AOZ7655QI-13

High Efficiency Flyback Converter

General Description

The AOZ7655QI-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 AOZ7655QI-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 AOZ7655QI-13 is available in a 6mm×6mm QFN-17L package.

Table 1. Function Behavior

Function	Protection Behavior
Internal OTP	Auto recovery
HOCP	Auto recovery
Open CS Pin	Auto recovery
Open Pro Pin	Auto recovery
VPRO OVP	Auto recovery
VDD OVPLatch	Auto recovery
Transmission Fail	Auto recovery

Features

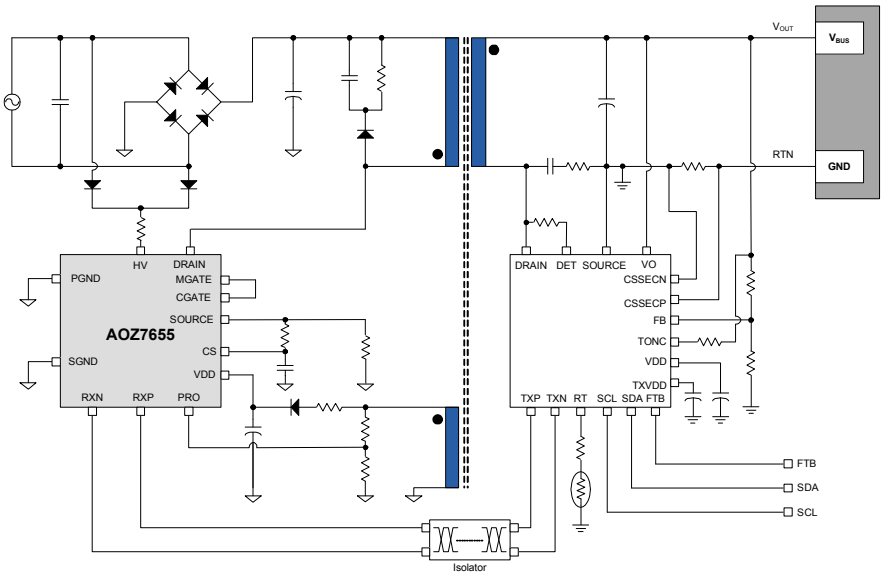
- Integrated HV start-up device
- Integrated with HV MOSFET
- 100kHz maximum start-up switching frequency
- V_{DD} over-voltage protection
- Under-voltage lockout (6.7V/15.5V)
- Current sense leading edge blanking time
- Cycle by cycle current limit
- Secondary rectifier short-circuit protection
- CS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

Green Product

Typical Application

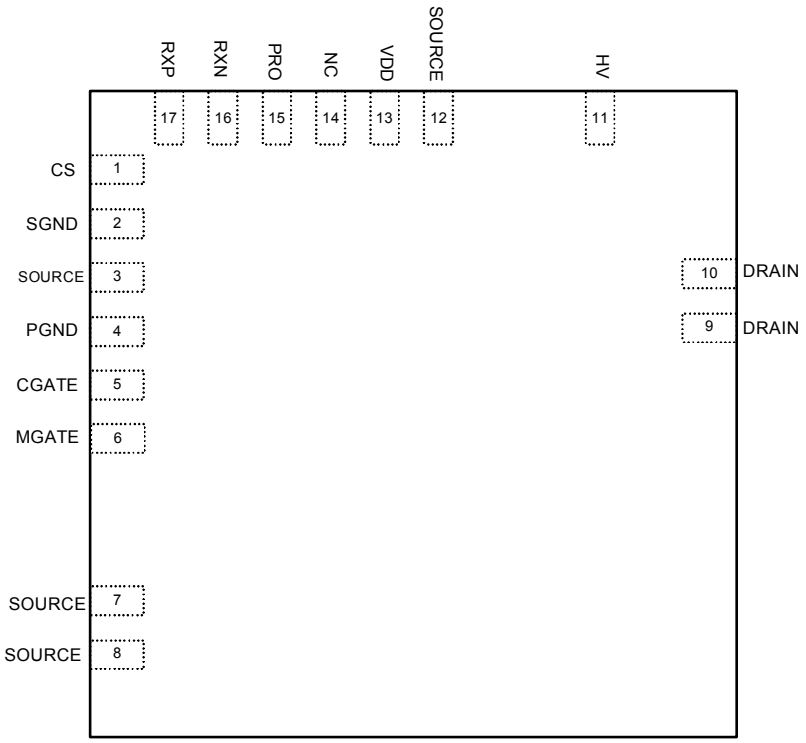


Ordering Information

Part Number	Ambient Temperature Range	Package	Environmental
AOZ7655QI-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.

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

V_{DD}=15V, T_A = -25°C to 85°C, unless otherwise specified.

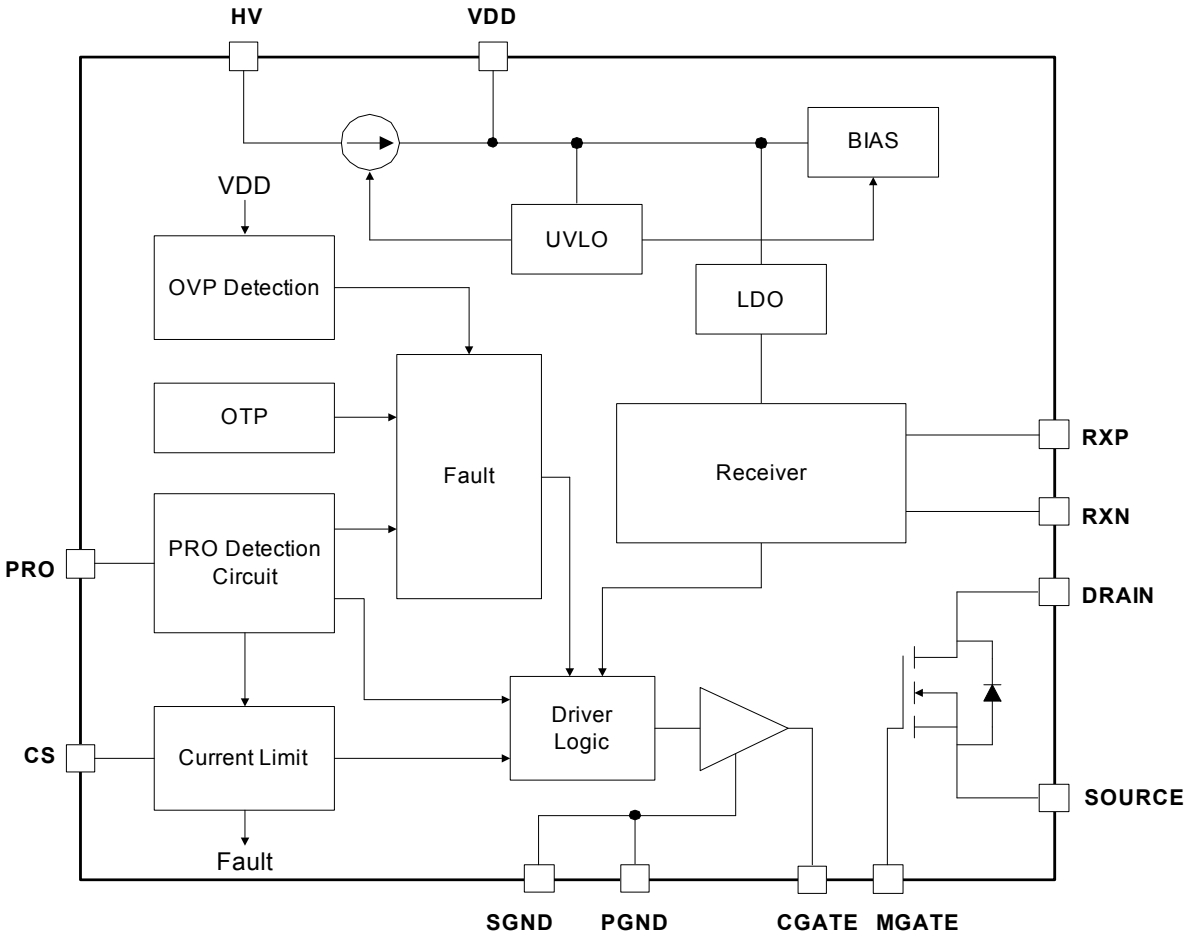
Symbol	Parameter	Conditions	Min	Typ	Max	Units
MOSFET						
$R_{DS(ON)}$	ON State Resistance	Static, I_{DRAIN} = 1A, V_{DD} = 10V, T_J = 25°C		0.33	0.4	Ω
HV						
I_{HV}	Supply Current from HV Pin	V_{HV} = 100V, V_{DD} = 0V, converter OFF		3.2	4.6	mA
I_{HV_LC}	Leakage Current from HV Pin	V_{HV} = 500V, 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	0.6	1.2	1.8	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
Protection Function						
V_{PRO_MIN}	Min. Clamp Voltage	I_{PRO} = -0.1mA	0.15	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

Electrical Characteristics *(Continued)*

V_{DD}=15V, T_A = -25°C to 85°C, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
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} = 120µA	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						
T_{SD}	Thermal Shutdown	T_J Rising		145		°C
T_{SDR}	Thermal Shutdown Recovery Threshold	T_J Falling		125		°C

Functional Block Diagram



Typical Characteristics

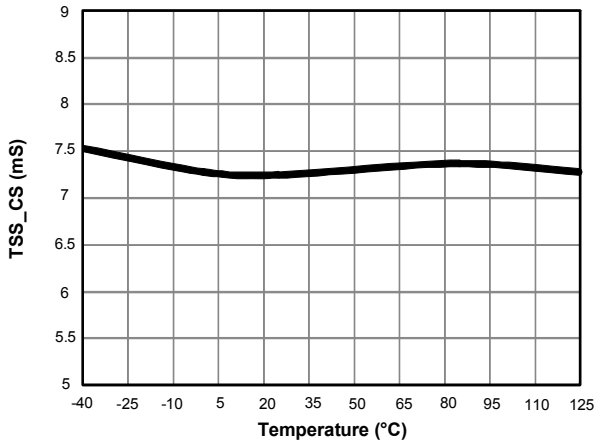


Figure 1. Soft Start Time for Current Limit vs. Temperature

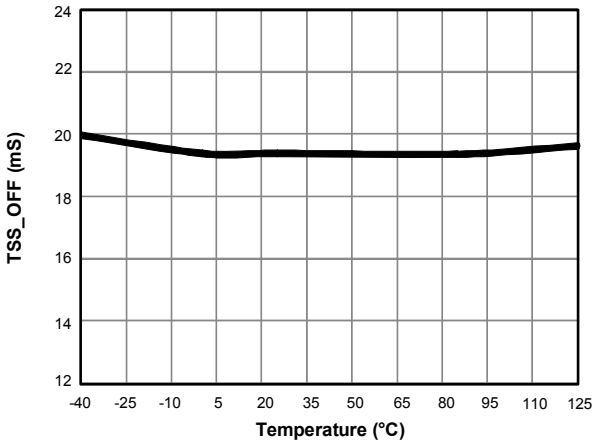


Figure 2. Soft Start Time for Shut Down vs. Temperature

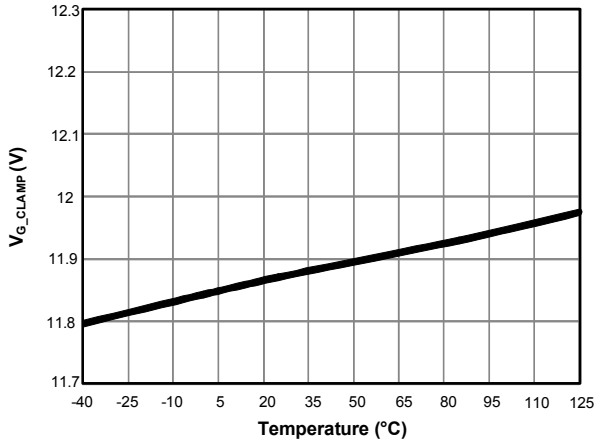


Figure 3. Gate Clamping Voltage vs. Temperature

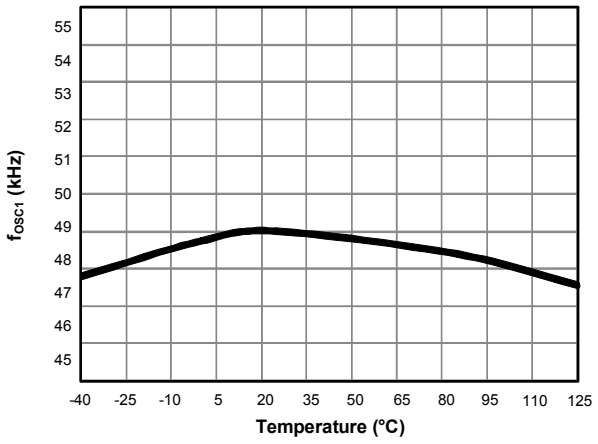


Figure 4. Minimum of the Start-up Operation Frequency vs. Temperature

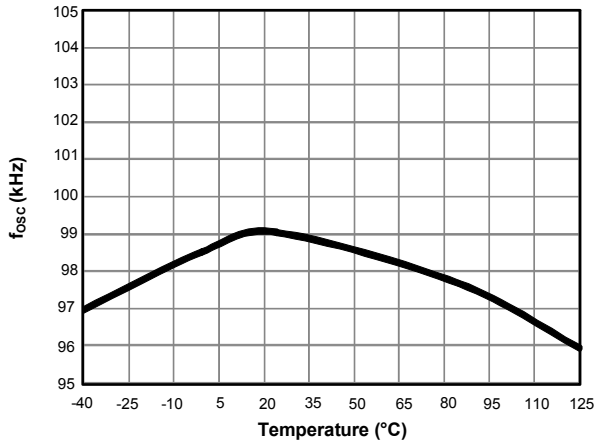


Figure 5. Maximum of the Start-up Operation Frequency vs. Temperature

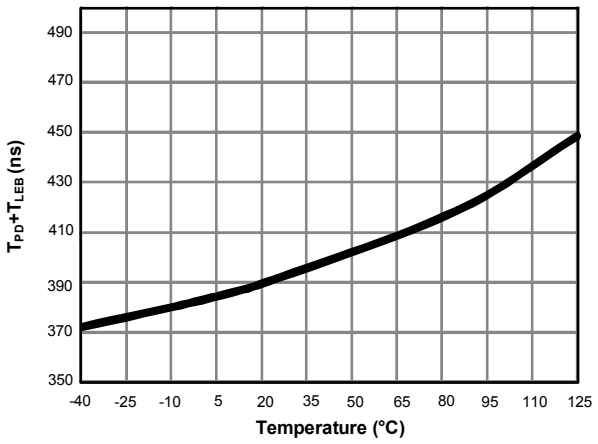


Figure 6. Minimum of the Turn-on Period vs. Temperature

Typical Characteristics

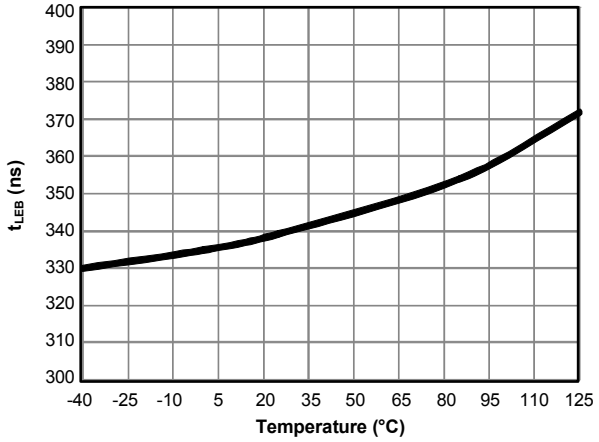


Figure 7. Leading Edge Blanking Time vs. Temperature

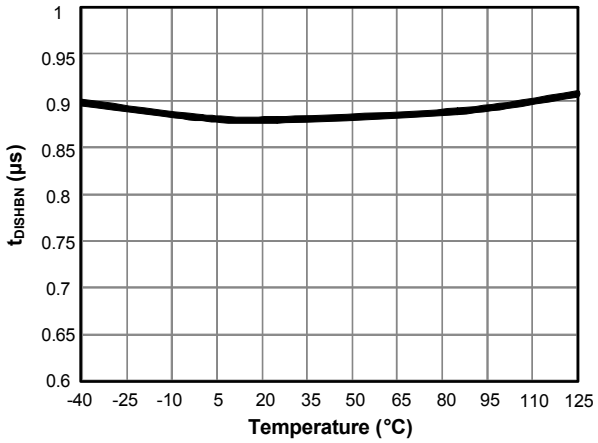


Figure 8. The Blanking Time of the Disable Voltage Level vs. Temperature

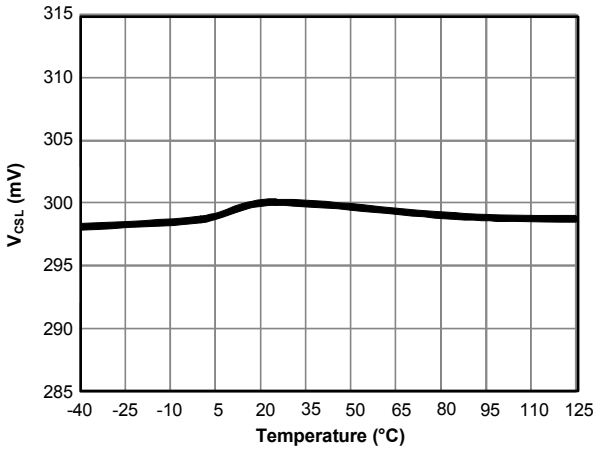


Figure 9. General Continuous Operation Current Sense Limit vs. Temperature

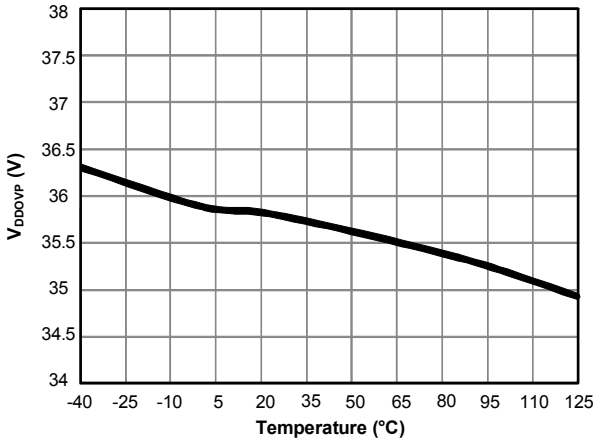


Figure 10. V_{DD} Over-Voltage Protection Level vs. Temperature

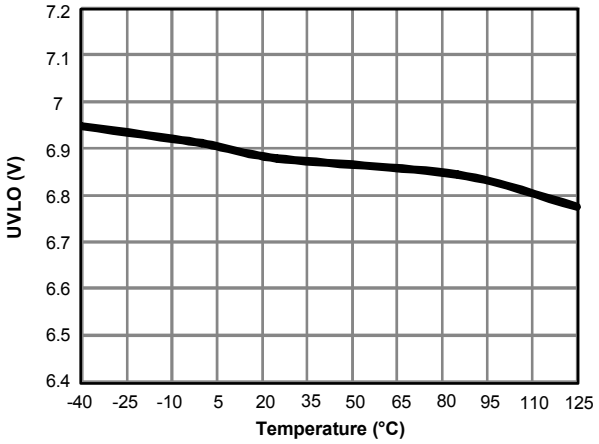


Figure 11. Turn-OFF and Under Voltage Lock Out vs. Temperature

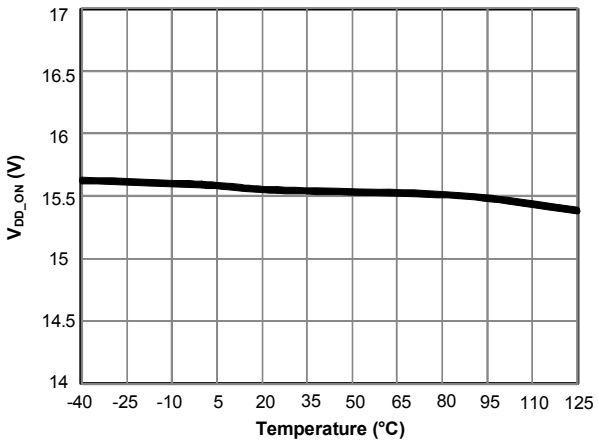


Figure 12. Turn-ON Threshold Voltage vs. Temperature

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 AOZ7655QI-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 AOZ7655QI-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 AOZ7655QI-13 never receives the ON time information from the secondary side converter, the AOZ7655QI-13 will be shut down after 18ms (t_{SS_OFF}) from start-up.

ON Time Receiver

The AOZ7655QI-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 AOZ7655QI-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.

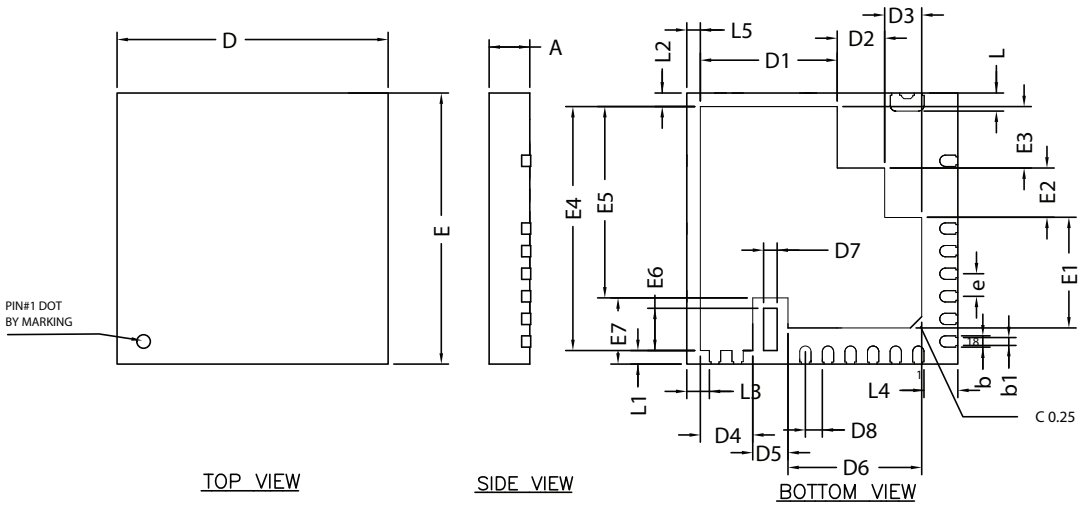
CS Pin Open-Circuit Protection

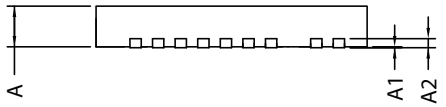
The CS pin features open-loop protection to pass the CS pin single fault testing. When the CS pin is opened, the CS will be pulled high by internal circuit and CS pin voltage will higher than V_{CSH} and the converter will be shut down after four consecutive cycles and then return to the start state.

Over-Temperature Protection

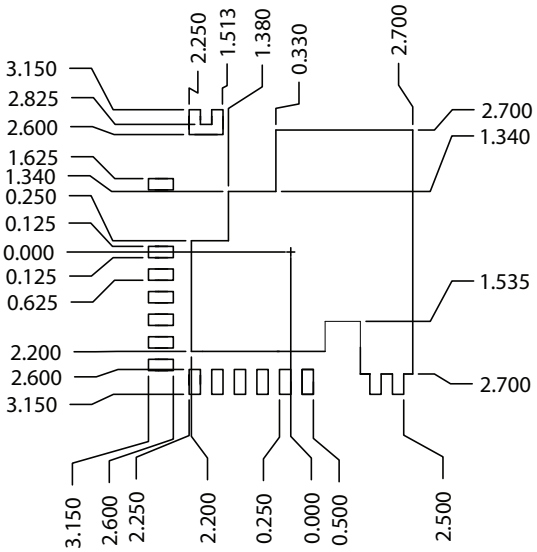
The AOZ7655QI-13 provides an internal OTP protection function. If the junction temperature reaches the OTP threshold, the AOZ7655QI-13 will stop switching until the junction temperature decreases below the OTP recovery temperature.

Package Dimensions, QFN6x6A-17L, EP1_S





RECOMMENDED LAND PATTERN



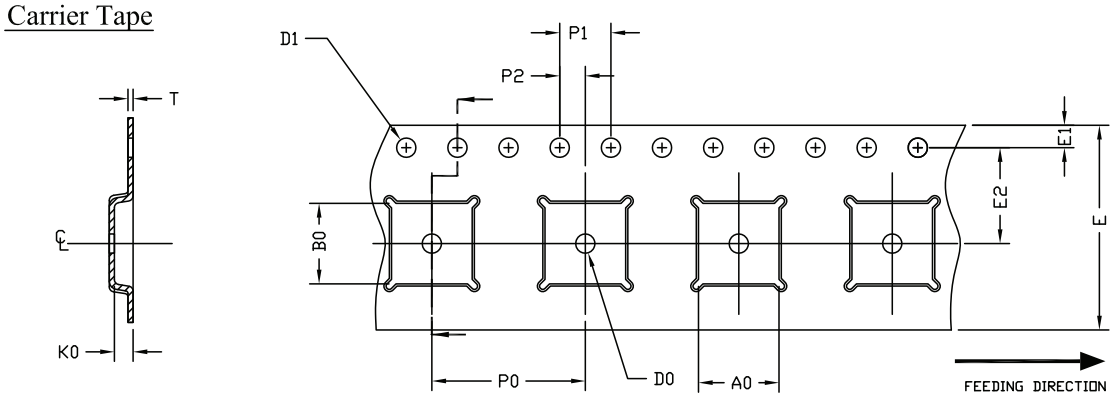
SYMBOLS	DIMENSION IN MM			DIMENSION IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.90	1.00	0.031	0.035	0.039
A1	0.00	-	0.05	0.000	-	0.002
A2		0.2REF			0.008REF	
E	5.90	6.00	6.10	0.232	0.236	0.240
D	5.90	6.00	6.10	0.232	0.236	0.240
D1	2.93	3.03	3.13	0.115	0.119	0.123
D2	0.95	1.05	1.15	0.037	0.041	0.045
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	

UNIT: mm

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

Tape and Reel, QFN6x6A-17L, EP1_S

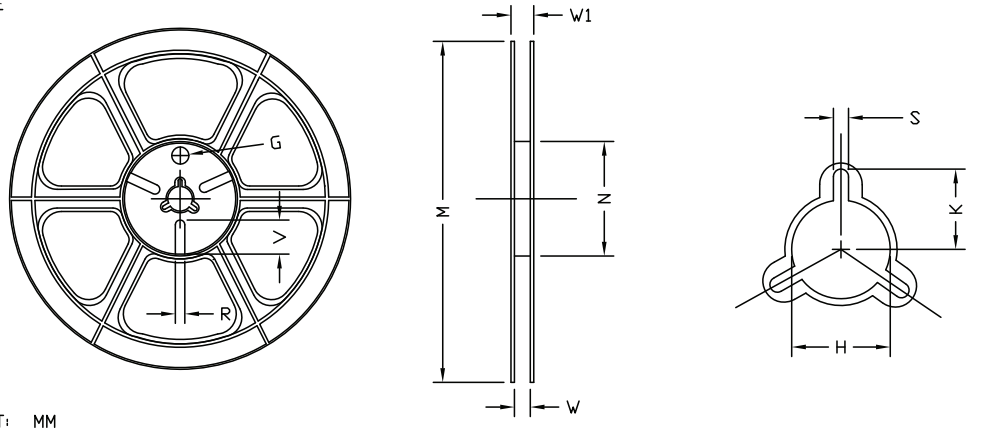
Carrier Tape



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

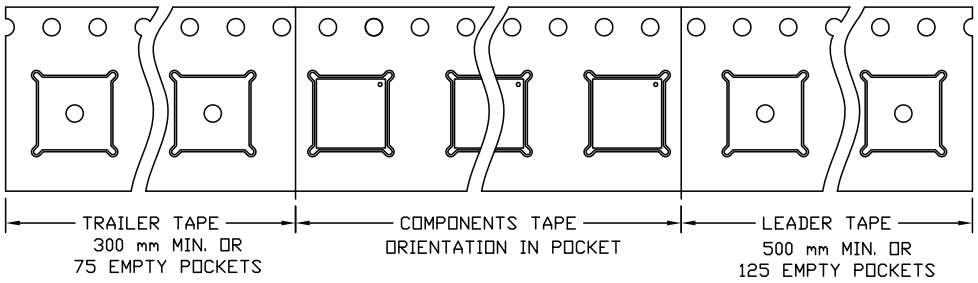


UNIT: MM

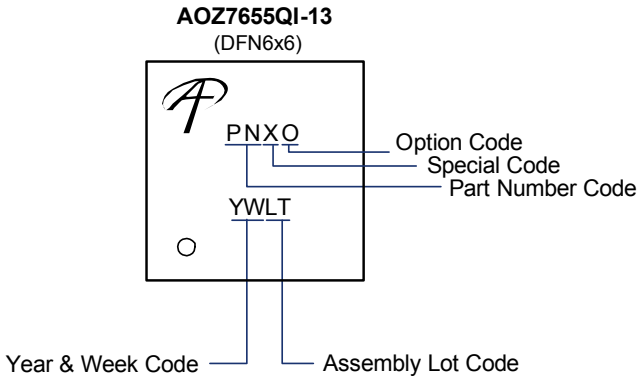
TAPE SIZE	REEL SIZE	M	N	W	W1	H	K	S	G	R	V
16 mm	ø330	ø330 MAX.	ø100 MIN.	16.4 +2.0 -0.0	22.4 MAX.	ø13.0 +0.5 -0.2	10.1 MIN.	1.5 MIN.	---	---	---

Tape

Leader / Trailer & Orientation



Part Marking



Part No.	Description	Code
AOZ7655QI	Green Product	BC0D