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# Features

- **Temperature and Voltage Compensated Frequency (Fully Integrated Oscillator)**
- **Warning Indication of Lamp Failure by Means of Frequency Doubling**
- **Voltage Dependence of the Indicator Lamps also Compensated for Lamp Failure**
- **Relay Output with High Current Capability and Low Saturation Voltage**
- **Frequency Doubling only During Direction Mode**
- **Temperature Compensated Threshold for Lamp Failure Detection**
- **Overvoltage and Undervoltage Shut Down of the Relay Outputs**
- **Quiescent Current I ≤ 10 μA (Switches Open)**
- **EMI Protection According to ISO TR 7637/1, Test Level 4 (Exclusive Load Dump)**
- **Reversed Battery Protection by Means of a Serial Resistor and Relay Coil Connected**
- **Load Dump Protection 80 V with External Protection Components**
- **12 V/24 V Application**
- **Package: SO16**

Electrostatic sensitive device.
Observe precautions for handling.

# Description

The integrated circuit ATA6140 is used in relay-controlled automotive flashers. With two output stages, each side of the vehicle is controlled separately. A left and a right direction indicator input with only a small control current makes switch contacts for small loads possible. The separate hazard warning input simplifies the construction of the hazard switch. Lamp outage is indicated by frequency doubling during direction mode. Thanks to the extreme low current consumption the ATA6140 can be connected to the battery directly.
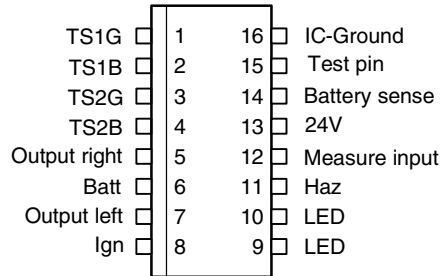
**Figure 1.** Block Diagram
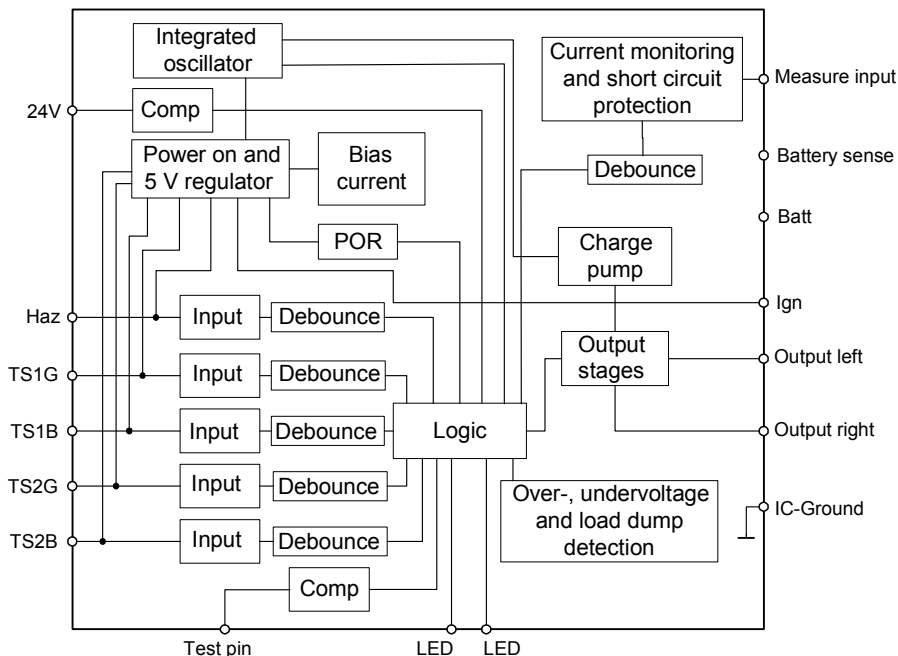


**Two-relay Flasher**

**ATA6140**

# Pin Configuration

**Figure 2.** Pinning SO16

```
           TS1G ☐  1      16 ☐ IC-Ground
           TS1B ☐  2      15 ☐  Test pin
           TS2G ☐  3      14 ☐ Battery sense
           TS2B ☐  4      13 ☐ 24V
   Output right ☐  5      12 ☐ Measure input
           Batt ☐  6      11 ☐ Haz
    Output left ☐  7      10 ☐ LED
            Ign ☐  8       9 ☐ LED
```

# Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1 | TS1G | Input left ground |
| 2 | TS1B | Input left battery |
| 3 | TS2G | Input right ground |
| 4 | TS2B | Input right battery |
| 5 | Output right | Output right |
| 6 | Batt | Battery force |
| 7 | Output left | Output left |
| 8 | Ign | Ignition |
| 9 | LED | LED outage left |
| 10 | LED | LED outage right |
| 11 | Haz | Input hazard |
| 12 | Measure input | Measure input |
| 13 | 24V | 24 V version |
| 14 | Battery sense | Battery sense |
| 15 | Test pin | Test pin |
| 16 | IC-Ground | IC ground |

## Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage, pin 6 | $V_{VS}$ | 6 to 40 | V |
| Ambient temperature range | $T_{amb}$ | -40 to +105 | °C |
| Junction temperature range | $T_j$ | -40 to +150 | °C |
| Storage temperature range | $T_{stg}$ | -55 to +150 | °C |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Maximum thermal resistance SO16 | $R_{thJA}$ | 110 | K/W |

## Operating Range

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply voltage, pin 6 | $V_{VS}$ | 6 to 24 | V |
| Supply voltage, pin 6 (24 V version, pin 13 to GND) | $V_{VS}$ | 18 to 33 | V |

## Noise and Surge Immunity

| Parameters | Test Conditions | Value |
|---|---|---|
| Conducted interferences[1] | ISO 7637-1 | Level 4 |
| ESD (Human Body Model) | MIL-STD-883D Method 3015.7[2] | 2 kV |
| | MIL-STD-883D Method 3015.7 (pin 12 and pin 14) | 1 kV |
| ESD FCDM (Field induced Charge Device Model) | ESD - S. 5.3 | 500 V |

Note:   1.  At both outputs a relay of minimum 130 Ω should be added (for details see application circuits Figure 4 on page 7 to Figure 11 on page 11).

2.  Exclusive pin 12 and pin 14.

## Electrical Characteristics

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **Supply Voltage Range** | | | | | | | | |
| 1.1 | Supply voltage | | 6 | $V_{VS}$ | 8 | | 16 | V | C |
| 1.1 | Supply voltage (24 V version) | | 6 | $V_{VS}$ | 18 | | 33 | V | C |
| **2** | **Current Consumption** | | | | | | | | |
| 2.1 | Quiescent current ($V_S$) | $V_{VS}$ < 16 V switches open | 6 | $I_{VS}$ | | | 10 | µA | A |
| 2.1 | Quiescent current ($V_S$, 24 V version) | $V_{VS}$ < 33 V switches open | 6 | $I_{VS}$ | | | 20 | µA | A |
| 2.2 | Supply current ($V_S$) | $V_{VS}$ < 16 V | 6 | $I_{VS}$ | | | 6 | mA | A |
| 2.2 | Supply current ($V_S$, 24 V version) | $V_{VS}$ < 33 V | 6 | $I_{VS}$ | | | 8 | mA | A |
| **3** | **Under and Overvoltage Detection** | | | | | | | | |
| 3.1 | Undervoltage detection threshold | | 6 | $V_{VU}$ | 6 | | 8 | V | A |
| 3.2 | Undervoltage detection delay time | | | $t_{dUV}$ | 2.5 | | 10 | ms | A |
| 3.3 | Overvoltage detection threshold | | 6 | $V_{VO}$ | 18 | | 22 | V | A |
| 3.3 | Overvoltage detection threshold (24 V version) | Disabled in 24 V version (pin 13 to GND) | 6 | $V_{VO}$ | | | | V | A |
| **4** | **Relay Outputs** | | | | | | | | |
| 4.1 | Current output right | | 5 | $I_{I5}$ | | | 170 | mA | A |
| 4.2 | Current output left | | 7 | $I_{I7}$ | | | 170 | mA | A |
| 4.3 | Saturation voltage right | 170 mA at 23°C | 5 | $V_{SATR}$ | | | 1 | V | A |
| 4.4 | Saturation voltage left | 170 mA at 23°C | 7 | $V_{SATL}$ | | | 1 | V | A |
| 4.5 | Leakage current right | | 5 | $I_{LEAKR}$ | | | 3 | µA | A |
| 4.5 | Leakage current right (24 V version) | | 5 | $I_{LEAKR}$ | | | 6 | µA | A |
| 4.6 | Leakage current left | | 7 | $I_{LEAKL}$ | | | 3 | µA | A |
| 4.6 | Leakage current left (24 V version) | | 7 | $I_{LEAKL}$ | | | 6 | µA | A |
| 4.7 | Start delay time right | | 5 | $T_{DR}$ | 10 | | 40 | ms | A |
| 4.8 | Start delay time left | | 7 | $T_{DL}$ | 10 | | 40 | ms | A |
| **5** | **Control Signal Thresholds** | | | | | | | | |
| 5.1 | Frequency doubling | $V_S$ = 9 V | 12 | $V_{THFD9}$ | 42 | 45 | 48 | mV | A |
| 5.2 | Frequency doubling | $V_S$ = 15 V | 12 | $V_{THFD15}$ | 50 | 53 | 57 | mV | A |
| 5.2 | Frequency doubling (24 V version) | $V_S$ = 24 V | 12 | $V_{THFD24}$ | | 65 | | mV | A |
| 5.3 | Short circuit detection | $V_S$ = 13.5 V | 12 | $V_{THSC}$ | 425 | 475 | 525 | mV | B |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Electrical Characteristics (Continued)

| No. | Parameters | Test Conditions | Pin | Symbol | Min. | Typ. | Max. | Unit | Type* |
|-----|------------|-----------------|-----|--------|------|------|------|------|-------|
| 5.3 | Short circuit detection (24 V version) | $V_S$ = 24 V | 12 | $V_{THSC}$ | | 650 | | mV | B |
| 5.4 | Temperature coefficient | -40°C to +105°C | 12 | $C_{TH}$ | | 30 | | µV/K | C |
| 5.5 | Input current | $V_S$ = 13.5 V | 12 | $I_{TH}$ | | | 2 | µA | A |
| 5.5 | Input current (24 V version) | $V_S$ = 24 V | 12 | $I_{TH}$ | | | 4 | µA | A |
| **6** | **LED Inputs** | | | | | | | | |
| 6.1 | Threshold left | $V_S$ = 13.5 V | 9 | $V_{LEDL}$ | 1 | | 4.5 | V | A |
| 6.2 | Threshold right | $V_S$ = 13.5 V | 10 | $V_{LEDR}$ | 1 | | 4.5 | V | A |
| 6.3 | Pull-up resistor left | | 9 | $R_{LEDL}$ | 10 | | 75 | kΩ | A |
| 6.4 | Pull-up resistor right | | 10 | $R_{LEDR}$ | 10 | | 75 | kΩ | A |
| **7** | **Timing** | | | | | | | | |
| 7.1 | Basic frequency | 1/f = 706 ms | | $F_B$ | -10.5 | | +12 | % | A |
| 7.2 | Bright period | | | | | 50 | | % | A |
| 7.3 | Bright period in failure mode | | | | | 40 | | % | A |
| 7.4 | Failure frequency | | | $F_F$ | | | 2.2 × $F_B$ | | A |

*) Type means: A = 100% tested, B = 100% correlation tested, C = Characterized on samples, D = Design parameter

## Short Circuit or Overload Detection Delay

Direction mode:
100 ms during the first bright phase, 50 ms during all following bright phases

Hazard mode: 100 ms during all bright phases

In case of overload the relay output switches off (not stored)

## Bulb Outage Detection

The detection of bulb outage takes place during the bright phase. There is a delay time of typically 128 ms before ATA6140 measures the bulb current with a debounce period of 5 ms. After this time the inrush current dropped significantly.

Application hint:
It has to be considered that a slow relay contact may shorten the inrush current decay time and too high current would be measured and falsely an outage may not be detected. If operated with low supply voltage (e.g., 8 V) the relay speed could be even slower.

## Flasher Operating Mode

| Ignition | Input Left Ground | Input Right Ground | Input Left Ignition | Input Right Ignition | Input Hazard | Left Lamps[1] | Right Lamps[1] | Frequency in Case of Lamp Failure[1] |
|---|---|---|---|---|---|---|---|---|
| Off | Open | Open | IC-Ground | IC-Ground | Open | x | x | x |
| Off | Ground | Open | IC-Ground | IC-Ground | Open | x | x | x |
| Off | Open | Ground | IC-Ground | IC-Ground | Open | x | x | x |
| Off | Open | Open | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| Off | Ground | Open | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| Off | Open | Ground | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| Off | Ground | Ground | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| Off | Ground | Ground | IC-Ground | IC-Ground | Open | x | x | x[2] |
| On | Open | Open | IC-Ground | IC-Ground | Open | x | x | x |
| On | Ground | Open | IC-Ground | IC-Ground | Open | Flash | x | Double |
| On | Open | Ground | IC-Ground | IC-Ground | Open | x | Flash | Double |
| On | Open | Open | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| On | Ground | Open | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| On | Open | Ground | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| On | Ground | Ground | IC-Ground | IC-Ground | Ground | Flash | Flash | Normal |
| On | Ground | Ground | IC-Ground | IC-Ground | Open | Flash | Flash | Normal |
| Off | $V_{BATT}$ | $V_{BATT}$ | Open | Open | Open | x | x | x |
| Off | $V_{BATT}$ | $V_{BATT}$ | Ignition | Open | Open | x | x | x |
| Off | $V_{BATT}$ | $V_{BATT}$ | Open | Ignition | Open | x | x | x |
| Off | $V_{BATT}$ | $V_{BATT}$ | Open | Open | Ground | Flash | Flash | Normal |
| Off | $V_{BATT}$ | $V_{BATT}$ | Ignition | Open | Ground | Flash | Flash | Normal |
| Off | $V_{BATT}$ | $V_{BATT}$ | Open | Ignition | Ground | Flash | Flash | Normal |
| Off | $V_{BATT}$ | $V_{BATT}$ | Ignition | Ignition | Ground | Flash | Flash | Normal |
| Off | $V_{BATT}$ | $V_{BATT}$ | Ignition | Ignition | Open | x | x | x[3] |
| On | $V_{BATT}$ | $V_{BATT}$ | Open | Open | Open | x | x | x |
| On | $V_{BATT}$ | $V_{BATT}$ | Ignition | Open | Open | Flash | x | Double |
| On | $V_{BATT}$ | $V_{BATT}$ | Open | Ignition | Open | x | Flash | Double |
| On | $V_{BATT}$ | $V_{BATT}$ | Open | Open | Ground | Flash | Flash | Normal |
| On | $V_{BATT}$ | $V_{BATT}$ | Ignition | Open | Ground | Flash | Flash | Normal |
| On | $V_{BATT}$ | $V_{BATT}$ | Open | Ignition | Ground | Flash | Flash | Normal |
| On | $V_{BATT}$ | $V_{BATT}$ | Ignition | Ignition | Ground | Flash | Flash | Normal |
| On | $V_{BATT}$ | $V_{BATT}$ | Ignition | Ignition | Open | Flash | Flash | Nnormal |

Notes:
1. x = no flashing
2. If ignition is OFF, the input level cannot be sensed (the IC is in the sleep mode). For hazard mode use the input hazard.
3. For hazard mode use input hazard or switch to battery as shown in Figure 6 on page 8 and Figure 10 on page 10.

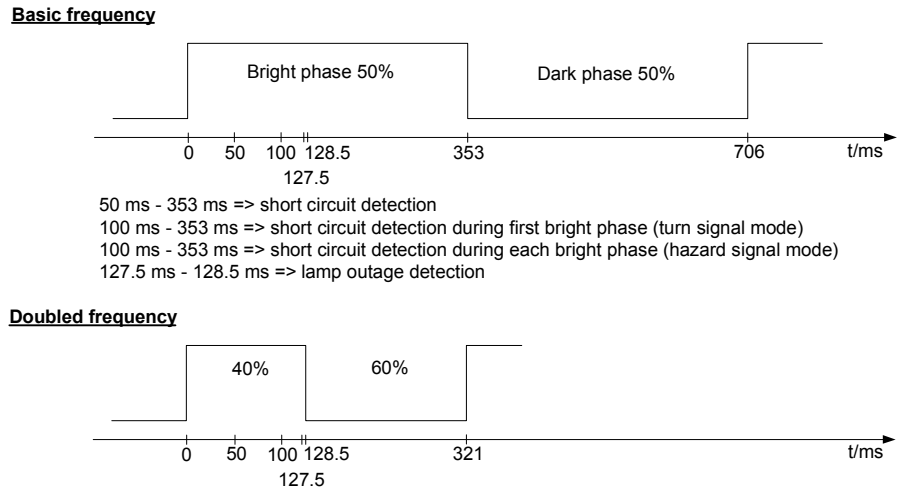# Diagrams

**Figure 3.** Timing Diagram

**Basic frequency**

| | Bright phase 50% | | Dark phase 50% | |
|---|---|---|---|---|

0   50   100  128.5          353                                706        t/ms
          127.5

50 ms - 353 ms => short circuit detection
100 ms - 353 ms => short circuit detection during first bright phase (turn signal mode)
100 ms - 353 ms => short circuit detection during each bright phase (hazard signal mode)
127.5 ms - 128.5 ms => lamp outage detection

**Doubled frequency**

40%        60%

0   50   100  128.5      321                                              t/ms
          127.5

**Figure 4.** Application 1: 12 V Version, Turn Signal Switches to GND, Hazard Switch to GND
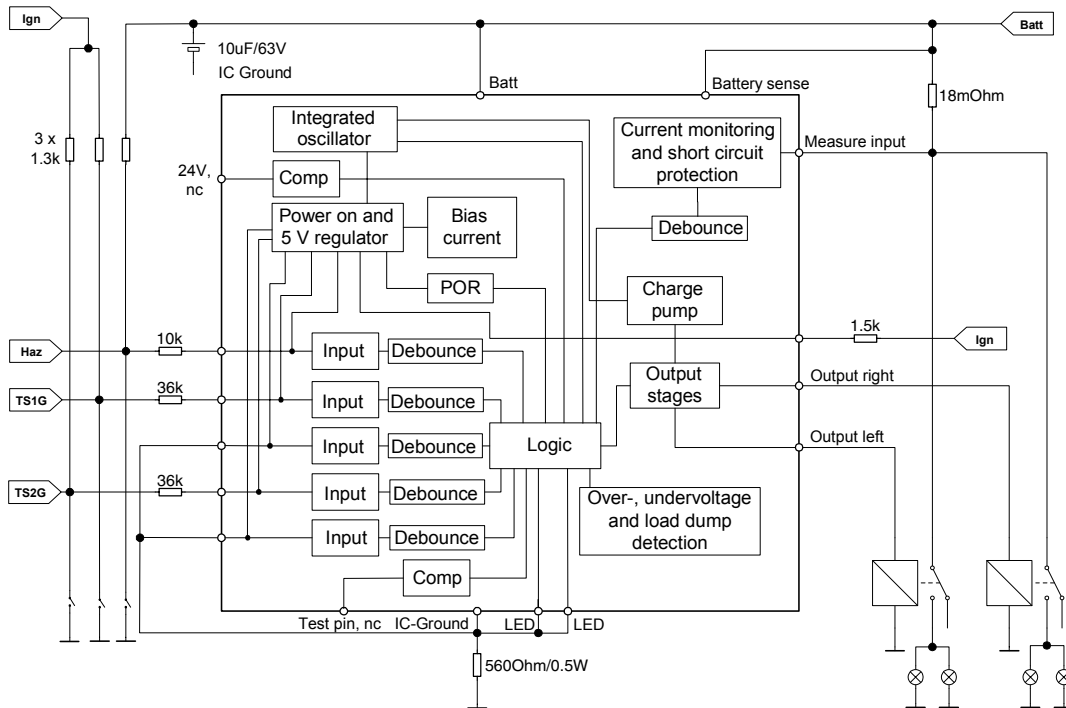
**Figure 5.** Application 2: 12 V Version, Turn Signal Switches to Ignition, Hazard Switch to GND
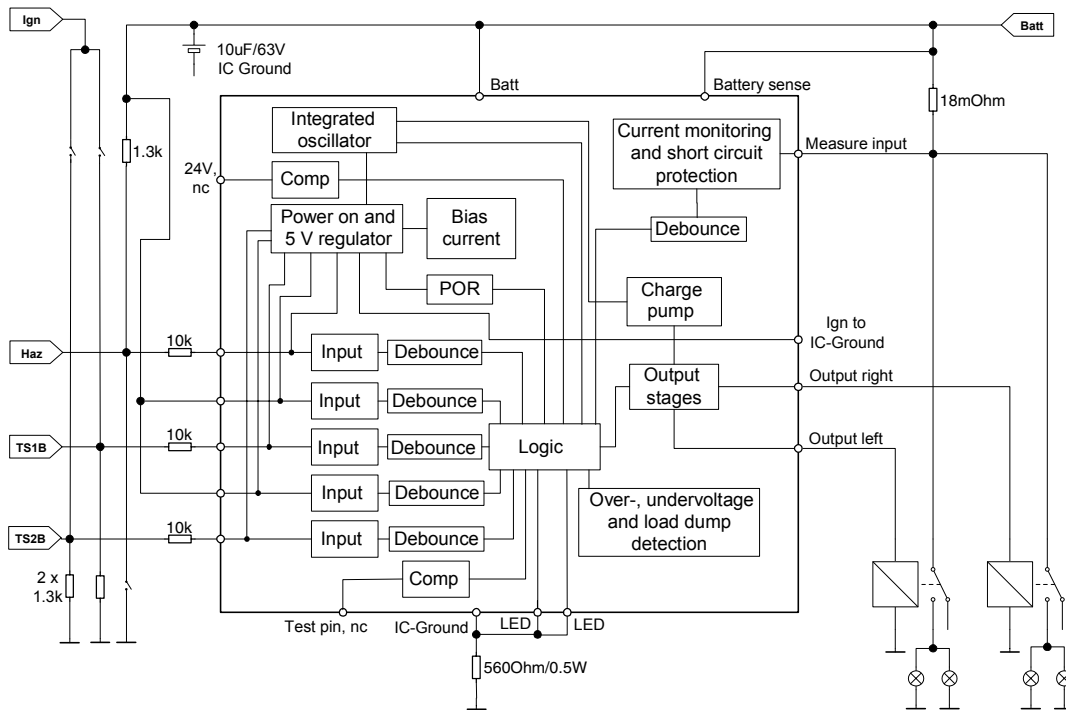


**Figure 6.** Application 3: 12 V Version, Turn Signal Switches to Ignition, Hazard Switch to Battery
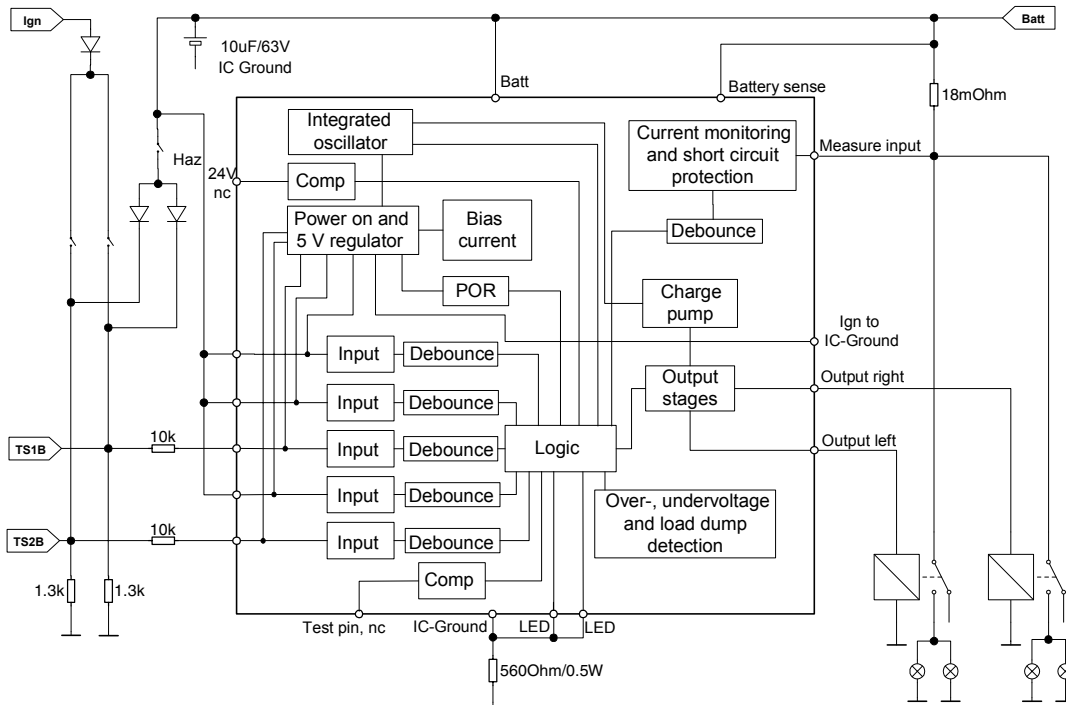
**Figure 7.** Application 4: 12 V Version, Turn Signal Switches to Ignition, Hazard Switch to GND, additional LED Outage
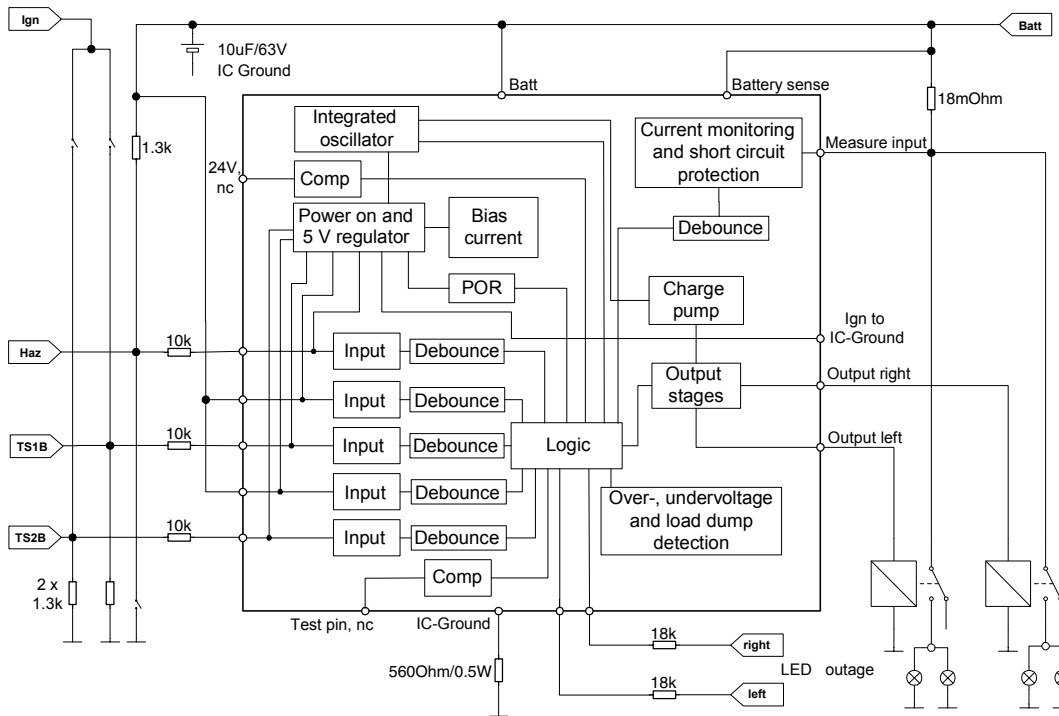


**Figure 8.** Application 1: 24 V Version, Turn Signal Switches to GND, Hazard Switch to GND



**9**
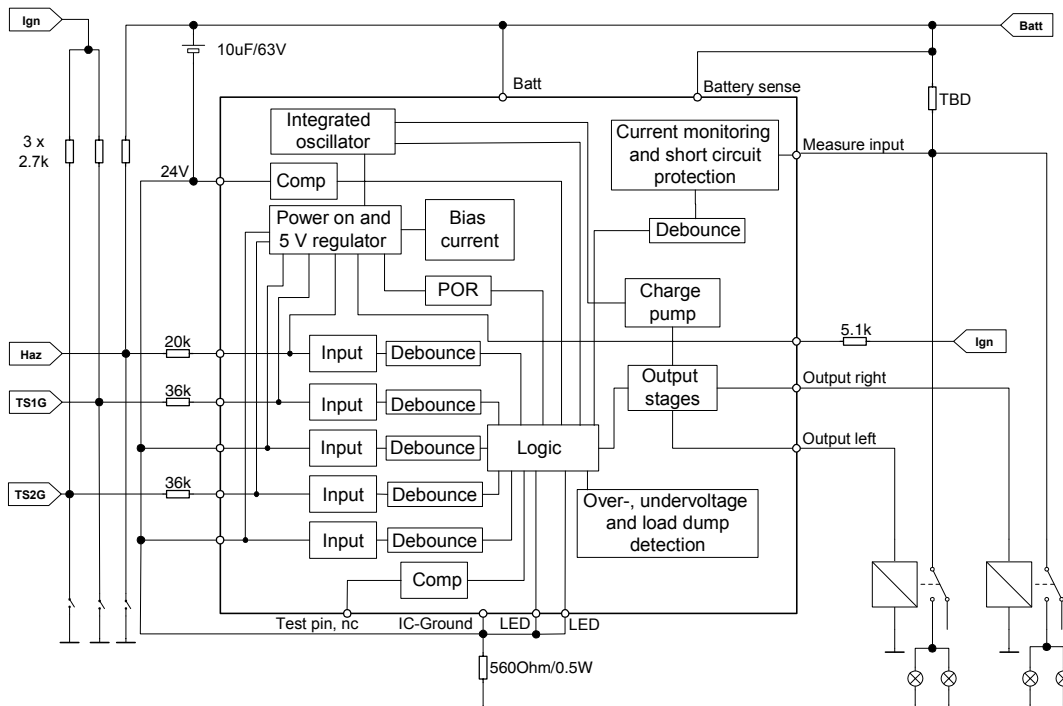
**Figure 9.** Application 2: 24 V Version, Turn Signal Switches to Ignition, Hazard Switch to GND
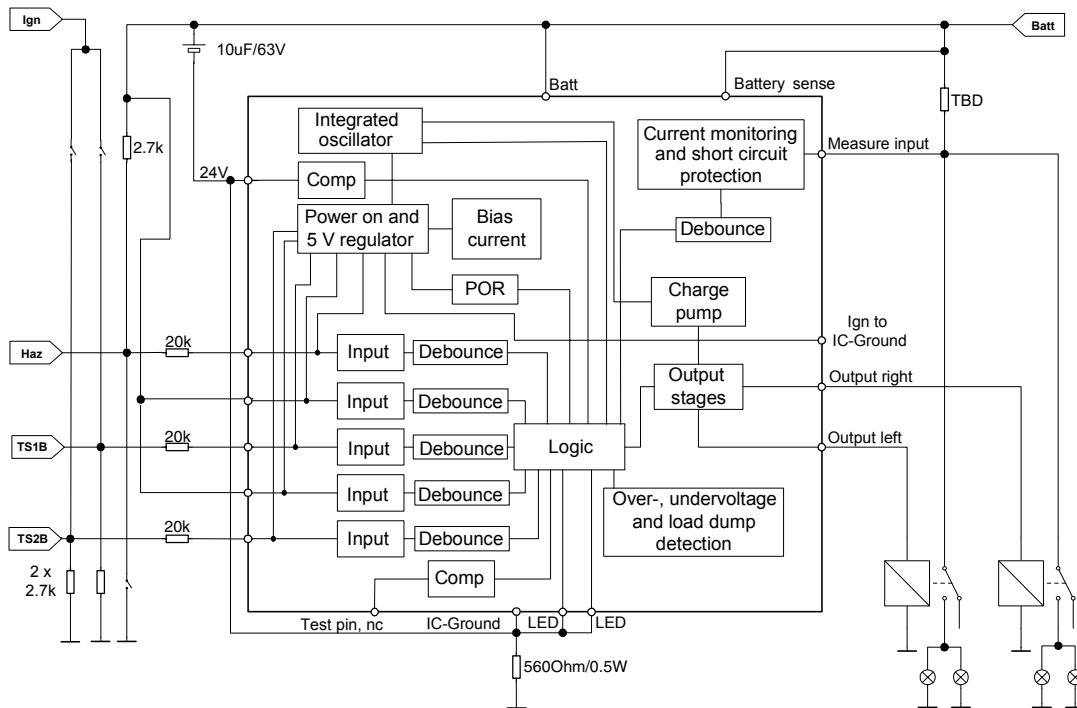


**Figure 10.** Application 3: 24 V Version, Turn Signal Switches to Ignition, Hazard Switch to Battery
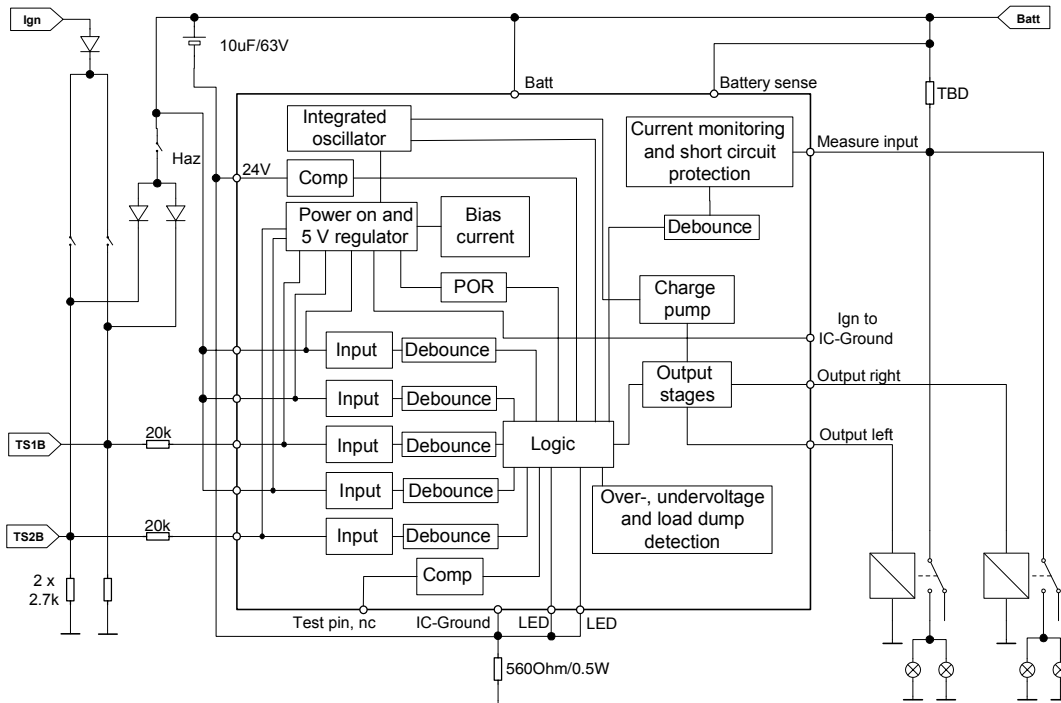
**Figure 11.** Application 4: 24 V Version, Turn Signal Switches to Ignition, Hazard Switch to GND, additional LED Outage
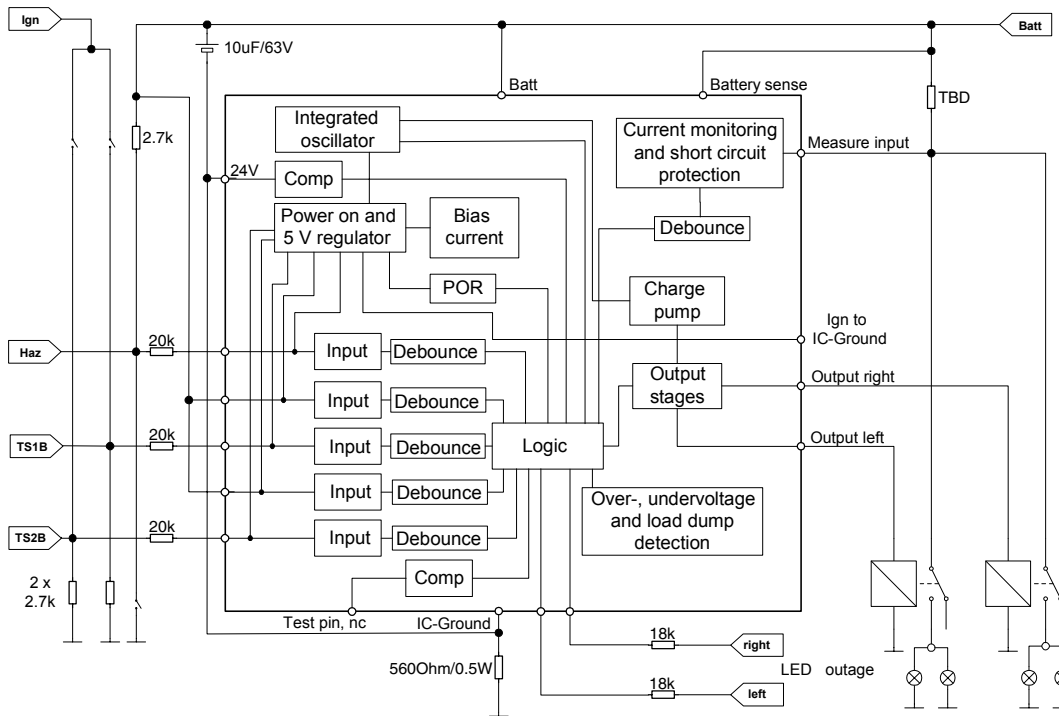
## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| ATA6140-TBQ | SO16 | Taped and reeled |

## Package Information

Package SO16
Dimensions in mm



technical drawings
according to DIN
specifications
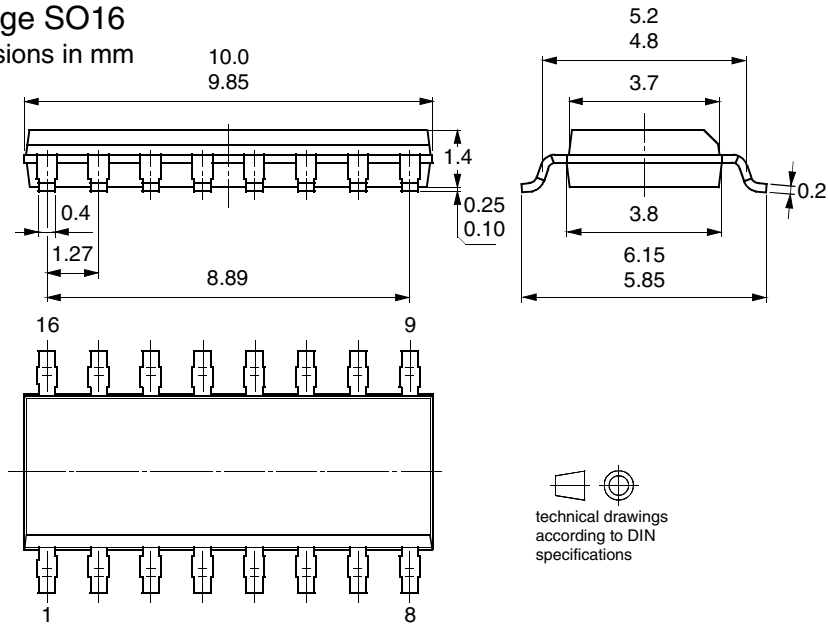
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