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a leap ahead in analog

# AS1720

## Solenoid / Valve Driver with Current Limitation

## 1 General Description

The AS1720A is a low side current source providing an optimized DC Operation for power saving and ultra low electromagnetic radiation.

The AS1720B is a low side switch providing a PWM output, which frequency is defined by an internal RC oscillator. The adjustable PWM allows a fine control of the power delivered to the load.

*Table 1. Standard Products*

| Model | Operation Mode |
|---|---|
| AS1720A | DC Current Source Operation |
| AS1720B | PWM Switching Operation |

The AS1720A and AS1720B can be set to provide a strong initial closure current and is automatically switching to hold mode for power saving. The initial DC current, the hold current and the duty cycle of the PWM can be adjusted by external resistors. An internal thermal sensor prevents damage of the circuit due to excessive heating up.

Both devices are optimized for driving electromechanical devices such as valves, solenoids relays, actuators and positioners.

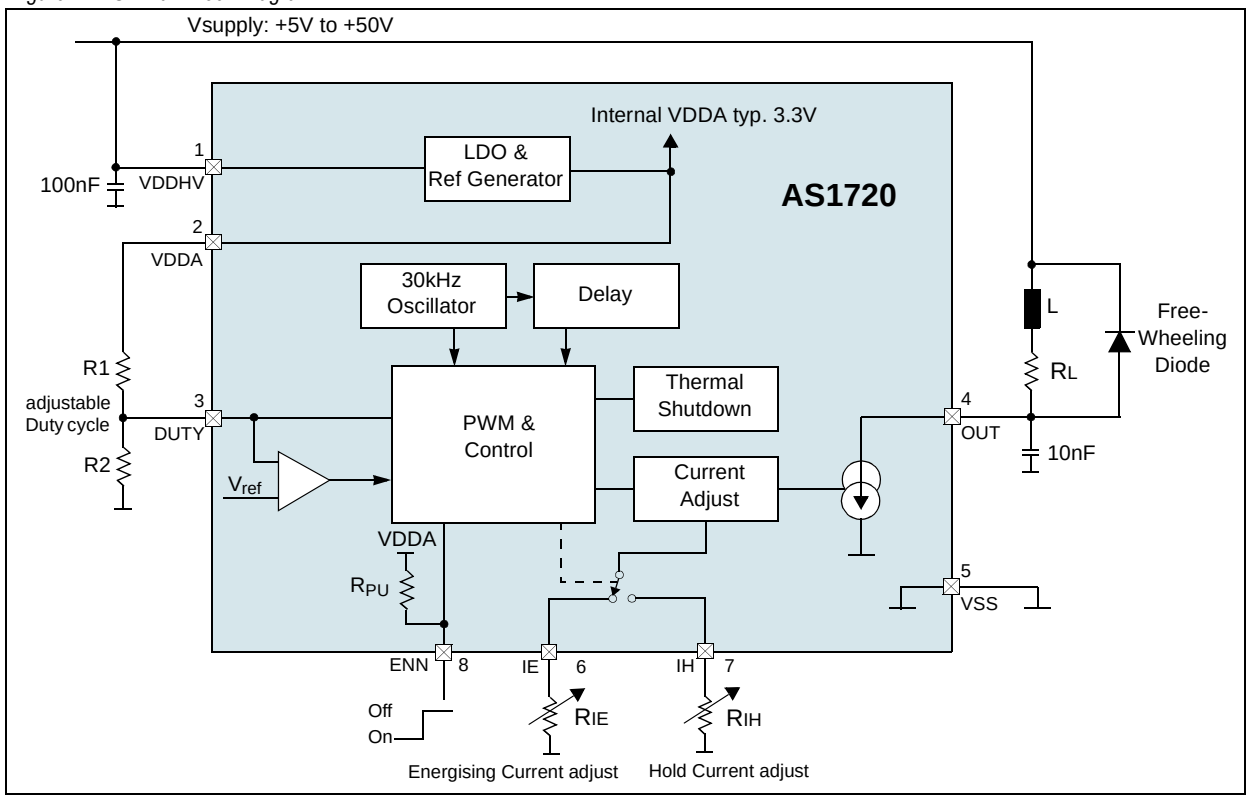
## 2 Key Features

- Supply Range: +5V to +50V
- Internal VDDA: 3.3V
- Supply Current: 1 mA
- Internal osc frequency: 30kHz
- Fix delay: 136ms
- Adjustable duty cycle: 20% – 90% (AS1720B only)
- Adjustable energizing current: 10mA – 100mA
- Adjustable hold current: 30% - 70% of energizing current
- Current Limitation
- Thermal shutdown: 150°C
- 8-pin MLPD (2x2mm) Package
- On request SOIC 8 Package (reduced temperature range -40°C to +85°C)

## 3 Applications

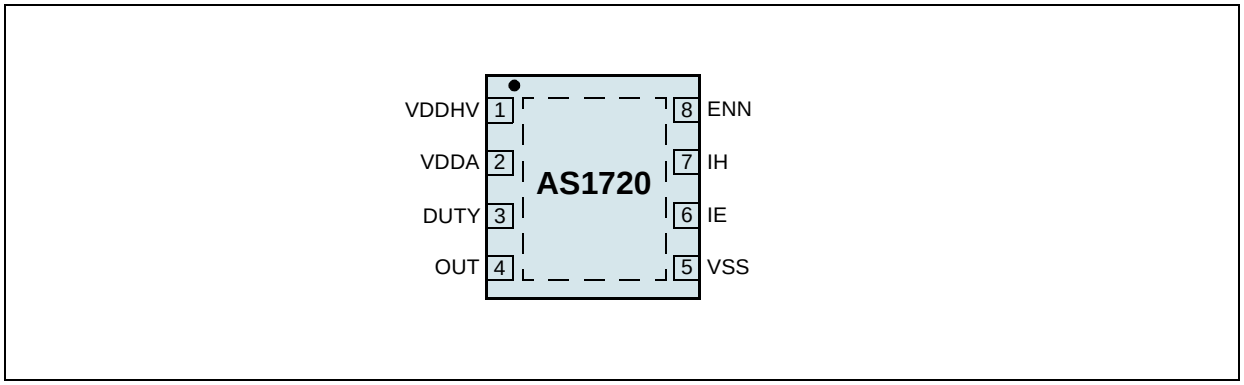
The AS1720 is ideal for fluid and gas flow systems, industrial control, electrical heaters, motor speed control.

*Figure 1. AS1720 - Block Diagram*



# 4 Pin Assignments

*Figure 2. Pin Out (Top View)*




## Pin Description

*Table 2. Pin Descriptions*

| Pin Name | Pin Number | Description |
|---|---|---|
| VDDHV | 1 | **Positive supply voltage** |
| VDDA | 2 | **Internal supply of 3.3V (typ.)** |
| DUTY | 3 | **Duty-Cycle.** By means of this pin the duty cycle can be adjusted between 20% and 90% during hold phase. The duty cycle can be adjusted by a voltage source or an external resistor divider. Setting this pin to $V_{DDA}$ the 50% duty cycle is selected automatically. |
| OUT | 4 | **Current Source Output** |
| VSS | 5 | **Ground** |
| IE | 6 | **Energize Current.** This pin defines the current during energize phase by means of a resistor. |
| IH | 7 | **Hold Current.** This pin defines the current during hold phase by means of a resistor. |
| ENN | 8 | **Enable Not.** This pin can be used to switch on/off the current source (e.g. via a µP), when the AS1720 is always powered on.<br>Low during start-up: When VDDHV is applied, the device starts with the energise phase, followed by the hold phase.<br>When the device is constantly powered on, it can be controlled by this pin.<br>High: The output current source is switched off.<br>Low: The device starts with the energise phase, followed by the hold phase. |

# 5 Absolute Maximum Ratings

Stresses beyond those listed in Table 3 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 Section 6 Electrical Characteristics on page 4 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

*Table 3. Absolute Maximum Ratings*

| Parameter | Min | Max | Units | Notes |
|---|---|---|---|---|
| **Electrical Parameters** | | | | |
| VDDHV, OUT | -0.9 | +55 | V | |
| VDDA, DUTY, ENN, IE, IH | -0.3 | +5 | V | |
| Input Current (latch-up immunity) | -100 | 100 | mA | Norm: JEDEC 78 @85°C |
| **Electrostatic Discharge** | | | | |
| Electrostatic Discharge HBM | +/- 1.5 | | kV | Norm: MIL 883 E method 3015 |
| **Temperature Ranges and Storage Conditions** | | | | |
| Thermal Resistance $\theta_{JA}$ | +36 | | °C/W | |
| Junction Temperature $T_J$ | +140 | | °C | Internally limited |
| Storage Temperature Range | -55 | +150 | °C | |
| Package Body Temperature | +260 | | °C | The reflow peak soldering temperature (body temperature) specified is in accordance with *IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices".* The lead finish for Pb-free leaded packages is matte tin (100% Sn). |
| Humidity | 5 | 85 | % | Non-condensing |
| Moisture Sensitive Level | 1 | | | Represents a max. floor life time of unlimited |

# 6 Electrical Characteristics

$V_{DDHV}$ = 5V, $V_{SS}$ = 0V, Typical Values are at $T_{AMB}$ = +25ºC (unless otherwise specified). All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

*Table 4. Electrical Characteristics*

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $T_{AMB}$ | Operating Ambient Temperature | | -40 | | +85 | °C |
| $T_J$ | Operating Junction Temperature | | -40 | | +125 | °C |
| **valid for AS1720A & AS1720B** | | | | | | |
| $V_{DDHV}$ | Supply Voltage Range | | 5 | | 50 | V |
| $V_{DDA}$ | Internal Supply | no load | 3.1 | 3.3 | 3.5 | V |
| $I_{DD}$ | Supply Current | | | 1 | 2 | mA |
| $I_{OUT\_E}$ | Output Energizing Current Range[1] | defined by $R_{IE}$ (see Figure 10 on page 7) | 10 | | 100 | mA |
| $V_{IH}$ | Digital Input Threshold | @ pin ENN | 2 | | $V_{DDA}$ | V |
| $V_{IL}$ | | | $V_{SS}$ | | 1.2 | |
| $V_{HYST}$ | Hysteresis | @ pin ENN | | 200 | | mV |
| $R_{PU}$ | Pull-Up Resistor | @ pin ENN | | 100 | | kΩ |
| | Delay Time | See Delay on page 6 | | 136 | | ms |
| $T_{SHDN}$ | Thermal Shutdown Temperature | | | 160 | | ºC |
| $\Delta T_{SHDN}$ | Thermal Shutdown Hysteresis | | | 15 | | ºC |
| **only valid for AS1720A** | | | | | | |
| $V_{OUT}$ | Saturation Voltage, Sink[1] | $I_{OUT}$ = 100mA | | 0.6 | 1 | V |
| k | Transfer Value | $R_{IE}$ = 12kΩ, $V_{DDHV}$ = 5V to 50V, OUT = 1V to 40V (see page 7) | 1080 | 1200 | 1320 | AΩ |
| $I_{OUT\_H}$ | Output Hold Current Range[1] | defined by $R_{IH}$ (see Figure 10 on page 7) | 0.3 x $I_{OUT\_E}$ | | 0.7 x $I_{OUT\_E}$ | mA |
| **only valid for AS1720B** | | | | | | |
| | Minimum Duty Cycle | | 15 | 20 | 25 | % |
| | Maximum Duty Cycle | | 83 | 90 | 95 | % |
| | Internal Duty Cycle | | | 50 | | % |
| Vtrig | Trigger level to select internal voltage divider | @ pin DUTY | | $V_{DDA}$ | | V |
| $f_{PWM}$ | PWM Frequency | | 25.5 | 30 | 34.5 | kHz |

1. The parameters are tested with proprietary test modes.

# 7 Typical Operating Characteristics

*VSUPPLY = 5V, RIE = 30kΩ, RIH = 120kΩ, TAMB = +25°C (unless otherwise specified);*

*Figure 3. Duty Cycle vs. VDUTY*

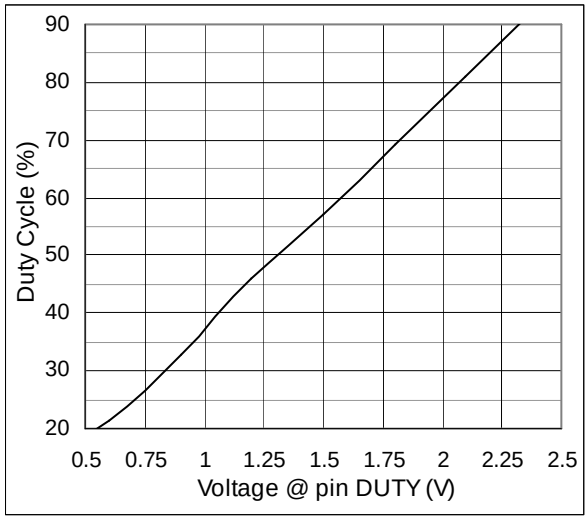



*Figure 4. PWM Frequency vs. Temperature*

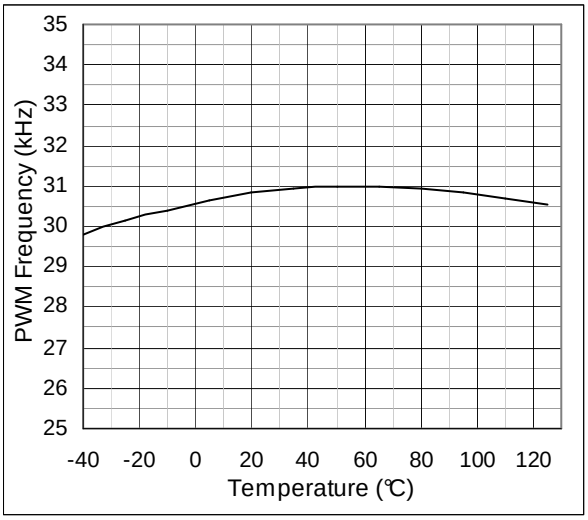



*Figure 5. Supply Current vs. Supply Voltage*

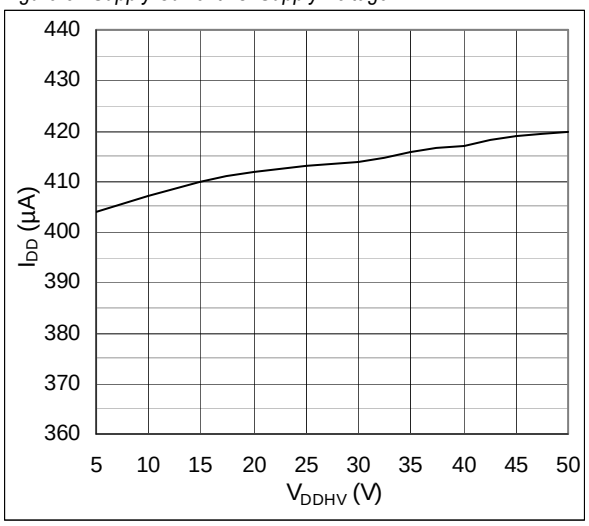



*Figure 6. Supply Current vs. Temperature*

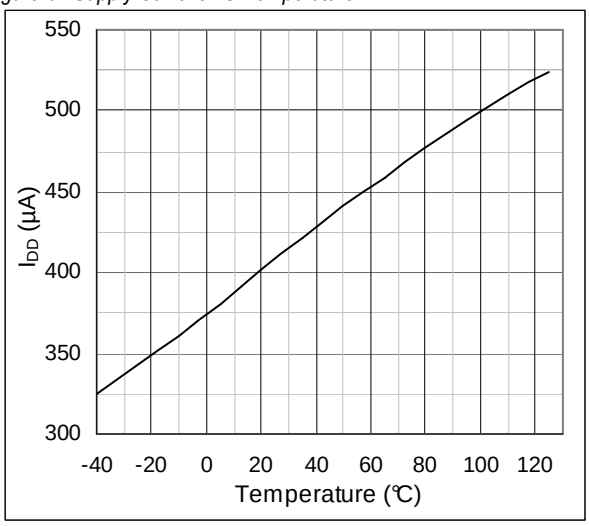



*Figure 7. Transfer Function vs. Supply Voltage*

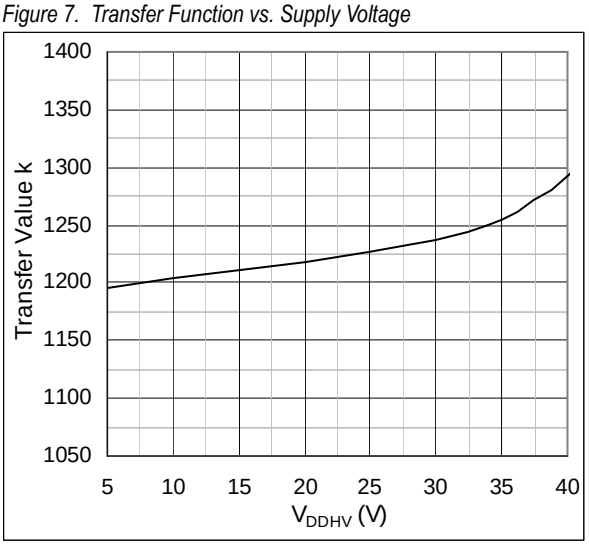
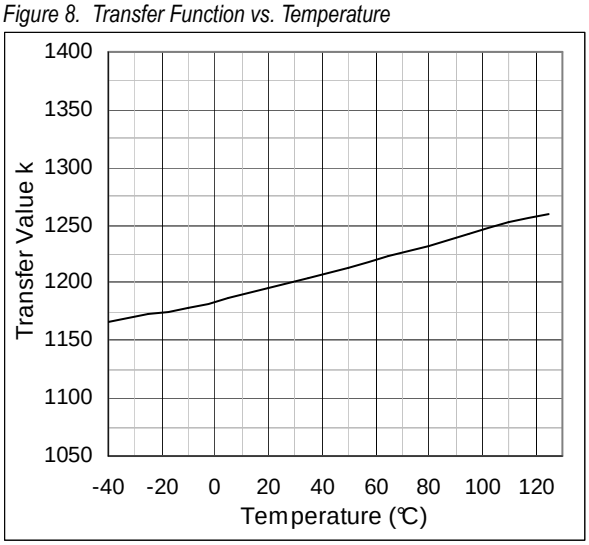



*Figure 8. Transfer Function vs. Temperature*



# 8 Detailed Description

## Delay

The delay time is generated internally by a digital divider.

## LDO and Reference Generator

This block provides the internal supply voltage of typ. 3.3V and all bias currents for the analog cells. Further the external resistor divider for setting the duty cycle will be supplied.

## Thermal shutdown

The temperature is constantly monitored. If the temperature exceeds typ. 160°C the output is disabled. In order to exit the over temperature condition, the device has to cool down and the reason of over temperature (e.g. short circuit) must be removed. After exiting the overtemperature condition the system restarts beginning with the energizing phase followed by the hold phase.

## DC Operation (AS1720A only)

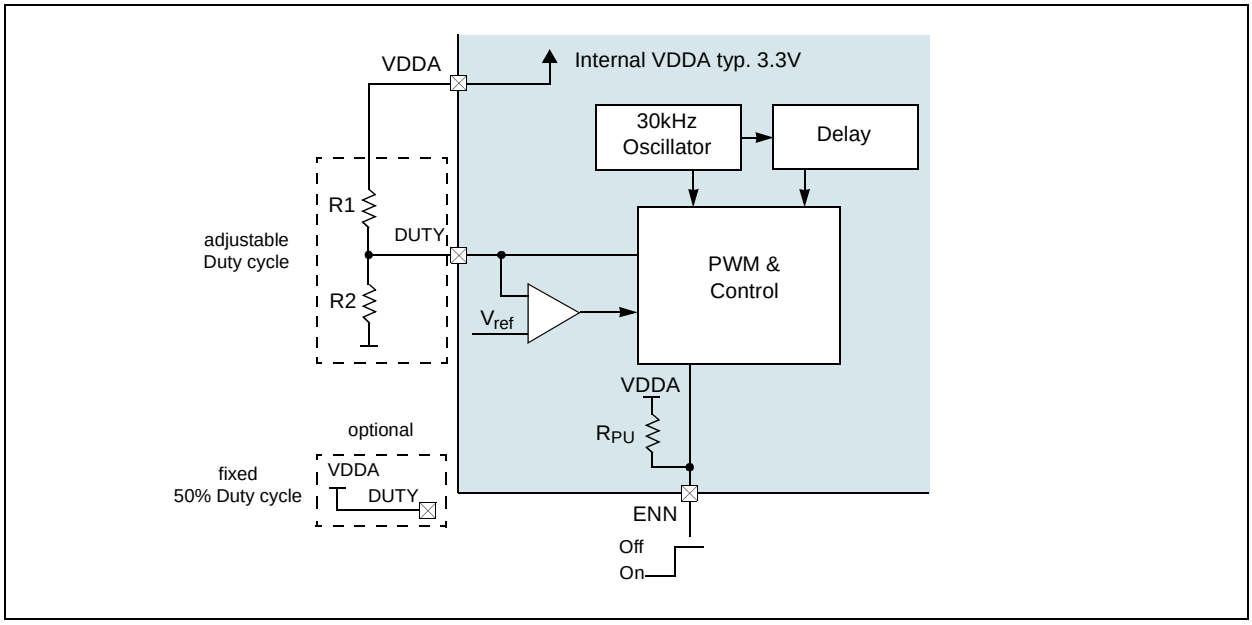
After power up, the delay time (see Delay) starts running. After expiration of the delay the hold phase starts automatically. During the hold phase the DC output current is reduced according to the RIH on pin IH.

## PWM Operation (AS1720B only)

After power up, the delay time (see Delay) starts running. After expiration of the delay the hold phase starts automatically. The internal RC oscillator sets the PWM period. The duty cycle is either defined by the external resistor divider (voltage) at pin DUTY or by the fixed internal divider. When using the external divider the duty cycle can be adjusted between 20% and 90% (e.g. from a DAC). Alternatively the pin can be driven by a voltage source. For using the internal divider the pin DUTY has to be connected to VDDA. The comparator recognizes this condition and switches to the internal divider, which causes a fixed 50% duty cycle.

$$DUTYCYCLE(V_{DUTY}) = 0,381 \times V_{DUTY} - 0,014 \qquad \text{(EQ 1)}$$

*Figure 9. Simplified Circuit of Block PWM and Control*



## Control by pin ENN

When VDDHV is constantly switched on the AS1720 can be controlled by pin ENN. The functionality is the same as for controlling the device via pin VDDHV. This feature is useful when controlling by a microprocessor is desired.

Because of the internal pull-up resistor to $V_{DDA}$ a microprocessor with open-drain or with push/pull (max 3.3V) output can be used.

## Current Adjust (AS1720A) and Current Limitation (AS1720B)

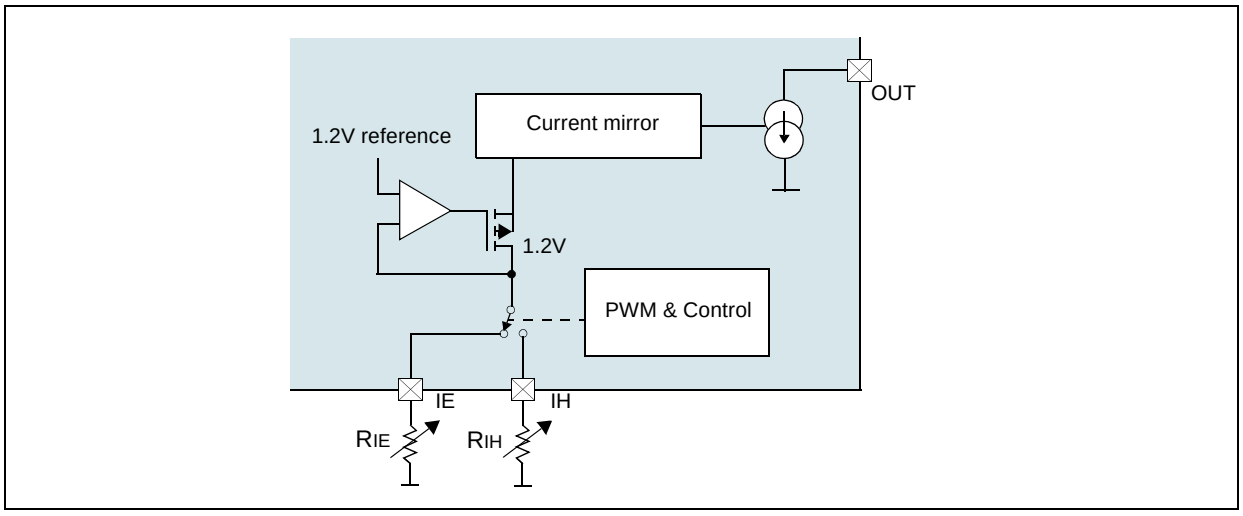
This block provides the current reference for the output current source. The current is generated by regulating the internal Bandgap voltage to the pins IE and IH. The external resistors $R_{IE}$ and $R_{IH}$ define the output current and can be expressed as:

$$R_{IE/IH} = \frac{k}{I_{OUT}} \qquad \text{(EQ 2)}$$

The temperature coefficient depends on the Bandgap voltage (100ppm/K, box method) and external resistor (in the range of several ppm/K).

The saturation voltage of the output current source for a 100mA current is typical 600mV.

*Figure 10. Simplified Circuit of Blocks Current Adjust and Current Source*



# 9 Application Information

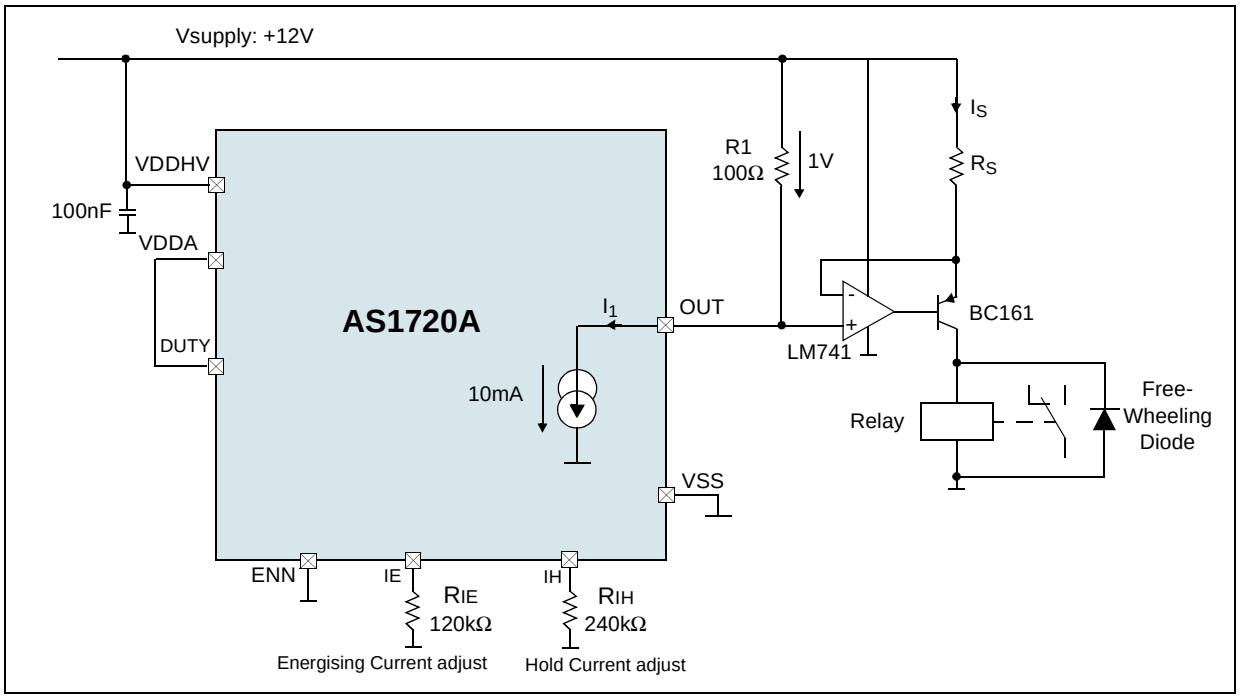
In order to drive relays, which need more than 100mA current, an external circuitry (see Figure 11) can be used. This application shows how to drive 5W @12V relays.

This circuit is only applicable for AS1720A.

For this example with R1 = 100Ω and $R_S$ = 2.5Ω the current Is is calculated as follows:

$$I_S = I_1 \times \frac{R_1}{R_S} = 0,01A \times \frac{100}{2,5} = 400mA \qquad \text{(EQ 3)}$$

*Figure 11. AS1720A - Typical Application*



# 10 Package Drawings and Markings

*Figure 12. 8-pin MLPD (2x2mm) Marking*

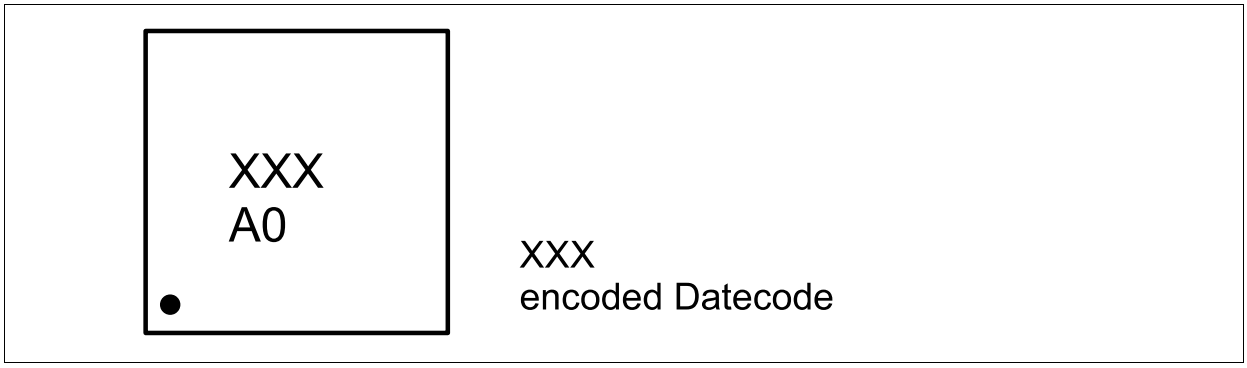
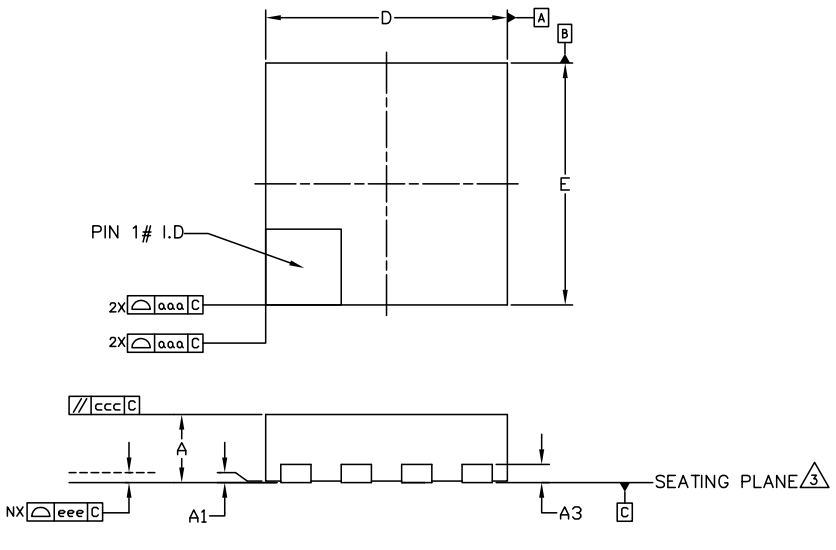
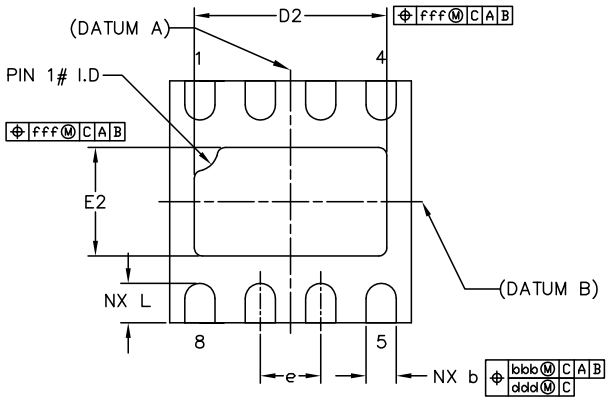


*Figure 13. 8-pin MLPD (2x2mm) Package*






| REF. | MIN | NOM | MAX |
|---|---|---|---|
| A | 0.51 | 0.55 | 0.60 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | | 0.15 REF | |
| L | 0.225 | 0.325 | 0.425 |
| b | 0.18 | 0.25 | 0.30 |
| D | | 2.00 BSC | |
| E | | 2.00 BSC | |
| e | | 0.50 BSC | |
| D2 | 1.45 | 1.60 | 1.70 |
| E2 | 0.75 | 0.90 | 1.00 |
| aaa | – | 0.15 | – |
| bbb | – | 0.10 | – |
| ccc | | 0.10 | – |
| ddd | – | 0.05 | – |
| eee | – | 0.08 | – |
| fff | – | 0.10 | – |
| N | | 8 | |

NOTE:

1. DIMENSIONS & TOLERANCEING CONFIRM TO ASME Y14.5M–1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGELS ARE IN DEGREES.
3. COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.
4. RADIUS ON TERMINAL IS OPTIONAL.
5. N IS THE TOTAL NUMBER OF TERMINALS.

| | | | | |
|---|---|---|---|---|
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| DRAWN RH8 | DATE 2011.02.02 | REV. N/C | TITLE MLPD 2x2x0.55mm 8 LEAD, 1.60X0.90mm ePAD | REFERENCE DOCUMENT JEDEC MO – 248 LATEST REVISION |
| CHECKED GBO | DATE 2011.02.02 | | DRAWING NO. QFF | UNIT |
| APPROVED MKR | DATE 2011.02.02 | SHEET 1 OF 1 | DIMENSION AND TOLERANCE | SCALE NOT IN SCALE |

# 11 Ordering Information

The device is available as the standard products shown in Table 5.

*Table 5. Ordering Information*

| Ordering Code | Marking | Description | Delivery Form | Package |
|---|---|---|---|---|
| AS1720A-ATDT | A0 | Solenoid / Valve Driver with Current Limitation and with DC Current Source Operation | Tape and Reel | 8-pin MLPD (2x2mm) |
| AS1720B-ATDT | AW | Solenoid / Valve Driver with Current Limitation and with PWM Switching Operation | Tape and Reel | 8-pin MLPD (2x2mm) |

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## Contact Information

Headquarters

austriamicrosystems AG
Tobelbaderstrasse 30
A-8141 Unterpremstaetten, Austria

Tel: +43 (0) 3136 500 0
Fax: +43 (0) 3136 525 01

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