COMPLEMENTARY N-CHANNEL AND P-CHANNEL MOSFET

GENERAL DESCRIPTION

The ALD1115 is a monolithic complementary N-channel and P-channel 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 a N-channel MOSFET and a P-channel MOSFET in one package. The ALD1115 is a dual version of the quad complementary ALD1105.

The ALD1115 offers high input impedance and negative current temperature coefficient. The transistor pair is designed for precision signal switching and amplifying applications in +1V 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 connected in parallel with sources, drains and gates connected together, a CMOS analog switch can be constructed. In addition, the ALD1115 is intended as a building block for CMOS inverters, differential amplifier input stages, transmission gates, and multiplexer applications.

The ALD1115 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. V+ is connected to the substrate, which is the most positive voltage potential of the ALD1115, usually SP (5). Similarly, V- is connected to the most negative voltage potential of the ALD1115, usually SN (1).

FEATURES

- Thermal tracking between N-channel and P-channel
- Low threshold voltage of 0.7V for both N-channel and P-channel MOSFETs
- Low input capacitance
- 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
- Single N-channel MOSFET and single P-channel MOSFET in one package

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

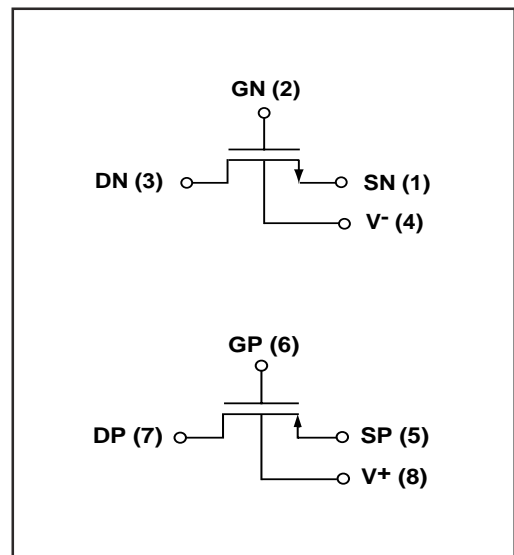| Operating Temperature Range*	
0°C to +70°C	0°C to +70°C
8-Pin SOIC Package	8-Pin Plastic Dip Package
ALD1115SAL	ALD1115PAL

* Contact factory for high temperature versions.

APPLICATIONS

- Precision current mirrors
- Complementary push-pull linear drives
- Discrete analog switches
- Analog signal choppers
- Differential amplifier input stage
- Voltage comparator
- Data converters
- Sample and Hold
- Analog current inverter
- Precision matched current sources
- CMOS inverter stage
- Diode clamps
- Source followers

PIN CONFIGURATION

TOP VIEW
SAL, PAL PACKAGES
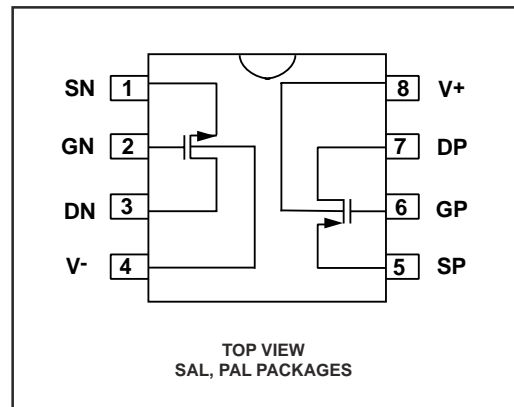
BLOCK DIAGRAM

ABSOLUTE MAXIMUM RATINGS

Drain-source voltage, V_{DS} —— 10V
Gate-source voltage, V_{GS} —— 10V
Power dissipation —— 500mW
Operating temperature range SAL, PAL 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.

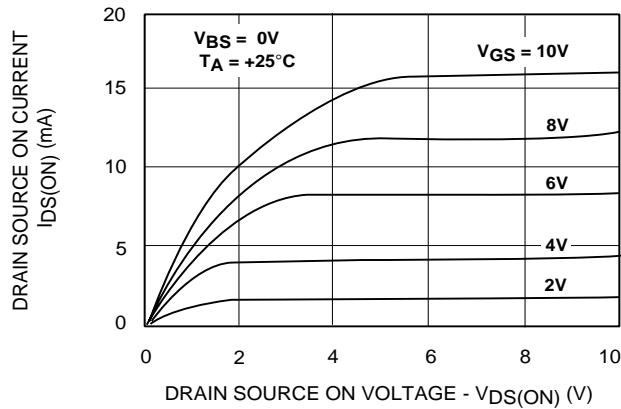## OPERATING ELECTRICAL CHARACTERISTICS
$T_A = 25°C$ unless otherwise specified

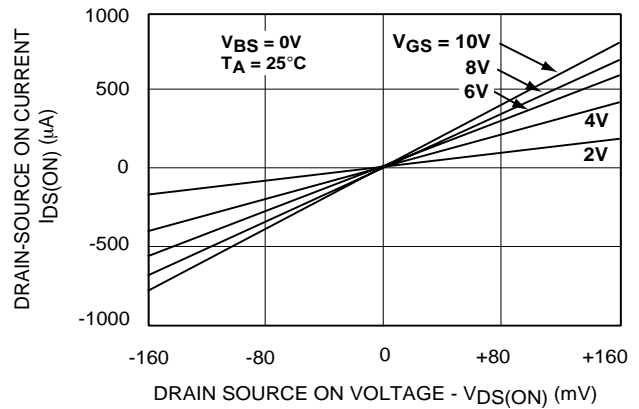| Parameter	Symbol	N - Channel			Unit	Test Conditions	P - Channel			Unit	Test Conditions
		Min	Typ	Max			Min	Typ	Max		
Gate Threshold Voltage	V_T	0.4	0.7	1.0	V	$I_{DS} = 1\mu A$ $V_{GS} = V_{DS}$	-0.4	-0.7	-1.2	V	$I_{DS} = -1\mu A$ $V_{GS} = V_{DS}$
Gate Threshold Temperature Drift	TC_{VT}		-1.2		mV/°C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

TYPICAL N-CHANNEL PERFORMANCE CHARACTERISTICS

OUTPUT CHARACTERISTICS

$V_{BS} = 0V$
$T_A = +25°C$

$V_{GS} = 10V$

8V

6V

4V

2V

DRAIN SOURCE ON CURRENT $I_{DS(ON)}$ (mA)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (V)

LOW VOLTAGE OUTPUT CHARACTERISTICS

$V_{BS} = 0V$
$T_A = 25°C$

$V_{GS} = 10V$
8V
6V

4V

2V

DRAIN-SOURCE ON CURRENT $I_{DS(ON)}$ (μA)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (mV)

FORWARD TRANSCONDUCTANCE vs. DRAIN-SOURCE VOLTAGE

$V_{BS} = 0V$
$f = 1KHz$

$I_{DS} = 10mA$

$T_A = +25°C$

$T_A = +125°C$

$I_{DS} = 1mA$

FORWARD TRANSCONDUCTANCE (mmho)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (V)

TRANSFER CHARACTERISTIC WITH SUBSTRATE BIAS

$V_{BS} = 0V$

-2V

-4V

-6V

-8V

-10V

$V_{GS} = V_{DS}$
$T_A = +25°C$

DRAIN SOURCE ON CURRENT $I_{DS(ON)}$ (μA)

GATE SOURCE ON VOLTAGE - $V_{GS(ON)}$ (V)

DRAIN SOURCE ON RESISTANCE vs. GATE-SOURCE VOLTAGE

$V_{DS} = 0.2V$
$V_{BS} = 0V$

$T_A = +125°C$

$T_A = +25°C$

DRAIN SOURCE ON RESISTANCE $R_{DS(ON)}$ (KΩ)

GATE SOURCE ON VOLTAGE - $V_{GS(ON)}$ (V)

DRAIN SOURCE OFF CURRENT vs. AMBIENT TEMPERATURE

$V_{DS} = 10V$
$V_{GS} = V_{BS} = 0V$
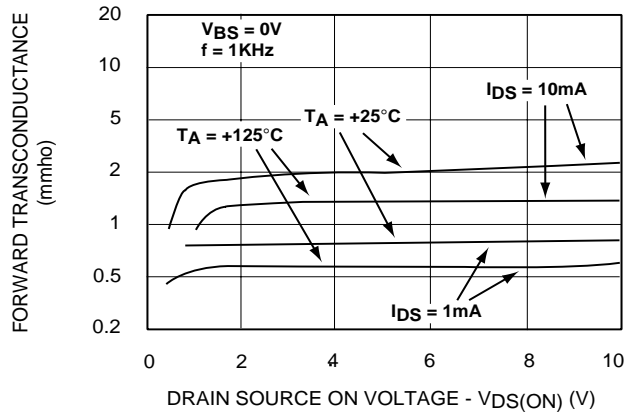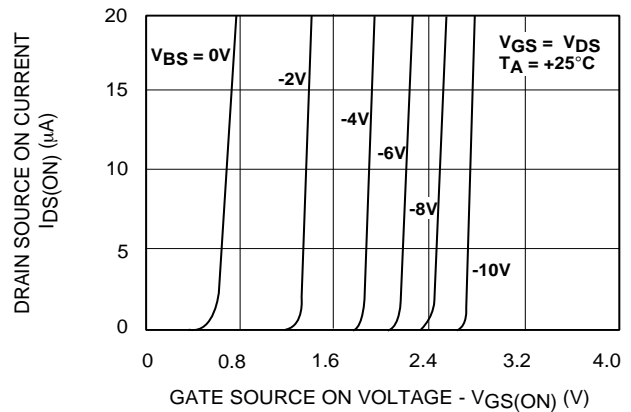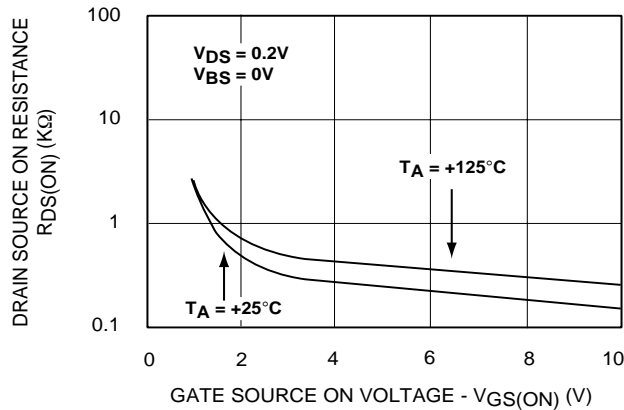
DRAIN SOURCE OFF CURRENT $R_{DS(OFF)}$ (pA)

AMBIENT TEMPERATURE - T_A (°C)
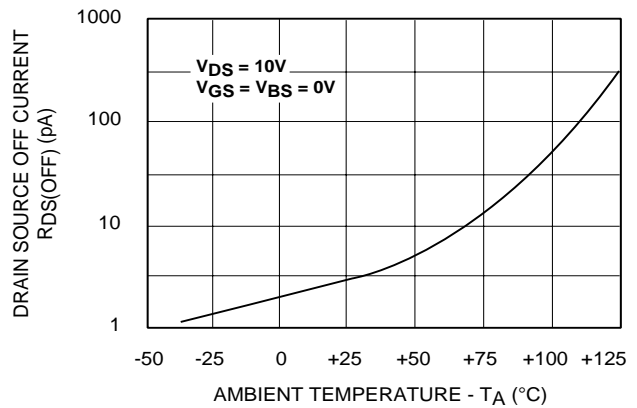
TYPICAL P-CHANNEL PERFORMANCE CHARACTERISTICS
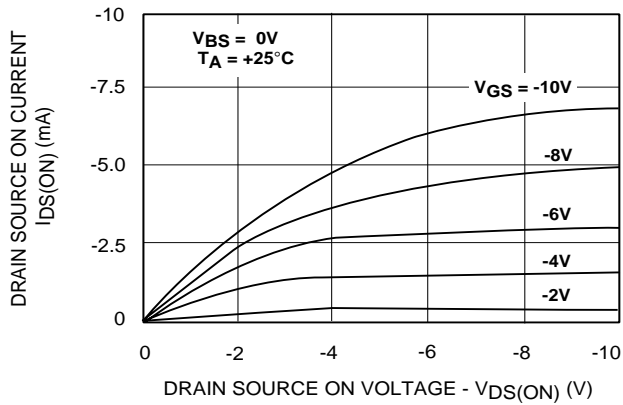
OUTPUT CHARACTERISTICS

$V_{BS} = 0V$
$T_A = +25°C$

$V_{GS} = -10V$
-8V
-6V
-4V
-2V

DRAIN SOURCE ON CURRENT $I_{DS(ON)}$ (mA)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (V)

LOW VOLTAGE OUTPUT CHARACTERISTICS

$V_{BS} = 0V$
$T_A = 25°C$

$V_{GS} = -10V$
-8V
-6V
-4V
-2V

DRAIN SOURCE ON CURRENT $I_{DS(ON)}$ (uA)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (mV)

FORWARD TRANSCONDUCTANCE vs. DRAIN-SOURCE VOLTAGE

$T_A = +25°C$
$I_{DS} = -5mA$
$T_A = +125°C$
$I_{DS} = -1mA$
$V_{BS} = 0V$
$f = 1KHz$

FORWARD TRANSCONDUCTANCE (mmho)

DRAIN SOURCE ON VOLTAGE - $V_{DS(ON)}$ (V)

TRANSFER CHARACTERISTIC WITH SUBSTRATE BIAS

$V_{BS} = 0V$
2V
4V
6V
8V
10V

$V_{GS} = V_{DS}$
$T_A = +25°C$

DRAIN SOURCE ON CURRENT $I_{DS(ON)}$ (uA)

GATE SOURCE ON VOLTAGE - $V_{GS(ON)}$ (V)

DRAIN SOURCE ON RESISTANCE vs. GATE-SOURCE VOLTAGE

$V_{DS} = 0.4V$
$V_{BS} = 0V$

$T_A = +125°C$

$T_A = +25°C$

DRAIN SOURCE ON RESISTANCE $R_{DS(ON)}$ (KΩ)

GATE SOURCE ON VOLTAGE - $V_{GS(ON)}$ (V)

DRAIN SOURCE OFF CURRENT vs. AMBIENT TEMPERATURE

$V_{DS} = -10V$
$V_{GS} = V_{BS} = 0V$
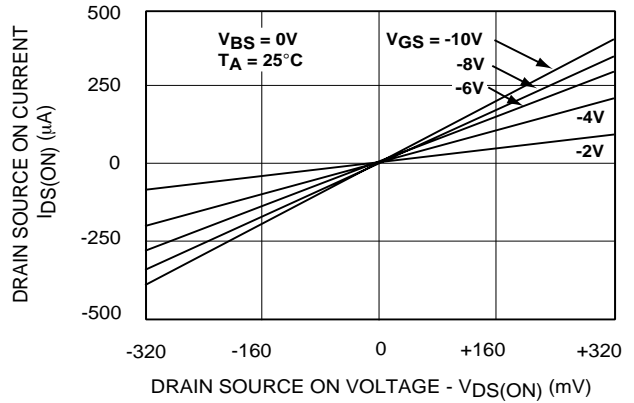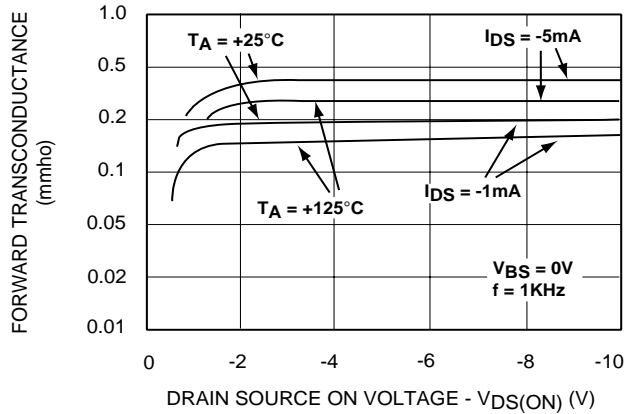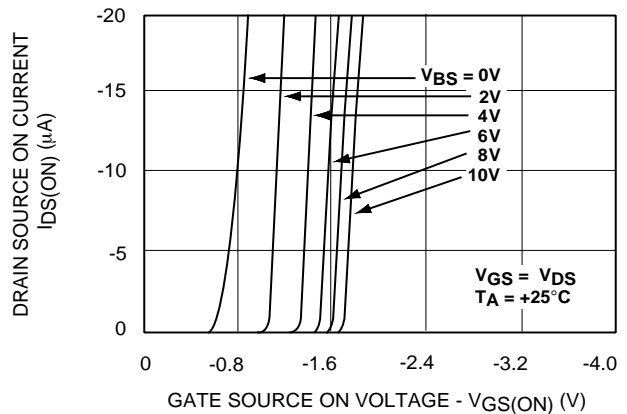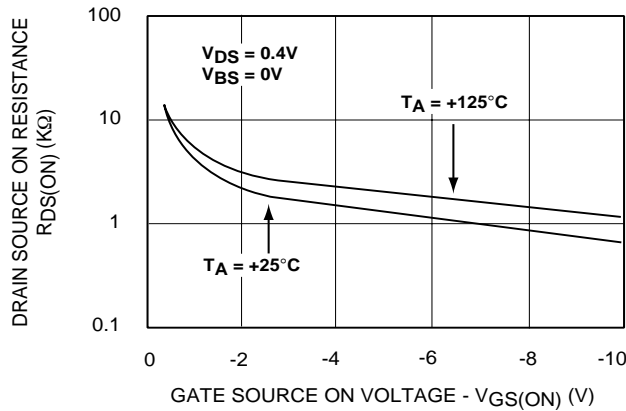
DRAIN SOURCE OFF CURRENT $R_{DS(OFF)}$ (pA)

AMBIENT TEMPERATURE - T_A (°C)
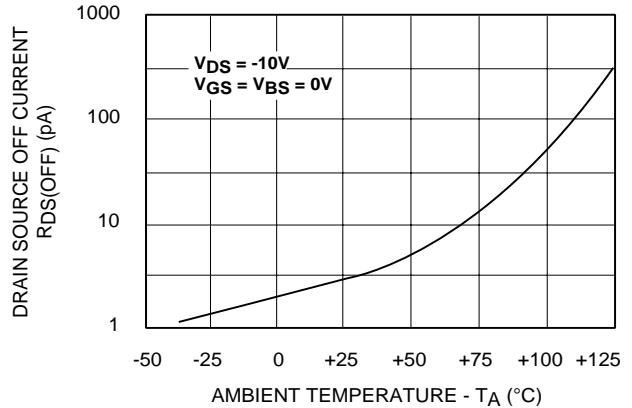
TYPICAL APPLICATIONS

CURRENT SOURCE MIRROR

V+ = +5V

V+ = +5V

I_{SET} R_{SET}

Q_3 Q_4

I_{SOURCE}

Q_1 Q_2

$$I_{SOURCE} = I_{SET}$$
$$= \frac{V^+ - V_t}{R_{SET}}$$
$$\cong \frac{4}{R_{SET}}$$
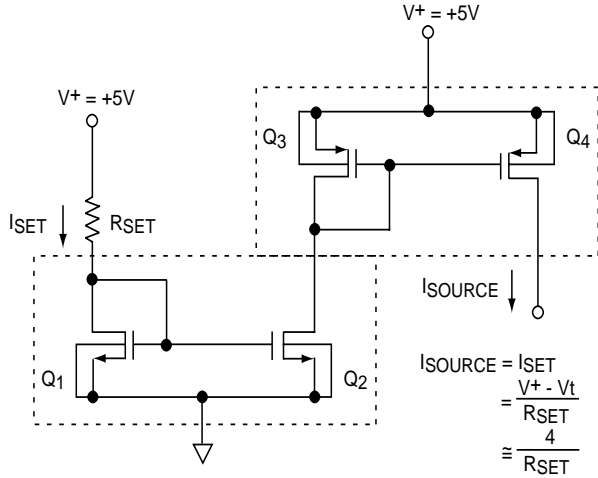
Q_1, Q_2: N-Channel MOSFET
Q_3, Q_4: P-Channel MOSFET

CURRENT SOURCE WITH GATE CONTROL

V+ = +5V

Q_3 Q_4

I_{SET} R_{SET}

I_{SOURCE}

Digital Logic Control
of Current Source

ON

OFF

Q_1
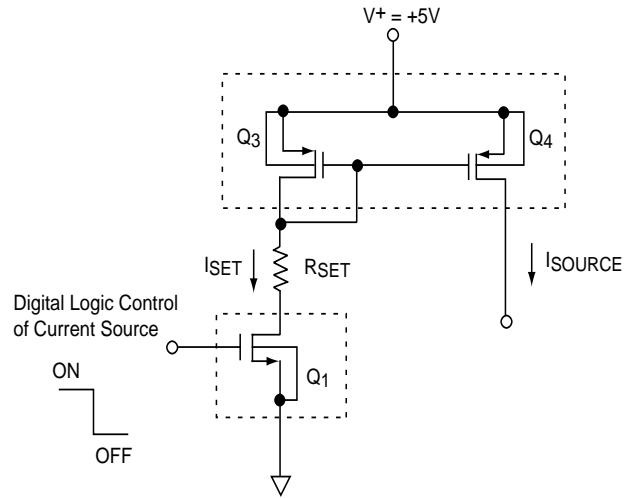
Q_1 : N-Channel MOSFET
Q_3, Q_4: P-Channel MOSFET

CMOS INVERTER

V+

IN   OUT

CMOS ANALOG SWITCH

CONTROL

IN   OUT

V+

$\overline{CONTROL}$
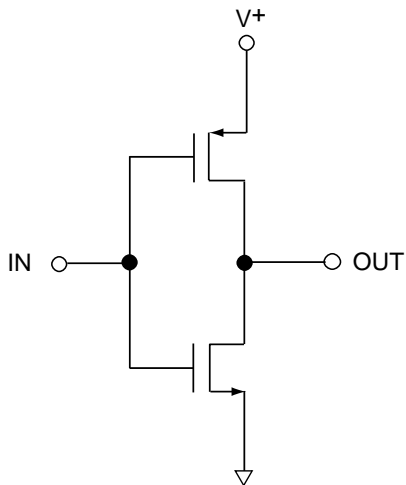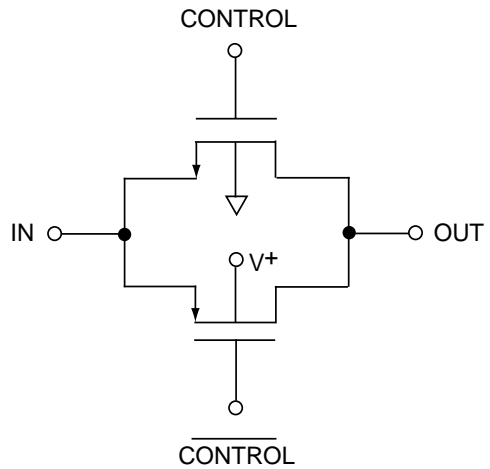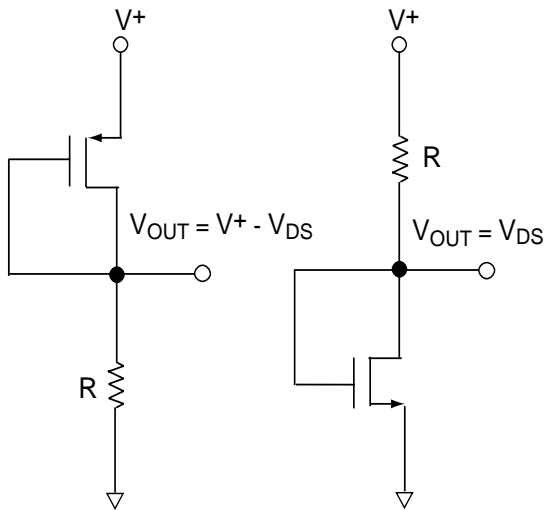
TYPICAL APPLICATIONS (cont.)

DIODE-CONNECTED CONFIGURATION

V+

$V_{OUT} = V^+ - V_{DS}$

R

V+

R

$V_{OUT} = V_{DS}$

SOURCE FOLLOWER

V+

IN

OUT

R_A

R_B
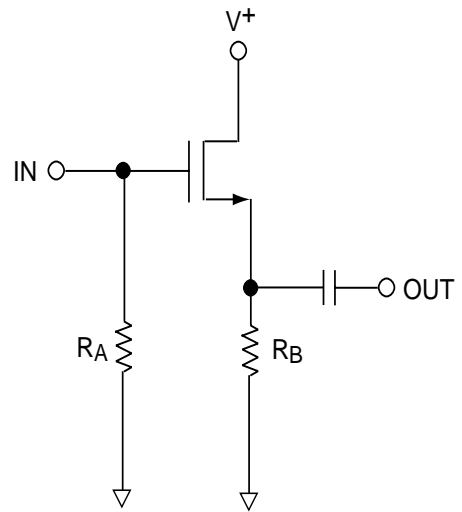
CASCODE CURRENT SOURCES

V+ = +5V

I_{SET} R_{SET}

I_{SOURCE}

Q_4

Q_3

Q_2

Q_1
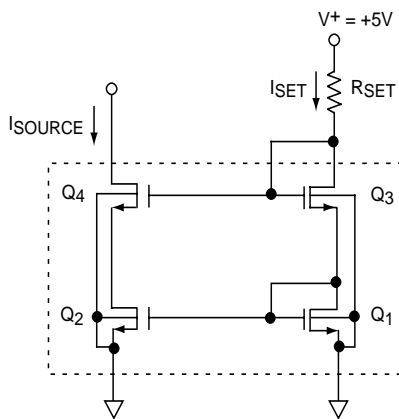
Q_1, Q_2, Q_3, Q_4: N-Channel MOSFET

V+ = +5V

Q_1

Q_2

Q_3

Q_4

I_{SET} R_{SET}

I_{SOURCE}

$$I_{SOURCE} = I_{SET} = \frac{V^+ - 2Vt}{R_{SET}} \cong \frac{3}{R_{SET}}$$
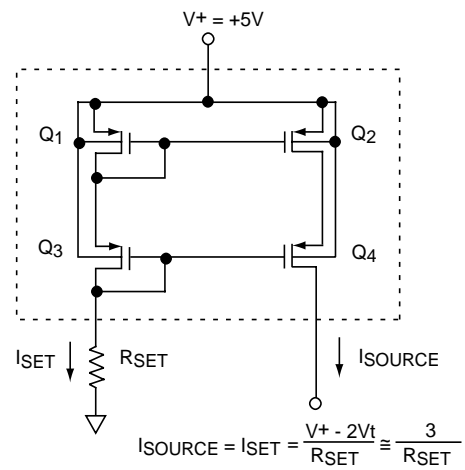
Q_1, Q_2, Q_3, Q_4: P-Channel MOSFET

SOIC-8 PACKAGE DRAWING

8 Pin Plastic SOIC Package
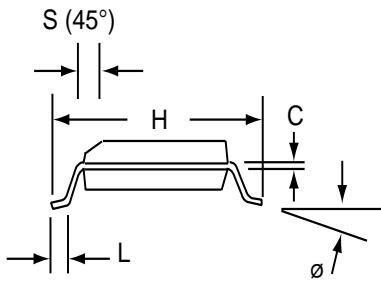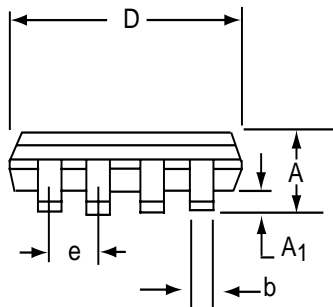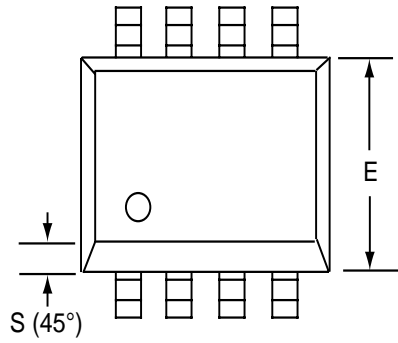
Dim	Millimeters		Inches	
	Min	**Max**	**Min**	**Max**
A	1.35	1.75	0.053	0.069
A$_1$	0.10	0.25	0.004	0.010
b	0.35	0.45	0.014	0.018
C	0.18	0.25	0.007	0.010
D-8	4.69	5.00	0.185	0.196
E	3.50	4.05	0.140	0.160
e	1.27 BSC		0.050 BSC	
H	5.70	6.30	0.224	0.248
L	0.60	0.937	0.024	0.037
Ø	0°	8°	0°	8°
S	0.25	0.50	0.010	0.020

PDIP-8 PACKAGE DRAWING

8 Pin Plastic DIP Package
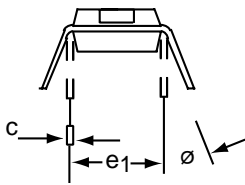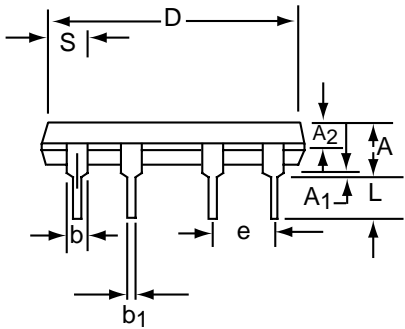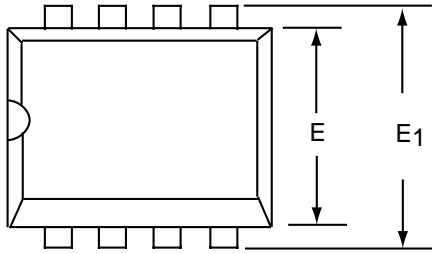
Dim	Millimeters		Inches	
	Min	**Max**	**Min**	**Max**
A	3.81	5.08	0.105	0.200
A$_1$	0.38	1.27	0.015	0.050
A$_2$	1.27	2.03	0.050	0.080
b	0.89	1.65	0.035	0.065
b$_1$	0.38	0.51	0.015	0.020
c	0.20	0.30	0.008	0.012
D-8	9.40	11.68	0.370	0.460
E	5.59	7.11	0.220	0.280
E$_1$	7.62	8.26	0.300	0.325
e	2.29	2.79	0.090	0.110
e$_1$	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
S-8	1.02	2.03	0.040	0.080
ø	0°	15°	0°	15°