



element14

---

**EN** - For pricing and availability in your local country please visit one of the below links:

**DE** - Informationen zu Preisen und Verfügbarkeit in Ihrem Land erhalten Sie über die unten aufgeführten Links:

**FR** - Pour connaître les tarifs et la disponibilité dans votre pays, cliquez sur l'un des liens suivants:

[TCA785HKLA1](#)

**EN**

This Datasheet is presented by  
the manufacturer

**DE**

Dieses Datenblatt wird vom  
Hersteller bereitgestellt

**FR**

Cette fiche technique est  
présentée par le fabricant

## Phase Control IC

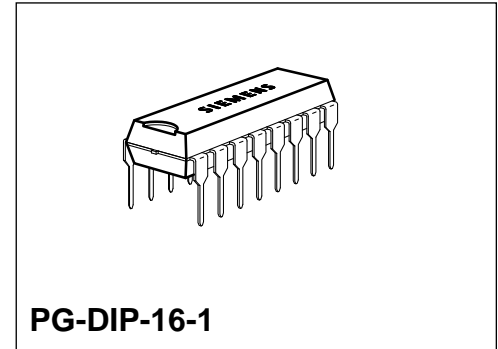
TCA 785

Pb-free lead plating; RoHS compliant

Bipolar IC

### Features

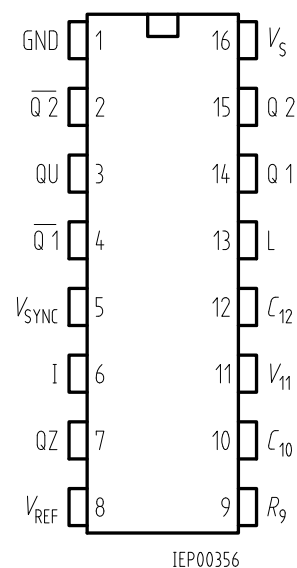
- 
- Large application scope
- May be used as zero point switch
- 
- Three-phase operation possible (3 ICs)
- Output current 250 mA
- Large ramp current range
- Wide temperature range



| Type    | Ordering Code | Package     |
|---------|---------------|-------------|
| TCA 785 | Q67000-A2321  | PG-DIP-16-1 |

This phase control IC is intended to control thyristors, triacs, and transistors. The trigger pulses can be shifted within a phase angle between 0 ° and 180 °. Typical applications include converter circuits, AC controllers and three-phase current controllers.

This IC replaces the previous types TCA 780 and TCA 780 D.



### Pin Configuration (top view)

### Pin Definitions and Functions

| Pin | Symbol          | Function            |
|-----|-----------------|---------------------|
| 1   | GND             | Ground              |
| 2   | $\overline{Q2}$ | Output 2 inverted   |
| 3   | $\overline{QU}$ | Output U            |
| 4   | $\overline{Q1}$ | Output 1 inverted   |
| 5   | $V_{SYNC}$      | Synchronous voltage |
| 6   | I               | Inhibit             |
| 7   | QZ              | Output Z            |
| 8   | $V_{REF}$       | Stabilized voltage  |
| 9   | $R_9$           | Ramp resistance     |
| 10  | $C_{10}$        | Ramp capacitance    |
| 11  | $V_{11}$        | Control voltage     |
| 12  | $C_{12}$        | Pulse extension     |
| 13  | L               | Long pulse          |
| 14  | Q 1             | Output 1            |
| 15  | Q 2             | Output 2            |
| 16  | $V_S$           | Supply voltage      |

**Functional Description**

The synchronization signal is obtained via a high-ohmic resistance from the line voltage (voltage  $V_s$ ). A zero voltage detector evaluates the zero passages and transfers them to the synchronization register.

This synchronization register controls a ramp generator, the capacitor  $C_{10}$  of which is charged by a constant current (determined by  $R_9$ ). If the ramp voltage  $V_{10}$  exceeds the control voltage  $V_{11}$  (triggering angle  $\varphi$ ), a signal is processed to the logic. Dependent on the magnitude of the control voltage  $V_{11}$ , the triggering angle  $\varphi$  can be shifted within a phase angle of  $0^\circ$  to  $180^\circ$ .

For every half wave, a positive pulse of approx.  $30 \mu s$  duration appears at the outputs Q 1 and Q 2. The pulse duration can be prolonged up to  $180^\circ$  via a capacitor  $C_{12}$ . If pin 12 is connected to ground, pulses with a duration between  $\varphi$  and  $180^\circ$  will result.

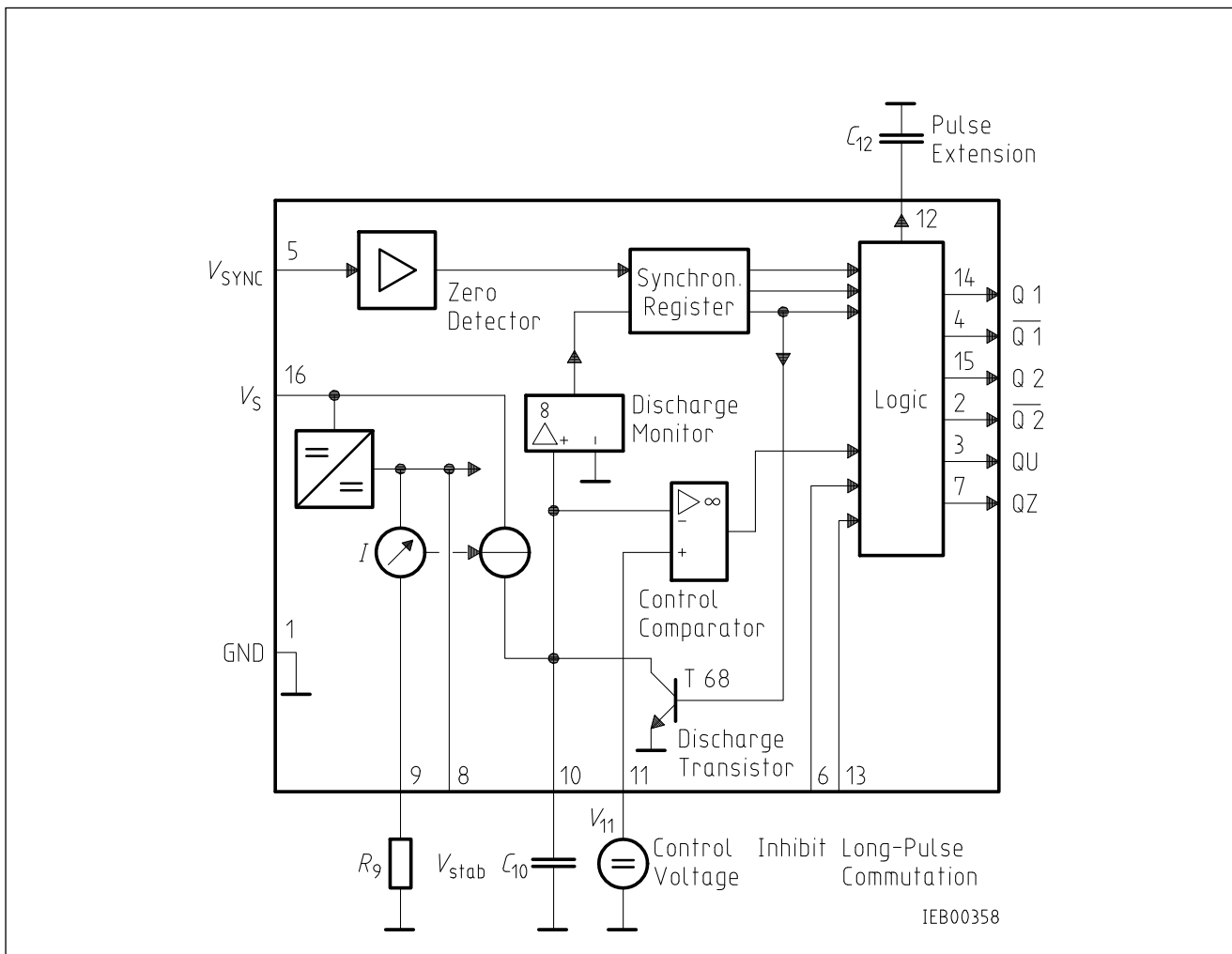
Outputs  $\overline{Q1}$  and  $\overline{Q2}$  supply the inverse signals of Q 1 and Q 2.

A signal of  $\varphi + 180^\circ$  which can be used for controlling an external logic, is available at pin 3.

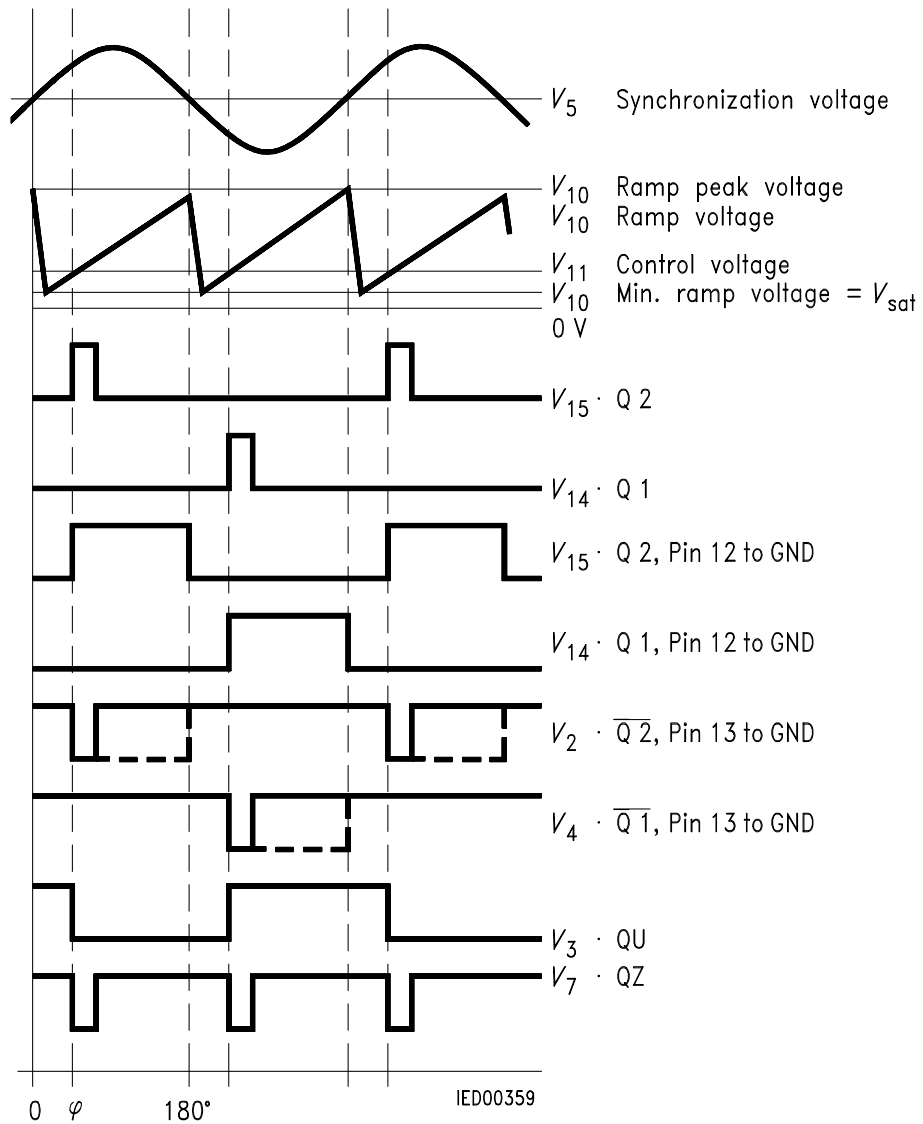
A signal which corresponds to the NOR link of Q 1 and Q 2 is available at output Q Z (pin 7).

The inhibit input can be used to disable outputs Q1, Q2 and  $\overline{Q1}$ ,  $\overline{Q2}$ .

Pin 13 can be used to extend the outputs  $\overline{Q1}$  and  $\overline{Q2}$  to full pulse length ( $180^\circ - \varphi$ ).



**Block Diagram**



Pulse Diagram

## Absolute Maximum Ratings

| Parameter                        | Symbol      | Limit Values |           | Unit        |
|----------------------------------|-------------|--------------|-----------|-------------|
|                                  |             | min.         | max.      |             |
| Supply voltage                   | $V_S$       | - 0.5        | 18        | V           |
| Output current at pin 14, 15     | $I_Q$       | - 10         | 400       | mA          |
| Inhibit voltage                  | $V_6$       | - 0.5        | $V_S$     | V           |
| Control voltage                  | $V_{11}$    | - 0.5        | $V_S$     | V           |
| Voltage short-pulse circuit      | $V_{13}$    | - 0.5        | $V_S$     | V           |
| Synchronization input current    | $V_5$       | - 200        | $\pm 200$ | $\mu A$     |
| Output voltage at pin 14, 15     | $V_Q$       |              | $V_S$     | V           |
| Output current at pin 2, 3, 4, 7 | $I_Q$       |              | 10        | mA          |
| Output voltage at pin 2, 3, 4, 7 | $V_Q$       |              | $V_S$     | V           |
| Junction temperature             | $T_j$       |              | 150       | $^{\circ}C$ |
| Storage temperature              | $T_{stg}$   | - 55         | 125       | $^{\circ}C$ |
| Thermal resistance system - air  | $R_{th SA}$ |              | 80        | K/W         |

## Operating Range

|                     |       |      |     |             |
|---------------------|-------|------|-----|-------------|
| Supply voltage      | $V_S$ | 8    | 18  | V           |
| Operating frequency | $f$   | 10   | 500 | Hz          |
| Ambient temperature | $T_A$ | - 25 | 85  | $^{\circ}C$ |

## Characteristics

$8 \leq V_S \leq 18 \text{ V}$ ;  $- 25 \text{ }^{\circ}C \leq T_A \leq 85 \text{ }^{\circ}C$ ;  $f = 50 \text{ Hz}$

| Parameter  | Symbol              | Limit Values |      |                       | Unit      | Test Circuit |
|--|---------------------|--------------|------|-----------------------|-----------|--------------|
|  |                     | min.         | typ. | max.                  |           |              |
| Supply current consumption<br>S1 ... S6 open<br>$V_{11} = 0 \text{ V}$<br>$C_{10} = 47 \text{ nF}$ ; $R_9 = 100 \text{ k}\Omega$ | $I_S$               | 4.5          | 6.5  | 10                    | mA        | 1            |
| Synchronization pin 5<br>Input current<br>$R_2$ varied   | $I_{5 \text{ rms}}$ | 30           |      | 200                   | $\mu A$   | 1            |
| Offset voltage   | $\Delta V_5$        |              | 30   | 75                    | mV        | 4            |
| Control input pin 11<br>Control voltage range  | $V_{11}$            | 0.2          |      | $V_{10 \text{ peak}}$ | V         | 1            |
| Input resistance   | $R_{11}$            |              | 15   |                       | $k\Omega$ | 5            |
| Semiconductor Group  |                     | 4            |      |                       |           |              |

### Characteristics (cont'd)

$8 \leq V_S \leq 18 \text{ V}$ ;  $-25 \text{ }^\circ\text{C} \leq T_A \leq 85 \text{ }^\circ\text{C}$ ;  $f = 50 \text{ Hz}$

| Parameter                                       | Symbol                      | Limit Values |         |           | Unit             | Test Circuit |
|---|-----------------------------|--------------|---------|-----------|------------------|--------------|
|   |                             | min.         | typ.    | max.      |                  |              |
| Ramp generator                                  |                             |              |         |           |                  |              |
| Charge current                                  | $I_{10}$                    | 10           |         | 1000      | $\mu\text{A}$    |              |
| Max. ramp voltage                               | $V_{10}$                    |              |         | $V_2 - 2$ | V                | 1            |
| Saturation voltage at capacitor                 | $V_{10}$                    | 100          | 225     | 350       | mV               | 1.6          |
| Ramp resistance                                 | $R_9$                       | 3            |         | 30        | $\text{k}\Omega$ | 1            |
| Sawtooth return time                            | $t_f$                       |              | 80      |           | $\mu\text{s}$    | 1            |
| Inhibit pin 6                                   |                             |              |         |           |                  |              |
| switch-over of pin 7                            |                             |              |         |           |                  |              |
| Outputs disabled                                | $V_{6L}$                    |              | 3.3     | 2.5       | V                | 1            |
| Outputs enabled                                 | $V_{6H}$                    | 4            | 3.3     |           | V                | 1            |
| Signal transition time                          | $t_r$                       | 1            |         | 5         | $\mu\text{s}$    | 1            |
| Input current                                   | $I_{6H}$                    |              | 500     | 800       | $\mu\text{A}$    | 1            |
| $V_6 = 8 \text{ V}$                             |                             |              |         |           |                  |              |
| Input current                                   | $-I_{6L}$                   | 80           | 150     | 20        | $\mu\text{A}$    | 1            |
| $V_6 = 1.7 \text{ V}$                           |                             |              |         |           |                  |              |
| Deviation of $I_{10}$                           | $I_{10}$                    | -5           |         | 5         | %                | 1            |
| $R_9 = \text{const.}$                           |                             |              |         |           |                  |              |
| $V_S = 12 \text{ V}$ ; $C_{10} = 47 \text{ nF}$ |                             |              |         |           |                  |              |
| Deviation of $I_{10}$                           | $I_{10}$                    | -20          |         | 20        | %                | 1            |
| $R_9 = \text{const.}$                           |                             |              |         |           |                  |              |
| $V_S = 8 \text{ V to } 18 \text{ V}$            |                             |              |         |           |                  |              |
| Deviation of the ramp voltage                   |                             |              |         |           |                  |              |
| between 2 following                             |                             |              |         |           |                  |              |
| half-waves, $V_S = \text{const.}$               | $\Delta V_{10 \text{ max}}$ |              | $\pm 1$ |           | %                |              |
| Long pulse switch-over                          |                             |              |         |           |                  |              |
| pin 13  |                             |              |         |           |                  |              |
| switch-over of S8                               |                             |              |         |           |                  |              |
| Short pulse at output                           | $V_{13H}$                   | 3.5          | 2.5     |           | V                | 1            |
| Long pulse at output                            | $V_{13L}$                   |              | 2.5     | 2         | V                | 1            |
| Input current                                   | $I_{13H}$                   |              |         | 10        | $\mu\text{A}$    | 1            |
| $V_{13} = 8 \text{ V}$                          |                             |              |         |           |                  |              |
| Input current                                   | $-I_{13L}$                  | 45           | 65      | 10        | $\mu\text{A}$    | 1            |
| $V_{13} = 1.7 \text{ V}$                        |                             |              |         |           |                  |              |
| Outputs pin 2, 3, 4, 7                          |                             |              |         |           |                  |              |
| Reverse current                                 | $I_{CEO}$                   |              |         | 10        | $\mu\text{A}$    | 2.6          |
| $V_Q = V_S$                                     |                             |              |         |           |                  |              |
| Saturation voltage                              | $V_{\text{sat}}$            | 0.1          | 0.4     | 2         | V                | 2.6          |
| $I_Q = 2 \text{ mA}$                            |                             |              |         |           |                  |              |

### Characteristics (cont'd)

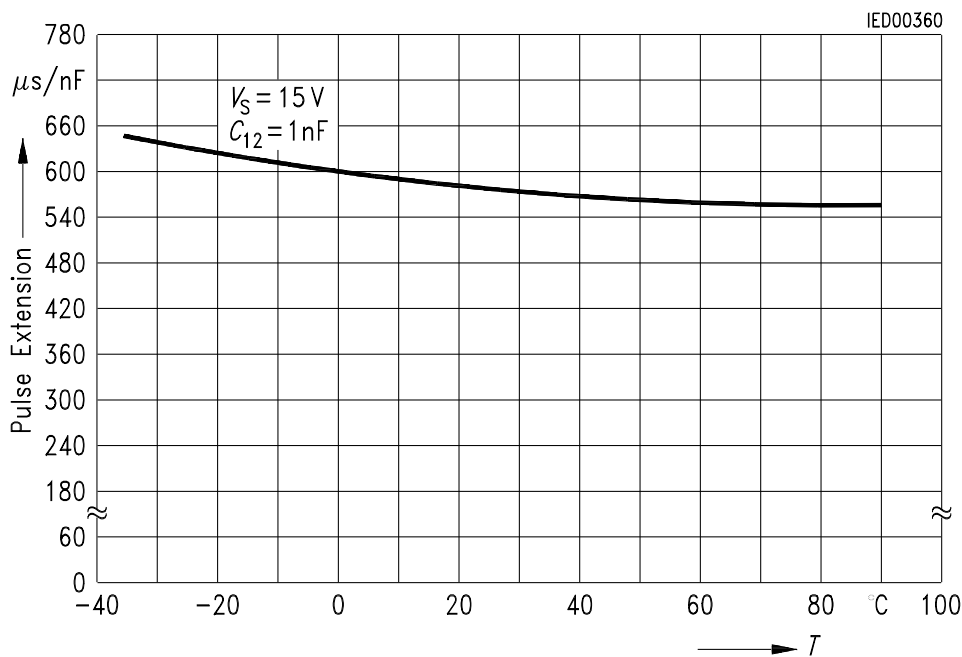
$8 \leq V_S \leq 18 \text{ V}; -25 \text{ }^\circ\text{C} \leq T_A \leq 85 \text{ }^\circ\text{C}; f = 50 \text{ Hz}$

| Parameter  | Symbol         | Limit Values |             |                    | Unit                    | Test Circuit |   |
|--|----------------|--------------|-------------|--------------------|-------------------------|--------------|---|
|  |                | min.         | typ.        | max.               |                         |              |   |
| Outputs pin 14, 15<br>H-output voltage<br>– $I_Q = 250 \text{ mA}$                         | $V_{14/15 H}$  | $V_S - 3$    | $V_S - 2.5$ | $V_S - 1.0$        | V                       | 3.6          |   |
| L-output voltage<br>$I_Q = 2 \text{ mA}$   | $V_{14/15 L}$  | 0.3          | 0.8         | 2                  | V                       | 2.6          |   |
| Pulse width (short pulse)<br>S9 open   | $t_p$          | 20           | 30          | 40                 | $\mu\text{s}$           | 1            |   |
| Pulse width (short pulse)<br>with $C_{12}$   | $t_p$          | 530          | 620         | 760                | $\mu\text{s}/\text{nF}$ | 1            |   |
| Internal voltage control<br>Reference voltage<br>Parallel connection of<br>10 ICs possible | $V_{REF}$      | 2.8          | 1           | 3.1                | 3.4                     | V            |   |
| TC of reference voltage  | $\alpha_{REF}$ |              |             | $2 \times 10^{-4}$ | $5 \times 10^{-4}$      | 1/K          | 1 |

## Application Hints for External Components

|                  |   |        |  |                      |   |
|------------------|---|--------|--|----------------------|---|
|                  |   | min    |  | max                  |   |
| Ramp capacitance | $C_{10}$  | 500 pF |  | $1 \mu\text{F}^{1)}$ | The minimum and maximum values of $I_{10}$ are to be observed   |
| Triggering point | $t_{Tr} = \frac{V_{11} \times R_9 \times C_{10}}{V_{REF} \times K}$ |        |  | 2)                   |   |
| Charge current   | $I_{10} = \frac{V_{REF} \times K}{R_9}$                             |        |  | 2)                   | Ramp voltage<br>$V_{10 \max} = V_S - 2 V$ $V_{10} = \frac{V_{REF} \times K \times t}{R_9 \times C_{10}}$ 2) |

## Pulse Extension versus Temperature

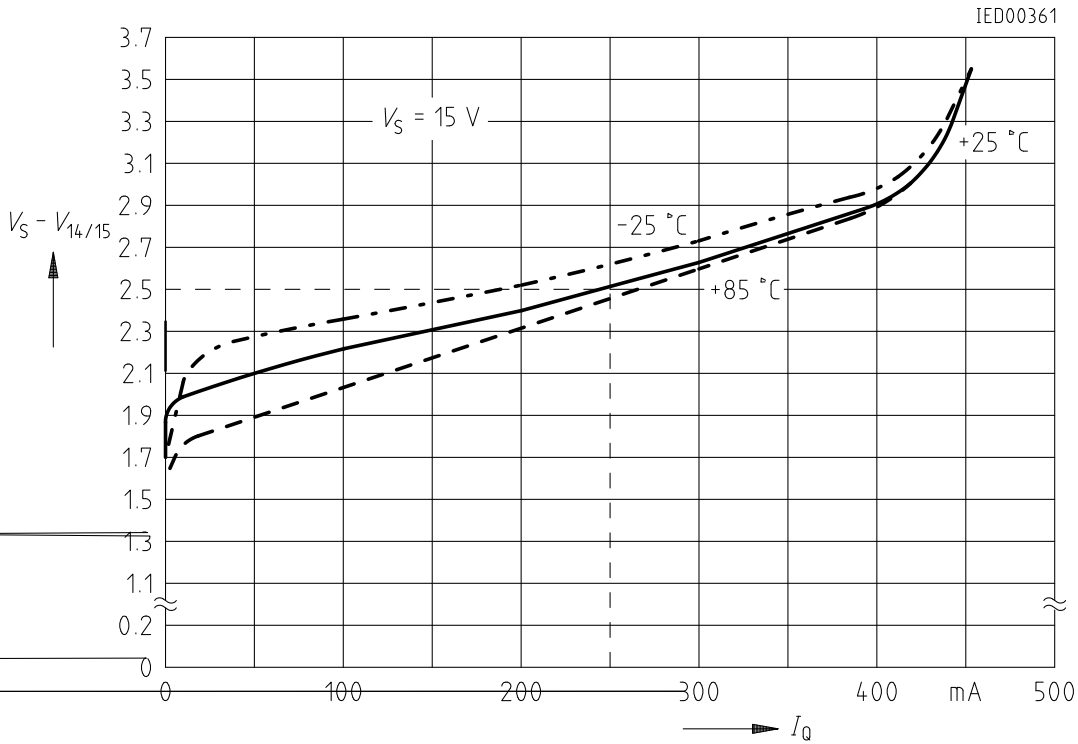


1) Attention to flyback times

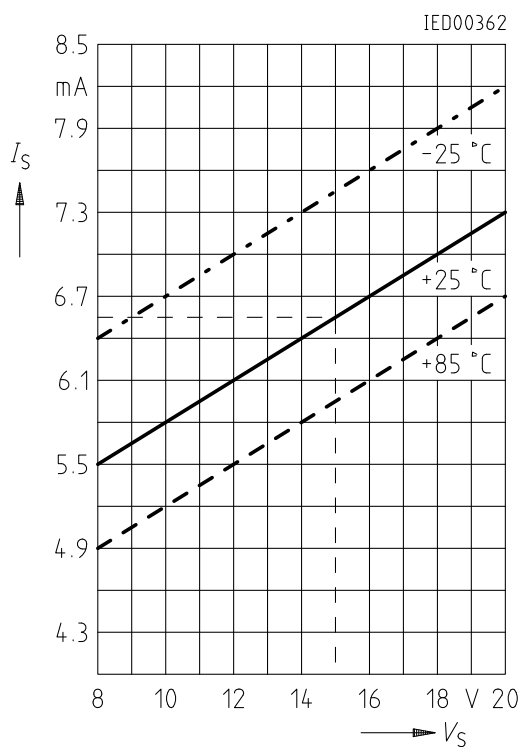
2)  $K = 1.10 \pm 20 \%$

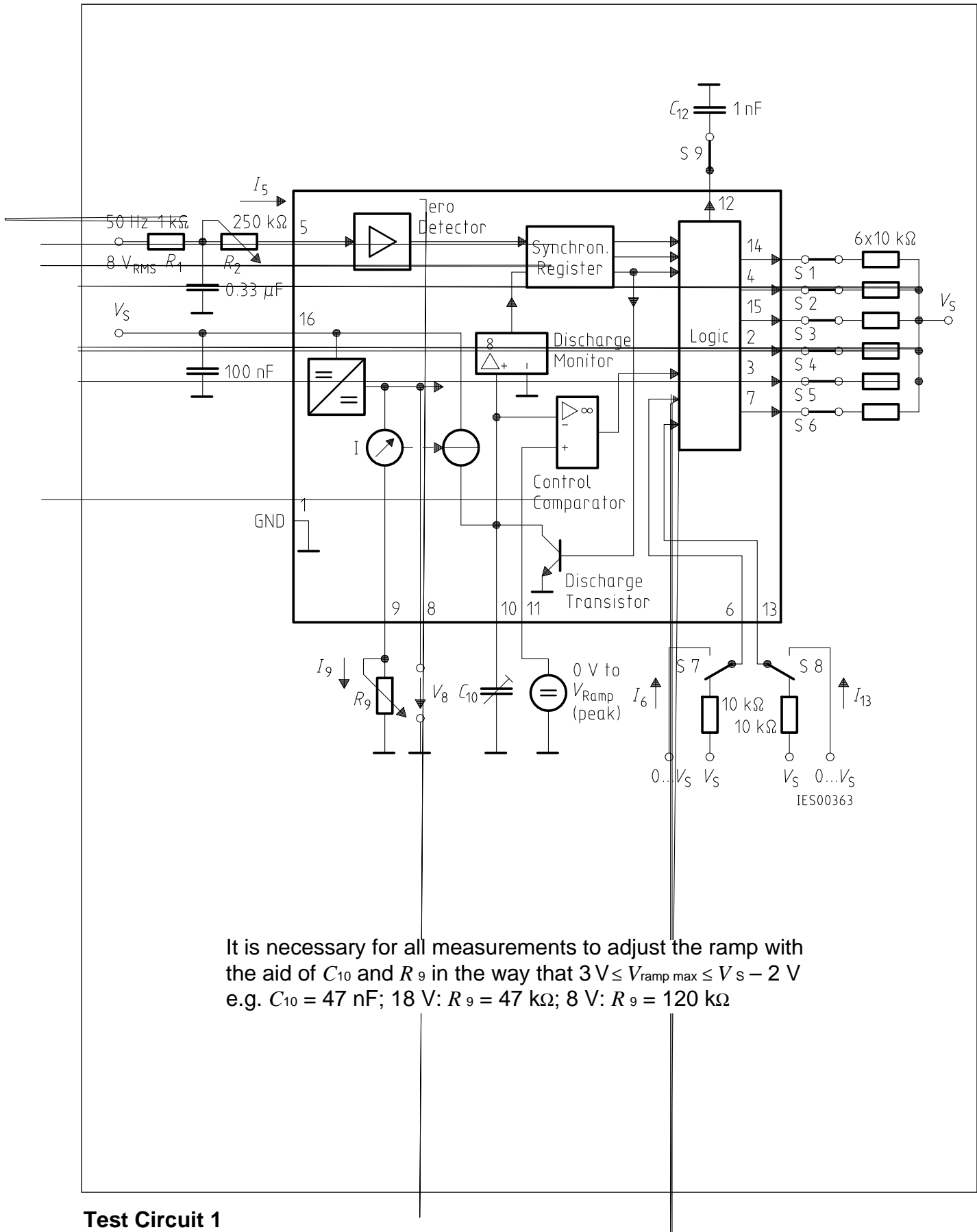


## Output Voltage measured to + $V_S$



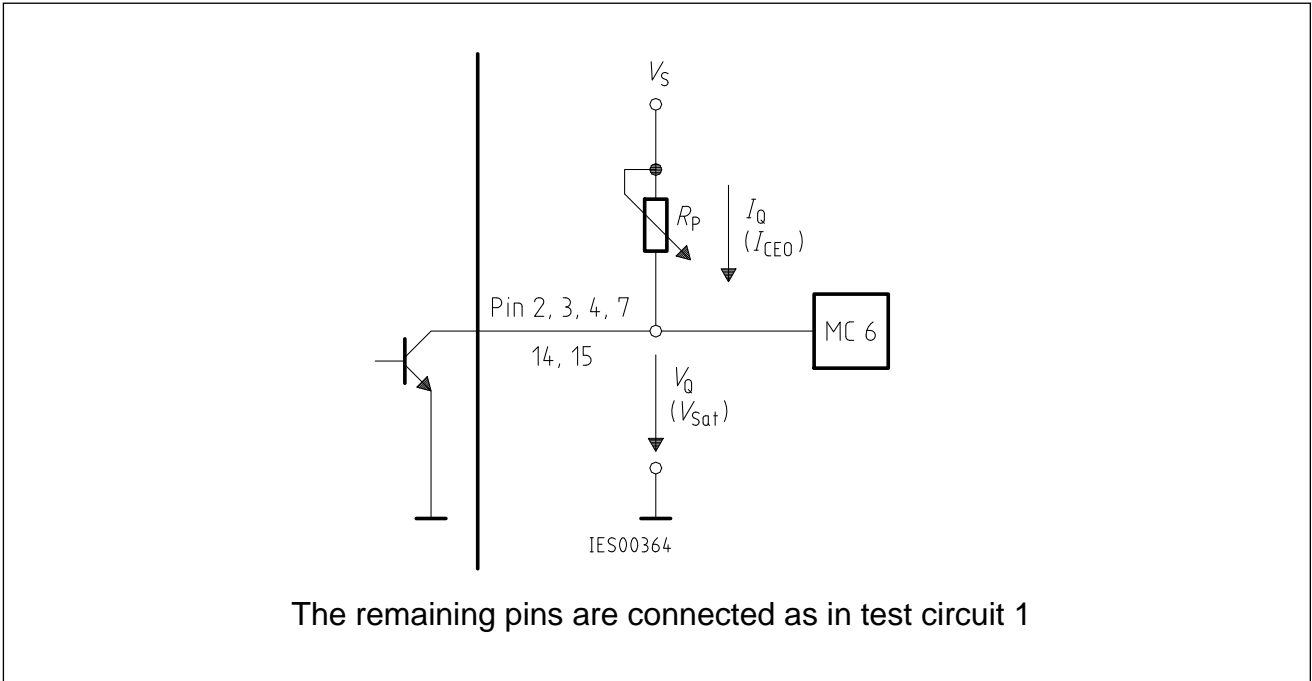
## Supply Current versus Supply Voltage



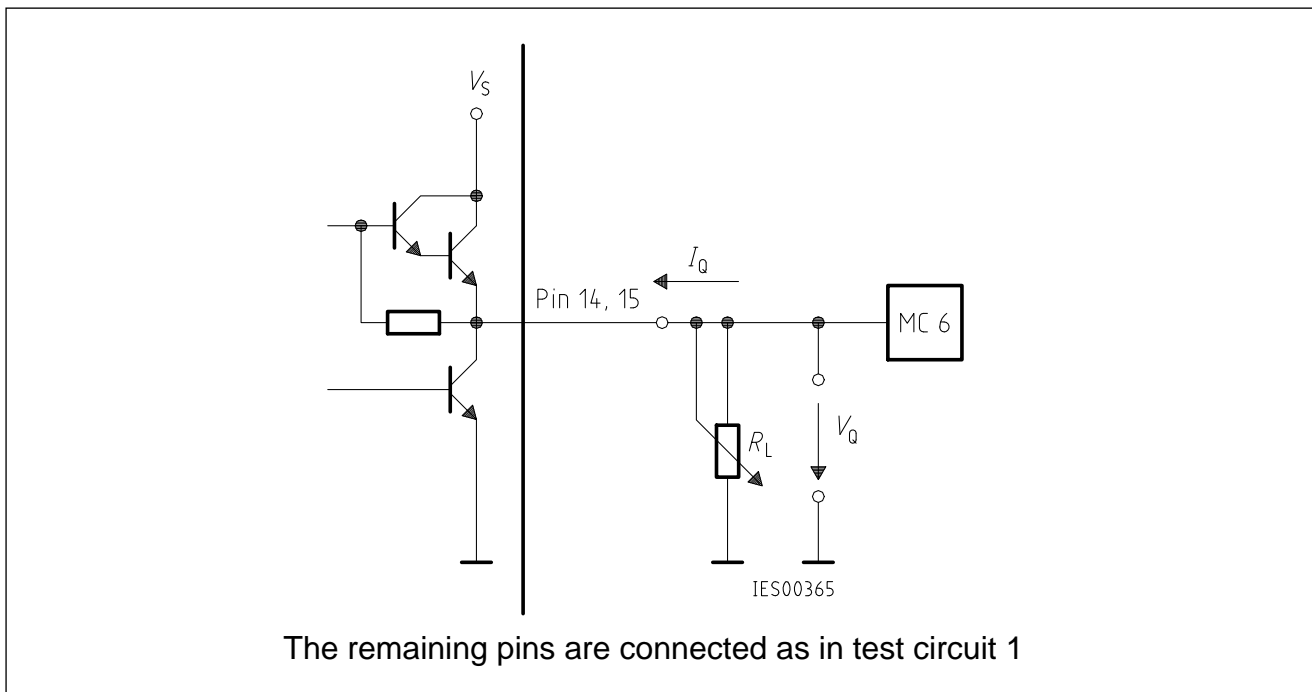


It is necessary for all measurements to adjust the ramp with the aid of  $C_{10}$  and  $R_9$  in the way that  $3\text{ V} \leq V_{\text{ramp max}} \leq V_S - 2\text{ V}$   
 e.g.  $C_{10} = 47\text{ nF}$ ;  $18\text{ V}$ :  $R_9 = 47\text{ k}\Omega$ ;  $8\text{ V}$ :  $R_9 = 120\text{ k}\Omega$

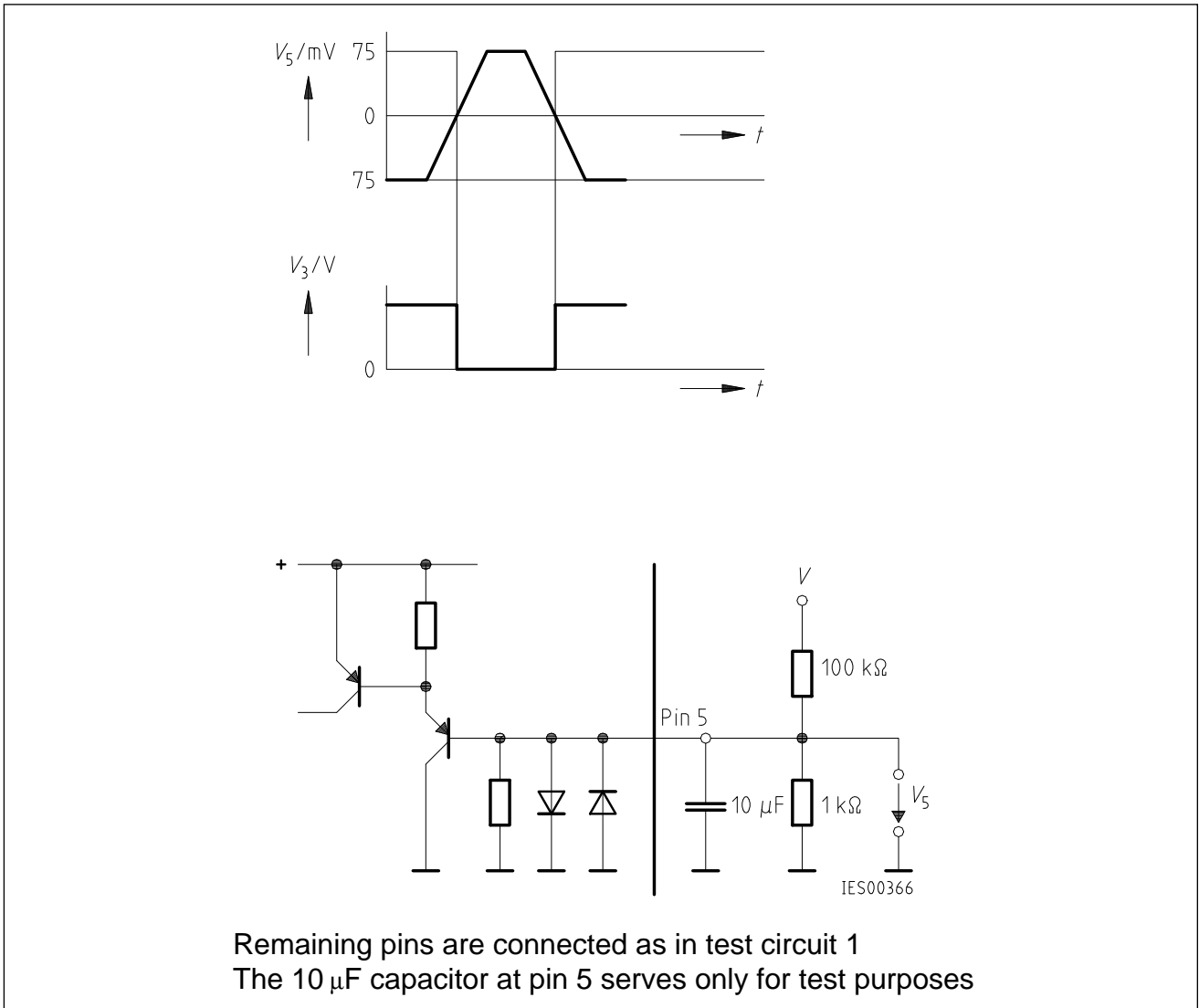
Test Circuit 1



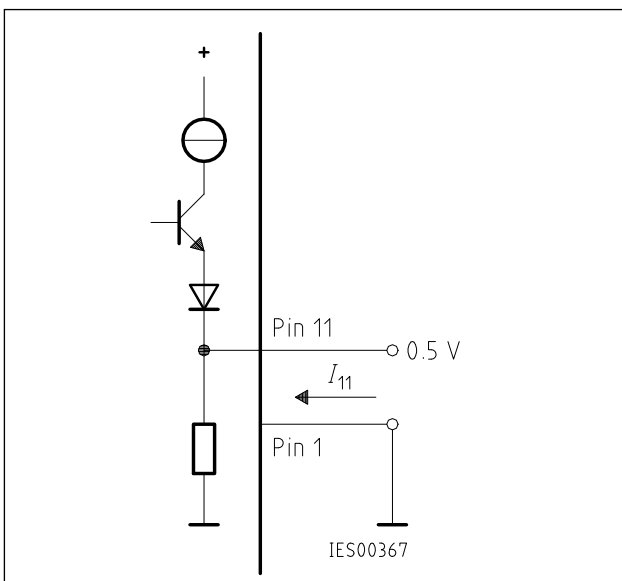
**Test Circuit 2**



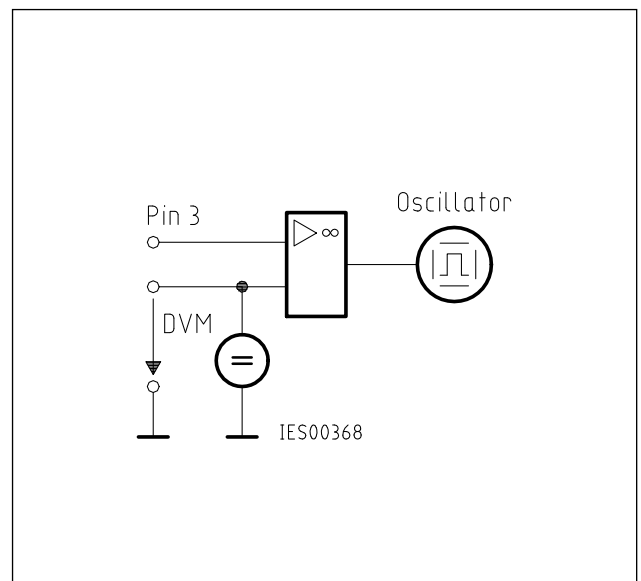
**Test Circuit 3**



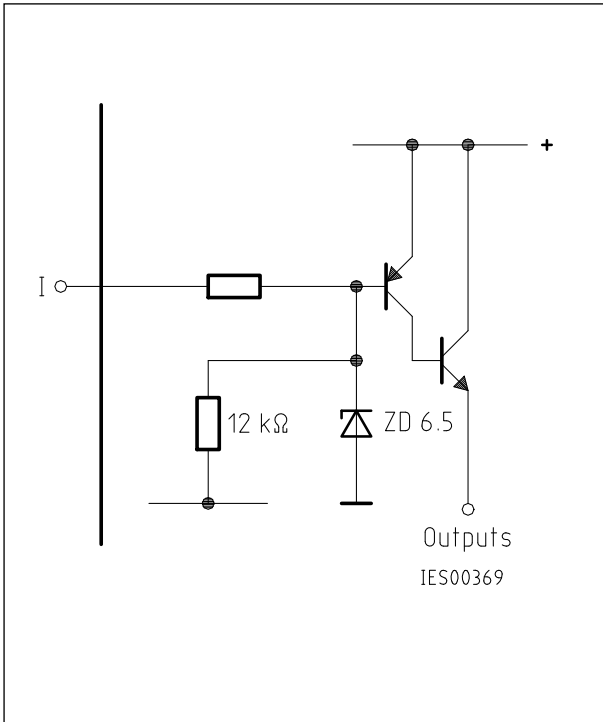
**Test Circuit 4**



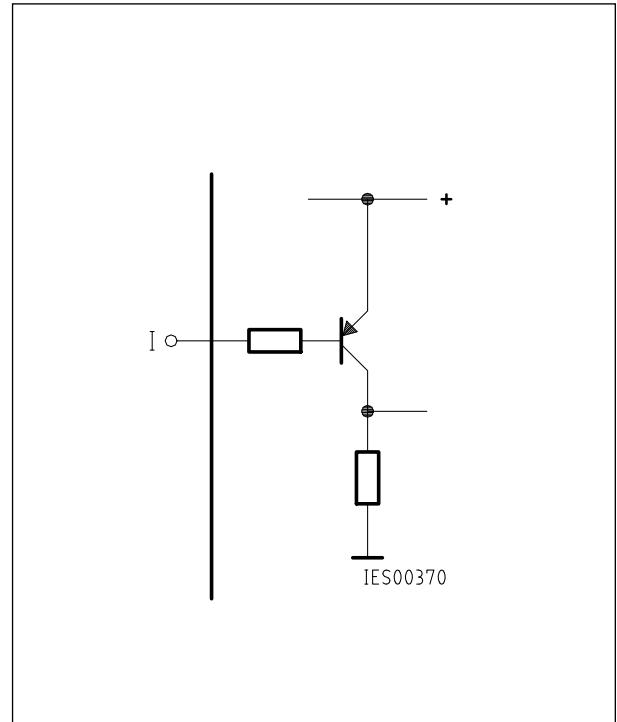
**Test Circuit 5**



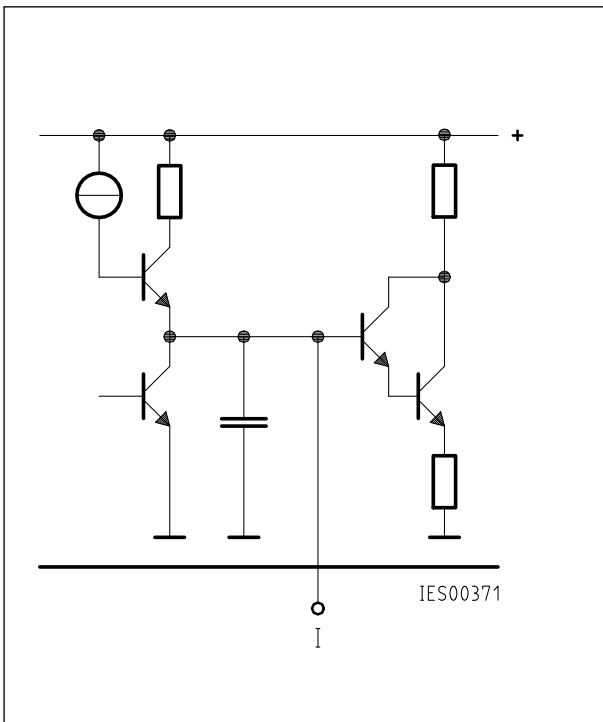
**Test Circuit 6**



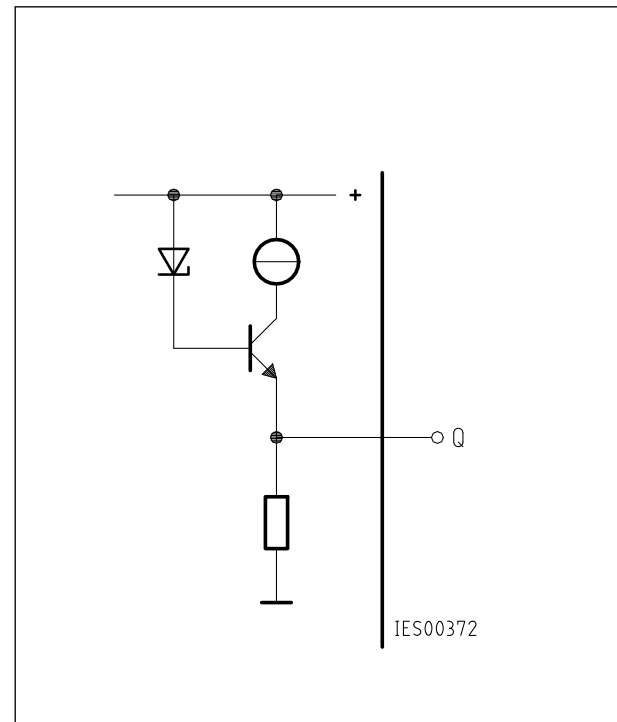
Inhibit 6



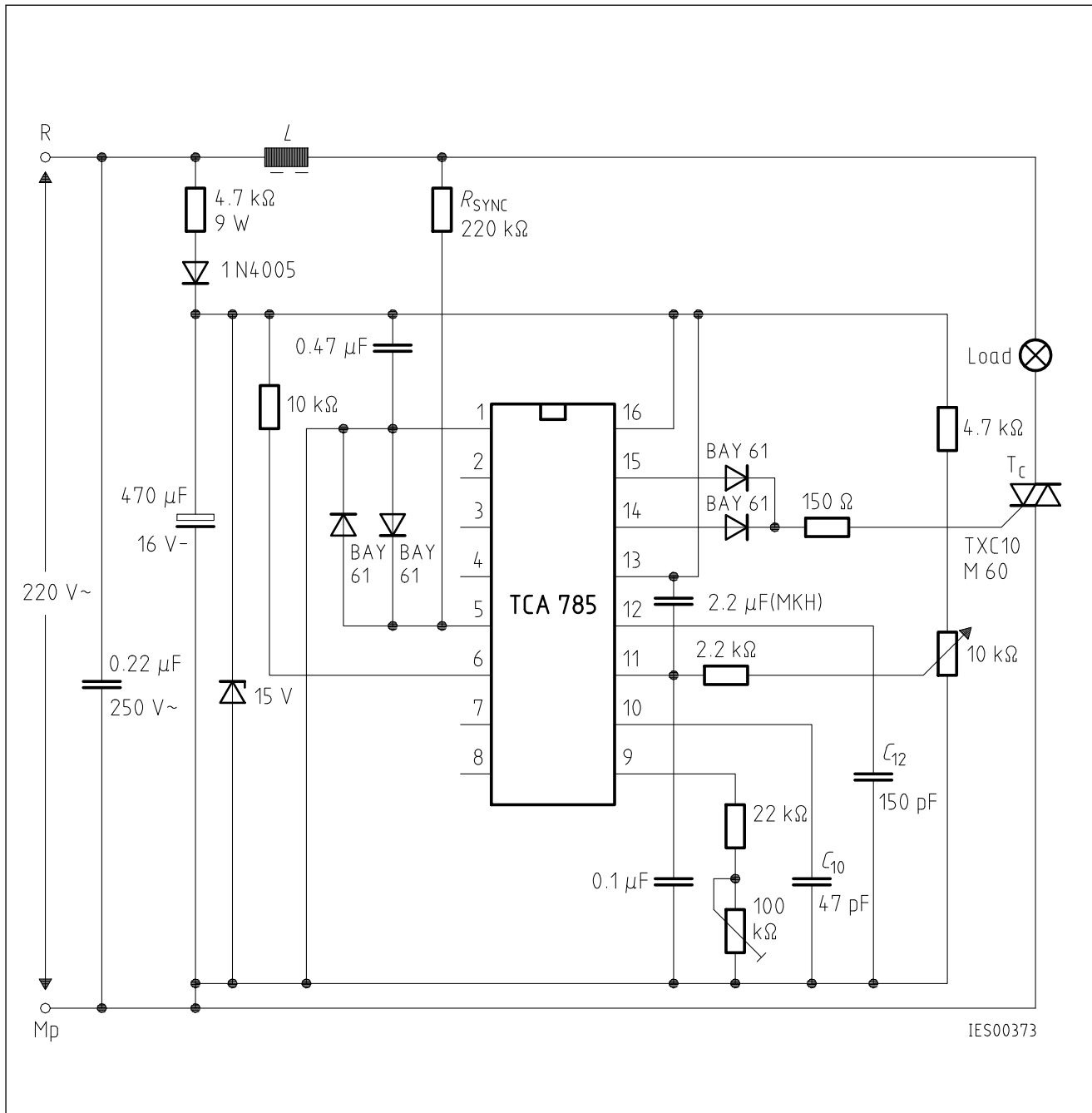
Long Pulse 13



Pulse Extension 12

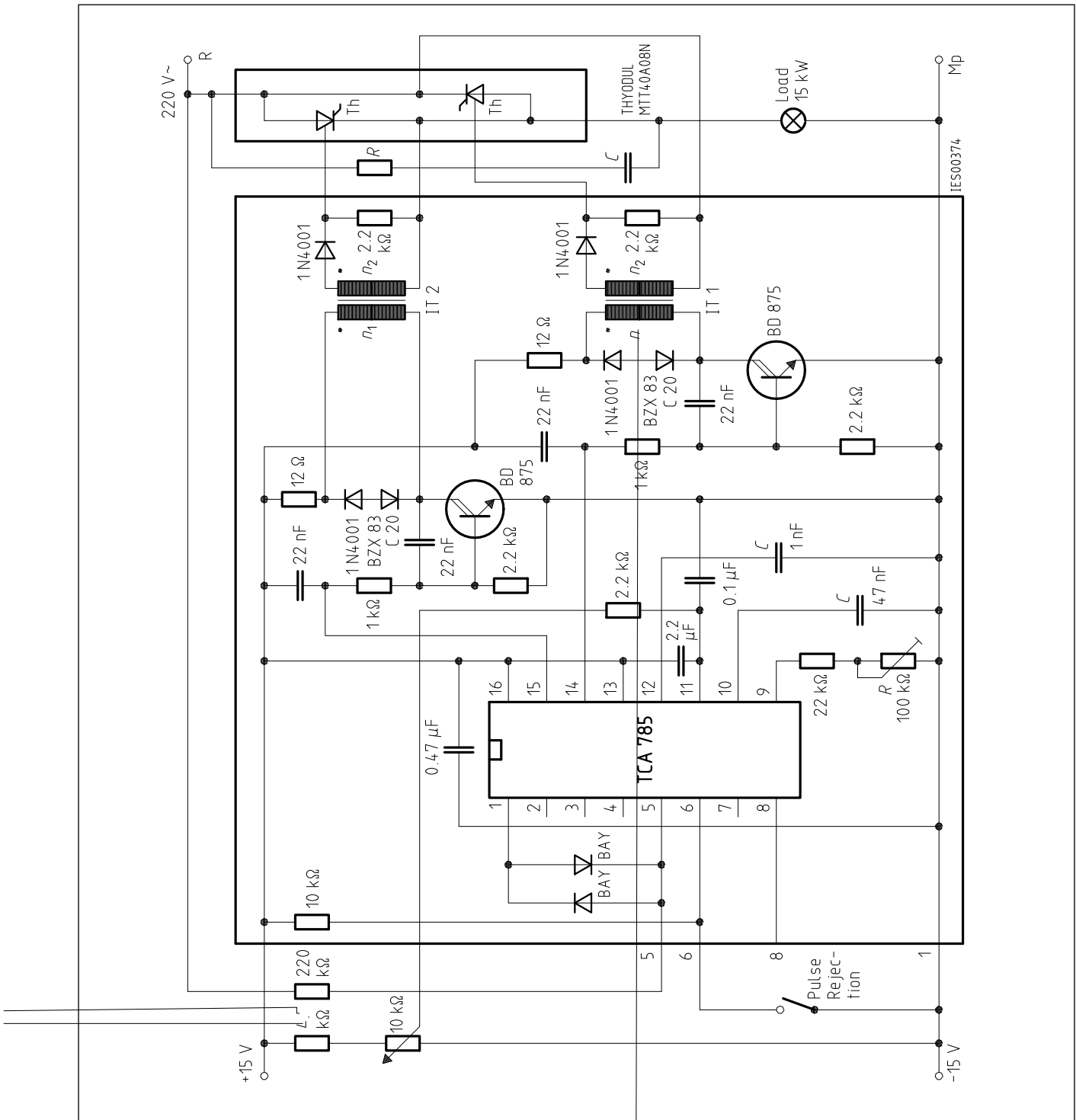


Reference Voltage 8



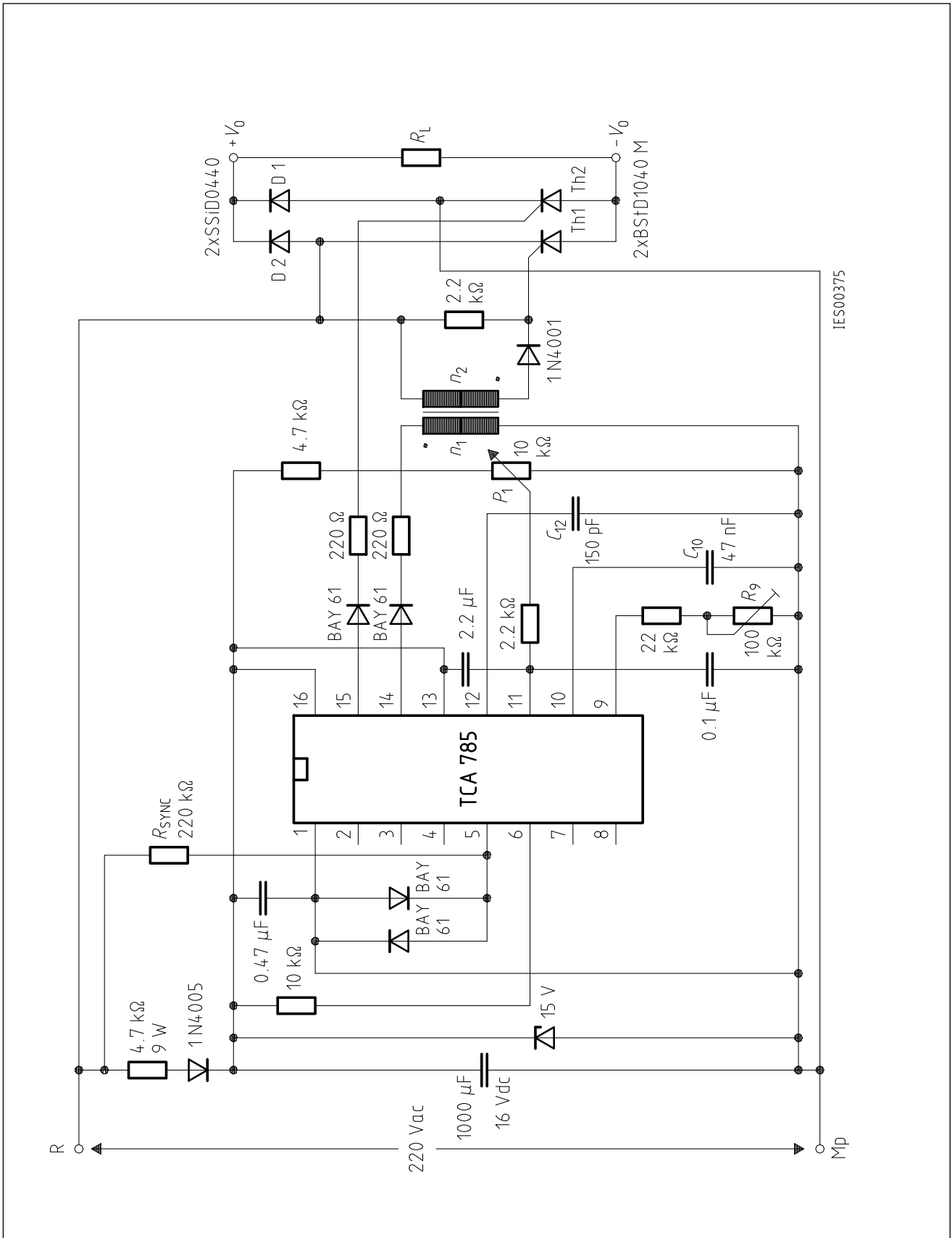
**Application Examples**  
**Triac Control for up to 50 mA Gate Trigger Current**

A phase control with a directly controlled triac is shown in the figure. The triggering angle of the triac can be adjusted continuously between 0° and 180° with the aid of an external potentiometer. During the positive half-wave of the line voltage, the triac receives a positive gate pulse from the IC output pin 15. During the negative half-wave, it also receives a positive trigger pulse from pin 14. The trigger pulse width is approx. 100 μs.



**Fully Controlled AC Power Controller  
Circuit for Two High-Power Thyristors**

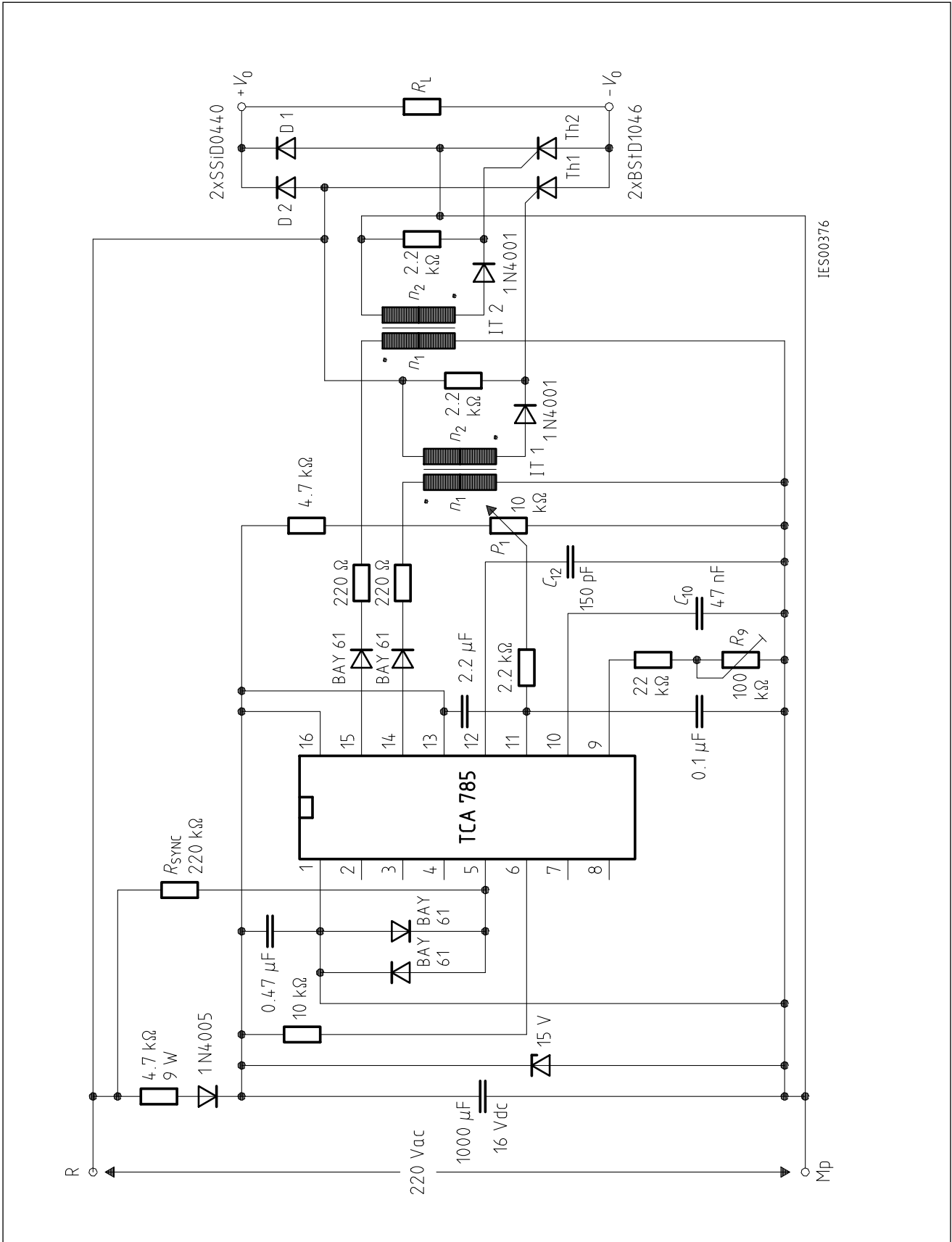
Shown is the possibility to trigger two antiparalleled thyristors with one IC TCA 785. The trigger pulse can be shifted continuously within a phase angle between 0° and 180° by means of a potentiometer. During the negative line half-wave the trigger pulse of pin 14 is fed to the relevant thyristor via a trigger pulse transformer. During the positive line half-wave, the gate of the second thyristor is triggered by a trigger pulse transformer at pin 15.



IES00375

Half-Controlled Single-Phase Bridge Circuit with Trigger Pulse Transformer and Direct Control for Low-Power Thyristors





Half-Controlled Single-Phase Bridge Circuit with Two Trigger Pulse Transformers for Low-Power Thyristors



element14

---

**EN** - For pricing and availability in your local country please visit one of the below links:

**DE** - Informationen zu Preisen und Verfügbarkeit in Ihrem Land erhalten Sie über die unten aufgeführten Links:

**FR** - Pour connaître les tarifs et la disponibilité dans votre pays, cliquez sur l'un des liens suivants:

[TCA785HKLA1](#)

**EN**

This Datasheet is presented by  
the manufacturer

**DE**

Dieses Datenblatt wird vom  
Hersteller bereitgestellt

**FR**

Cette fiche technique est  
présentée par le fabricant