Data Sheet

α1610

Coil Driver IC

Description

The α1610, combined with an external NMOS, is used as a low loss driver for coils, relays or magnets.
The integrated circuit includes a self protection of broken wires and short circuits on the input line.
The chip overtemperature protection is adjusted from 80 to 150 °C with an external resistor.
Chip overtemperature and undervoltage errors are indicated on input IN.

Features

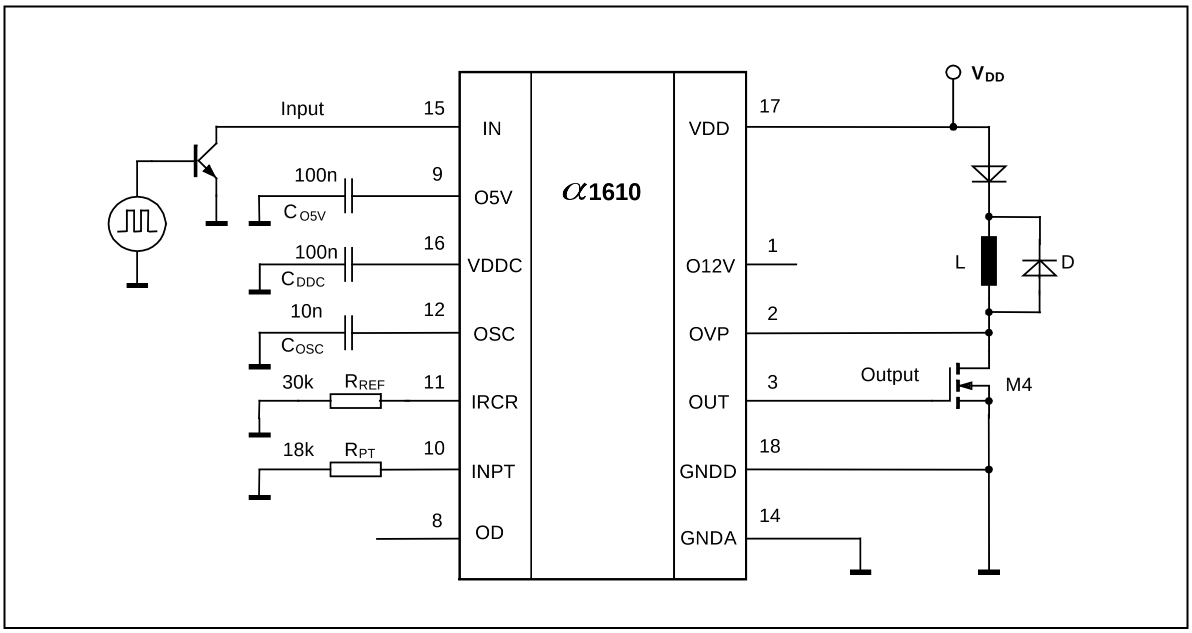
- Voltage supply 8 to 45 V DC
- 5 V reference voltage output
- 12 V reference voltage output
- Quiescent current 1.5 mA
- Output peak current up to 100 mA
- Undervoltage lockout and power-on reset
- Overvoltage protection for the external NMOS
- Protection against reversed battery and EMC to -300 V
- Adjustable chip overtemperature protection
- Temperature range -40°C to +150°C
- Package SOP 18 α1610AT
  Die α1610AX

Applications

- Driver for coils and relays

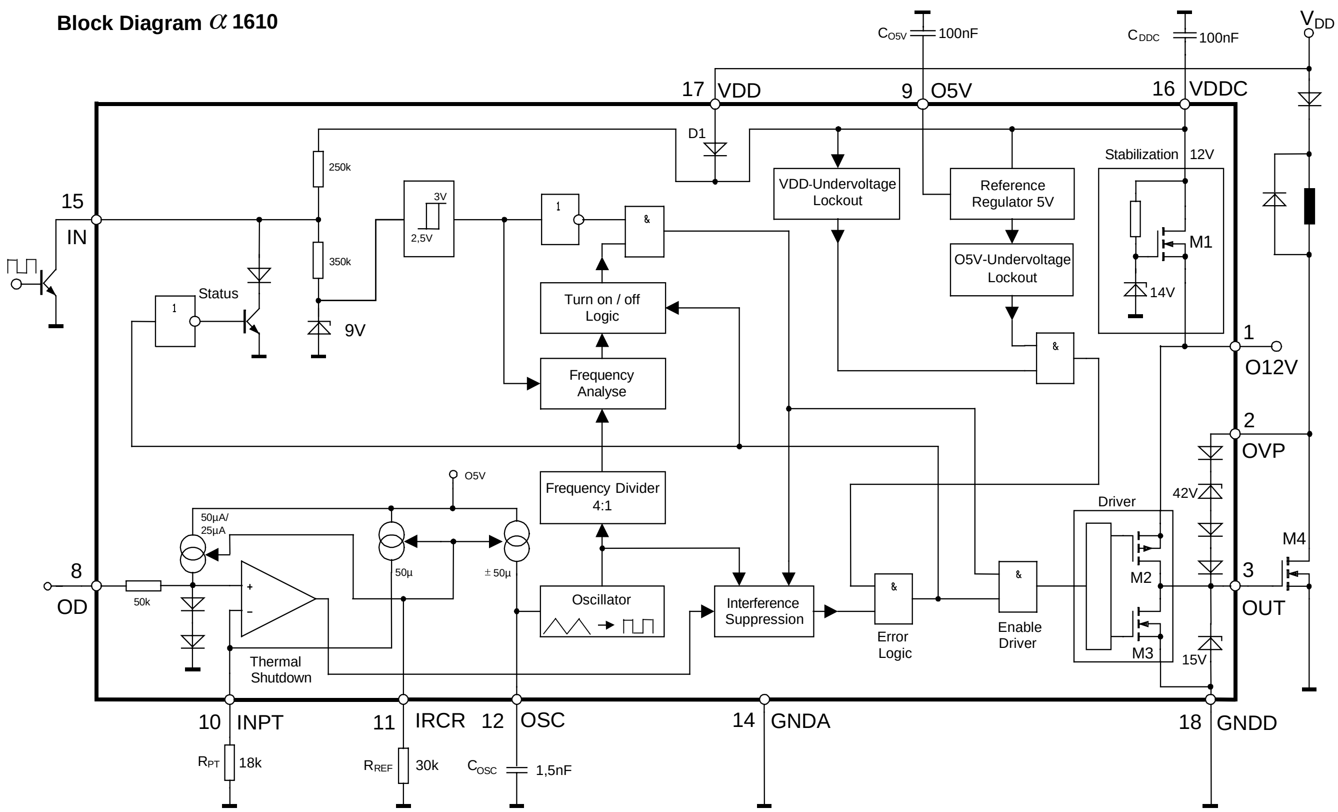
Typical Application

Coil driver using α1610



- **Functional Block Diagram**

Block Diagram α 1610



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Pin Definition

Lead Definition

Pin	Symbol	Designation
1	O12V	Reference Voltage Output 12 V
2	OVP	Overvoltage Protection Input for external N-Kanal Power MOSFET
3	OUT	Output
8	OD	Output Diode Temperature Sensor
9	O5V	Reference Voltage Output 5 V
10	INPT	Resistor R_{PT} for Overtemperature Protection
11	IRCR	Resistor R_{REF} for Current Reference
12	OSC	Capacitor C_{OSC} for Oscillator Frequency
14	GNDA	GND-Analog
15	IN	Input
16	VDDC	Block Capacitor
17	VDD	Supply Voltage
18	GNDD	GND-Digital

General function and description

The α1610 combined with an external N-channel power MOSFET serves for the low loss control of electrical magnetic actuators like relays or magnets and similar kinds of coils. It is especially suitable in automotive applications.
It is designed for a power supply range from 8 to 45 V.
As protection against reverse polarity of the supply voltage the IC is supplied with an internal dumping diode D1 in the supply voltage connection (forward voltage approx. 0.6 V).
The chip generates two internally stabilized voltages.
There are a 5 V-voltage source for the digital logic and a 12 V-voltage source for the push-pull drivers.
The chip realizes protection against undervoltage of VDD (VDD-Undervoltage Lockout), undervoltage of O5V (O5V-Undervoltage Lockout), overvoltage of VDS of the external transistor M4 and against overtemperature (Thermal Shutdown).
The outputs of the Undervoltages Lockout of VDD and O5V are logical AND combined.

VDD

At start up of the supply voltage the output of VDD-Undervoltage Lockout switches to "High" at about $V_{DD} \approx 7.6$ V.
If the voltage VO5V rises to the switching threshold at 4 V, the "power on reset" of the logic will finish and the output of the O5V-Undervoltage Lockout goes to "High".
The output of the Error Logic switches to "High" if no overtemperature is detected.
Concurrent the dynamic input will be released and triggers the Enable Driver for the push pull drivers.
The output of the Error Logic switches to "Low", if the supply voltage V_{DD} decreases under a value of 7 V.
The Output OUT and the input IN switch to "Low" and the logic enables power on reset.
The undervoltage detection senses the voltage at V_{DDC}. With it the integrational effect of the back-up capacitor $C_{\mathbf{DDC}}$ is to take into account.
Short-term drops of supply voltage V_{DD} below the switching threshold of 7 V do not actuate the undervoltage detector.

VDDC

At this pin a forward voltage of the dumping diode D1 reduces the supply voltage V_{DD}.
This pin must be connected to a back-up capacitor.
It is allowed to connect the power supply directly to the pin VDDC.
In this case the protection against EMC and against reverse polarity of the supply voltage is cancelled.
The threshold value for the detecting of the undervoltage decreases by a forward voltage.

O5V

The reference regulator 5 V must wired-up to a back-up capacitor.
The output may be loaded with 5 mA maximally. If the output O5V is reloaded more than 1.5 mA deviations are permitted data.

O12V

The 12 V-voltage source is a source follower stage M1 with $R_{DS(on)M1}$ of about 60 Ω.
From V_{DD} = 0 to 14 V the output voltage shows a linear dependence on the supply voltage.
The output may be loaded with 10 mA maximally.
Besides you must keep the dependence of load for the voltage. If the output O12V is reloaded deviations are permitted data.

OUT

The closing resistors $R_{DS(on)}$ of the push-pull driver transistors M2 and M3 are about 45 Ω respectively 20 Ω. The push-pull driver transistors can drive at T_a = 25 °C reloading currents of about 100 mA. Without load the maximal output voltage of the push-pull driver is identical with the voltage V_{O12V}.
The output is internal protected with a 15 V - Zener diode against external overvoltage.
The resistive load must not exceed 10 mA.
The current limititation of the external transistor M4, e.g. against short-circuit, must be external guarded.

OVP

The input OVP is internal connected by a 42 V - Zener diode and three forward diodes to the output OUT. With that it is possible to protect the external transistors M4 in the switched off condition against excess voltages by clamping the drain of this transistor to typically (44 V + V_{GSM4}).
The threshold for the protection against overvoltage is reached if a current > 70 µA flows in the input OVP. In result the internal Low side driver transistor M3 switches off. After that the current loads the gate of the external transistor to V_{GSM4} and switches it on.
At use of external transistors with a higher breakdown voltage the overvoltage protection can be modified by an external Zener diode.
The function overvoltage protection is dimensioning at inductive loads. With the driving other loads limit the current in the Pin OVP if necessary.

IN

Input voltages > 4 V are logical high and input voltages < 2,0 V are logical Low.
If the input is open (non-connected) the internal value is recognized as logical high.
An internal RC filter with a delay time of 700 ns inhibits short disturbing pulses.
The input IN is Low active.
The internal Turn on/ off Logic separates the functions of the input:

1. Dynamic switching on

The dynamic switching on condition is derived from the oscillator frequency.
In the case the input signal (rectangle, sinus, triangle) should meet the following frequency condition the output of the Turn on/off Logic is set to High:

Dynamic switching on condition: $f_{IN-ON} > 0.6 * f_{OSC}$

The turning-on delay time is a multiple of the oscillator frequency T_{POSC}. It has no fixed value but it depends on the phase position and is between $2*T_{POSC}$ and $6*T_{POSC}$.
The dimension has to set to $6*T_{POSC}$ (worst case).

2. Dynamic switching off
The dynamic turning-off condition is derived from the oscillator frequency.
In the case the input signal should meet the following frequency condition the output of the Turn on/off Logic is set to Low:

Dynamic switching off condition: $f_{IN-OFF} < 0.2 * f_{OSC}$

The turning-off delay time is a multiple of the oscillator frequency T_{POSC}. It has no fixed value but it depends on the phase position and is between $2*T_{POSC}$ and $6*T_{POSC}$.
The dimension has to set to $6*T_{POSC}$ (worst case).

3. Static switching off
Following three static conditions at the input switch off the output OUT:

Static switching off conditions:
- $V_{IN-OFF} > 4$ **V "High"**
- $V_{IN-OFF} < 2$ **V "Low"**
- **Input open**

There is no turning off delay time in case of switching off with static High, cable interrupt (input open) and short circuit to VDD
The turning off delay time is a multiple of the period of the oscillator frequency in case of switching off with static Low or short-circuit to GND.
It has no fixed value but it depends on the phase position and is between $2*T_{POSC}$ and $6*T_{POSC}$.
The dimension has to set to $6*T_{POSC}$ (worst case).

4. External PWM control of OUT
After fulfilment the turning-on condition and the turn-on delay time a Low - level of the external PWM - signal at the input corresponds to a High - level of the PWM - signal at OUT.

5. Low-Indication of state
The input indicates the state in case of detecting undervoltage at VDD, undervoltage at O5V or overtemperature.
During this errors the input is with low-resistance clamped to a low signal (approx. 1 V). In this state the input current has to be external limited to maximum 30 mA.
During the active indication of state the supply current increases to about 5 mA.

OSC

The current source at the oscillator input delivers for the external capacitor C_{OSC} a reload current of 50 µA respective -50 µA.
Resulting a triangle voltage on the pin OSC is produced. The lower switching threshold of the oscillator is about 0.8 V; the upper threshold is about 4 V. The oscillator frequency is dependent on the technological tolerance of the voltage V_{O5V}.
The triangle voltage is internal transformed into a square-wave voltage.
Through frequency division by 4:1 an internal frequency of ¼ f_{OSC} is realized for the analysis of the external PWM signal.
The operational frequency range of α1610 is between 50 - 5 000 Hz.

The external capacitor may be dimension approximately by

$$C_{OSC} [nF] = 7070 / f_{OSC} [Hz]$$

IRCR

By external resistance R_{REF} the reference current for the internal control currents is produced. The voltage at this pin is in relationship to an internal voltage of 1.5 V.

A reference current of 50 µA require a value R_{REF} = 30 kΩ

$$(I_{RREF} = 1.5\ V / 30\ k\Omega).$$

The tolerance and the temperature coefficient of the resistance R_{REF} are directly entered into the tolerance and the temperature coefficient the I_{INPT} and f_{OSC}.

OD

At this output the voltages of the both thermal reference diodes available for measurement and evaluation purposes.

The voltage V_{OD} has a temperature coefficient

$$TC\_V_{OD} \sim -4\ mV/K.$$

The output may be loaded with 50 nA maximally.

INPT

The internal current source at the input INPT drives a current of 50 µA.

The voltage at the external resistance R_{PT} is internal compared to the voltage of the both reference diodes.

The value of the resistor is used to set the chip cut-off temperature of the thermal protection infinitely variable between T_{joff} = 80 to 175 °C.

If the input INPT is connected to GND the thermal protection is inactive. If the input INPT is open, e.g. at cable interruption, the output switches to Low (emergency cut-out).

The hysteresis of the thermal protection is typical 12 K and is produced by changing of the current (50 µA / 25 µA) by the both Thermo-reference diodes.

The external resistance for a definite chip cut-off temperature T_{joff} 's calculated approximately as follows:

$$R_{PT} = 22\ k\Omega - 0{,}058\ k\Omega/K * (T_{joff} - 60\ °C)$$

The calculated chip cut-off temperature is (T_{Mes} = measuring temperature):

$$T_{joff} = [V_{OD(\ at\ TMes)} - ((|I_{INPT\ (at\ TMes)}| * R_{PT}) + 6\ mV)]\ /\ 4\ mV/K + T_{Mes}$$

The tolerance of the chip cut-off temperature is typical ± 6 K.

Instead of using the resistor R_{PT} the chip cut-off temperature is adjustable by using of external Low-ohm voltage source.

The Thermal Protection Circuit has a filter for gating out of short-term drops be caused by switching of the output stage. At overtemperature the Low signal at the Comparator output in the Interference Suppression will be saved in a scratch pad about 200 ns before every Low-High-Slope of the output signal.

With the next L/H-Slope of the output signal this Low Signal will be latched from the scratch pad into the Latch.

The scratch pad and the Latch will be getting a reset signal if the comparator output goes to High.

This ensures fading down of incidental failures at the inquiry time.

In the case of standby or during the Indication State the rectangular oscillator signal takes over the control of the scratch pad and the latch.

Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
V_{DD}	Supply Voltage	-300	80	V
V_{DDC}	Block Capacitor	0	80	V
V_{IN}	Input Voltage	-80	80	V
V_{DDC} - V_{IN}	Difference Voltage	-80	80	V
I_{DDC}	Output Current VDDC	-40	0	mA
I_{OUT}	Output Current OUT	-10	10	mA
I_{O12V}	Output Current O12V	-10	0	mA
I_{O5V}	Output Current O5V	-5	0	mA
I_{IN}	Input Current at Status Undervoltage or Overtemperature	0	30	mA
I_{OVP}	Input Current OVP	0	1	mA
V_{OSC}	Input Voltage OSC	0	V_{O5V}	V
V_{INPT}	Input Voltage INPT	0	V_{O5V}	V
I_{OD}	Output Current OD	-1	1	µA
I_{IRCR}	Input Current IRCR	-100	0	µA
C_{DDC}	Block Capacitor VDDC depending VDD V_{DD} = 15 V V_{DD} = 45V		 470 100	 nF nF
C_{OUT}	Capacitor OUT		10	nF
C_{O12V}	Block Capacitor O12V		100	nF
C_{O5V}	Block Capacitor O5V		220	nF
T_a	Ambient Temperature	-40	150	°C
T_j	Junction Temperature		175	°C
T_{stg}	Storage Temperature Range	-55	150	°C
R_{thja}	Thermal Resistance SOP18		85	K/W

Electrical Characteristics

Operational Range

Symbol	Parameter	Min	Max	Unit
V_{DD}	Supply Voltage *)	8	45	V
C_{DDC}	Block Capacitor VDDC	100		nF
C_{O5V}	Block Capacitor O5V	100		nF
f_{OSC}	Oscillator Frequency	50	5000	Hz
T_a	Ambient Temperature Range	-40	150	°C

*) For V_{DD} > 40 V an external Z-diode on Pin OVP is necessary

DC Characteristics

at T_a = -40°C ... 150°C, V_{DD} = 15 V

R_{REF} = 30 kΩ ± 0 %, TC_{RREF} = 0 ppm, C_{OSC} = 1.5 nF ± 0 %, TC_{COSC} = 0 ppm, C_{DDC} = C_{O5V} = 100 nF, I_{DDC} = I_{O12V} = I_{O5V} = 0, Pin INPT to GNDA, IN, OD, OVP and OUT open ; unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{DD}	Current Consumption	V_{DD} = 15 V V_{DD} = 45 V		1.4 1.7	2.5 2.5	mA mA
$V_{DD\ LON}$ $V_{DD\ LOFF}$	Undervoltage Lockout Turn on Undervoltage Lockout Turn off		 6.6	7.7 7.0	8.0	V V
V_{O12V}	Driver Supply Voltage	I_{O12V} = -10 µA I_{O12V} = -5 mA	11.0 10.0	12.5 12.0	14.0 14.0	V V
V_{O5V}	Reference Voltage	I_{O5V} = 0 to -1.5 mA V_{DD} = 8 V to 45 V	4.75	5.00	5,25	V
V_{OUTH}	High Output Voltage	I_{OUT} = 0 mA f_{IN_ON} > 0,6*f_{OSC}	11.0	12.5	14.0	V
V_{OUTL}	Low Output Voltage	I_{OUT} = 10 µA			200	mV
V_{OUTH}	High Output Voltage	I_{OUT} = -10 mA f_{IN_ON} > 0,6*f_{OSC}	9.0	11.2	14.0	V
V_{OUTL}	Low Output Voltage	I_{OUT} = 10 mA		0,2	1,0	V
$R_{DS(on)}$	Driver Drain Source M2 On-State Resistance M3	V_{O12V} = 12 V T_a = 25 °C		45 20		Ω Ω
I_{INPT}	Input Current INPT	V_{INPT} = 900 mV T_{Mes} = 15 ... 35 °C		-50		µA
V_{OD}	Output Voltage Diode Temperature Sensor	I_{OD} = -50 nA T_a = 25 °C		1320		mV
V_{IN}	Input Voltage at Status Undervoltage or Overtemperature	I_{IN} = 30 mA		1.0	1.8	V
V_{INH}	Input Threshold High			3	4	V
V_{INL}	Input Threshold Low		2	2,5		V
V_{OVP}	Response Threshold Overvoltage Protection	I_{OVP} = 100 µA	40	44	48	V
T_{joff}	Tolerance Chip Cut-off Temperature **)	TC_{RPT} = 0 ppm	-20		20	K

**) Calculated Chip Cut-off Temperature:

$$T_{joff} = [\, V_{OD\ (at\ TMes)} - ((|I_{INPT\ (at\ TMes)}| * R_{PT}) + 6\ mV)] \,/\, 4\ mV/K + T_{Mes}$$

AC Characteristics

at T_a = -40 °C ... 150 °C, V_{DD} = 8 V to 45 V, R_{REF} = 30 kΩ ± 0 %, TC_{RREF} = 0 ppm,
C_{OSC} = 1.5 nF ± 0 %, TC_{COSC} = 0 ppm; unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{OSC}	Oscillator Frequency		4.3	4.7	5.1	kHz
f_{IN_ON}	Closing Condition	f_{IN}: Square-Wave Signal 5 V	0.6*f_{OSC}			Hz
f_{IN_OFF}	Cut-off Condition				0.2*f_{OSC}	Hz

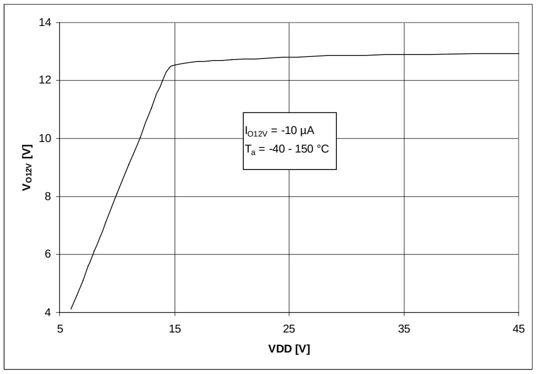
ESD Protection

at T_a = 25 °C -5 K, CEEC 90 000
Reference Pins: 14, 18

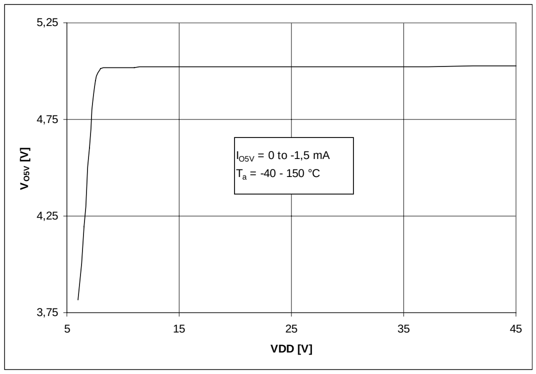
Human body model: C = 100 pF
R = 1.5 kΩ

Pin	Prüfspannung
1	± 400 V
2	± 400 V
3	± 400 V
8	± 2000 V
9	± 2000 V
10	± 2000 V
11	± 2000 V
12	± 2000 V
15	± 400 V
16	± 400 V
17	± 400 V

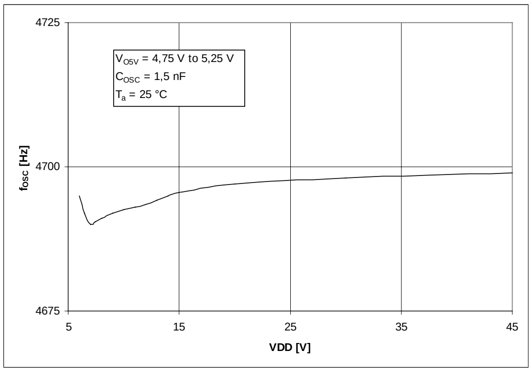
Typical Performance Curves



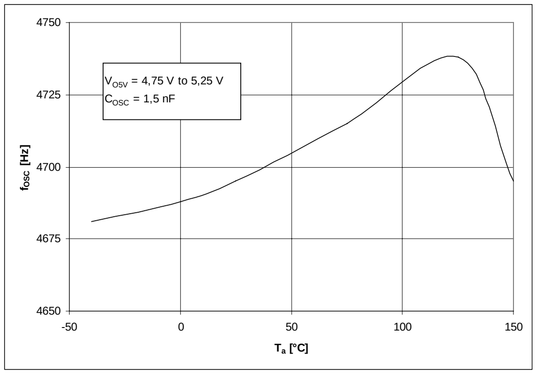
Voltage VO12V versus Supply Voltage



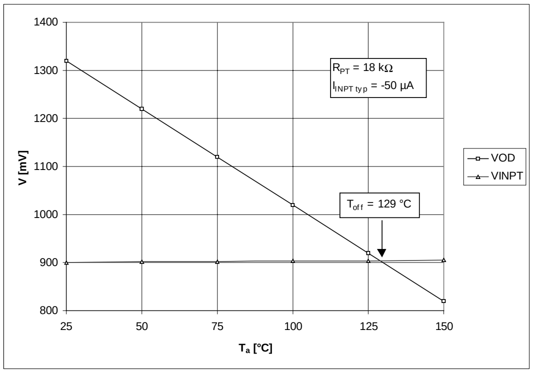
Voltage VO5V versus Supply Voltage



Oscillator Frequency versus Supply Voltage

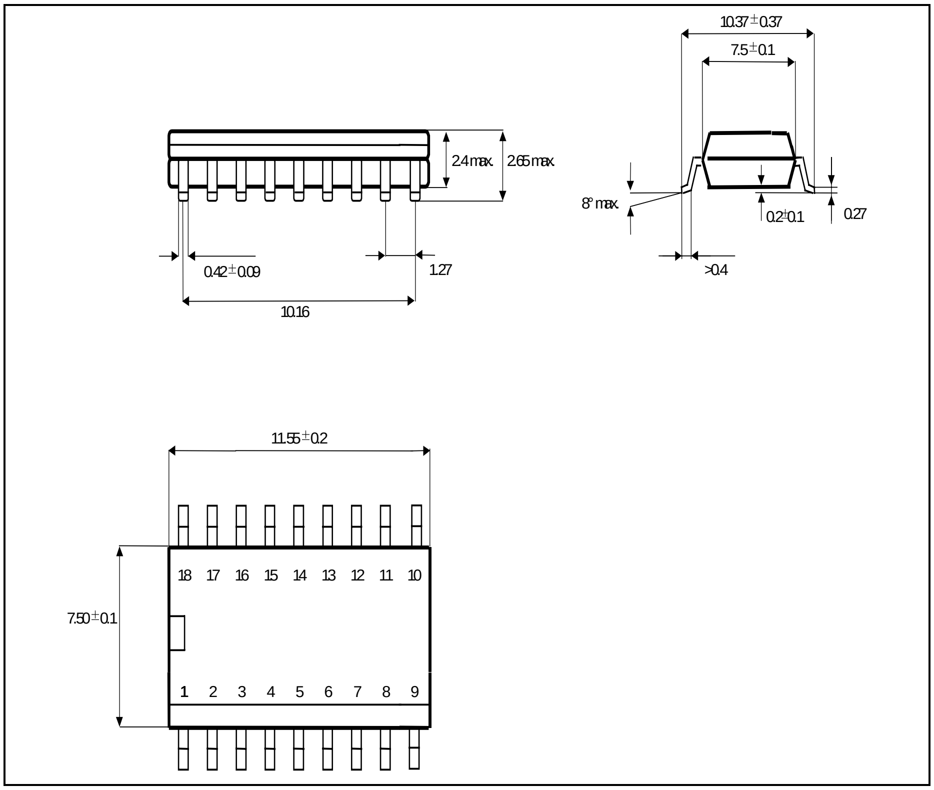


Oscillator Frequency versus ambient Temperature



Voltage V_{OD} and V_{INPT} versus ambient Temperature,
Demonstration of the Cut-off Temperature

Package 18-pin Plastic SOP



SOP 18

Note

It is not given warranty that the declared circuits, devices, facilities, components, assembly groups or treatments included herein are free from legal claims of third parties.
The declared data are only a description of product. They are not guaranteed properties as defined by law. The examples are given without obligation and cannot given rise to any liability.

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