



CAT5114

32-Tap Digitally Programmable Potentiometer (DPP™)

FEATURES

- 32-position linear taper potentiometer
- Non-volatile EEPROM wiper storage
- 10nA ultra-low standby current
- Single supply operation: 2.5V-6.0V
- Increment Up/Down serial interface
- Resistance values: 10kΩ, 50kΩ and 100kΩ
- Available in PDIP, SOIC, TSSOP, MSOP and space saving 2x3mm TDFN packages

APPLICATIONS

- Automated product calibration
- Remote control adjustments
- Offset, gain and zero control
- Tamper-proof calibrations
- Contrast, brightness and volume controls
- Motor controls and feedback systems
- Programmable analog functions

DESCRIPTION

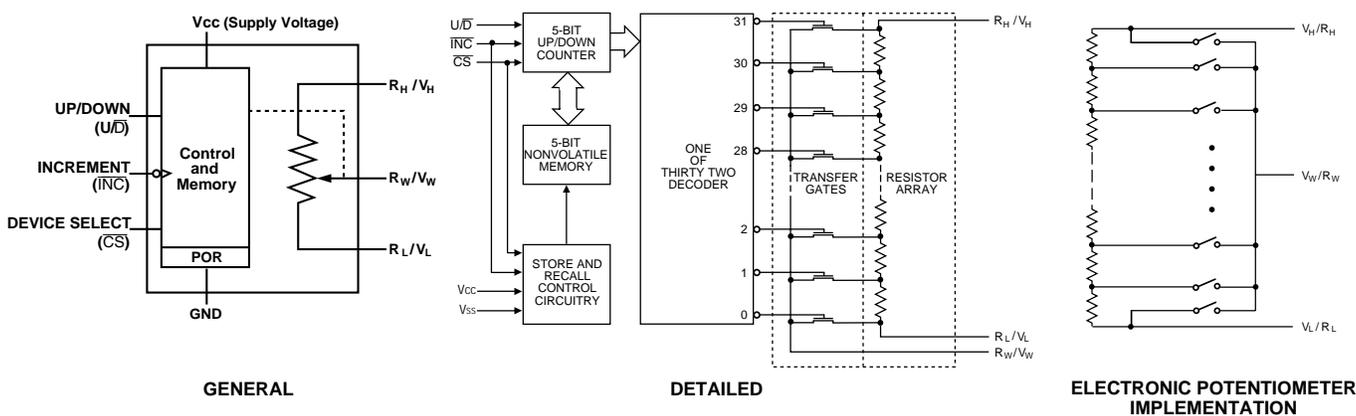
The CAT5114 is a single digitally programmable potentiometer (DPP™) designed as a electronic replacement for mechanical potentiometers and trim pots. Ideal for automated adjustments on high volume production lines, they are also well suited for applications where equipment requiring periodic adjustment is either difficult to access or located in a hazardous or remote environment.

The CAT5114 contains a 32-tap series resistor array connected between two terminals R_H and R_L . An up/down counter and decoder that are controlled by three input pins, determines which tap is connected to the wiper, R_W . The wiper setting, stored in nonvolatile memory, is not lost when the device is powered down and is automatically reinstated when power is returned. The wiper can be adjusted to test

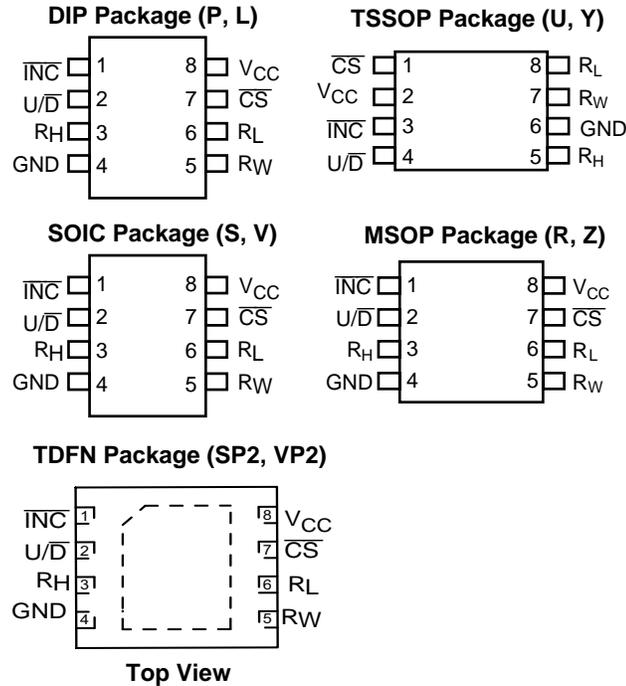
new system values without effecting the stored setting. Wiper-control of the CAT5114 is accomplished with three input control pins, \overline{CS} , U/\overline{D} , and \overline{INC} . The \overline{INC} input increments the wiper in the direction which is determined by the logic state of the U/\overline{D} input. The \overline{CS} input is used to select the device and also store the wiper position prior to power down.

The digitally programmable potentiometer can be used as a three-terminal resistive divider or as a two-terminal variable resistor. DPPs bring variability and programmability to a wide variety of applications including control, parameter adjustments, and signal processing.

FUNCTIONAL DIAGRAM



PIN CONFIGURATION



PIN FUNCTIONS

| Pin Name | Function |
|-----------------|------------------------------|
| INC | Increment Control |
| U/D | Up/Down Control |
| R _H | Potentiometer High Terminal |
| GND | Ground |
| R _W | Potentiometer Wiper Terminal |
| R _L | Potentiometer Low Terminal |
| CS | Chip Select |
| V _{CC} | Supply Voltage |

PIN DESCRIPTIONS

INC: Increment Control Input

The INC input moves the wiper in the up or down direction determined by the condition of the U/D input.

U/D: Up/Down Control Input

The U/D input controls the direction of the wiper movement. When in a high state and CS is low, any high-to-low transition on INC will cause the wiper to move one increment toward the R_H terminal. When in a low state and CS is low, any high-to-low transition on INC will cause the wiper to move one increment towards the R_L terminal.

R_H: High End Potentiometer Terminal

R_H is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the R_L terminal. Voltage applied to the R_H terminal cannot exceed the supply voltage, V_{CC} or go below ground, GND.

R_W: Wiper Potentiometer Terminal

R_W is the wiper terminal of the potentiometer. Its position on the resistor array is controlled by the control inputs, INC, U/D and CS. Voltage applied to the R_W terminal cannot exceed the supply voltage, V_{CC} or go below ground, GND.

R_L: Low End Potentiometer Terminal

R_L is the low end terminal of the potentiometer. It is not required that this terminal be connected to a potential less than the R_H terminal. Voltage applied to the R_L terminal cannot exceed the supply voltage, V_{CC} or go below ground, GND. R_L and R_H are electrically interchangeable.

CS: Chip Select

The chip select input is used to activate the control input of the CAT5114 and is active low. When in a high state, activity on the INC and U/D inputs will not affect or change the position of the wiper.

DEVICE OPERATION

The CAT5114 operates like a digitally controlled potentiometer with R_H and R_L equivalent to the high and low terminals and R_W equivalent to the mechanical potentiometer's wiper. There are 32 available tap positions including the resistor end points, R_H and R_L . There are 31 resistor elements connected in series between the R_H and R_L terminals. The wiper terminal is connected to one of the 32 taps and controlled by three inputs, \overline{INC} , U/\overline{D} and \overline{CS} . These inputs control a five-bit up/down counter whose output is decoded to select the wiper position. The selected wiper position can be stored in nonvolatile memory using the \overline{INC} and \overline{CS} inputs.

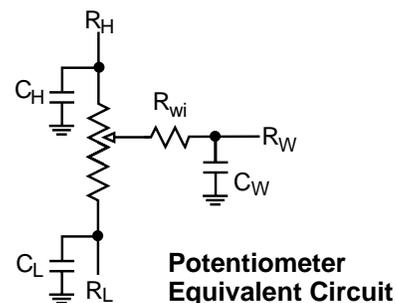
With \overline{CS} set LOW the CAT5114 is selected and will respond to the U/\overline{D} and \overline{INC} inputs. HIGH to LOW transitions on \overline{INC} will increment or decrement the

wiper (depending on the state of the U/\overline{D} input and five-bit counter). The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. The value of the counter is stored in nonvolatile memory whenever \overline{CS} transitions HIGH while the \overline{INC} input is also HIGH. When the CAT5114 is powered-down, the last stored wiper counter position is maintained in the nonvolatile memory. When power is restored, the contents of the memory are recalled and the counter is set to the value stored.

With \overline{INC} set low, the CAT5114 may be de-selected and powered down without storing the current wiper position in nonvolatile memory. This allows the system to always power up to a preset value stored in nonvolatile memory.

OPERATION MODES

| \overline{INC} | \overline{CS} | U/\overline{D} | Operation |
|------------------|-----------------|------------------|-----------------------------|
| High to Low | Low | High | Wiper toward H |
| High to Low | Low | Low | Wiper toward L |
| High | Low to High | X | Store Wiper Position |
| Low | Low to High | X | No Store, Return to Standby |
| X | High | X | Standby |



ABSOLUTE MAXIMUM RATINGS

Supply Voltage
 V_{CC} to GND -0.5V to +7V

Inputs
 \overline{CS} to GND -0.5V to $V_{CC} + 0.5V$
 \overline{INC} to GND -0.5V to $V_{CC} + 0.5V$
 U/\overline{D} to GND -0.5V to $V_{CC} + 0.5V$
H to GND -0.5V to $V_{CC} + 0.5V$
L to GND -0.5V to $V_{CC} + 0.5V$
W to GND -0.5V to $V_{CC} + 0.5V$

Operating Ambient Temperature

Commercial ('C' or Blank suffix) 0°C to +70°C
Industrial ('I' suffix) -40°C to +85°C
Junction Temperature +150°C
Storage Temperature -65°C to +150°C
Lead Soldering (10 sec max) +300°C

* Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. Absolute Maximum Ratings are limited values applied individually while other parameters are within specified operating conditions, and functional operation at any of these conditions is NOT implied. Device performance and reliability may be impaired by exposure to absolute rating conditions for extended periods of time.

RELIABILITY CHARACTERISTICS

| Symbol | Parameter | Test Method | Min | Typ | Max | Units |
|--------------------|--------------------|-------------------------------|-----------|-----|-----|--------|
| $V_{ZAP}^{(1)}$ | ESD Susceptibility | MIL-STD-883, Test Method 3015 | 2000 | | | Volts |
| $I_{LTH}^{(1)(2)}$ | Latch-Up | JEDEC Standard 17 | 100 | | | mA |
| T_{DR} | Data Retention | MIL-STD-883, Test Method 1008 | 100 | | | Years |
| N_{END} | Endurance | MIL-STD-883, Test Method 1003 | 1,000,000 | | | Stores |

DC Electrical Characteristics: $V_{CC} = +2.5V$ to $+6.0V$ unless otherwise specified

Power Supply

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---------------|----------------------------|--|-----|------|-----------|---------------|
| V_{CC} | Operating Voltage Range | | 2.5 | | 6.0 | V |
| I_{CC1} | Supply Current (Increment) | $V_{CC} = 6V, f = 1MHz, I_W=0$ $V_{CC} = 6V, f = 250kHz, I_W=0$ | | | 100 50 | μA |
| I_{CC2} | Supply Current (Write) | Programming, $V_{CC} = 6V$ $V_{CC} = 3V$ | | | 1 500 | mA μA |
| $ISB_1^{(2)}$ | Supply Current (Standby) | $CS = V_{CC} - 0.3V$ $U/D, INC = V_{CC} - 0.3V$ or GND | | 0.01 | 1 | μA |

Logic Inputs

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------|-------------------------------|------------------------------|---------------------|-----|---------------------|---------|
| I_{IH} | Input Leakage Current | $V_{IN} = V_{CC}$ | | | 10 | μA |
| I_{IL} | Input Leakage Current | $V_{IN} = 0V$ | | | -10 | μA |
| V_{IH1} | TTL High Level Input Voltage | $4.5V \leq V_{CC} \leq 5.5V$ | 2 | | V_{CC} | V |
| V_{IL1} | TTL Low Level Input Voltage | | 0 | | 0.8 | V |
| V_{IH2} | CMOS High Level Input Voltage | $2.5V \leq V_{CC} \leq 6V$ | $V_{CC} \times 0.7$ | | $V_{CC} + 0.3$ | V |
| V_{IL2} | CMOS Low Level Input Voltage | | -0.3 | | $V_{CC} \times 0.2$ | V |

- NOTES:** (1) This parameter is tested initially and after a design or process change that affects the parameter.
(2) Latch-up protection is provided for stresses up to 100mA on address and data pins from -1V to $V_{CC} + 1V$
(3) I_W =source or sink
(4) These parameters are periodically sampled and are not 100% tested.

Potentiometer Parameters

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--|-------------------------------|--|-----|--------|-----------------|--------|
| R _{POT} | Potentiometer Resistance | -10 Device | | 10 | | kΩ |
| | | -50 Device | | 50 | | |
| | | -00 Device | | 100 | | |
| R _{TOL} | Pot Resistance Tolerance | | | | ± 20 | % |
| V _{RH} | Voltage on R _H pin | | 0 | | V _{CC} | V |
| V _{RL} | Voltage on R _L pin | | 0 | | V _{CC} | V |
| RES | Resolution | | | 3.2 | | % |
| INL | Integral Linearity Error | I _W ≤ 2μA | | 0.5 | 1 | LSB |
| DNL | Differential Linearity Error | I _W ≤ 2μA | | 0.25 | 0.5 | LSB |
| R _{Wi} | Wiper Resistance | V _{CC} = 5V, I _W = 1mA | | | 400 | Ω |
| | | V _{CC} = 2.5V, I _W = 1mA | | | 1 | kΩ |
| I _W | Wiper Current | | | | 1 | mA |
| TC _{R_{POT}} | TC of Pot Resistance | | | 300 | | ppm/°C |
| TC _{R_{RATIO}} | Ratiometric TC | | | | 20 | ppm/°C |
| R _{ISO} | Isolation Resistance | | | TBD | | Ω |
| V _N | Noise | 100kHz / 1kHz | | 8/24 | | nV/√Hz |
| C _H /C _L /C _W | Potentiometer Capacitances | | | 8/8/25 | | pF |
| fc | Frequency Response | Passive Attenuator, 10kΩ | | 1.7 | | MHz |

AC CONDITIONS OF TEST

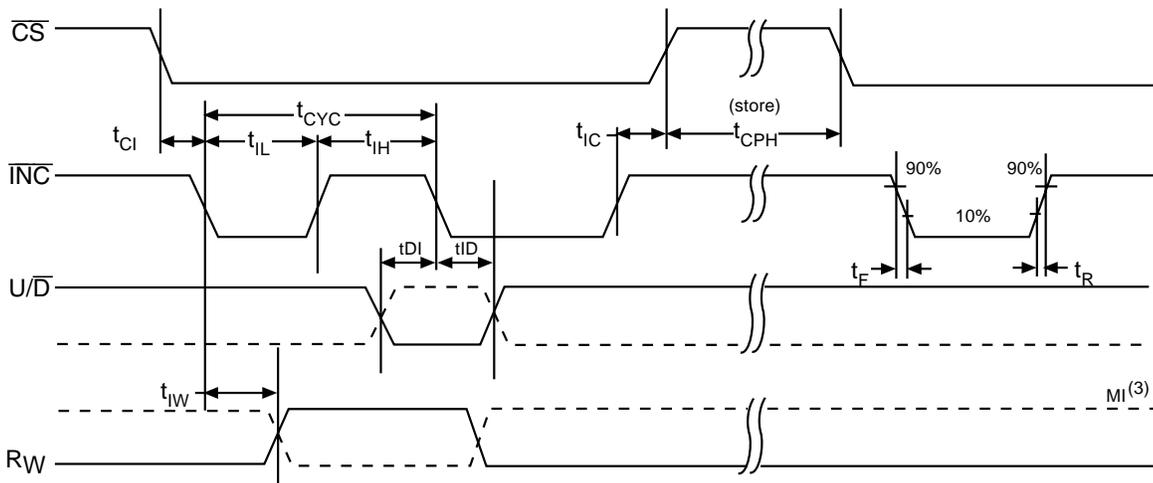
| | |
|---------------------------|--|
| V _{CC} Range | 2.5V ≤ V _{CC} ≤ 6V |
| Input Pulse Levels | 0.2V _{CC} to 0.7V _{CC} |
| Input Rise and Fall Times | 10ns |
| Input Reference Levels | 0.5V _{CC} |

AC OPERATING CHARACTERISTICS:

V_{CC} = +2.5V to +6.0V, V_H = V_{CC}, V_L = 0V, unless otherwise specified

| Symbol | Parameter | Min | Typ ⁽¹⁾ | Max | Units |
|--|---|-----|--------------------|-----|-------|
| t _{CI} | \overline{CS} to INC Setup | 100 | | | ns |
| t _{DI} | U/D to \overline{INC} Setup | 50 | | | ns |
| t _{ID} | U/D to \overline{INC} Hold | 100 | | | ns |
| t _{IL} | \overline{INC} LOW Period | 250 | | | ns |
| t _{IH} | \overline{INC} HIGH Period | 250 | | | ns |
| t _{IC} | \overline{INC} Inactive to \overline{CS} Inactive | 1 | | | μs |
| t _{CPH} | \overline{CS} Deselect Time (NO STORE) | 100 | | | ns |
| t _{CPH} | \overline{CS} Deselect Time (STORE) | 10 | | | ms |
| t _{IW} | \overline{INC} to V _{OUT} Change | | 1 | 5 | μs |
| t _{CYC} | \overline{INC} Cycle Time | 1 | | | μs |
| t _R , t _F ⁽²⁾ | \overline{INC} Input Rise and Fall Time | | | 500 | μs |
| t _{PU} ⁽²⁾ | Power-up to Wiper Stable | | | 1 | msec |
| t _{WR} | Store Cycle | | 5 | 10 | ms |

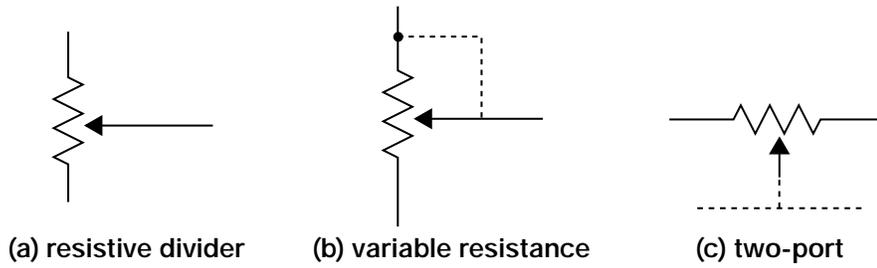
A. C. TIMING



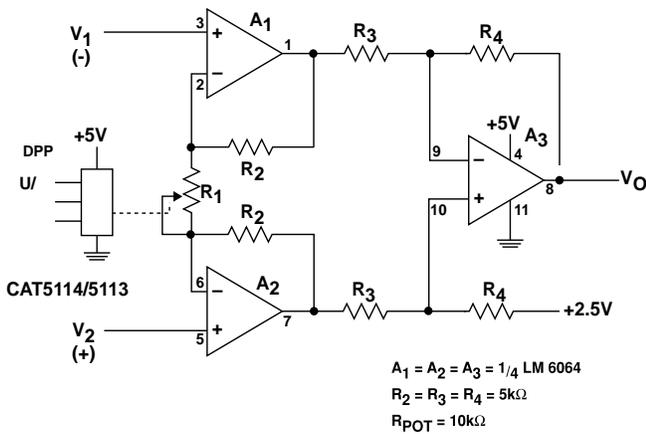
(1) Typical values are for T_A=25°C and nominal supply voltage.
 (2) This parameter is periodically sampled and not 100% tested.
 (3) MI in the A.C. Timing diagram refers to the minimum incremental change in the W output due to a change in the wiper position.

APPLICATIONS INFORMATION

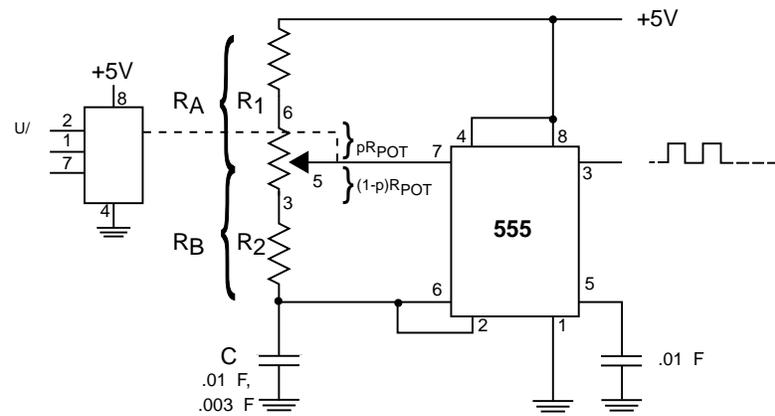
Potentiometer Configurations



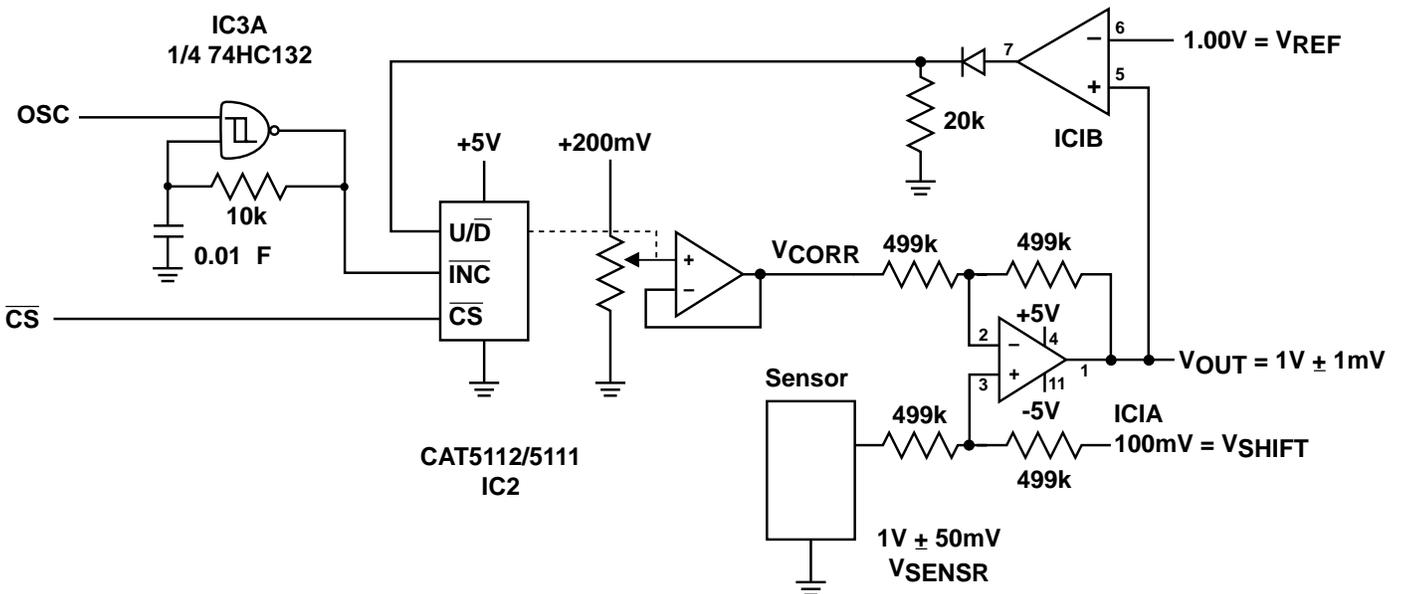
Applications



Programmable Instrumentation Amplifier

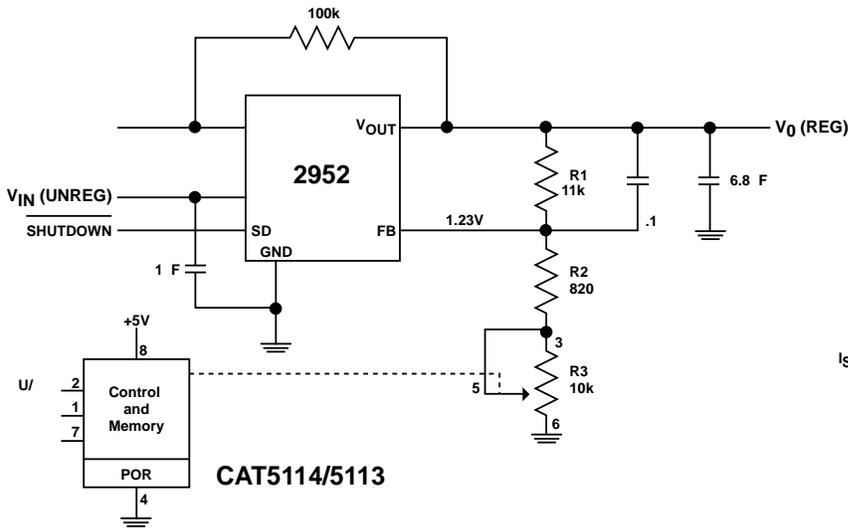


Programmable Sq. Wave Oscillator (555)

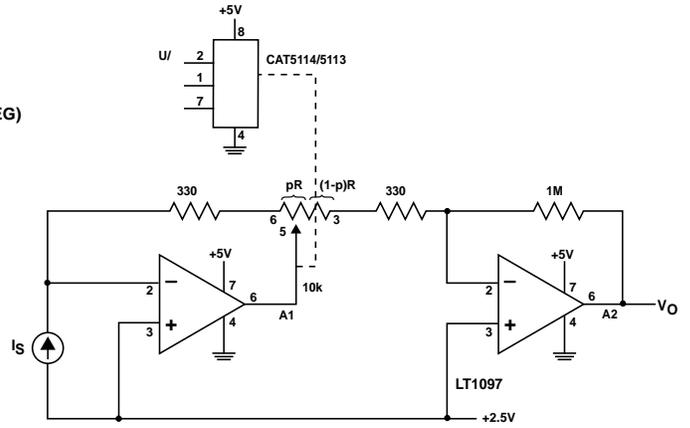


Sensor Auto Referencing Circuit

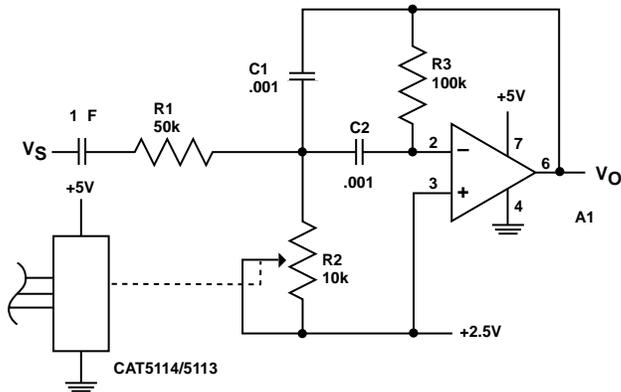
APPLICATIONS INFORMATION



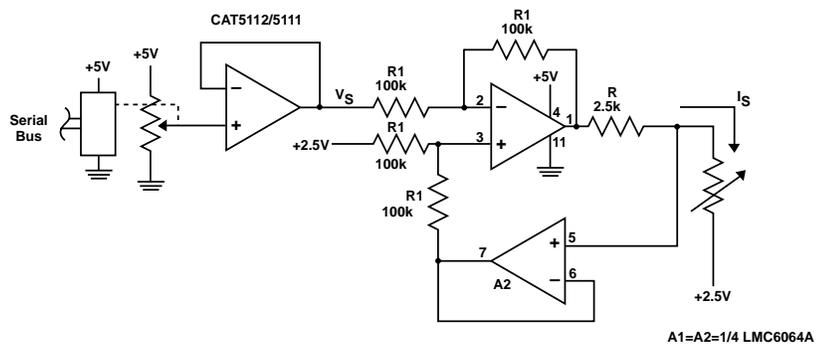
Programmable Voltage Regulator



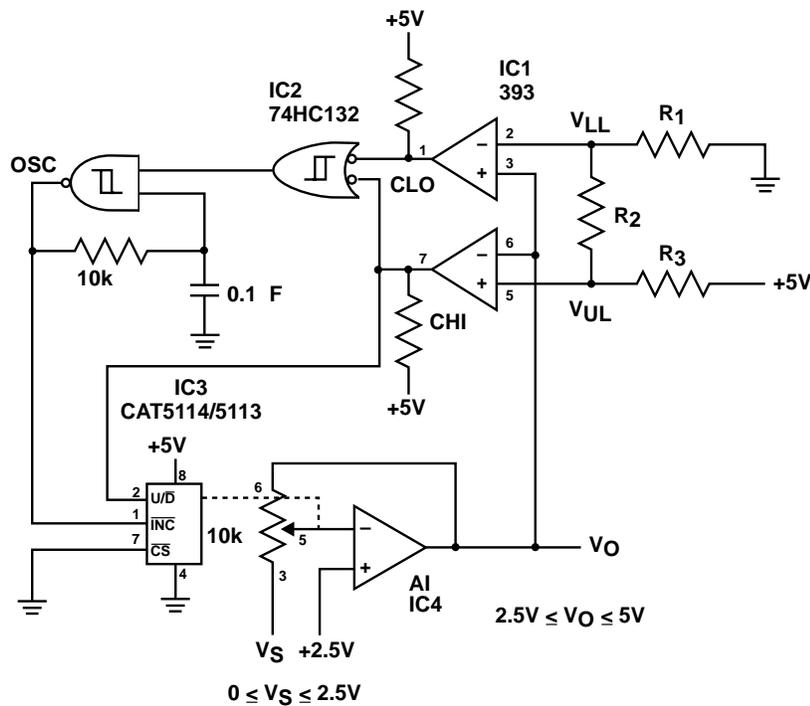
Programmable I to V convertor



Programmable Bandpass Filter

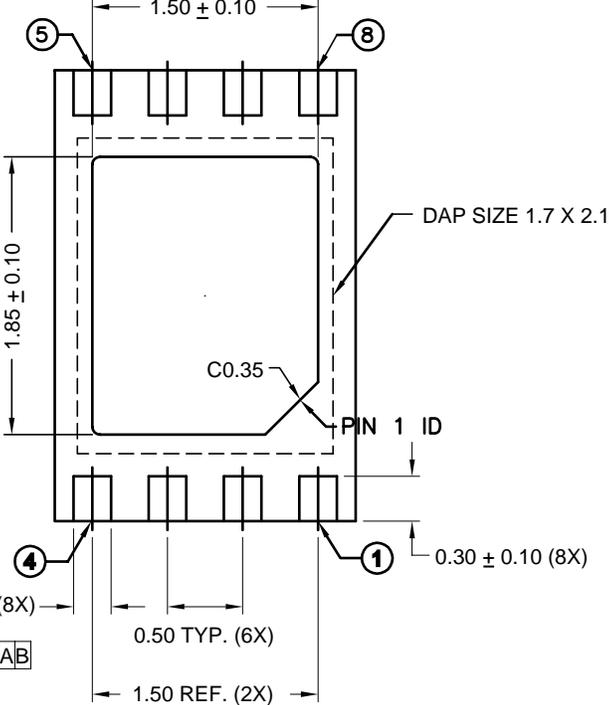
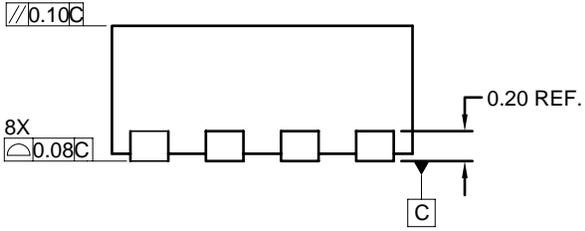
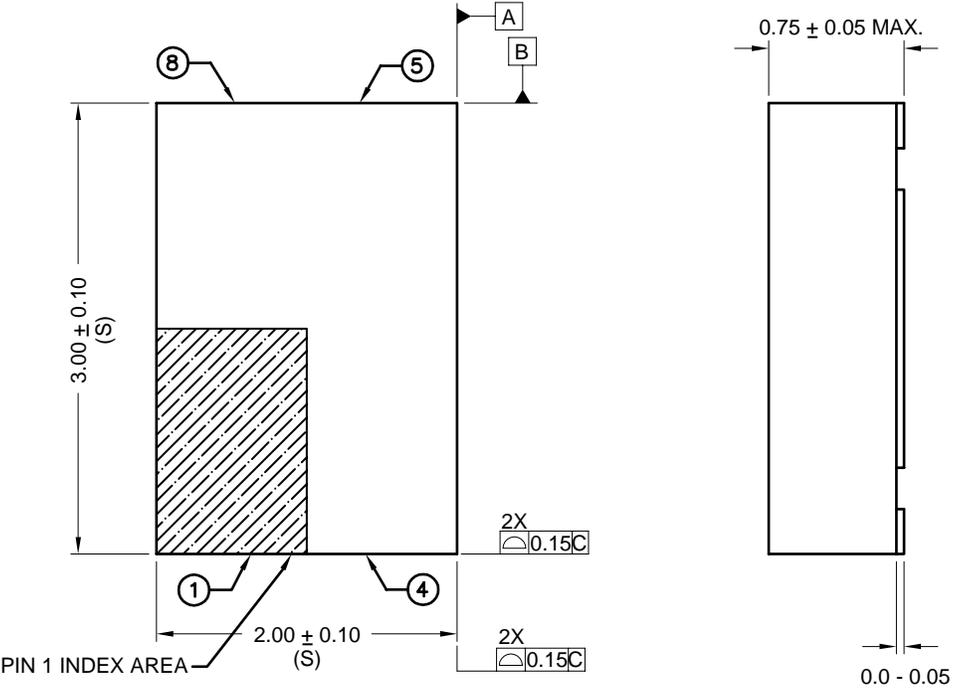


Programmable Current Source/Sink



Automatic Gain Control

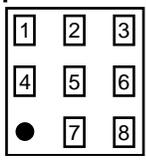
8-PAD TDFN 2 x 3 mm PACKAGE (SP2, VP2)



Top Marking

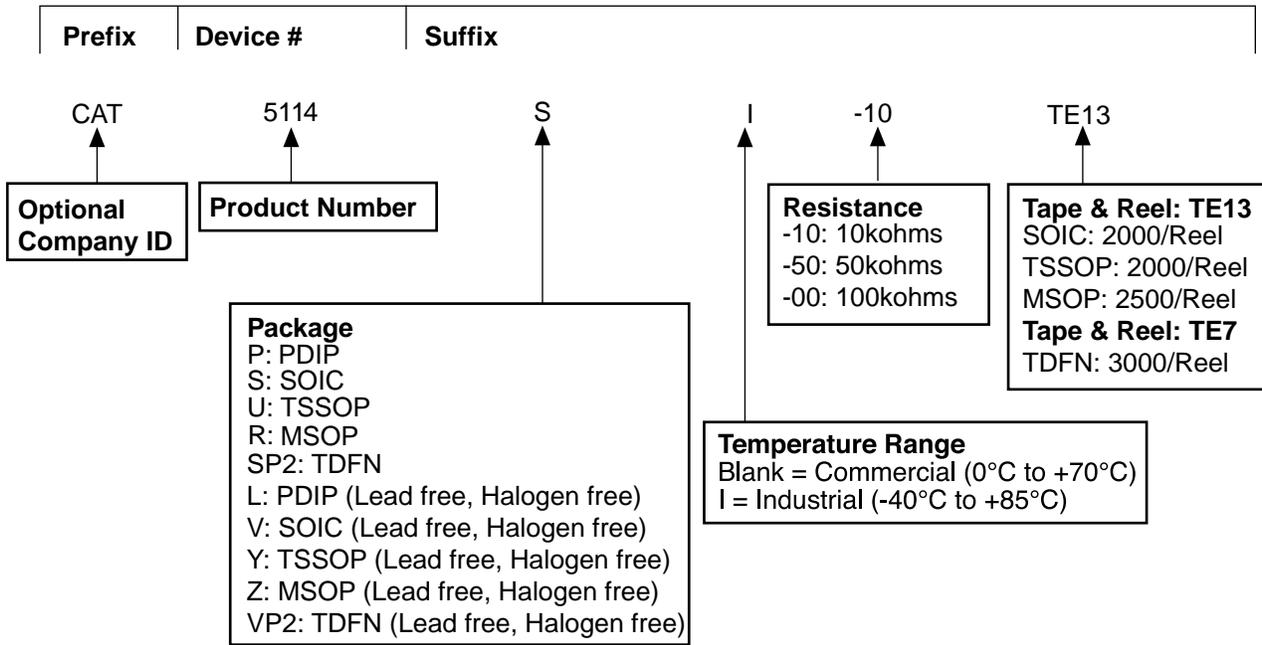
| Device | 1 | 2 |
|---------------|---|---|
| CAT5114SP2-00 | D | D |
| CAT5114SP2-10 | D | E |
| CAT5114SP2-50 | D | G |
| CAT5114VP2-00 | D | H |
| CAT5114VP2-10 | D | J |
| CAT5114VP2-50 | D | K |

Top Side Marking



- NOTE:
1. ALL DIMENSIONS IN MM. ANGLES IN DEGREES.
 2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMNALS. COPLANARITY SHALL NOT EXCEED 0.08 MM.
 3. WARPAGE SHALL NOT EXCEED 0.10 MM.
 4. PACKAGE LENGTH / PACKAGE WIDTH ARE NOT CONSIDERED AS SPECIAL CHARACTERISTIC.

ORDERING INFORMATION



Notes:

(1) The device used in the above example is a CAT5114 SI-10TE13 (SOIC, 10K Ohms, Industrial Temperature, Tape & Reel)

REVISION HISTORY

| Date | Rev. | Reason |
|-----------|------|--|
| 10/9/2003 | G | Revised Features Revised DC Electrical Characteristics |
| 3/10/2004 | H | Update Potentiometer Parameters |
| 3/29/2004 | I | Changed Green Package marking for SOIC from W to V Updated Ordering Information (removed old 5112 references) |
| 4/12/2004 | J | Updated Reel Ordering Information |
| 8/31/2004 | K | Added TDFN package in all areas |

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DPP™ AE²™

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