

General Description

The AOZ7645QI-13 is a flyback receiver in primary side that targeted for power supply solution. It receives the ON time information signal from secondary side converter to drive integrated main MOSFET in primary side. The integrated high-voltage (HV) device provides fast start-up function.

The AOZ7645QI-13 features include multiple protection functions such as V_{DD} under-voltage lockout, cycle-by-cycle current limit, V_{DD} over-voltage protection, secondary rectifier short-circuit protection, current sense pin open-circuit protection and internal over-temperature protection.

The AOZ7645QI-13 is available in a 6mm×6mm QFN-17L package.

Features

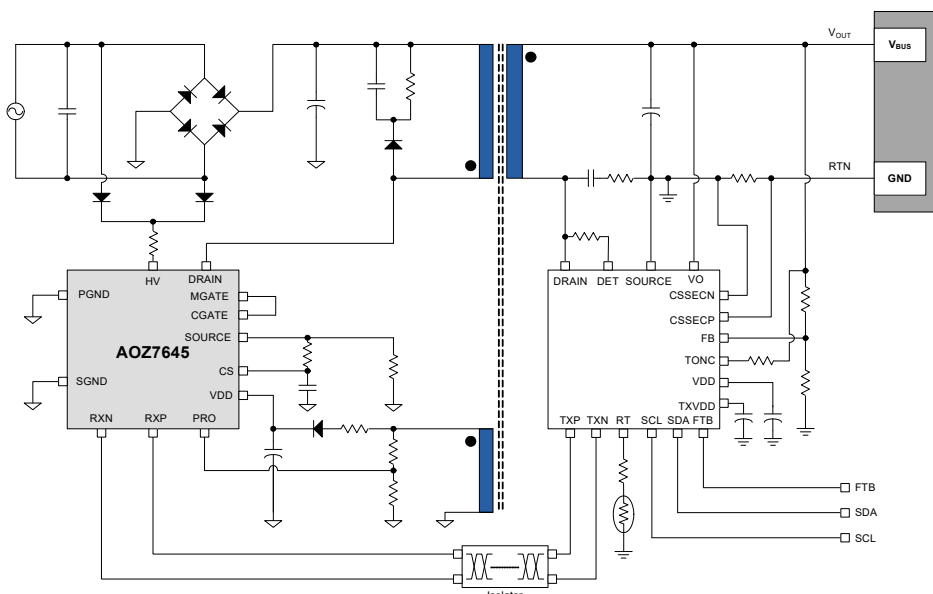
- Integrated HV start-up device
- Integrated with HV MOSFET
- 100kHz maximum start-up switching frequency
- V_{DD} over-voltage protection
- Under-voltage lockout (6.7V/15.5V)
- Current sense leading edge blanking time
- Cycle by cycle current limit
- Secondary rectifier short-circuit protection
- CS pin open-circuit protection
- Internal over-temperature protection
- Thermally enhanced 17-pin 6x6 QFN

Applications

- Smart charger
- Adapter
- TV and monitor applications
- Open frame power supply



Typical Application



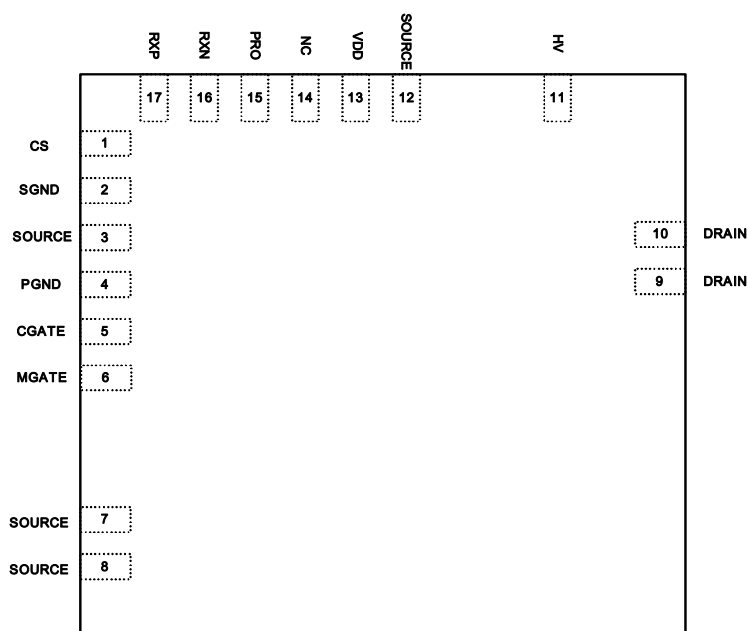
Ordering Information

| Part Number | Ambient Temperature Range | Package | Environmental |
|--------------|---------------------------|--------------|---------------|
| AOZ7645QI-13 | -40°C to +125°C | QFN 6x6A-17L | Green Product |



AOS Green Products use reduced levels of Halogens, and are also RoHS compliant.

Pin Configuration



**17-Pin 6mm x 6mm QFN
(Top View)**

Pin Description

| Pin Number | Pin Name | Pin Function |
|------------|----------|---|
| 1 | CS | Current sense input pin. |
| 2 | SGND | Signal GND |
| 3,7,8,12 | SOURCE | Source of the MOSFET. |
| 4 | PGND | Power GND. |
| 5 | CGATE | The gate pin of controller. |
| 6 | MGATE | The gate pin of the integrated MOSFET |
| 9,10 | DRAIN | Drain of the integrated MOSFET. |
| 11 | HV | High voltage start-up current source. |
| 13 | VDD | The VDD is the bias-supply input pin to the controller. |
| 14 | NC | No connection. |
| 15 | PRO | Protection pin. |
| 16 | RXN | ON time information receiver pin. |
| 17 | RXP | ON time information receiver pin. |

Absolute Maximum Ratings

Exceeding the Absolute Maximum Ratings may damage the device.

| Parameter | Rating |
|-------------------------------------|-----------------|
| V_{HV} | -0.3V to 500V |
| V_{DRAIN} | -0.7V to 700V |
| V_{DD}, V_{CGATE} | -0.3V to 40V |
| $V_{CS}, V_{RXP}, V_{RXN}, V_{PRO}$ | -0.3V to 7V |
| V_{MGATE} | -0.3V to 20V |
| Junction Temperature (T_J) | +150°C |
| Storage Temperature (T_S) | -65°C to +150°C |
| ESD HBM ⁽¹⁾ | 4kV |
| ESD CDM ⁽¹⁾ | 1kV |

Notes:

1. Devices are inherently ESD sensitive, handling precautions are required. Human body model rating: 1.5kΩ in series with 100pF.

2. 1x1inch, 2-layer PCB, follow JEDEC standard.

Electrical Characteristics

$V_{DD}=15V$, $T_A = -25^{\circ}C$ to $85^{\circ}C$, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|------------------|--|---|------|------|------|-------|
| MOSFET | | | | | | |
| $R_{DS(ON)}$ | ON State Resistance | Static, $I_{DRAIN} = 1A$, $V_{DD} = 10V$, $T_J = 25^{\circ}C$ | | 0.6 | 0.75 | Ω |
| HV | | | | | | |
| I_{HV} | Supply Current from HV Pin | $V_{HV} = 100V$, $V_{DD} = 0V$, converter OFF | | 3.2 | 4.6 | mA |
| I_{HV_LC} | Leakage Current from HV Pin | $V_{HV} = 500V$, $V_{DD} = 18V$, converter ON | | 0.8 | | μA |
| VDD | | | | | | |
| V_{DD_OVP} | VDD Over-Voltage Protection Level | | 34 | 36 | 38.2 | V |
| t_{D_OVP} | VDD Over-Voltage Protection Debounce Time ⁽¹⁾ | | | 20 | | μs |
| V_{DD_ON} | Turn-ON Threshold Voltage | | 14.0 | 15.5 | 17.0 | V |
| V_{DD_UVLO} | Turn-OFF and Under Voltage Lock Out | | 6.2 | 6.7 | 7.2 | V |
| I_{DD_OP} | Operation Current | $V_{DD} = 15V$, converter ON, $f_S = 80kHz$ | | 0.8 | 1.2 | mA |
| I_{DD_SKIP} | Skip Mode Operation Current | $V_{DD} = 7V$ | | 500 | 550 | μA |
| I_{DD_DIS} | Disable Mode Operation Current | $V_{DD} = 15V$, V_{DD_OVP} is enabled or no GATE output | | 70 | 100 | μA |
| Frequency | | | | | | |
| f_{OSC} | Start-up Operation Frequency | $V_{PRO} = 1V$ | | 100 | | kHz |
| f_{OSC1} | | $V_{PRO} = 0.5V$ | | 50 | | kHz |

Recommended Operating Conditions

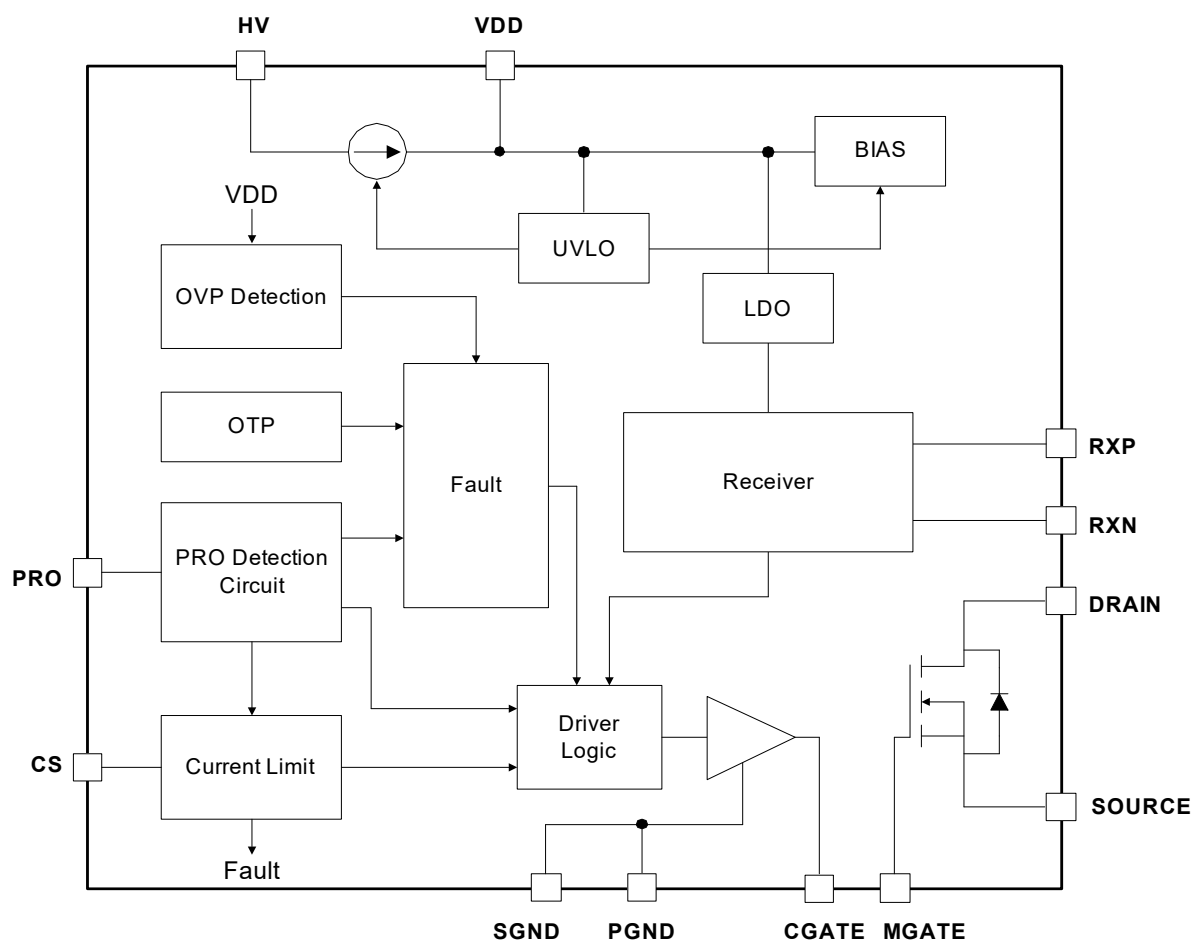
The device is not guaranteed to operate beyond the Maximum Recommended Operating Conditions.

| Parameter | Rating |
|-------------------------------|-----------------------|
| Supply Voltage (V_{DD}) | 8V to 33V |
| Ambient Temperature (T_A) | -40°C to +125°C |
| Package Thermal Resistance | 25°C/W ⁽²⁾ |

Electrical Characteristics (Continued)
 $V_{DD}=15V$, $T_A = -25^{\circ}C$ to $85^{\circ}C$, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|------------------------------------|--|---|-----|------|------|-------------|
| Protection Function | | | | | | |
| V_{PRO_MIN} | Min. Clamp Voltage | $I_{PRO} = -0.1mA$ | 0.1 | 0.2 | 0.25 | V |
| V_{DISH} | Disable Voltage Level (High) | | 1.4 | 1.5 | 1.6 | V |
| t_{DISHBN} | Blanking Time | | 0.6 | 0.8 | 1 | μs |
| t_{DISHDB} | V_{DISH} Debounce Cycles | | | 4 | | Cycles |
| GATE DRIVE | | | | | | |
| V_{G_CLAMP} | GATE Clamping Voltage | $V_{DD} = 15V$ | | 12 | | V |
| T_{LEB} | Leading Edge Blanking Time | | 300 | 350 | 400 | ns |
| T_{PD} | Propagation Delay Time | | | 50 | 100 | ns |
| Soft-start | | | | | | |
| T_{SS_OFF} | Soft-Start Time for Shut Down | | | 18 | 24 | ms |
| T_{SS_CS} | Soft-Start Time for Current Limit | | 5 | 7 | 9 | ms |
| Current LIMIT | | | | | | |
| V_{CSL} | General Continuous Operation Limited Current Sense Level | $I_{PRO} = 120\mu A$ | 285 | 300 | 315 | mV |
| V_{CSH} | Fast Over Current Protection Limit | | | 0.75 | | V |
| T_{OCPH} | Fast OCP for Auto Restart | $V_{CS} > 750mV$ and happening continuous | | 4 | | Cycles |
| ReCEIVER | | | | | | |
| T_{RD} | Delay Time for RX Rising Signal to GATE ON | | | | 100 | ns |
| T_{FD} | Delay Time for RX Falling Signal to GATE OFF | | | | 100 | ns |
| over temperature protection | | | | | | |
| | Thermal Shutdown | T_J Rising | | 145 | | $^{\circ}C$ |
| OTP_{REC} | Thermal Shutdown Recovery Threshold | T_J Falling | | 125 | | $^{\circ}C$ |

Functional Block Diagram



Typical Characteristics

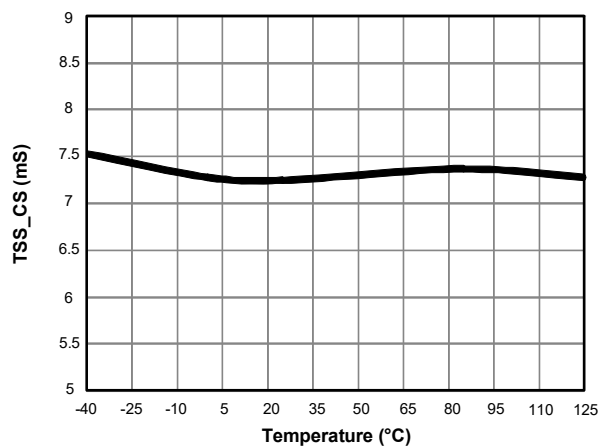


Figure 1. Soft Start Time for Current Limit vs. Temperature

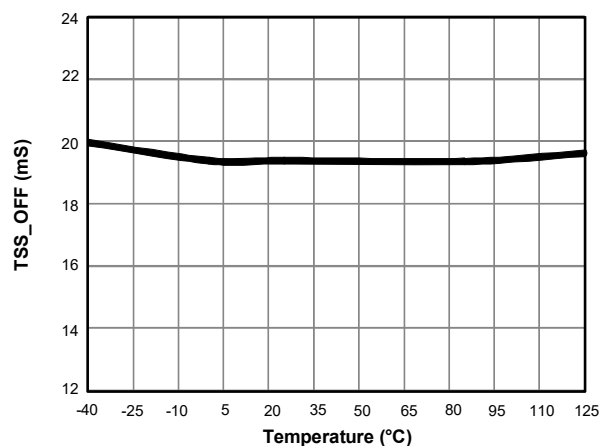


Figure 2. Soft Start Time for Shut Down vs. Temperature

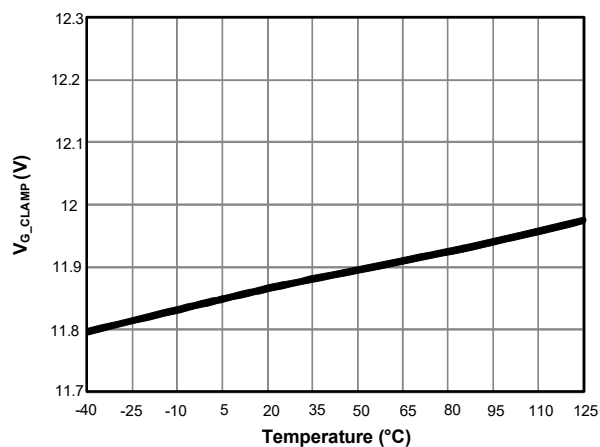


Figure 3. Gate Clamping Voltage vs. Temperature

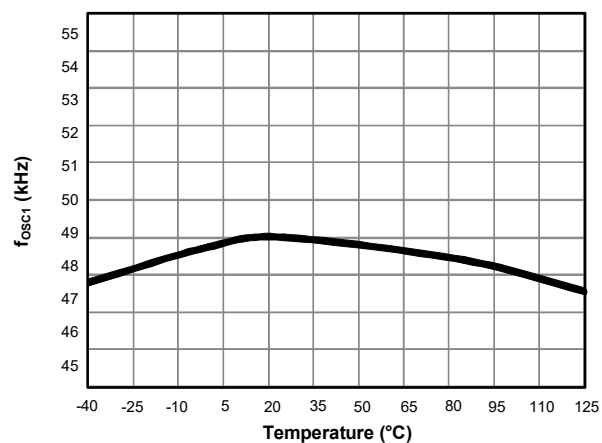


Figure 4. Minimum of the Start-up Operation Frequency vs. Temperature

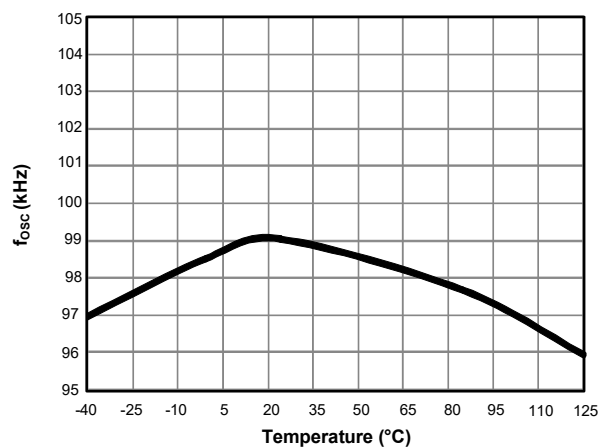


Figure 5. Maximum of the Start-up Operation Frequency vs. Temperature

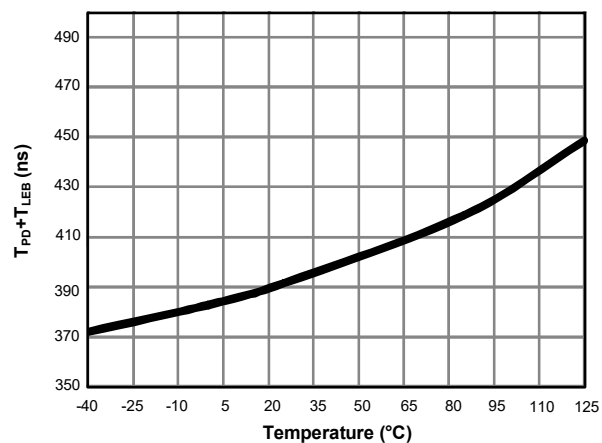


Figure 6. Minimum of the Turn-on Period vs. Temperature

Typical Characteristics

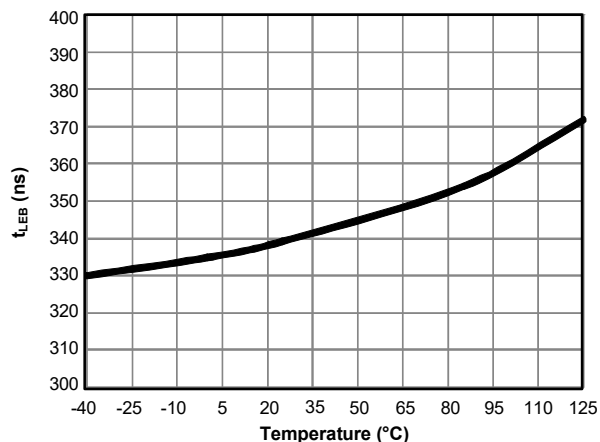


Figure 7. Leading Edge Blanking Time vs. Temperature

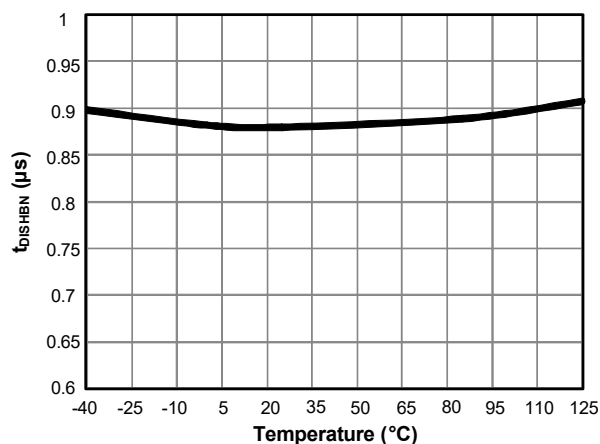


Figure 8. The Blanking Time of the Disable Voltage Level vs. Temperature

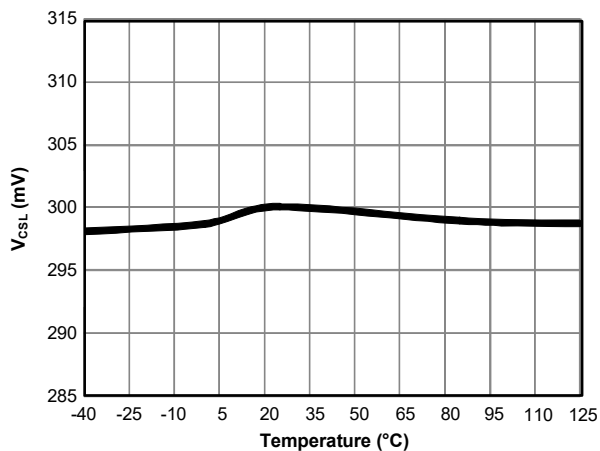


Figure 9. General Continuous Operation Current Sense Limit vs. Temperature

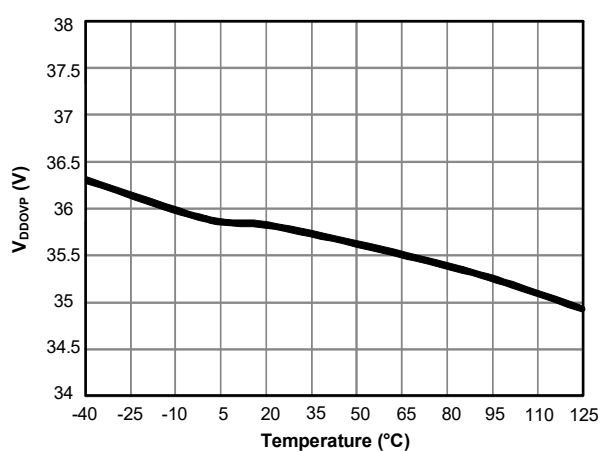


Figure 10. V_{DD} Over-Voltage Protection Level vs. Temperature

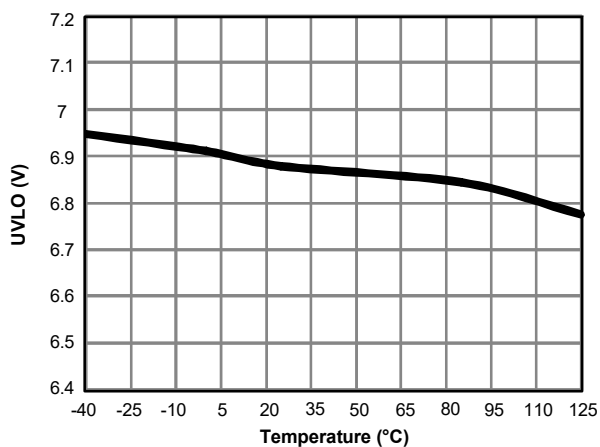


Figure 11. Turn-OFF and Under Voltage Lock Out vs. Temperature

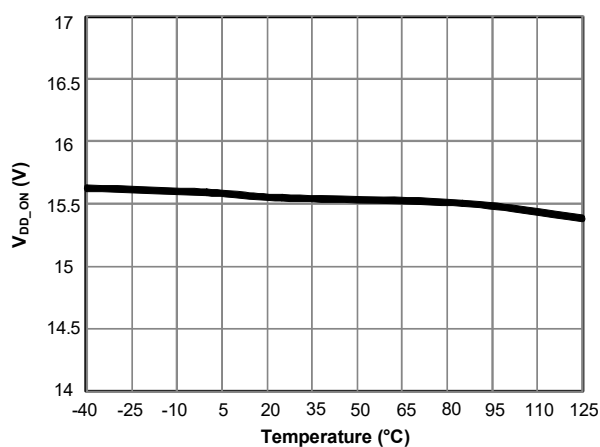


Figure 12. Turn-ON Threshold Voltage vs. Temperature

Detailed Description

HV Start-Up

There is a high-voltage (HV) device which is designed as a current source to charge the VDD capacitor during start-up. This current source will be turned off for reducing the power consumption after the AOZ7645QI-13 is powered on. The HV pin should be connected to the input terminals through the rectifier diodes and a series resistor, the series resistor is recommended to be 10kΩ.

Soft Start

The AOZ7645QI-13 has an internal soft start feature to limit inrush current and ensure the output voltage ramps up smoothly to the regulation voltage. If the AOZ7645QI-13 never receives the ON time information from the secondary side converter, the AOZ7645QI-13 will be shut down after 18ms (t_{SS_OFF}) from start-up.

ON Time Receiver

The AOZ7645QI-13 receives the ON time information from the secondary side converter through the RXP and RXN pins and send the ON time signal to the driver. The ON time width of the switching pulse varies according to the ON time signal.

VDD Over-Voltage Protection

The output voltage can be sensed roughly from the VDD pin. When the VDD voltage exceeds the VDD OVP level (V_{DD_OVP}), the converter will be shut down after the VDD OVP debounce time (t_{D_OVP}) and then return to the start state.

PRO Protection

The output voltage can be sensed indirectly by monitoring the auxiliary winding voltage. When the PRO voltage during turn-off period exceeds the PRO disable voltage level (V_{DISH}), the converter will be shut down after the V_{DISH} debounce cycles (t_{DISHDB}) and then return to the start state.

Cycle-by-Cycle Current Limit

The AOZ7645QI-13 detects the primary current through CS pin, and the CS peak voltage of each switching cycle is limited to V_{CSL} . The voltage across the current-sensing resistor R_{CS} is fed into the CS pin for current limit detection.

When the fault occurs due to transformer short circuit or secondary rectifier short circuit, and the large current will flow through the main MOSFET at turn-on period, and this will cause damage on power components. In order to protect the system, Fast over current protection function is added. If the CS voltage reaches V_{CSH} , the converter will be shut down after four consecutive cycles and then return to the start state.

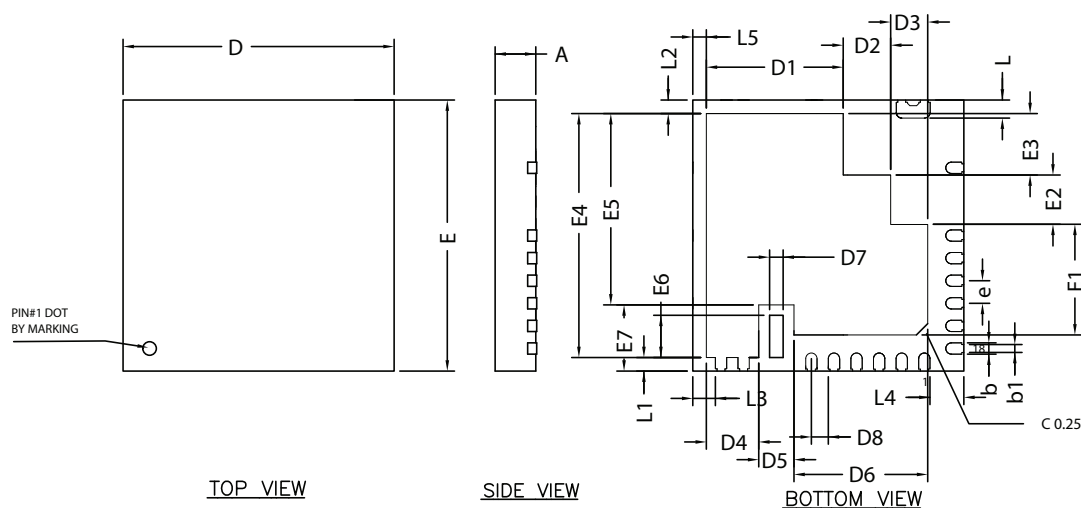
CS Pin Open-Circuit Protection

The CS pin features open-loop protection to pass the CS pin single fault testing. When the CS pin is opened, the CS will be pulled high by internal circuit and CS pin voltage will higher than V_{CSH} and the converter will be shut down after four consecutive cycles and then return to the start state.

Over-Temperature Protection

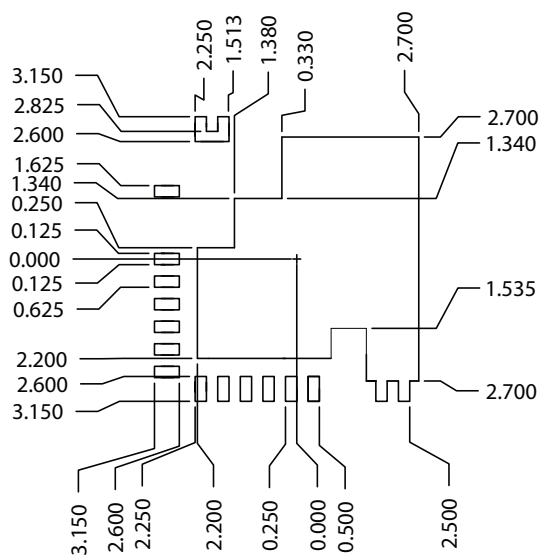
The AOZ7645QI-13 provides an internal OTP protection function. If the junction temperature reaches the OTP threshold, the AOZ7645QI-13 will stop switching until the junction temperature decreases below the OTP recovery temperature.

Package Dimensions, QFN6x6A-17L, EP1_S



SIDE VIEW

RECOMMENDED LAND PATTERN



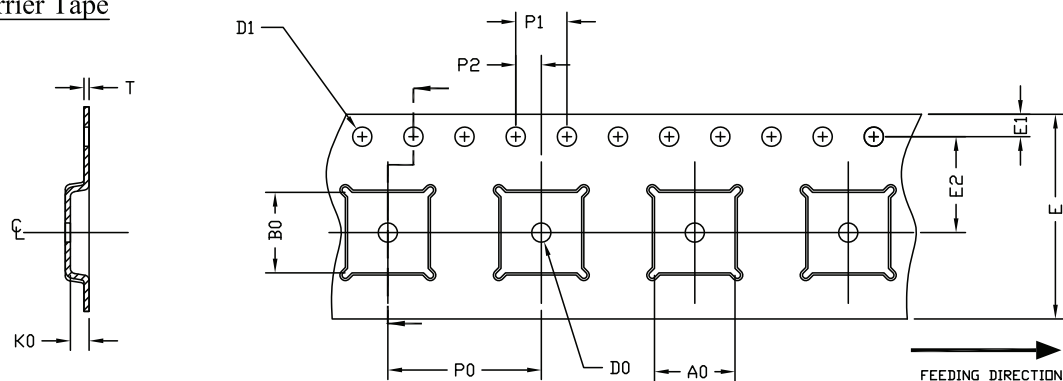
UNIT: mm

NOTE
CONTROLLING DIMENSION IS MILLIMETER.
CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

| SYMBOLS | DIMENSION IN MM | | | DIMENSION IN INCHES | | |
|---------|-----------------|------|------|---------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.80 | 0.90 | 1.00 | 0.031 | 0.035 | 0.039 |
| A1 | 0.00 | - | 0.05 | 0.000 | - | 0.002 |
| A2 | 0.2REF | | | 0.008REF | | |
| E | 5.90 | 6.00 | 6.10 | 0.232 | 0.236 | 0.240 |
| D | 5.90 | 6.00 | 6.10 | 0.232 | 0.236 | 0.240 |
| D1 | 2.93 | 3.03 | 3.13 | 0.115 | 0.119 | 0.123 |
| D2 | 0.95 | 1.05 | 1.15 | 0.037 | 0.041 | 0.045 |
| D3 | 0.72 | 0.82 | 0.92 | 0.028 | 0.032 | 0.036 |
| D4 | 1.06 | 1.16 | 1.26 | 0.042 | 0.046 | 0.050 |
| D5 | 0.68 | 0.78 | 0.88 | 0.027 | 0.031 | 0.035 |
| D6 | 2.86 | 2.96 | 3.06 | 0.113 | 0.117 | 0.120 |
| D7 | 0.20 | 0.30 | 0.40 | 0.008 | 0.012 | 0.016 |
| D8 | 0.28 | 0.38 | 0.48 | 0.011 | 0.015 | 0.019 |
| E1 | 2.35 | 2.45 | 2.55 | 0.093 | 0.096 | 0.100 |
| E2 | 0.99 | 1.09 | 1.19 | 0.039 | 0.043 | 0.047 |
| E3 | 1.26 | 1.36 | 1.46 | 0.050 | 0.054 | 0.057 |
| E4 | 5.30 | 5.40 | 5.50 | 0.209 | 0.213 | 0.217 |
| E5 | 4.14 | 4.24 | 4.34 | 0.163 | 0.167 | 0.171 |
| E6 | 0.84 | 0.94 | 1.04 | 0.033 | 0.037 | 0.041 |
| E7 | 1.37 | 1.47 | 1.57 | 0.054 | 0.058 | 0.062 |
| L | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| L1 | 0.20 | 0.30 | 0.40 | 0.008 | 0.012 | 0.016 |
| L2 | 0.20 | 0.30 | 0.40 | 0.008 | 0.012 | 0.016 |
| L3 | 0.40 | 0.50 | 0.60 | 0.016 | 0.020 | 0.024 |
| L4 | 0.65 | 0.75 | 0.85 | 0.026 | 0.030 | 0.033 |
| L5 | 0.20 | 0.30 | 0.40 | 0.008 | 0.012 | 0.016 |
| b | 0.20 | 0.25 | 0.30 | 0.008 | 0.010 | 0.012 |
| b1 | 0.17 | 0.18 | 0.19 | 0.006 | 0.007 | 0.007 |
| e | 0.50BSC | | | 0.02BSC | | |

Tape and Reel, QFN6x6A-17L, EP1_S

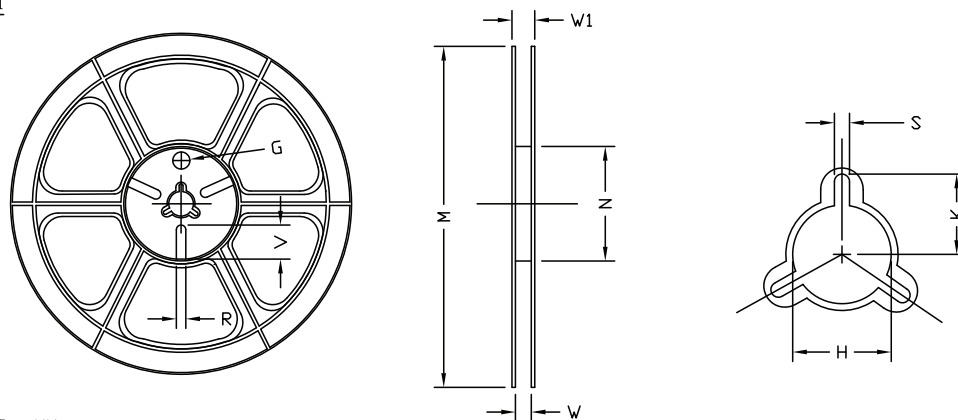
Carrier Tape



UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|-------------------|---------------|---------------|---------------|--------------|----------------------|--------------|---------------|-------------|----------------|---------------|---------------|---------------|
| QFN6x6 (16 mm) | 6.30 ±0.20 | 6.30 ±0.20 | 1.10 ±0.20 | 1.50 MIN. | 1.50 +0.1 -0.0 | 16.0 ±0.3 | 1.75 ±0.10 | 7.5 ±0.1 | 12.00 ±0.20 | 4.00 ±0.20 | 2.00 ±0.10 | 0.30 ±0.05 |

Reel

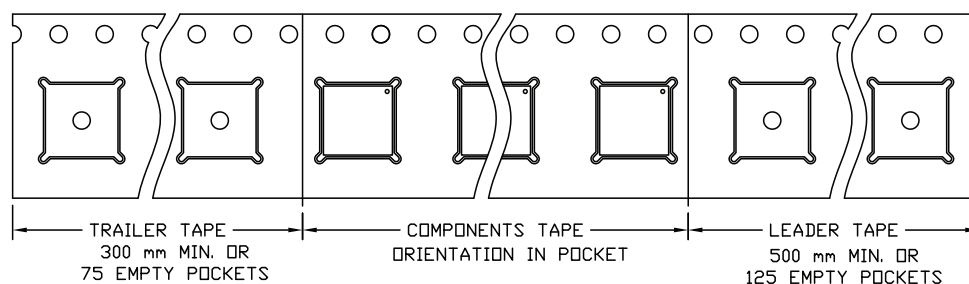


UNIT: MM

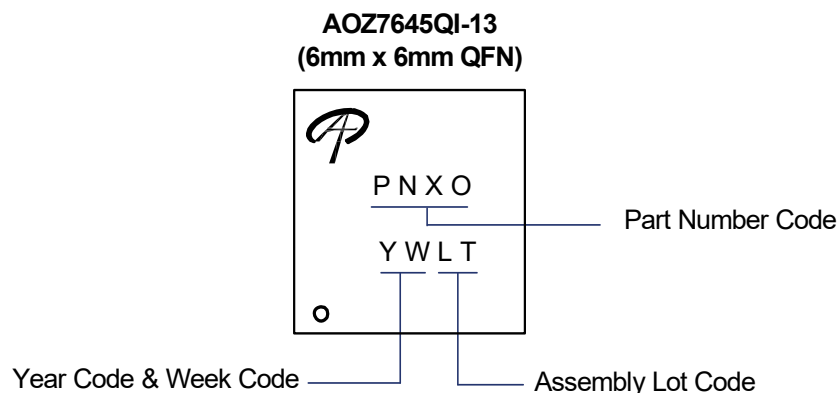
| TAPE SIZE | REEL SIZE | M | N | W | W1 | H | K | S | G | R | V |
|-----------|-----------|--------------|--------------|----------------------|--------------|-----------------------|--------------|-------------|-----|-----|-----|
| 16 mm | ø330 | ø330 MAX. | ø100 MIN. | 16.4 +2.0 -0.0 | 22.4 MAX. | ø13.0 +0.5 -0.2 | 10.1 MIN. | 1.5 MIN. | --- | --- | --- |

Tape

Leader / Trailer
& Orientation



Part Marking



| Part No. | Description | Code |
|--------------|---------------|------|
| AOZ7645QI-13 | Green Product | AY0D |

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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.