

HIGH-TEMPERATURE FAMILY OF N-CHANNEL POWER MOSFET WITH DRIVER

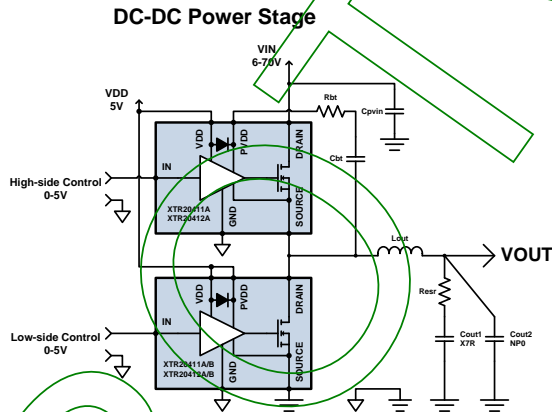
FEATURES

- ▲ Operation as low-side or high-side switch.
- ▲ Input-to-output stages offset voltage from -40V to +40V.
- ▲ Operational beyond the -60°C to +230°C temperature range.
- ▲ Standard Schmitt-trigger CMOS input.
- ▲ Plug-and-play with any digital 5V output.
- ▲ Low R_{ON}
 - XTR20411: 540 mΩ @ 230°C
 - XTR20412: 210 mΩ @ 230°C
- ▲ Maximum I_D :
 - XTR20411: 5A @ 230°C
 - XTR20412: 12A @ 230°C
- ▲ On-time ($t_{d-On}+t_r$):
 - XTR20411: 70nsec @ 230°C
 - XTR20412: 90nsec @ 230°C
- ▲ Off-time ($t_{d-Off}+t_f$):
 - XTR20411: 50nsec @ 230°C
 - XTR20412: 60nsec @ 230°C
- ▲ Monolithic design.
- ▲ Latch-up free.
- ▲ Ruggedized 6-lead TO257 and ceramic side braze DIP8 packages.
- ▲ Also available as bare die.

APPLICATIONS

- ▲ Reliability-critical, Automotive, Aeronautics & Aerospace, Down-hole.
- ▲ DC/DC converters, switching power supplies, switching control.

PRODUCT HIGHLIGHT

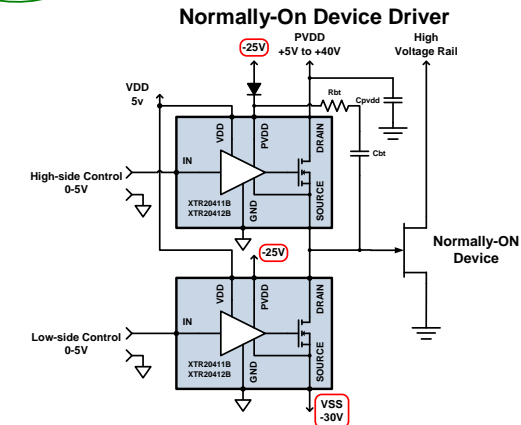


DESCRIPTION

XTR20410 is a family of extremely flexible power N-channel MOSFETs with integrated driver designed for extreme reliability and temperature applications such as DC/DC converters and switching applications. XTR20410 parts can be used either as low-side or high-side switches, while receiving a control input signal referenced to GND. The integrated level shifter operates with both negative and positive offsets (-40V to +40V) between the control and the output stages.

XTR20410 parts can be directly driven by any 5V digital output, making them fully plug-and-play devices. The internal power driver is optimized for the output transistor, so that the user has no need to perform any time consuming optimization of the matching network between driver and power transistor. Especial design techniques were used allowing the XTR20410 parts to offer a precise, robust and reliable operation in critical applications. Full functionality is guaranteed from -60°C to +230°C, though operation well below and above this temperature range is achieved.

XTR20410 family parts have been designed to reduce system cost and ease adoption by reducing the learning curve and providing smart and easy to use features. Parts from the XTR20410 family are available in ruggedized 6-lead TO257 and ceramic side braze DIP8 packages, as well as bare dies.



ORDERING INFORMATION



Product Reference	Temperature Range	Package	Pin Count	Marking
XTR20411-BD	-60°C to +230°C	Bare die		XTR20411
XTR20412-BD	-60°C to +230°C	Bare die		XTR20412
XTR20411A-D	-60°C to +230°C	Ceramic side braze DIL	8	XTR20411A
XTR20411A-T	-60°C to +230°C	TO257	6	XTR20411A
XTR20412A-T	-60°C to +230°C	TO257	6	XTR20412A
XTR20411B-D	-60°C to +230°C	Ceramic side braze DIL	8	XTR20411B
XTR20411B-T	-60°C to +230°C	TO257	6	XTR20411B
XTR20412B-T	-60°C to +230°C	TO257	6	XTR20412B

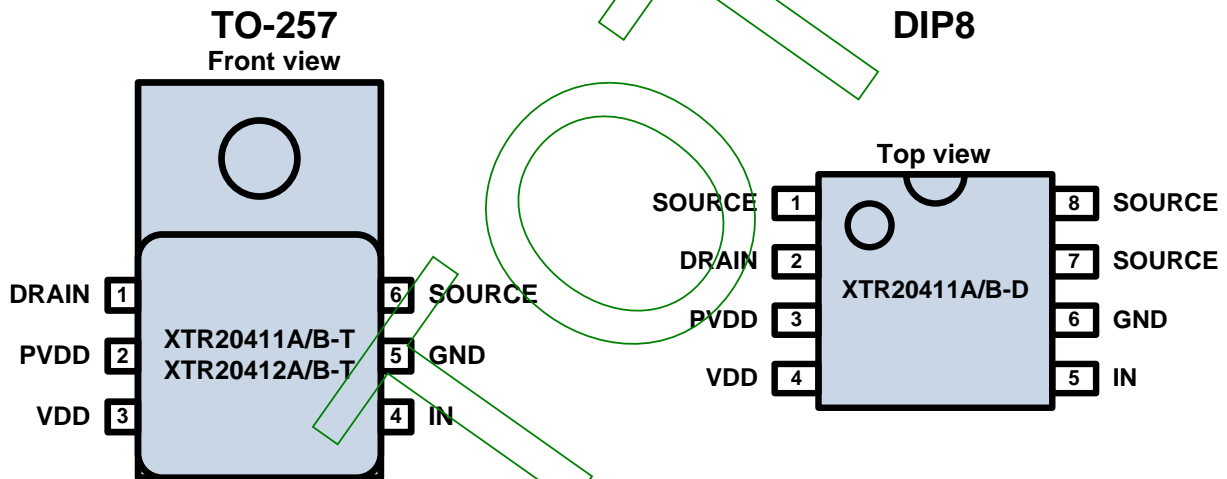
Other packages and packaging configurations possible upon request.

ABSOLUTE MAXIMUM RATINGS

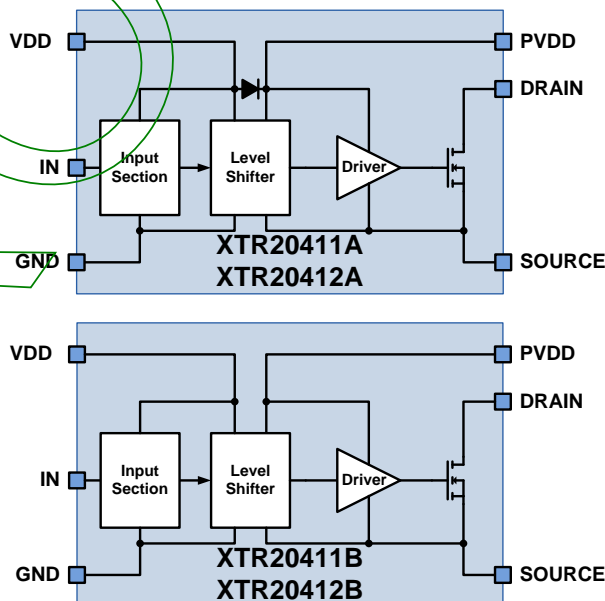
Voltage on DRAIN to SOURCE	-1.5 to 50V
Voltage on IN and VDD to GND	-0.5 to 6.0V
Voltage on PVDD to SOURCE	-0.5 to 6.0V
Voltage on PVDD to VDD for XTR20411A and XTR20412A	-0.5 to 50V
Voltage on PVDD to VDD for XTR20411B and XTR20412B	-50V to 50V
Storage Temperature Range	-70°C to +230°C
Operating Junction Temperature Range	-70°C to +300°C
ESD Classification	1kV HBM MIL-STD-883

Caution: Stresses beyond those listed in "ABSOLUTE MAXIMUM RATINGS" may cause permanent damage to the device. These are stress ratings only and functionality of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to "ABSOLUTE MAXIMUM RATINGS" conditions for extended periods may permanently affect device reliability.

PRODUCT VARIANTS



BLOCK DIAGRAM



PIN DESCRIPTION

Pin Number		Name	Description
DIP8	TO-257		
1	—	SOURCE	Source of the power NMOS transistor.
2	1	DRAIN	Drain of the power NMOS transistor.
3	2	PVDD	Supply voltage of power section. Referenced to SOURCE.
4	3	VDD	Supply voltage of the input section. Referenced to GND.
5	4	IN	Input signal. Referenced to GND.
6	5	GND	Circuit ground.
7	6	SOURCE	Source of the power NMOS transistor.
8	—	SOURCE	Source of the power NMOS transistor.

RECOMMENDED OPERATING CONDITIONS

Parameter	Min	Typ	Max	Units
Supply voltage VDD to GND	4.5		5.5	V
Supply voltage PVDD to SOURCE	3.5		5.5	V
Voltage on PVDD to VDD				
XTR20411A and XTR20412A	0		40	V
XTR20411B and XTR20412B	-40		40	V
Voltage on IN to GND	-0.3		VDD	V
DRAIN-SOURCE Voltage V_{DS}	-1		+40	V
Junction Temperature ¹ T_j	-60		230	°C

¹ Operation beyond the specified temperature range is achieved with little degradation on electrical parameters.

THERMAL CHARACTERISTICS

Parameter	Condition	Min	Typ	Max	Units
XTR20411A/B					
Thermal Resistance: J-C R_{Th_J-C}			10		°C/W
Thermal Resistance: J-A R_{Th_J-A}			50		°C/W
XTR20412A/B T					
Thermal Resistance: J-C R_{Th_J-C}			5		°C/W
Thermal Resistance: J-A R_{Th_J-A}			45		°C/W

ELECTRICAL SPECIFICATIONS XTR20411A/B

STATIC CHARACTERISTICS

Unless otherwise stated, VDD=5V, PVDD=5V, GND=SOURCE, IN=0V, V_{DS}=20V, I_{DRAIN}=1A, -60°C<T_j<230°C.

Parameter	Condition	Min	Typ	Max	Units
Supply Current					
Static VDD Supply Current I _{VDD_Sta}	V _{IN} =GND or VDD			25	μA
Static PVDD Supply Current I _{PVDD_Sta}	V _{IN} =GND or VDD			70	μA
Control INPUT					
Input Low voltage V _{IL}			2.16	2	V
Input High voltage V _{IH}		3.7	3.49		V
Input current I _{IN}	V _{IN} =GND or VDD T _j =25°C T _j =230°C			0.1 50	nA
Output Transistor					
Drain-Source Breakdown Voltage V _{(BR)DSS}	T _j =25°C	55V			V
Off-State Drain Current I _{DSS}	For V _{IN} =GND and V _{DS} =40V. T _j =25°C T _j =230°C			0.002 25	μA
Static ON Resistance R _{DSon}	I _{DRAIN} =1A T _j =25°C T _j =230°C		250 540		mΩ
Source-Drain Body Diode					
Continuous Forward Current I _{BD}		1			A
Forward Voltage V _{BD}	I _{DRAIN} =0.4A T _j =25°C T _j =230°C		TBD TBD		V
Bootstrap Diode (XTR20411A only)					
Continuous Forward Current I _{BSTD}		1			A
Forward Voltage V _{BSTD}	I _{DIODE} =1A T _j =25°C T _j =230°C		TBD TBD		V

DYNAMIC CHARACTERISTICS

Unless otherwise stated, VDD=5V, PVDD=5V, GND=SOURCE, IN=0V, V_{DS}=20V, I_{DRAIN}=1A, -60°C<T_j<230°C.

Parameter	Condition	Min	Typ	Max	Units
Supply Current					
Dynamic VDD Supply Current I _{PVDD_Dyn}	For Freq V _{IN} =1MHZ and duty cycle=50%			40	μA
Dynamic PVDD Supply Current I _{VDD_Dyn}	For Freq V _{IN} =1MHZ and duty cycle=50%			3	mA
I_{DRAIN} peak					
Peak Drain current I _{Dpeak}	2μs pulse T _j =25°C T _j =230°C		8 5		A
Switching Time					
Delay ON Time T _{d(ON)}	T _j =25°C T _j =230°C		37 48		ns
Rise Time T _r	T _j =25°C T _j =230°C		13 22		ns
Delay OFF Time T _{d(OFF)}	T _j =25°C T _j =230°C		30 37		ns
Fall Time T _f	T _j =25°C T _j =230°C		10 13		ns

ELECTRICAL SPECIFICATIONS XTR2412A/B

STATIC CHARACTERISTICS

Unless otherwise stated, VDD=5V, PVDD=5V, GND=SOURCE, IN=0V, VDS=20V, IDRAIN=2.5A, -60°C<Tj<230°C.

Parameter	Condition	Min	Typ	Max	Units
Supply Current					
Static VDD Supply Current I _{VDD_Sta}	V _{IN} =GND or VDD			25	μA
Static PVDD Supply Current I _{PVDD_Sta}	V _{IN} =GND or VDD			90	μA
Control INPUT					
Input Low voltage V _{IL}			2.16	2	V
Input High voltage V _{IH}		3.7	3.49		V
Input current I _{IN}	V _{IN} =GND or VDD T _j =25°C T _j =230°C			0.1 50	nA
Output Transistor					
Drain-Source Breakdown Voltage V _{(BR)DSS}	T _j =25°C	55V			V
Off-State Drain Current I _{DSS}	For V _{IN} =GND and V _{DRAIN} =40V T _j =25°C T _j =230°C			0.005 60	μA
Static ON Resistance R _{DSon}	I _{DRAIN} =2.5A T _j =25°C T _j =230°C		100 210		mΩ
Source-Drain Body Diode					
Continuous Forward Current I _{BD}		2.5			A
Forward Voltage V _{BD}	I _{DRAIN} =1A T _j =25°C T _j =230°C		TBD TBD		V
Bootstrap Diode (XTR20412A only)					
Continuous Forward Current I _{BSTD}		1			A
Forward Voltage V _{BSTD}	I _{DIODE} =1A T _j =25°C T _j =230°C		TBD TBD		V

DYNAMIC CHARACTERISTICS

Unless otherwise stated, VDD=5V, PVDD=5V, GND=SOURCE, IN=0V, VDS=20V, IDRAIN=2.5A, -60°C<Tj<230°C.

Parameter	Condition	Min	Typ	Max	Units
Supply Current					
Dynamic VDD Supply Current I _{PVDD_Dyn}	For Freq V _{IN} =1MHZ and duty cycle=50%			40	μA
Dynamic PVDD Supply Current I _{VDD_Dyn}	For Freq V _{IN} =1MHZ and duty cycle=50%			7	mA
I_{DRAIN} peak					
Peak Drain current I _{Dpeak}	2μs pulse T _j =25°C T _j =230°C		20 12		A
Switching Time					
Delay ON Time T _{d(ON)}	T _j =25°C T _j =230°C		39 50		ns
Rise Time T _r	T _j =25°C T _j =230°C		24 40		ns
Delay OFF Time T _{d(OFF)}	T _j =25°C T _j =230°C		33 40		ns
Fall Time T _f	T _j =25°C T _j =230°C		17 20		ns

THEORY OF OPERATION

Introduction

The XTR20410 is a family of N-channel power MOS transistors with integrated driver able to operate from -60°C to +230°C. Unique features of this product family make them an extremely flexible block when designing power switching applications.

Parts from the XTR20410 are divided into two variants depending upon the range of the common mode voltage of the output stage with respect to the input stage.

Devices XTR20411A and XTR20412A accept output common modes from 0V to 40V and include a high-current diode from VDD (input stage) to PVDD (output stage) which can be used as bootstrap diode when using these parts as high-side drivers.

On the other side, devices XTR20411B and XTR20412B accept output common modes from -40V to +40V. In this case the PVDD supply voltage must be provided by an independent supply.

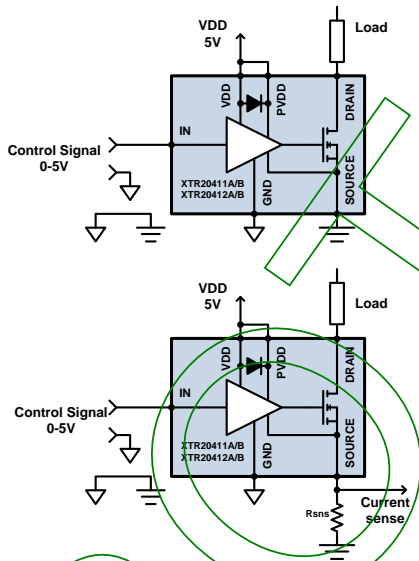
Level shifting is performed within the XTR20410 parts. A unique feature of these devices is the possibility to shift the output signal to positive and negative levels of the output stage.

Operation Modes

Low-side mode (SOURCE=0V)

In low-side mode operation, the SOURCE terminal is either directly tied to ground or through a small current sense resistor. In this mode both variants (A and B) can be used as VDD and PVDD must be shorted.

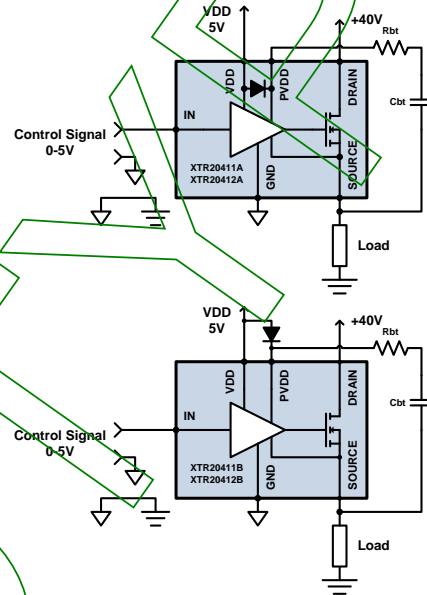
The use of power and a signal ground planes connected on a unique point as well as proper layout techniques is recommended.



High-side mode

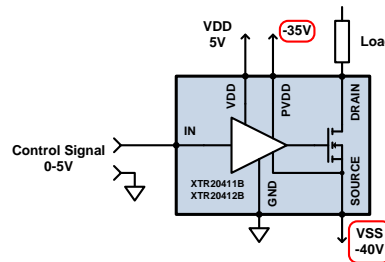
Operation in high-side mode can be obtained with both product variants (A and B). When using variant A, the bootstrap diode is already provided within the XTR20410 parts between VDD and PVDD terminals.

In high-side mode the drain of the power transistor is directly tied to the input voltage while the load is seen on the transistor source.



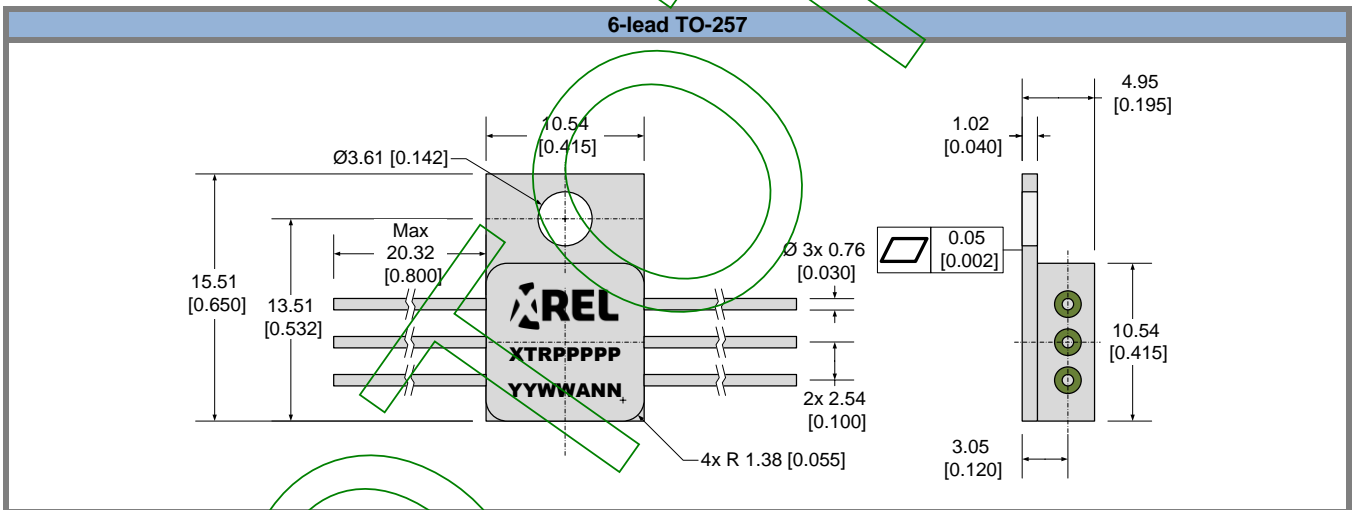
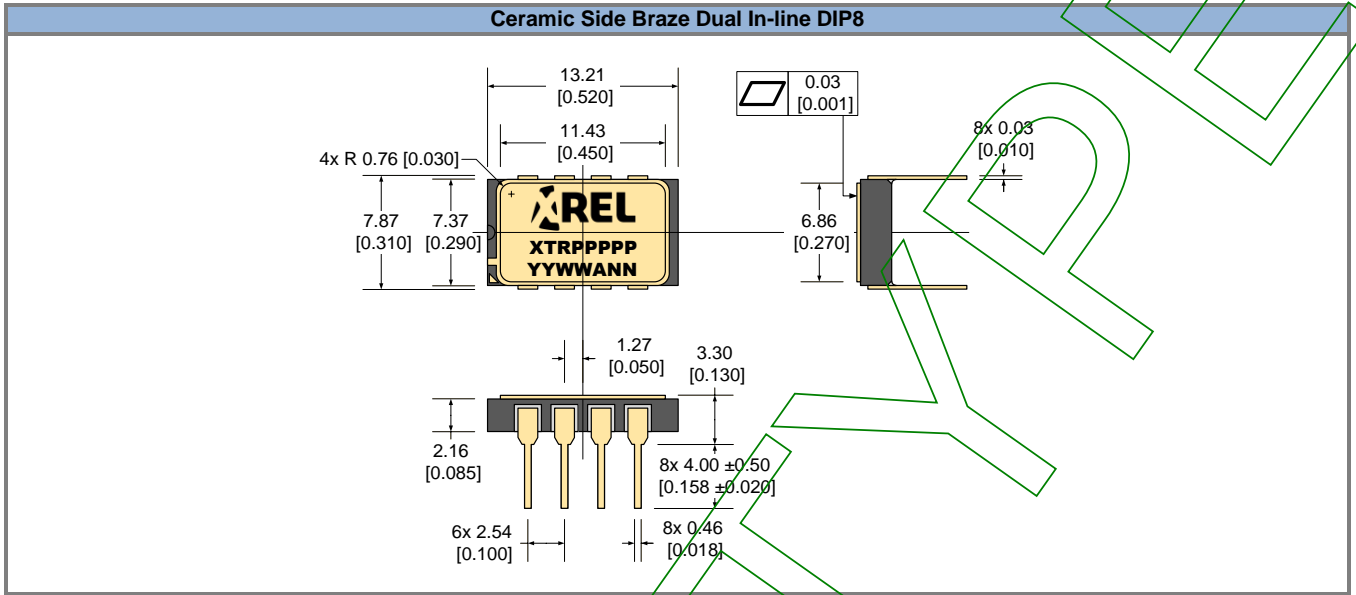
Floating mode

This operation mode can only be achieved with the B variant, allowing the output stage to be shifted to negative as well as to positive levels (from -40V to +40V) with respect to the input stage. In this case a source must provide a 5V supply voltage between PVDD and SOURCE.



PACKAGE OUTLINES

Dimensions shown in mm [inches].



Part Marking Convention

Part Reference: XTRPPPPPP

XTR	X-REL Semiconductor, high-temperature, high-reliability product (XTRM Series).
PPPPPP	Part number (0-9, A-Z).

Unique Lot Assembly Code: YYWWANN

YY	Two last digits of assembly year (e.g. 12 = 2012).
WW	Assembly week (01 to 52).
A	Assembly location code.
NN	Assembly lot code (01 to 99).

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