



## DUAL N-CHANNEL AND DUAL P-CHANNEL MATCHED MOSFET PAIR

### GENERAL DESCRIPTION

The ALD1105 is a monolithic dual N-channel and dual P-channel complementary matched transistor pair intended for a broad range of analog applications. These enhancement-mode transistors are manufactured with Advanced Linear Devices' enhanced ACMOS silicon gate CMOS process. It consists of an ALD1116 N-channel MOSFET pair and an ALD1117 P-channel MOSFET pair in one package. The ALD1105 is a low drain current, low leakage current version of the ALD1103.

The ALD1105 offers high input impedance and negative current temperature coefficient. The transistor pair is matched for minimum offset voltage and differential thermal response, and it is designed for precision signal switching and amplifying applications in +2V to +10V systems where low input bias current, low input capacitance and fast switching speed are desired. Since these are MOSFET devices, they feature very large (almost infinite) current gain in a low frequency, or near DC, operating environment. When used in pairs, a dual CMOS analog switch can be constructed. In addition, the ALD1105 is intended as a building block for differential amplifier input stages, transmission gates, and multiplexer applications.

The ALD1105 is suitable for use in precision applications which require very high current gain, beta, such as current mirrors and current sources. The high input impedance and the high DC current gain of the Field Effect Transistors result in extremely low current loss through the control gate. The DC current gain is limited by the gate input leakage current, which is specified at 100pA at room temperature. For example, DC beta of the device at a drain current of 3mA at 25°C is  $= 3\text{mA}/100\text{pA} = 300,000,000$ .

### FEATURES

- Thermal tracking between N-channel and P-channel pairs
- Low threshold voltage of 0.7V for both N-channel & P-channel MOSFETS
- Low input capacitance
- Low  $V_{os}$  -- 10mV
- High input impedance --  $10^{13}\Omega$  typical
- Low input and output leakage currents
- Negative current ( $I_{DS}$ ) temperature coefficient
- Enhancement mode (normally off)
- DC current gain  $10^9$
- Matched N-channel and matched P-channel in one package
- RoHS compliant

### ORDERING INFORMATION ("L" suffix denotes lead-free (RoHS))

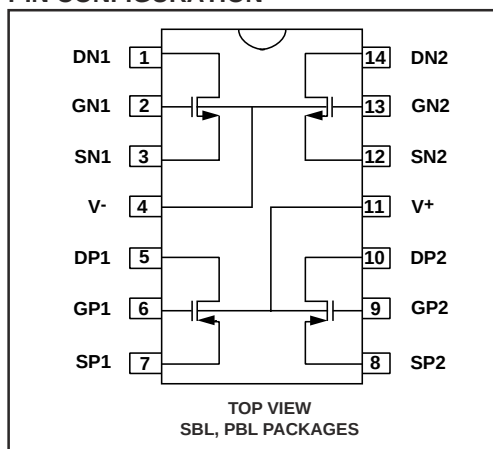
| Operating Temperature Range* |                                  |
|------------------------------|----------------------------------|
| 0°C to +70°C                 | 0°C to +70°C                     |
| 14-Pin<br>SOIC<br>Package    | 14-Pin<br>Plastic Dip<br>Package |
| ALD1105SBL                   | ALD1105PBL                       |

\* Contact factory for high temperature versions.

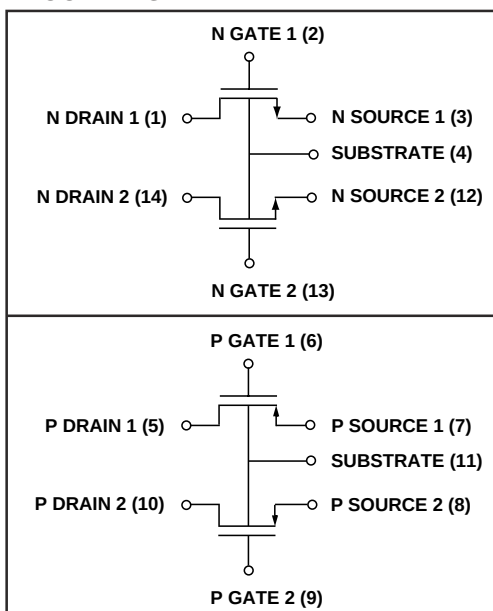
### APPLICATIONS

- Precision current mirrors
- Complementary push-pull linear drives
- Analog switches
- Choppers
- Differential amplifier input stage
- Voltage comparator
- Data converters
- Sample and Hold
- Analog inverter
- Precision matched current sources

### PIN CONFIGURATION



### BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Drain-source voltage,  $V_{DS}$  \_\_\_\_\_ 10V  
 Gate-source voltage,  $V_{GS}$  \_\_\_\_\_ 10V  
 Power dissipation \_\_\_\_\_ 500mW  
 Operating temperature range SBL, PBL packages \_\_\_\_\_ 0°C to +70°C  
 Storage temperature range \_\_\_\_\_ -65°C to +150°C  
 Lead temperature, 10 seconds \_\_\_\_\_ +260°C

**CAUTION: ESD Sensitive Device. Use static control procedures in ESD controlled environment.**

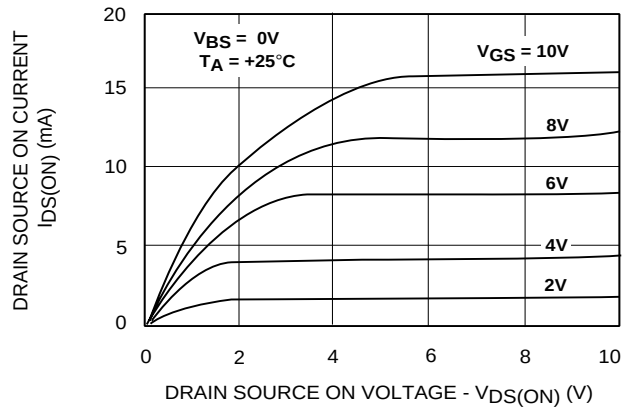
## OPERATING ELECTRICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$  unless otherwise specified

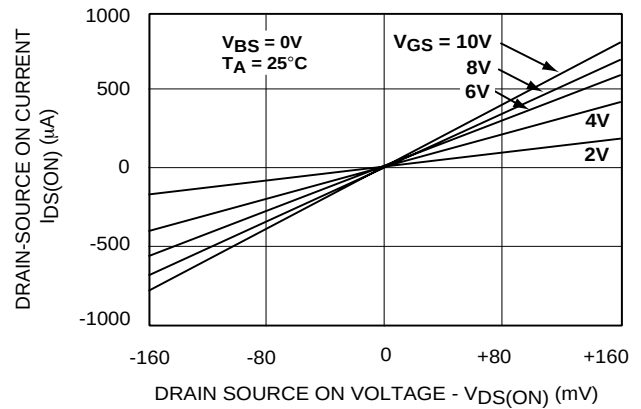
| Parameter                             | Symbol              | N - Channel |      |           | Unit            | Test Conditions                                                         | P - Channel |      |           | Unit            | Test Conditions                                                          |
|---------------------------------------|---------------------|-------------|------|-----------|-----------------|-------------------------------------------------------------------------|-------------|------|-----------|-----------------|--------------------------------------------------------------------------|
|                                       |                     | Min         | Typ  | Max       |                 |                                                                         | Min         | Typ  | Max       |                 |                                                                          |
| Gate Threshold Voltage                | $V_T$               | 0.4         | 0.7  | 1.0       | V               | $I_{DS} = 1\mu\text{A}$ $V_{GS} = V_{DS}$                               | -0.4        | -0.7 | -1.2      | V               | $I_{DS} = -1\mu\text{A}$ $V_{GS} = V_{DS}$                               |
| Offset Voltage<br>$V_{GS1} - V_{GS2}$ | $V_{OS}$            |             | 2    | 10        | mV              | $I_{DS} = 10\mu\text{A}$ $V_{GS} = V_{DS}$                              |             | 2    | 10        | mV              | $I_{DS} = -10\mu\text{A}$ $V_{GS} = V_{DS}$                              |
| Gate Threshold Temperature Drift      | $TC_{VT}$           |             | -1.2 |           | mV/°C           |                                                                         |             | -1.3 |           | mV/°C           |                                                                          |
| On Drain Current                      | $I_{DS(ON)}$        | 3           | 4.8  |           | mA              | $V_{GS} = V_{DS} = 5\text{V}$                                           | -1.3        | -2   |           | mA              | $V_{GS} = V_{DS} = -5\text{V}$                                           |
| Trans-. conductance                   | $G_{fs}$            | 1           | 1.8  |           | mmho            | $V_{DS} = 5\text{V}$ $I_{DS} = 10\text{mA}$                             | 0.25        | 0.67 |           | mmho            | $V_{DS} = -5\text{V}$ $I_{DS} = -10\text{mA}$                            |
| Mismatch                              | $\Delta G_{fs}$     |             | 0.5  |           | %               |                                                                         |             | 0.5  |           | %               |                                                                          |
| Output Conductance                    | $G_{OS}$            |             | 200  |           | $\mu\text{mho}$ | $V_{DS} = 5\text{V}$ $I_{DS} = 10\text{mA}$                             |             | 40   |           | $\mu\text{mho}$ | $V_{DS} = -5\text{V}$ $I_{DS} = -10\text{mA}$                            |
| Drain Source ON Resistance            | $R_{DS(ON)}$        |             | 350  | 500       | $\Omega$        | $V_{DS} = 0.1\text{V}$ $V_{GS} = 5\text{V}$                             |             | 1200 | 1800      | $\Omega$        | $V_{DS} = -0.1\text{V}$ $V_{GS} = -5\text{V}$                            |
| Drain Source ON Resistance Mismatch   | $\Delta R_{DS(ON)}$ |             | 0.5  |           | %               | $V_{DS} = 0.1\text{V}$ $V_{GS} = 5\text{V}$                             |             | 0.5  |           | %               | $V_{DS} = -0.1\text{V}$ $V_{GS} = -5\text{V}$                            |
| Drain Source Breakdown Voltage        | $BV_{DSS}$          | 10          |      |           | V               | $I_{DS} = 1\mu\text{A}$ $V_{GS} = 0\text{V}$                            | -10         |      |           | V               | $I_{DS} = -1\mu\text{A}$ $V_{GS} = 0\text{V}$                            |
| Off Drain Current                     | $I_{DS(OFF)}$       |             | 10   | 400<br>4  | pA<br>nA        | $V_{DS} = 10\text{V}$ $I_{GS} = 0\text{V}$<br>$T_A = 125^\circ\text{C}$ |             | 10   | 400<br>4  | pA<br>nA        | $V_{DS} = -10\text{V}$ $V_{GS} = 0\text{V}$<br>$T_A = 125^\circ\text{C}$ |
| Gate Leakage Current                  | $I_{GSS}$           |             | 1    | 100<br>10 | pA<br>nA        | $V_{DS} = 0\text{V}$ $V_{GS} = 10\text{V}$<br>$T_A = 125^\circ\text{C}$ |             | 1    | 100<br>10 | pA<br>nA        | $V_{DS} = 0\text{V}$ $V_{GS} = -10\text{V}$<br>$T_A = 125^\circ\text{C}$ |
| Input Capacitance                     | $C_{ISS}$           |             | 1    | 3         | pF              |                                                                         |             | 1    | 3         | pF              |                                                                          |

## TYPICAL N-CHANNEL PERFORMANCE CHARACTERISTICS

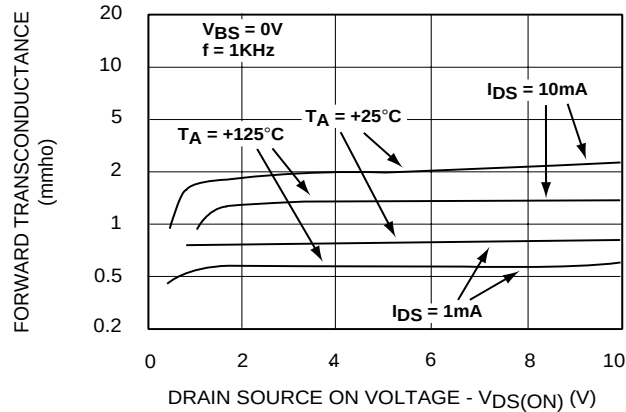
### OUTPUT CHARACTERISTICS



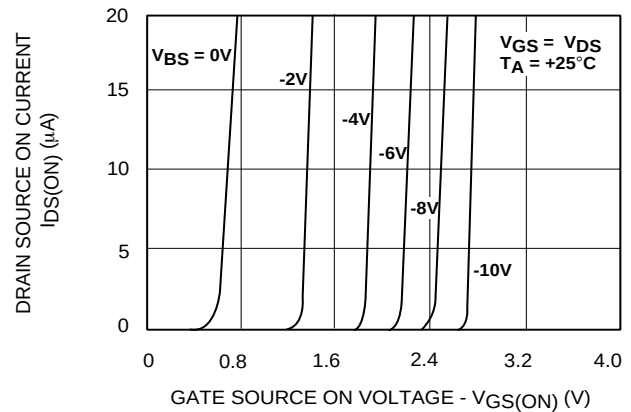
### LOW VOLTAGE OUTPUT CHARACTERISTICS



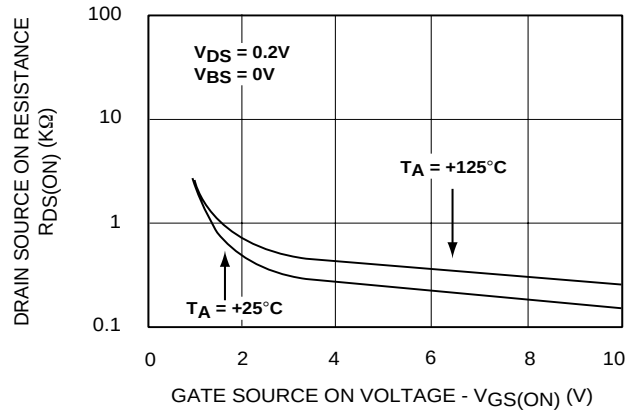
### FORWARD TRANSCONDUCTANCE vs. DRAIN-SOURCE VOLTAGE



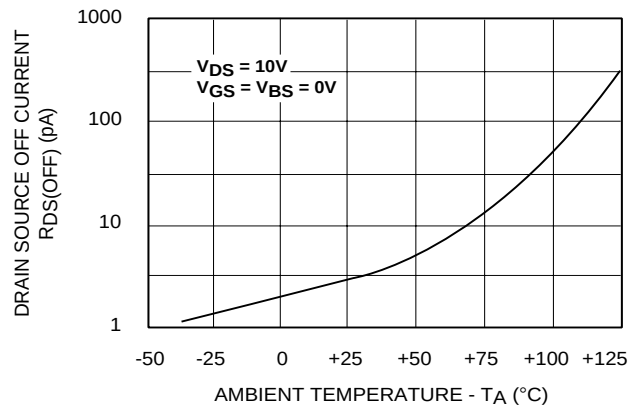
### TRANSFER CHARACTERISTIC WITH SUBSTRATE BIAS



### DRAIN SOURCE ON RESISTANCE vs. GATE-SOURCE VOLTAGE

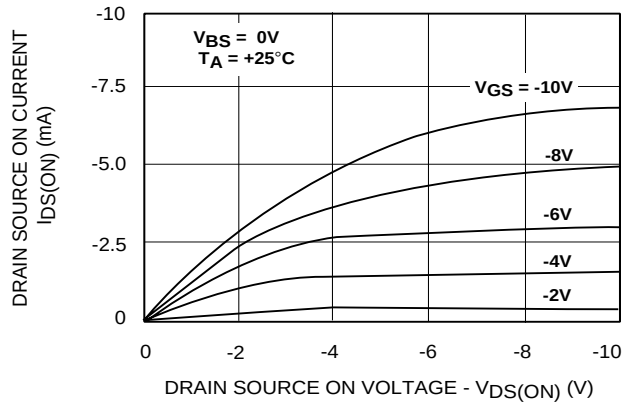


### DRAIN SOURCE OFF CURRENT vs. AMBIENT TEMPERATURE

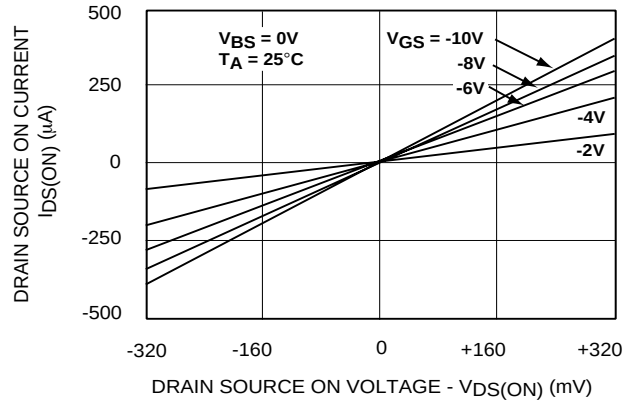


## TYPICAL P-CHANNEL PERFORMANCE CHARACTERISTICS

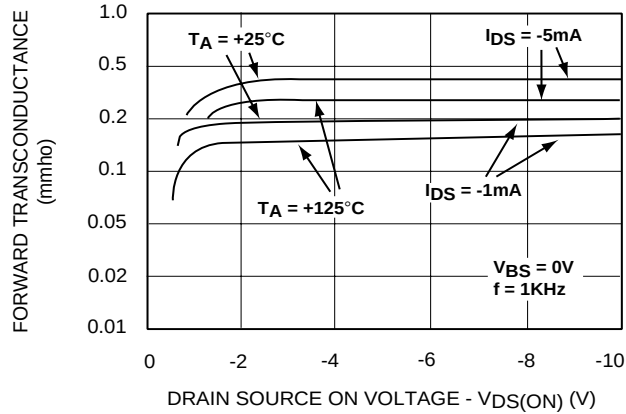
**OUTPUT CHARACTERISTICS**



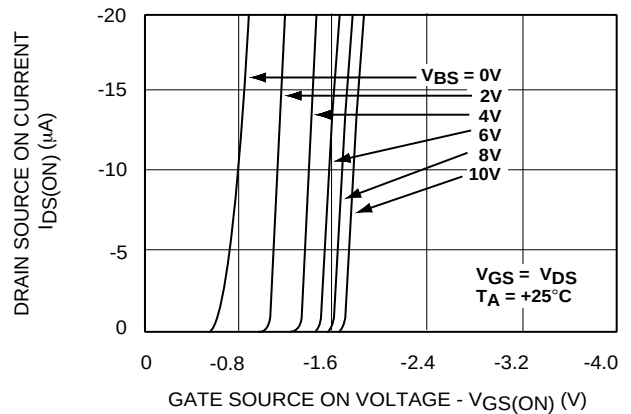
**LOW VOLTAGE OUTPUT CHARACTERISTICS**



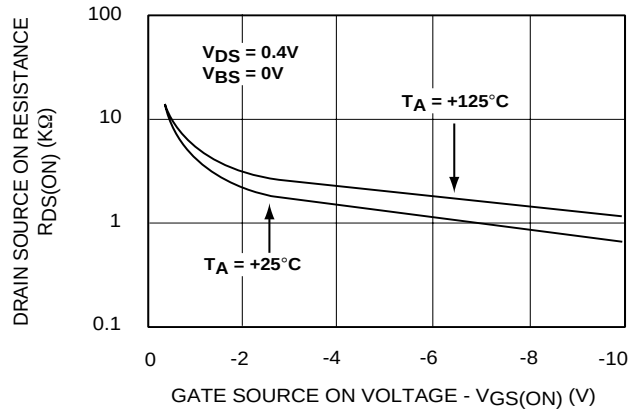
**FORWARD TRANSCONDUCTANCE vs. DRAIN-SOURCE VOLTAGE**



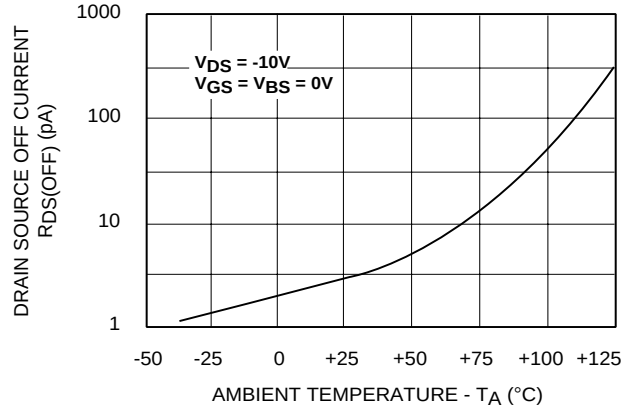
**TRANSFER CHARACTERISTIC WITH SUBSTRATE BIAS**



**DRAIN SOURCE ON RESISTANCE vs. GATE-SOURCE VOLTAGE**

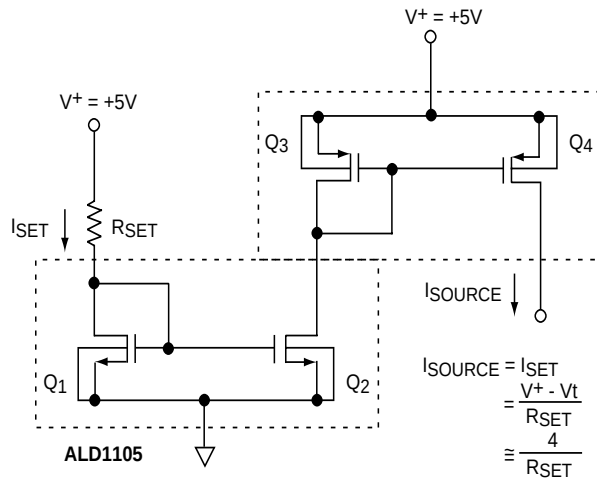


**DRAIN SOURCE OFF CURRENT vs. AMBIENT TEMPERATURE**



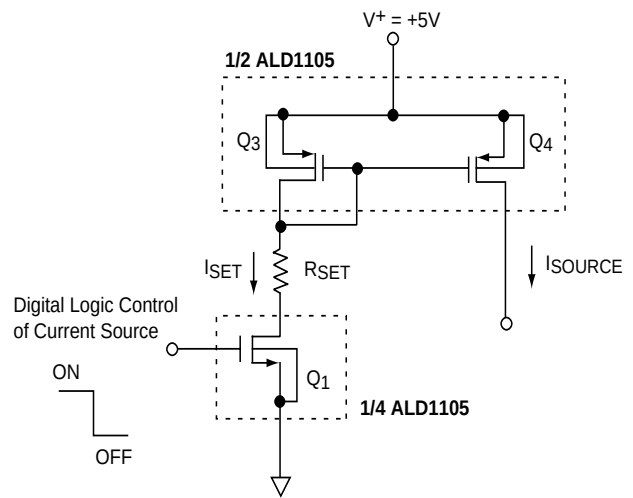
## TYPICAL APPLICATIONS

### CURRENT SOURCE MIRROR



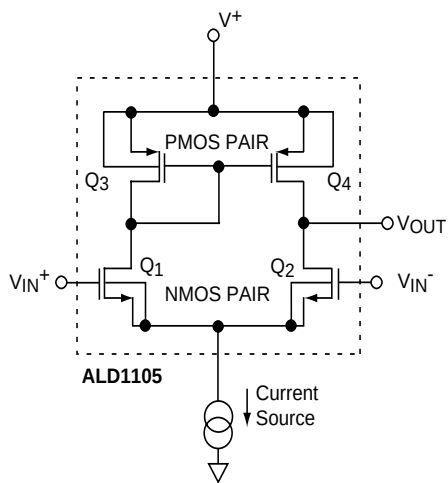
Q1, Q2: N-Channel MOSFET  
Q3, Q4: P-Channel MOSFET

### CURRENT SOURCE WITH GATE CONTROL



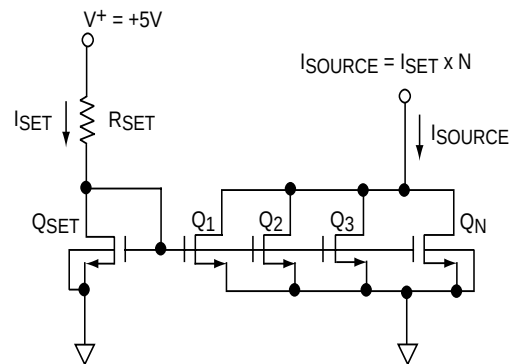
Q1 : N-Channel MOSFET  
Q3, Q4: P-Channel MOSFET

### DIFFERENTIAL AMPLIFIER



Q1, Q2: N-Channel MOSFET  
Q3, Q4: P-Channel MOSFET

### CURRENT SOURCE MULTIPLICATION

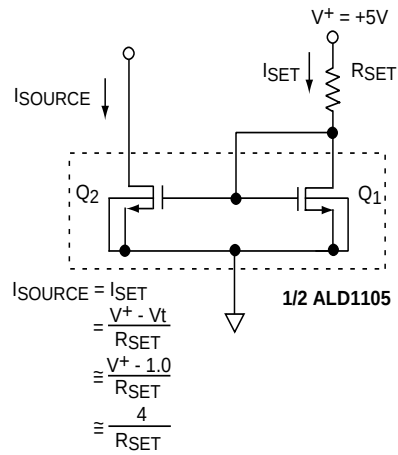


QSET, Q1..QN: ALD1106 or ALD1105  
N-Channel MOSFET

## TYPICAL APPLICATIONS (cont.)

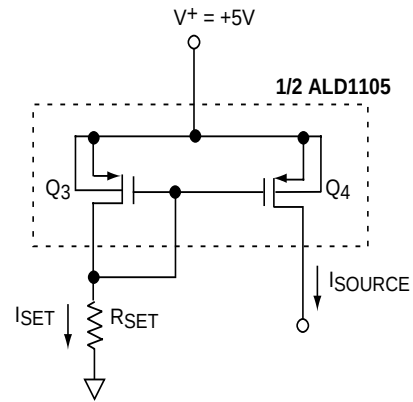
### BASIC CURRENT SOURCES

#### N-CHANNEL CURRENT SOURCE



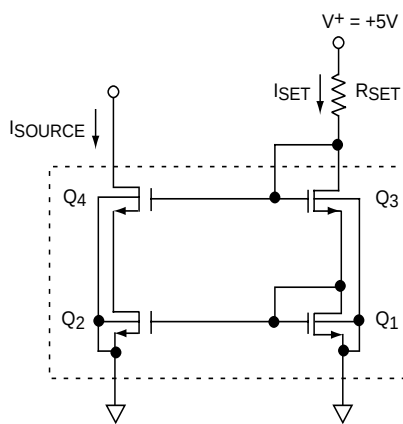
Q1, Q2: N-Channel MOSFET

#### P-CHANNEL CURRENT SOURCE

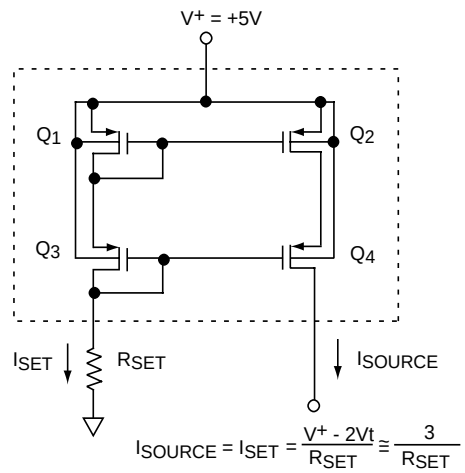


Q3, Q4: P-Channel MOSFET

### CASCODE CURRENT SOURCES



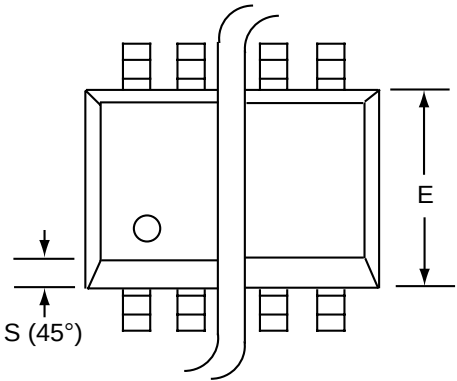
Q1, Q2, Q3, Q4: N-Channel MOSFET  
(1/2 ALD1105 or ALD1116)



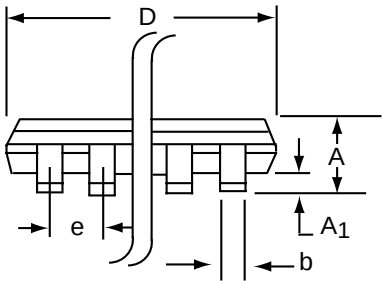
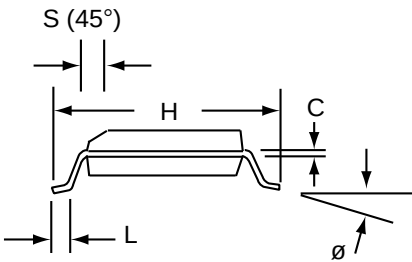
Q1, Q2, Q3, Q4: P-Channel MOSFET  
(1/2 ALD1105 or ALD1117)

SOIC-14 PACKAGE DRAWING

14 Pin Plastic SOIC Package

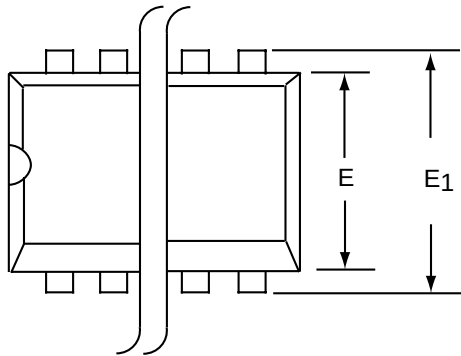
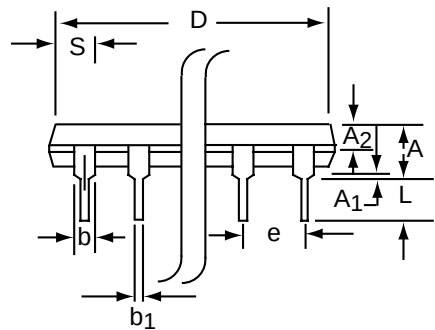


| Dim            | Millimeters |       | Inches    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.25  | 0.004     | 0.010 |
| b              | 0.35        | 0.45  | 0.014     | 0.018 |
| C              | 0.18        | 0.25  | 0.007     | 0.010 |
| D-14           | 8.55        | 8.75  | 0.336     | 0.345 |
| E              | 3.50        | 4.05  | 0.140     | 0.160 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H              | 5.70        | 6.30  | 0.224     | 0.248 |
| L              | 0.60        | 0.937 | 0.024     | 0.037 |
| Ø              | 0°          | 8°    | 0°        | 8°    |
| S              | 0.25        | 0.50  | 0.010     | 0.020 |



PDIP-14 PACKAGE DRAWING

14 Pin Plastic DIP Package



| Dim            | Millimeters |       | Inches |       |
|----------------|-------------|-------|--------|-------|
|                | Min         | Max   | Min    | Max   |
| A              | 3.81        | 5.08  | 0.105  | 0.200 |
| A <sub>1</sub> | 0.38        | 1.27  | 0.015  | 0.050 |
| A <sub>2</sub> | 1.27        | 2.03  | 0.050  | 0.080 |
| b              | 0.89        | 1.65  | 0.035  | 0.065 |
| b <sub>1</sub> | 0.38        | 0.51  | 0.015  | 0.020 |
| c              | 0.20        | 0.30  | 0.008  | 0.012 |
| D-14           | 17.27       | 19.30 | 0.680  | 0.760 |
| E              | 5.59        | 7.11  | 0.220  | 0.280 |
| E <sub>1</sub> | 7.62        | 8.26  | 0.300  | 0.325 |
| e              | 2.29        | 2.79  | 0.090  | 0.110 |
| e <sub>1</sub> | 7.37        | 7.87  | 0.290  | 0.310 |
| L              | 2.79        | 3.81  | 0.110  | 0.150 |
| S-14           | 1.02        | 2.03  | 0.040  | 0.080 |
| ∅              | 0°          | 15°   | 0°     | 15°   |

