 V; $T_A$ = –40 to +85°C.

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $V_{IGN}$ | Ignition supply voltage | | 7.5 | | 18 | V |
| $I_{IGN}$ | Ignition supply current | $V_{IGN}$ = 18 V no load<br>$V_{IGN}$ = 18 V with load<br>$R_{LC}$, $R_{LS}$ = $R_{LMIN}$[1,2] | | | 25<br><br>160 | mA |
| $I_{CC}$ | Logic supply current | $V_{CC}$ = 5.5 V | | | 1 | mA |
| $V_{OH}$ | Output high voltage | Data out $I_{OH}$ = 300 µA | $V_{CC}$ – 0.8 | | | |
| $V_{OL}$ | Output low voltage | Data out $I_{OL}$ = 1.5 mA | | | 0.4 | V |
| $V_{OL}$ Status | | $I_{OL}$ = 2.8 mA | | | 0.8 | V |
| $I_{OH}$ Status | | ST, $V_{CC}$ = 5 V | | | 25 | µA |
| $V_{IH}$ | Input high voltage | CS, $S_{CLK}$, $DATA_{IN}$ | 0.7 x $V_{CC}$ | | | V |
| $V_{IL}$ | Input low voltage | CS, $S_{CLK}$, $DATA_{IN}$ | | | 0.3 x $V_{CC}$ | V |
| $I_{IH}$ | Input high current | CS, $S_{CLK}$, $DATA_{IN}$, $V_{IN}$ = 0.7 x $V_{CC}$ | | | 10 | µA |
| $I_{IL}$ | Input low current | CS, $S_{CLK}$, $DATA_{IN}$, $V_{IN}$ = 0.3 x $V_{CC}$ | | | 10 | µA |
| $A_{CC}$ | Output function accuracy[3] | $R_{LC}$, $R_{LS}$ = $R_{LMIN}$ | –0.5 | | 0.5 | Degree |
| $I_{SD}$ | Output shut-down current | COS+, COS–, SIN+, SIN–<br>$I_{SINK}$ $V_{IGN}$ = $V_{IGN\ (MAX)}$<br>$V_{IGN}$ = $V_{IGN\ (MIN)}$<br>$I_{SOURCE}$ $V_{IGN}$ = $V_{IGN\ (MAX)}$<br>$V_{IGN}$ = $V_{IGN\ (MIN)}$ | <br>97<br>43<br>85<br>43 | | <br>500<br>300<br>500<br>300 | <br>mA<br>mA<br>mA<br>mA |
| $V_{DRIVE}$ | Coil drive voltage | $V_{IGN}$ = $V_{IGN\ (MAX)}$<br>$V_{IGN}$ = $V_{IGN\ (MIN)}$ | 68 | | 78 | %$V_{IGN}$ |
| $R_{LMIN}$ | Minimum load resistance | $T_A$ = 85°C<br>$T_A$ = 25°C<br>$T_A$ = –40°C | 215<br>171<br>138 | | | Ω<br>Ω<br>Ω |

**NOTE:**
1. See Test Circuit.
2. Maximum current is when output is 45 degrees; $T_A$ = –40°C, and $R_L$ = 138 Ω.
3. See Table “Output function accuracy”

### Table 3. Output function accuracy

| Ideal | Nominal | Input Code |
|---|---|---|
| 0 | 0.176 | 0 |
| 45 | 45.176 | 128 |
| 90 | 90.176 | 256 |
| 135 | 135.176 | 384 |
| 180 | 180.176 | 512 |
| 225 | 225.176 | 640 |
| 270 | 270.176 | 768 |
| 360 | 359.820 | 1023 |
| **N = Binary Input Code**<br>**Equation for Output Angle (θ) vs Output Voltage** | | |
| **Quadrant** | **Equation** | |
| I | $\theta = \tan^{-1} \mid [(SIN+) – (SIN–)] / [(COS+) – (COS–)] \mid$ | |
| II | $\theta = 180° + \tan^{-1} \mid [(SIN+) – (SIN–)] / [(COS+) – (COS–)] \mid$ | |
| III | $\theta = 180° + \tan^{-1} \mid [(SIN+) – (SIN–)] / [(COS+) – (COS–)] \mid$ | |
| IV | $\theta = 360° + \tan^{-1} \mid [(SIN+) – (SIN–)] / [(COS+) – (COS–)] \mid$ | |

## AC ELECTRICAL CHARACTERISTICS

$V_{DD}$ = 7.5 to 18 V; $V_{CC}$ = 4.5 to 5.5 V; $T_A$ = –40 to +85°C

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $FS_{CLK}$ | Input frequency | | | | 1.6 | MHz |
| $TS_{CLKH}$ | $S_{CLK}$ high time | | 175 | | | ns |
| $TS_{CLKL}$ | $S_{CLK}$ low time | $V_{CC}$ = 5.5 V | 175 | | | ns |
| TRO | Output rise time DO | 0.75 to $V_{CC}$ –1.2 V, $C_L$ = 90 pF | | | 75 | ns |
| TFO | Output fall time DO | $V_{CC}$ –1.2 V to 0.75, $C_L$ = 90 pF | | | 75 | ns |
| TSU | DI set-up time | | 75 | | | ns |
| THI | DI hold time | | 75 | | | ns |

## TYPICAL APPLICATION

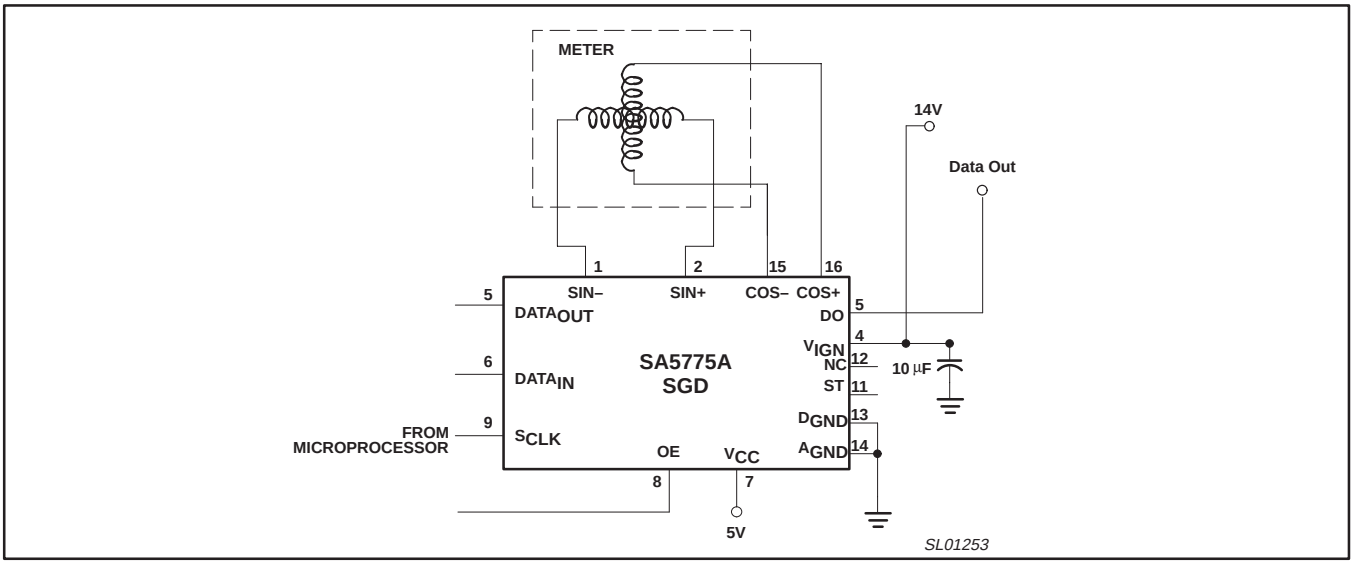



**Figure 3. Typical application**

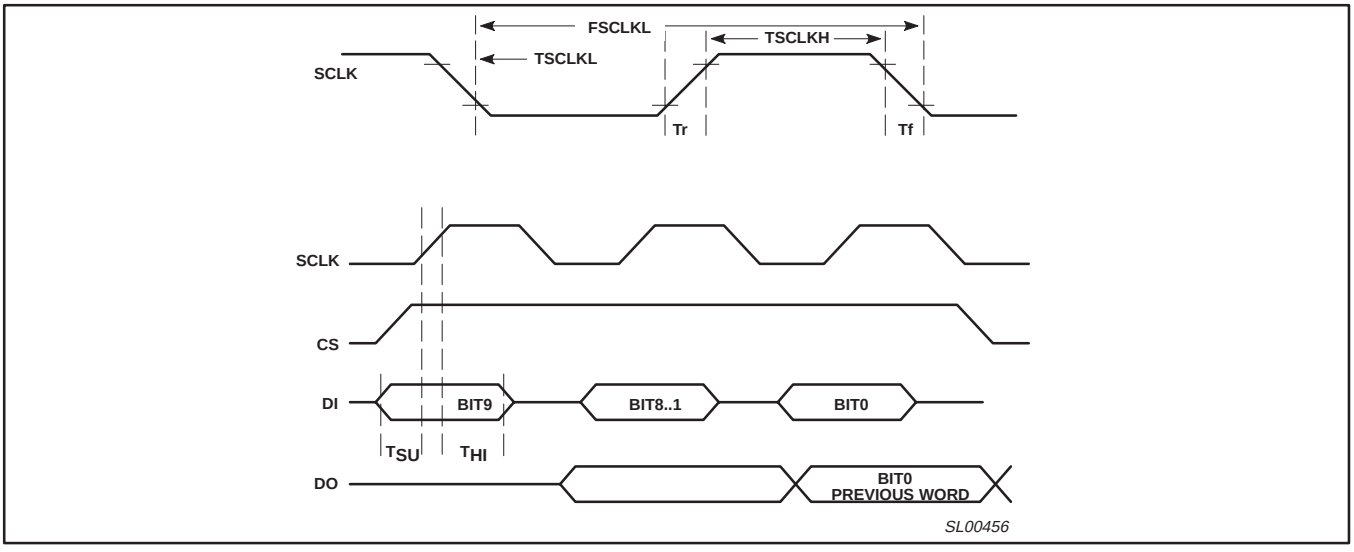



**Figure 4. Serial interface timing**

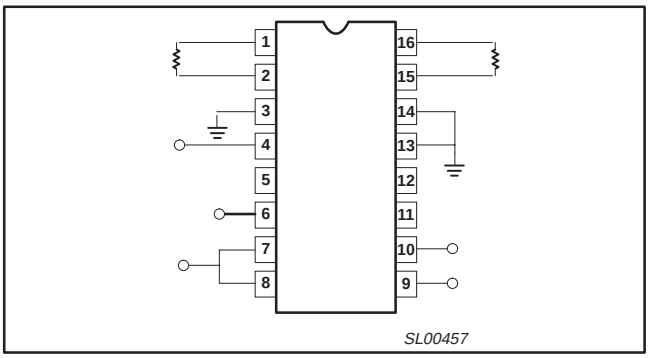



**Figure 5. SA5775A Test circuit, N package**

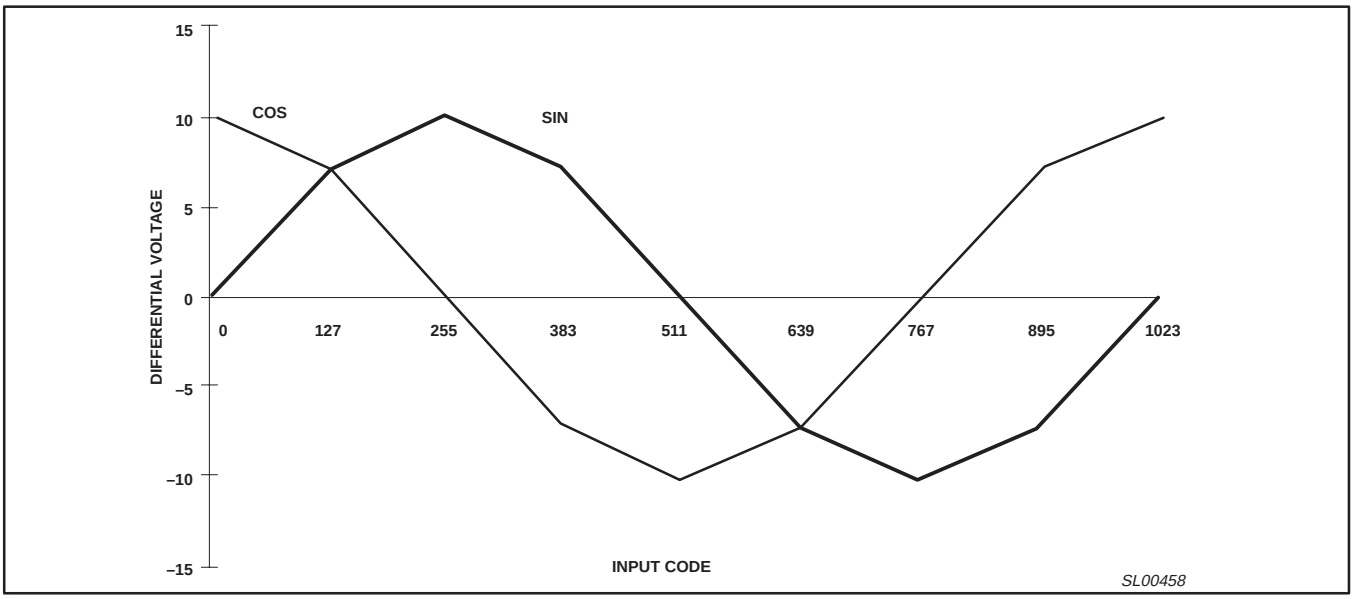



**Figure 6. SA5775A output voltages ($V_{IGN}$ = 14 V)**

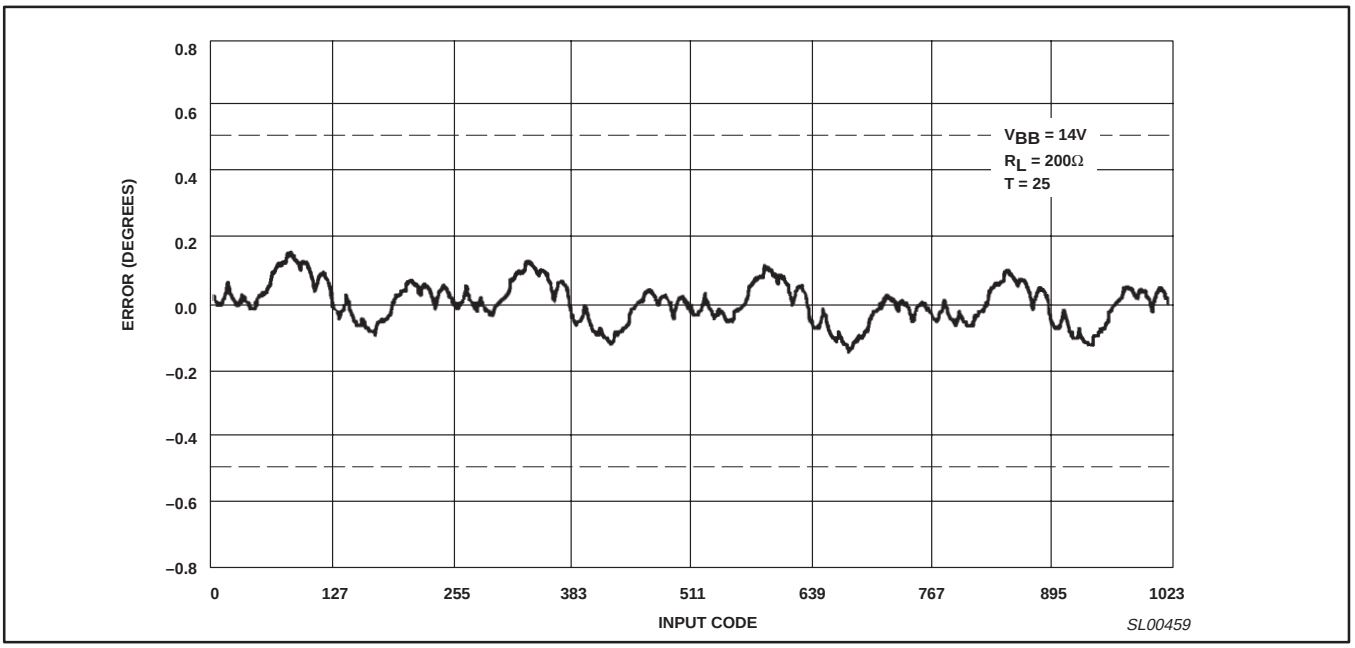
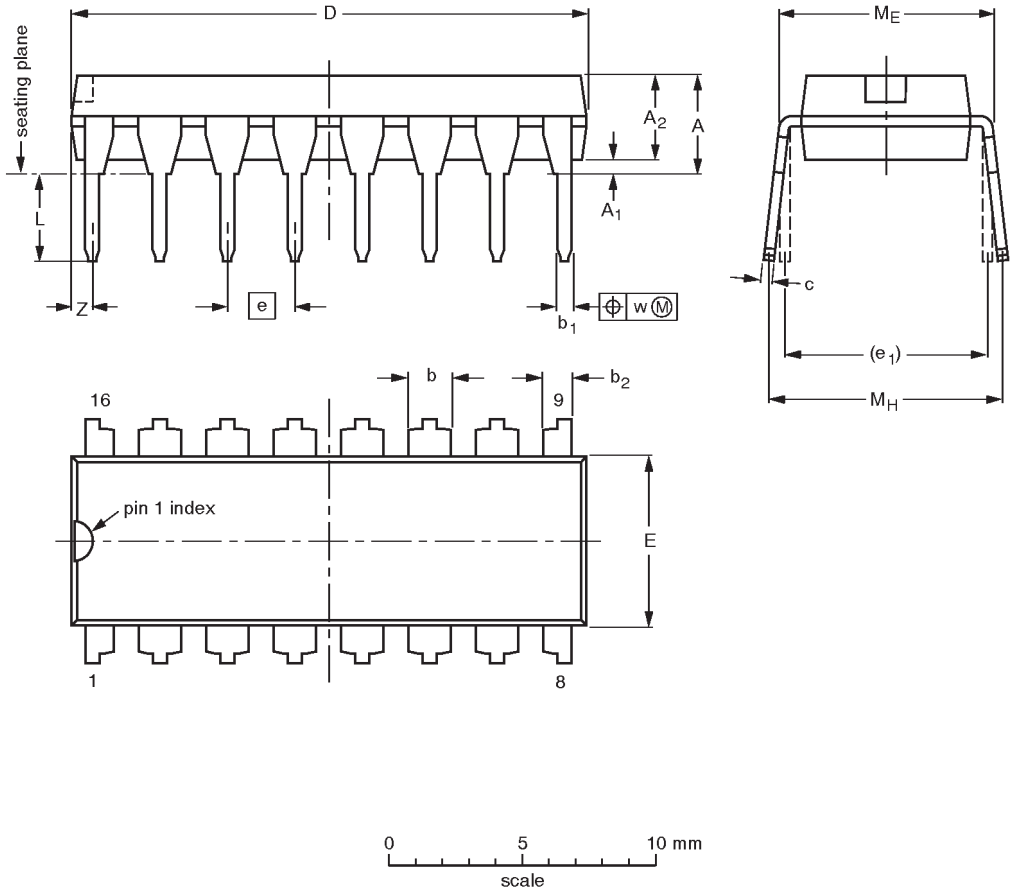



**Figure 7. Error graph**

**DIP16: plastic dual in-line package; 16 leads (300 mil)** **SOT38-4**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

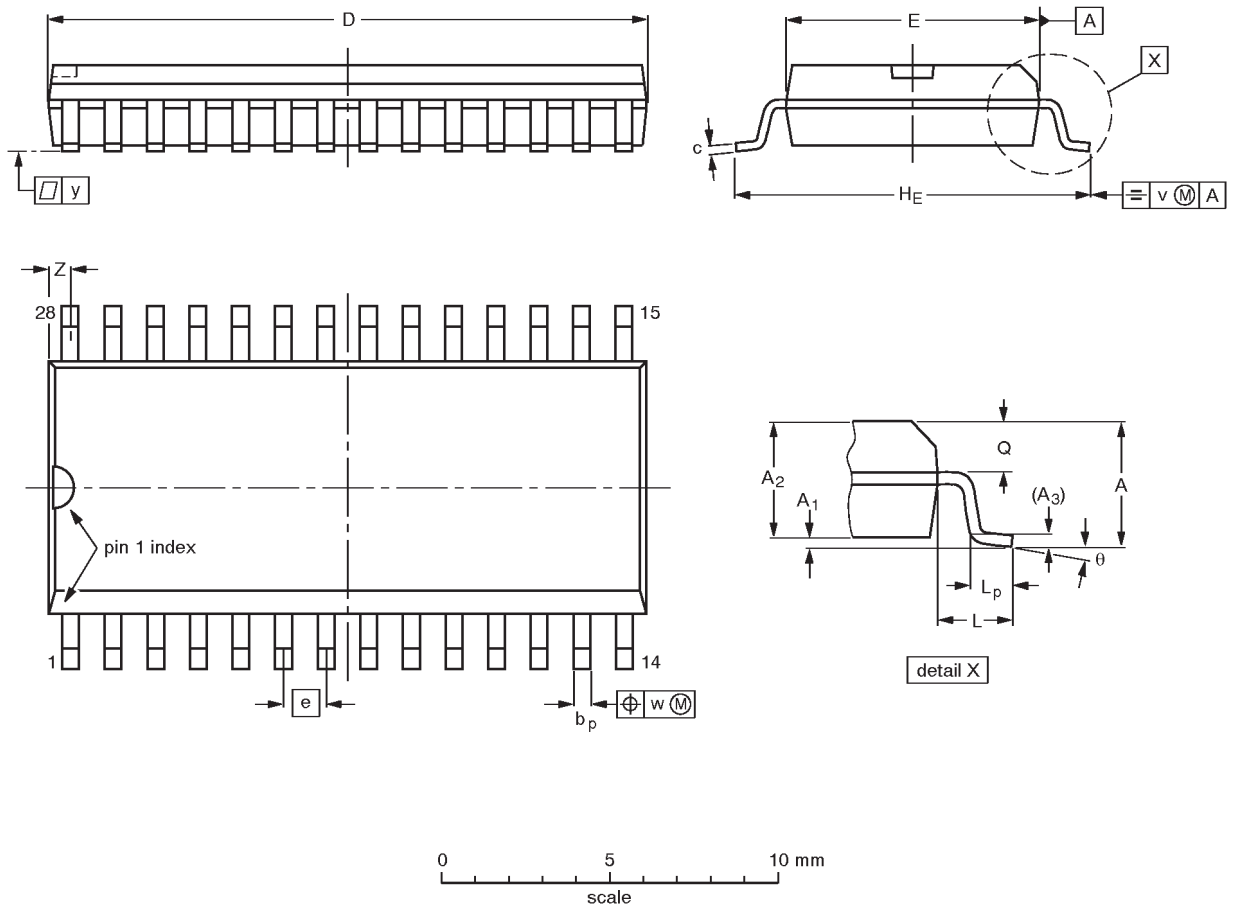
| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | $b_2$ | c | D (1) | E (1) | e | $e_1$ | L | $M_E$ | $M_H$ | w | Z (1) max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.2 | 0.51 | 3.2 | 1.73<br>1.30 | 0.53<br>0.38 | 1.25<br>0.85 | 0.36<br>0.23 | 19.50<br>18.55 | 6.48<br>6.20 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 0.76 |
| inches | 0.17 | 0.020 | 0.13 | 0.068<br>0.051 | 0.021<br>0.015 | 0.049<br>0.033 | 0.014<br>0.009 | 0.77<br>0.73 | 0.26<br>0.24 | 0.10 | 0.30 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.030 |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT38-4 | | | | | | ~~92-11-17~~<br>95-01-14 |

**SO28: plastic small outline package; 28 leads; body width 7.5mm** **SOT136-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.65 | 0.30<br>0.10 | 2.45<br>2.25 | 0.25 | 0.49<br>0.36 | 0.32<br>0.23 | 18.1<br>17.7 | 7.6<br>7.4 | 1.27 | 10.65<br>10.00 | 1.4 | 1.1<br>0.4 | 1.1<br>1.0 | 0.25 | 0.25 | 0.1 | 0.9<br>0.4 | 8°<br>0° |
| inches | 0.10 | 0.012<br>0.004 | 0.096<br>0.089 | 0.01 | 0.019<br>0.014 | 0.013<br>0.009 | 0.71<br>0.69 | 0.30<br>0.29 | 0.050 | 0.42<br>0.39 | 0.055 | 0.043<br>0.016 | 0.043<br>0.039 | 0.01 | 0.01 | 0.004 | 0.035<br>0.016 | |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT136-1 | 075E06 | MS-013AE | | | | ~~91-08-13~~<br>95-01-24 |

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