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## 2.4A/3.1A OUTPUT STEP-DOWN CONVERTER with DCP PROTOCOLS

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### 1 Features

- **Synchronous step-down converter**
  - Built-in Power MOSFETs
  - Wide Input Voltage Range, 8V to 32V
  - Output Voltage Range, 5V
  - Output Current, 2.4A/3.1A
  - Output Current Limit Protection
  - Conversion efficiency up to 92.4%
  - Soft-Start
  - Output Voltage Line Loss Compensation
- **Supports DCP(BC1.2, Apple, Samsung)**
- **Multiple Safety Protections**
  - Input Over-Current Protection, Output Over-Current Protection, Input Over/Under Voltage Protection, Short Circuit Protection
  - Over Temperature Protection
  - Input Voltage Withstand up to 40V
  - ESD 4KV

### 2 Application

- **Car Charger**
- **Charge Adapter**
- **Intelligent Power Hub**

### 3 Introduction

IP6536 is a synchronous step-down converter with built-in power MOSFETs. IP6536 supports DCP protocols (BC1.2, Apple and Samsung), providing total solution to car charger, charge adapter and intelligent power hub applications.

IP6536 exhibits CV/CC characteristics. The output in CV mode when the load current lower than current limit, otherwise in CC mode, in which the output voltage decreases as the load current increases.

IP6536 supports output voltage compensation due to the line loss. The output voltage increases as the load current increases.

IP6536 incorporates soft-start function to prevent the inrush current during start-up.

IP6536 incorporates multiple safety protections, such as input OV/UV, output OV/UV/OC and SC protection.

The package of IP6536 is ESOP8.

## 4. IP6536 Series Product Introduction

IC	REMARKS
IP6536	OCP is 2.4A; Dual DCP output
IP6536_2A4	OCP is 2.4A; Single DCP output
IP6536_3A1	OCP is 3.1A; Single DCP output

### NOTES:

The default function of PIN2 is LED, and the EN function needs to be customized.

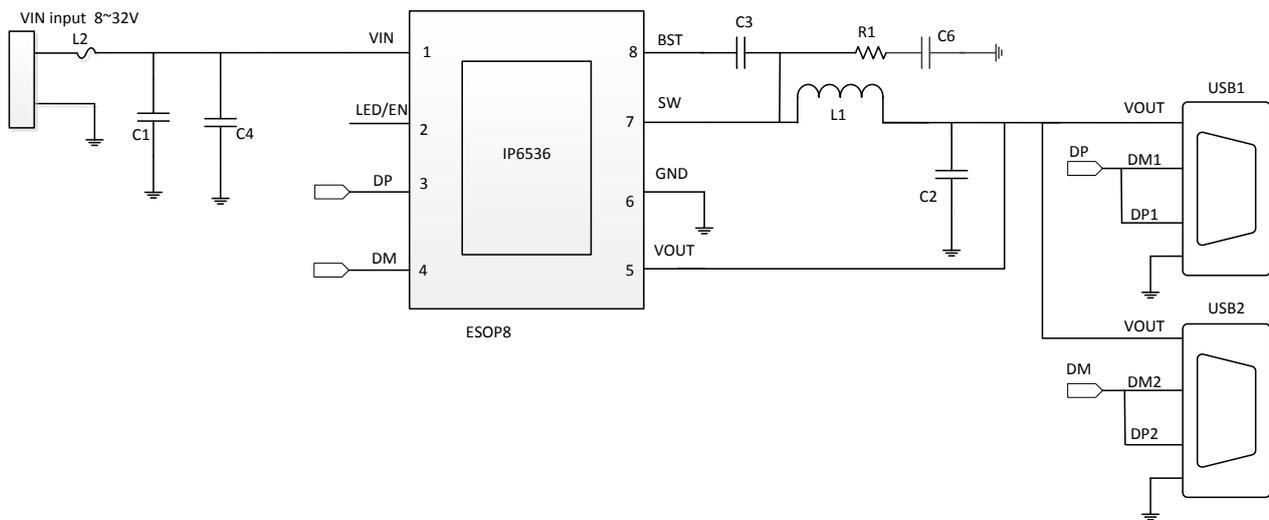


Fig. 1 IP6536 Simplified Schematic

## 5 PIN Definition

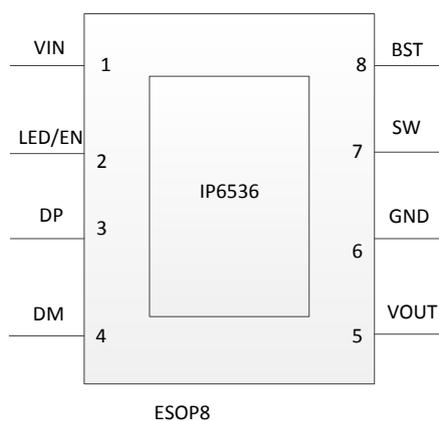


Fig. 2 IP6536 PIN Configuration

NO.	Name	Description
1	VIN	Input voltage node
2	LED/EN	LED function or EN function pin

3	DP	Connect to USB DP data line
4	DM	Connect to USB DM data line
5	VOUT	Output voltage feedback node
6	GND	Power ground
7	SW	Switching node of the DC-DC converter
8	BST	Bootstrap capacitor node
9(EPAD)	GND	Power and thermal ground

## 6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input voltage range	$V_{IN}$	-0.3 ~ 40	V
SW voltage range	$V_{LX}$	-0.3 ~ $V_{IN}+0.3$	V
DM/DP voltage range	$V_{DM/DP}$	-0.3 ~ 6	V
VOUT voltage range	$V_{vout}$	-0.3~8	V
Junction Temp range	$T_J$	-40 ~ 150	°C
Storage Temp range	Tstg	-60 ~ 150	°C
Thermal resistance (junction to ambient)	$\theta_{JA}$	40	°C/W
ESD (HBM)	ESD	4	KV

\* Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. Unless otherwise specified, all voltages are referenced to VSS pin.

## 7 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	$V_{IN}$	8	12/24	32	V

## 8 Electrical Characteristics

TA=25°C, L=33uH, C<sub>OUT</sub>=220uF E-cap(About 60mΩ ESR), VIN=12V, VOUT=5V, otherwise specified

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
<b>Input System</b>						
Input voltage	V <sub>IN</sub>		8	12	32	V
Input under voltage threshold	V <sub>IN-UV</sub>			8.1		V
		hysteresis		0.3		V
Input over voltage threshold	V <sub>IN-OV</sub>			32		V
		hysteresis		0.2		V
Input quiescent current	I <sub>Q</sub>	VIN=12V, VOUT=5V@0A		5		mA
<b>Converter System</b>						
High side MOSFET on resistance	R <sub>DS(ON)</sub>			100		mΩ
Low side MOSFET on resistance	R <sub>DS(ON)</sub>			80		mΩ
Switching frequency	F <sub>SW</sub>			150		KHz
<b>Output System</b>						
Output voltage	V <sub>OUT</sub>		4.75	5	5.25	V
Output voltage ripple	ΔV <sub>OUT</sub>	VIN=12V, VOUT=5V@3A		150		mV
Soft-start time	T <sub>SS</sub>	VIN=12V, VOUT=5V		1		ms
Line loss compensation	V <sub>COMP</sub>	VIN=12V, VOUT=5V, IOUT=3A		120		mV
Current limit in CC mode	I <sub>OUT</sub>	VIN=12V, VOUT=5V		3.1		A
Output hiccup restart voltage	V <sub>OUT</sub>	When output enters CC mode, output hiccup restart voltage		3.7		V
Thermal shutdown Temp.	T <sub>OTP</sub>			150		°C
Thermal shutdown Temp. hysteresis	ΔT <sub>OTP</sub>			40		°C

## 9 Detailed Description

### Synchronous Step-Down Converter

The IP6536 is a synchronous step-down converter with built-in power MOSFETs. .IP6536 supports wide input voltage range (8-32V) and 5V output at 3.1A Max. load current. The switching frequency is 150KHz. The conversion efficiency is up to 92.4% at  $V_{IN}=12V$ ,  $V_{OUT}=5V@2.4A$ .

The efficiency under different input voltage and load current is shown in Fig. 3. Fig. 4 shows the output voltage characteristics under different load current.

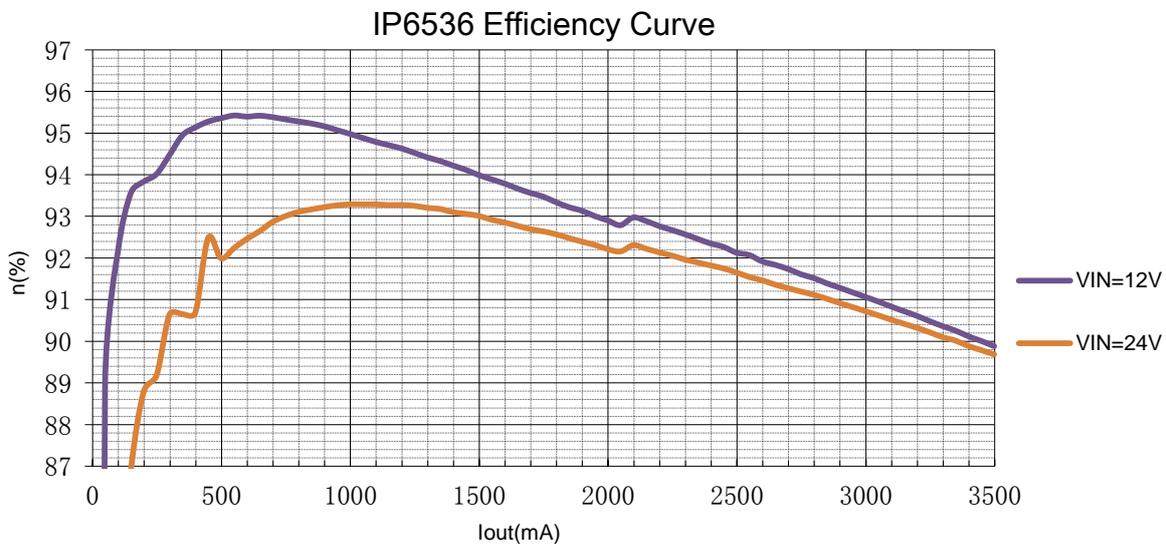


Fig. 3 IP6536 Conversion Efficiency

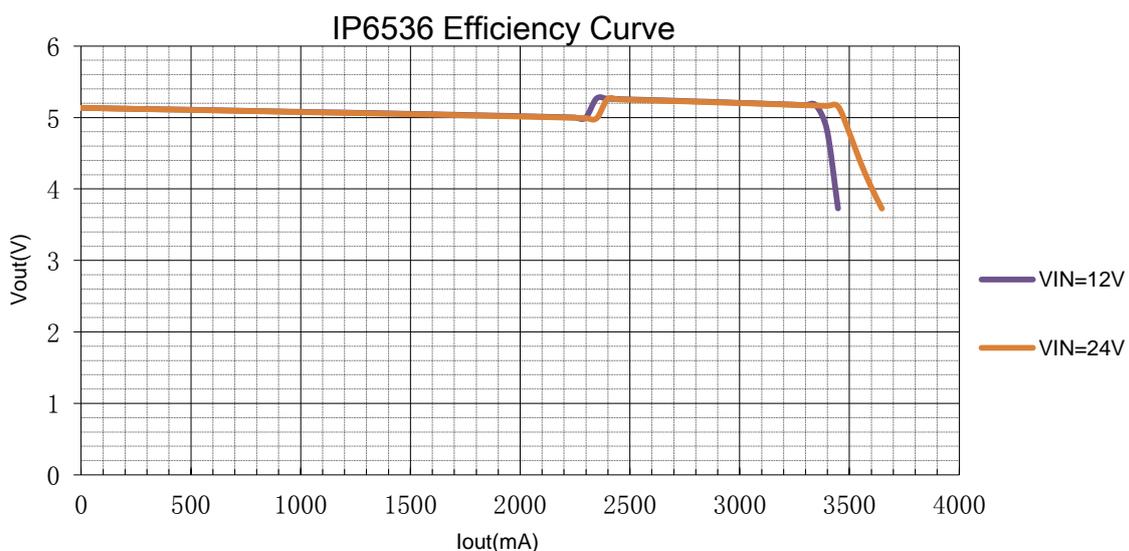


Fig.4 IP6536 Output Voltage Characteristics

## Output Voltage Line Loss Compensation

IP6536 supports output line loss compensation. The output voltage with 3A load is higher 120mV than the voltage without load.

## CC/CV Characteristics

IP6536 exhibits CV/CC characteristics. The output in CV mode when the load current lower than current limit, otherwise in CC mode, in which the output voltage decreases as the load current increases.

## Protections

IP6536 monitors voltage on VIN. If the voltage is lower than 8.1V, IP6536 enters standby mode, and shuts down the converter. If the voltage is higher than 32V, IP6536 detects over voltage, and then shuts down the converter. When VIN decreases 0.2V lower than the over voltage threshold, IP6536 resumes the output voltage.

IP6536 also monitors voltage on VOUT. If the voltage is lower than 3.7V, IP6536 detects output under voltage, and then shuts down the converter. During output under voltage protection, IP6536 enters hiccup mode, and restarts the converter every 2 seconds.

IP6536 incorporates short circuit protection. After 8ms from start-up, if VOUT is lower than 3.7V, IP6536 detects output short circuit, then shutting down the converter, and enters hiccup mode. IP6536 restarts the converter every 2 seconds.

IP6536 detects over temperature when the chip temperature is higher than 150°C. IP6536 shuts down the converter and restarts the every 2 seconds. When the chip temperature decreases below 110°C, IP6536 returns to normal state.

## Charge Protocols

IP6536 supports DCP (BC1.2, Apple, Samsung).

## 10 Typical Application

Fig.5 shows the typical application schematic.

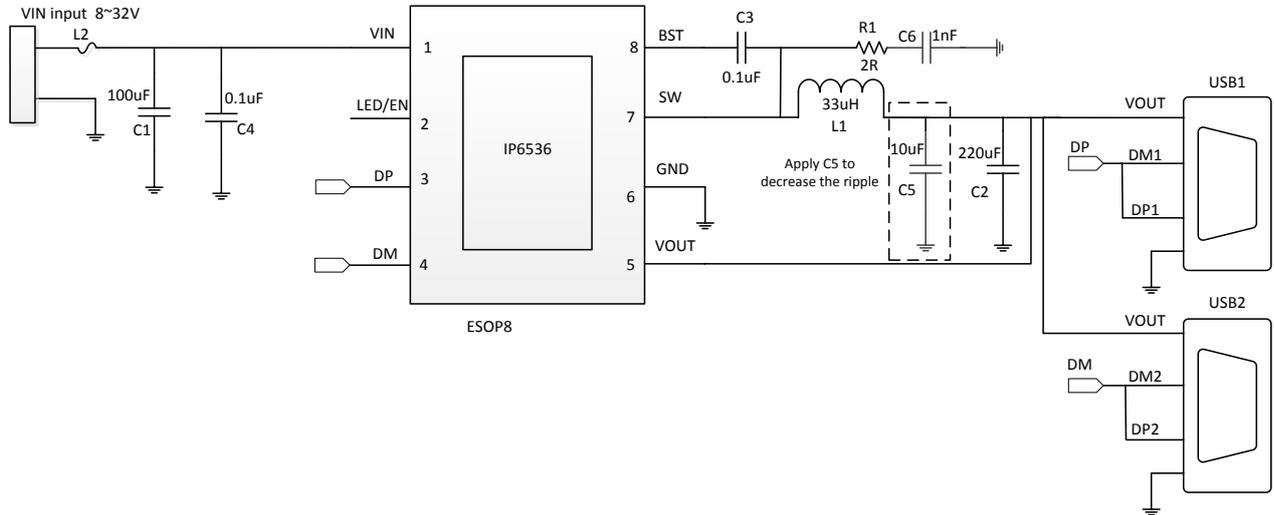


Fig. 5 IP6536 Application Schematic

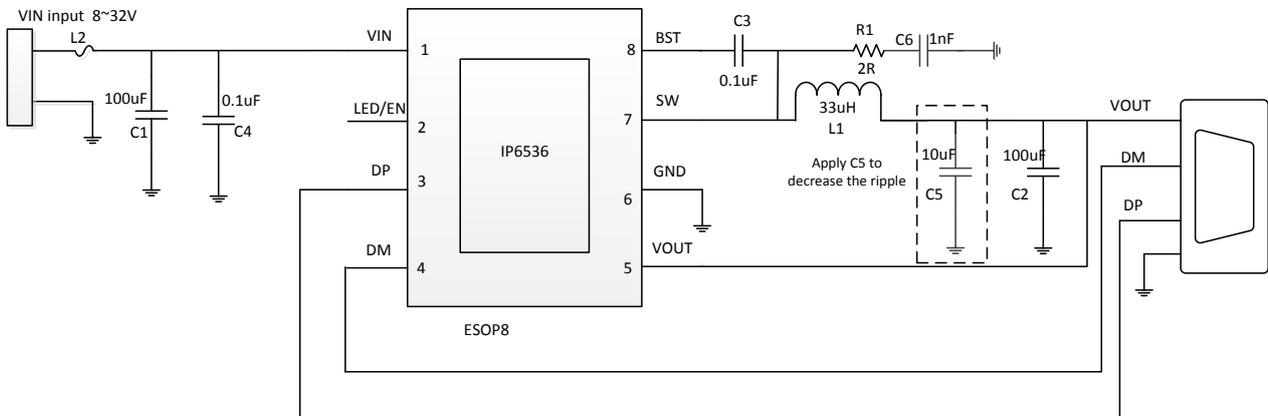


Fig. 6 IP6536\_2A4 and IP6536\_3A1 Application Schematic

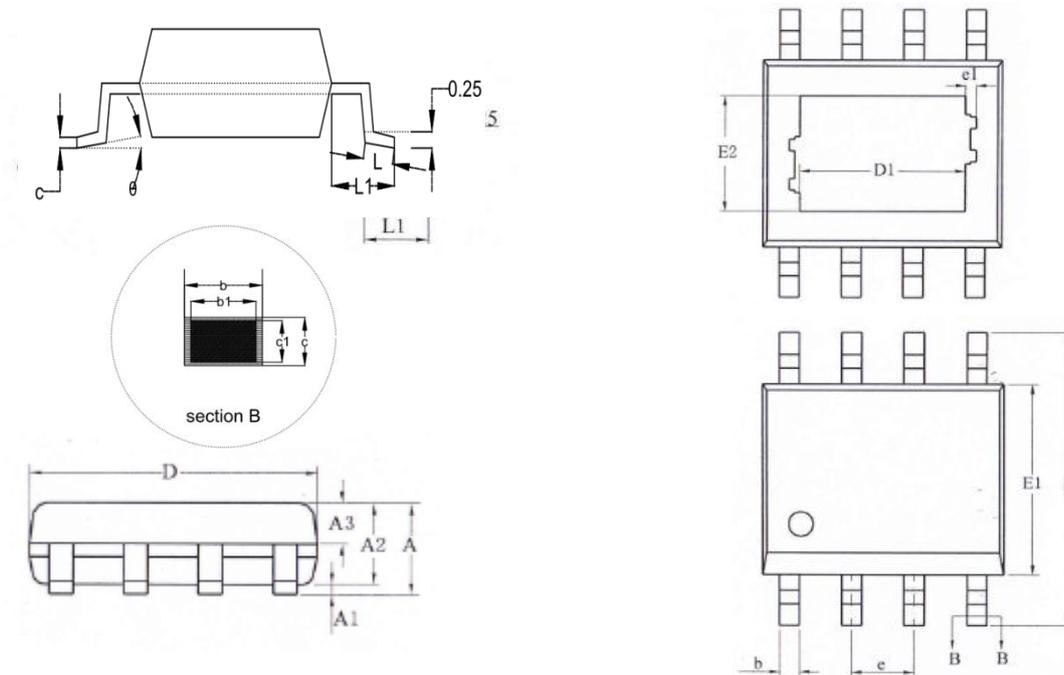
## 11 BOM

NO.	Device	Spec.	Unit	Counts	Designator	备注
1	IC	IP6503	PCS	1	U1	
2	electrolytic capacitor	100uF/35v	PCS	1	C1	Withstand voltage higher than 35V
3	electrolytic capacitor	100uF/16v	PCS	1	C2	Withstand voltage higher than 16V To decrease ripple, C2 is 220uF
4	SMT capacitor	0603 0.1uF 10%	PCS	1	C3	Withstand voltage higher than 10V
5	SMT capacitor	0603 0.1uF 10%	PCS	1	C4	Withstand voltage higher than 35V
6	Inductor	33uH+/-20%, current 4.5A DCR<12mohm	PCS	1	L1	
7	SMT resistor	0603 2R 5%	PCS	1	R1	
8	SMT capacitor	0603 10uF 10%	PCS	1	C5	Withstand voltage higher than 16V To decrease the ripple, apply C5, otherwise C5 NC.
9	SMT capacitor	0603 1nF 10%	PCS	1	C6	Withstand voltage higher than 35V
10	FUSE	L2	PCS	1	L2	Current 3A

## 12 IP Series Product Selection Table

IC 型号	放电 电流	双 路	支持的协议										封装		
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	规格	兼 容	
IP6502	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	SOP8	PIN2PIN
IP6503	3.1A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6503_2A4	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6503S	3.1A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
IP6503S_2A4	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6523S	3.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6536	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6536_2A4	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6536_3A1	3.1A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6505	24W	-	√	√	√	√	√	√	√	√	√	-	-	ESOP8	PIN2PIN
IP6505T	24W	-	√	√	√	√	√	√	√	√	√	-	-	ESOP8	
IP6525T	18W	-	√	√	√	√	-	√	-	-	-	-	-	ESOP8	
IP6510	18W	-	√	√	√	√	-	√	-	-	√	-	-	ESOP8	
IP6518C	36W	-	√	√	√	√	√	√	√	√	√	√	-	QFN24	PIN2PIN
IP6518	45W	-	√	√	√	√	√	√	√	√	√	√	-	QFN24	
IP6515	4.8A	√	√	-	-	-	-	-	-	-	-	-	-	QFN32	
IP6528_CC	27W	√	√	√	√	√	-	√	√	-	√	√	√	QFN32	PIN2PIN
IP6528_AC_H	27W	√	√	√	√	√	-	√	√	-	√	√	√	QFN32	
IP6528_AA_H	24W	√	√	√	√	√	-	√	√	-	-	-	-	QFN32	
IP6527_A	24W	-	√	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN
IP6527_C	27W	-	√	√	√	√	-	√	√	-	√	-	-	QFN32	

## 13 Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.47
b1	0.38	0.41	0.44
c	0.20	--	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	--	0.50
L	0.50	0.60	0.80
L1	1.05REF		
$\theta$	0	--	8°
D1	--	2.09REF	--
E2	--	2.09REF	--

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