Ultrahigh Threshold Voltage Depletion-Mode Power MOSFET

General Features

- ESD Improved Capability
- Depletion Mode (Normally On)
- Proprietary Advanced Planar Technology
- Proprietary Advanced Ultrahigh Vth Technology
- RoHS Compliant
- Halogen-free Available

SOT-89 SOT-23

Applications

- Quick Charger
- Current Source
- Voltage Source

General Description

This novel depletion mode MOSFET, developed and manufactured by ARK proprietary ultrahigh threshold voltage technology. By using the sub threshold characteristics, the depletion mode MOSFET can provide stably power to the load, and the voltage can be clamped to protect the load without Zener diode, and the circuit consumption is reduced.

Ordering Information

Part Number	Package	Marking	Remark
HM1010E	SOT-23	10**	Halogen Free
HM1010E	SOT-89	10**	Halogen Free

Absolute Maximum Ratings

T_A=25℃ unless otherwise specified

Symbol	Parameter	HM1010E	HM1010E	Unit
V_{DSX}	Drain-to-Source Voltage[1]	100		V
I_D	Continuous Drain Current	0.1		A
I_{DM}	Pulsed Drain Current[2]	0.4		
P_D	Power Dissipation	0.5	1.0	W
V_{GS}	Gate-to-Source Voltage	±30		V
V_{ESD}	Gate to Source ESD[3]	700		V
	Source to Gate ESD[3]	700		V
T_L	Soldering Temperature Distance of 1.6mm from case for 10 seconds	300		℃
T_J and T_{STG}	Operating and Storage Temperature Range	-55 to 150		

Caution: Stresses greater than those listed in the "Absolute Maximum Ratings" may cause permanent damage to the device.

Thermal Characteristics

Symbol	Parameter	HM1010E	HM1010E	Unit
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	250	125	K/W

Electrical Characteristics

OFF Characteristics

T_A =25℃ unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSX}	Drain-to-Source Breakdown Voltage	100	--	--	V	V_{GS}=-30V, I_D=1mA
I_{GSS}	Gate-to-Source Leakage Current	--	--	20	μA	V_{GS}=+30V, V_{DS}=0V
		--	--	-20		V_{GS}=-30V, V_{DS}=0V

ON Characteristics

T_A =25℃ unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
I_{DSS}	Saturated Drain-to-Source Current	100	--	--	mA	V_{GS}=0V, V_{DS}=25V
$R_{DS(ON)}$	Static Drain-to-Source On-Resistance	--	--	30	Ω	V_{GS}=0V， I_D=100mA[4]
$V_{GS(OFF)}$	Gate-to-Source Cut-off Voltage	--	--	-27	V	V_{DS}=9V, I_D=8μA
V_{CL}	Source-to-Gate Clamp Voltage	11.5	--	--	V	V_{DS}=9V, I_D=5mA

Source-Drain Diode Characteristics

T_A=25℃ unless otherwise specified

Symbol	Parameter	Min	Typ.	Max.	Units	Test Conditions
V_{SD}	Diode Forward Voltage	--	--	1.2	V	I_{SD}=100mA, V_{GS}=-30V

NOTE：

[1] T_J=+25℃ to +150℃
[2] Repetitive rating, pulse width limited by maximum junction temperature.
[3] The test is based on JEDEC EIA/JESD22-A114 (HBM).
[4] Pulse width≤380μs; duty cycle≤2%.

Typical and highlight Characteristics

HM1010E is an ultra-high threshold voltage depletion mode MOS device. A stable output voltage source or current source is implemented by using the sub-threshold characteristics of the device. Its basic application is shown as Figure 1:

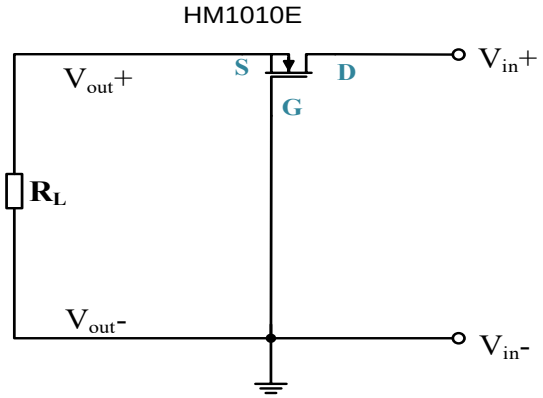


Figure1. Drain Current I_D is decided by Load Resistance

Figure 2. Clamp Voltage vs. Input Voltage

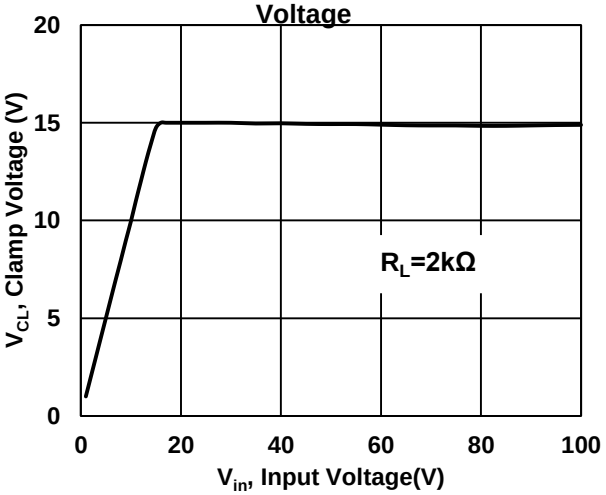


Figure 3. Clamp Voltage vs. Drain Current

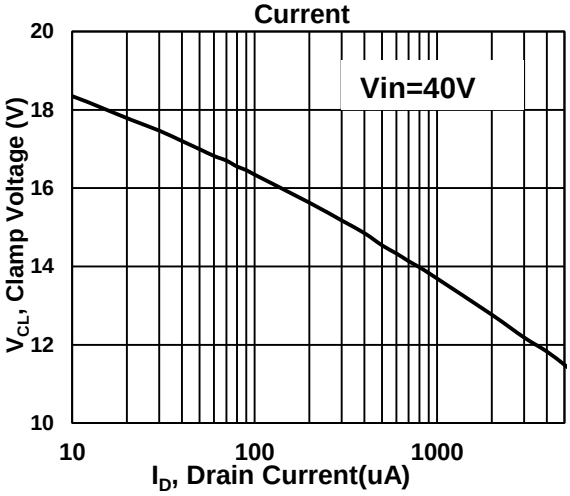
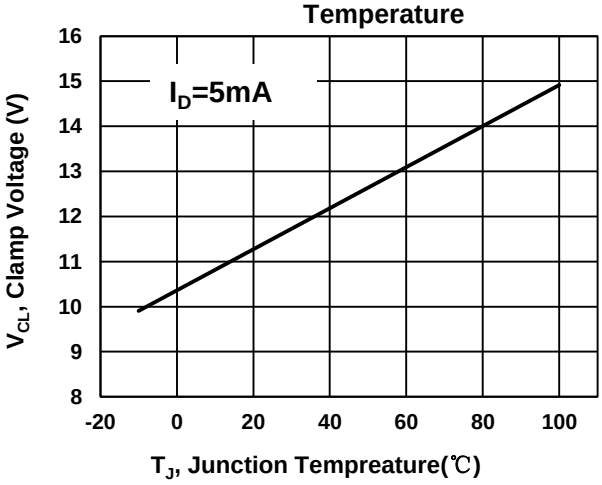


Figure 4. Clamp Voltage vs. Junction Temperature



Typical Application

In the QC2.0/3.0 and Type-C/PD charger circuits, using HM1010E as a high voltage linear regulagors can make the PWM IC power supply circuit more simplified, as shown below:
In Figure 5, the transistor Q is used to provide power, and the zener diode Z is used to clamp voltage, the power supply circuit of IC is composed of several components.

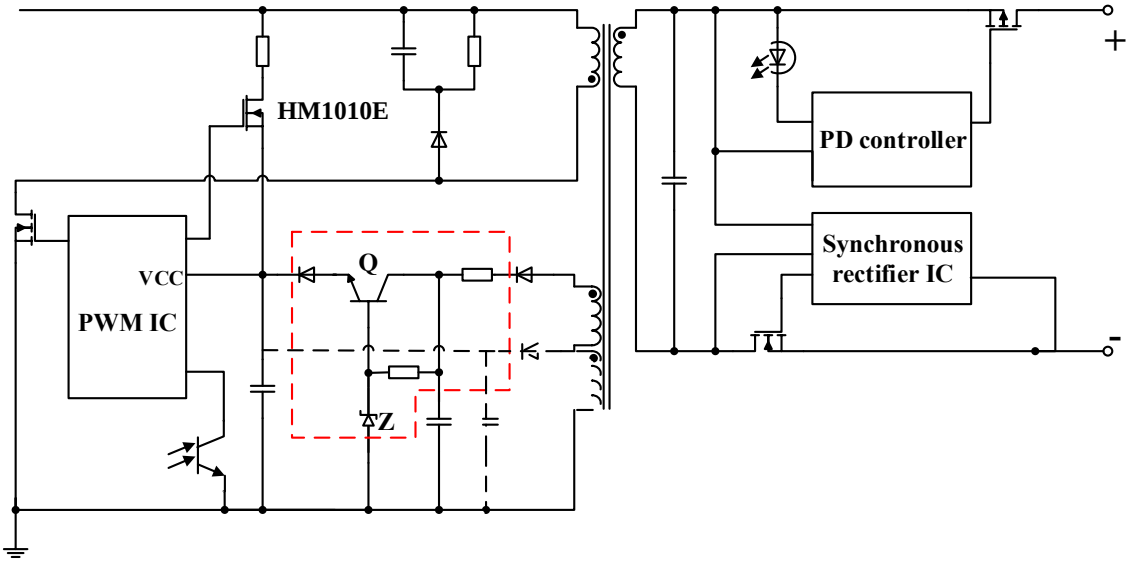


Figure 5. Normal Circuit with Transistor and Diode

In Figure 6, providing power and clamp voltage use only one device- HM1010E , the circuit is simplified.

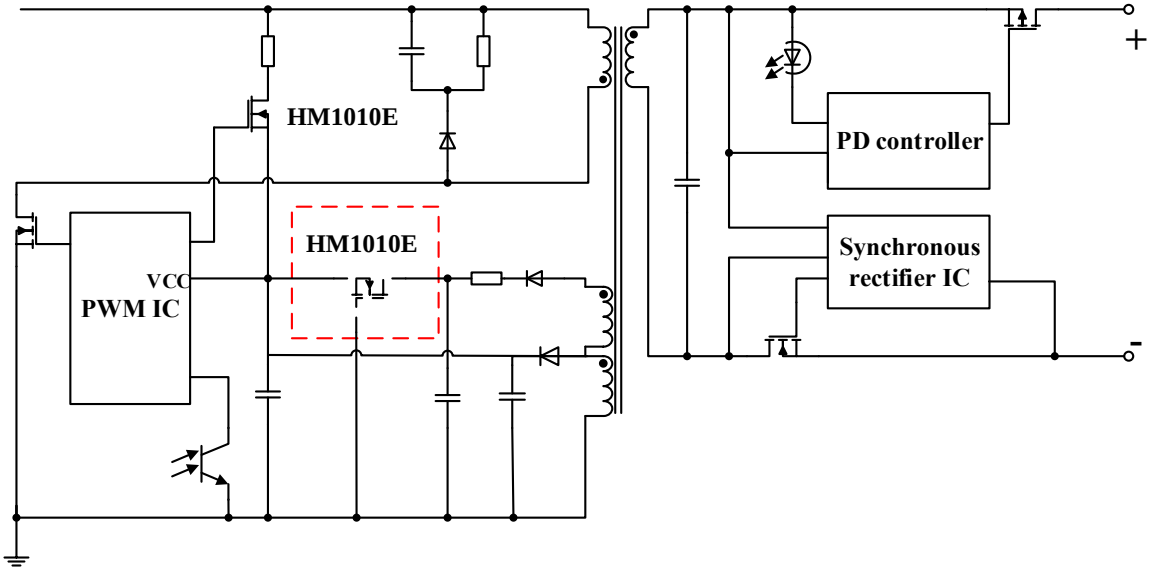


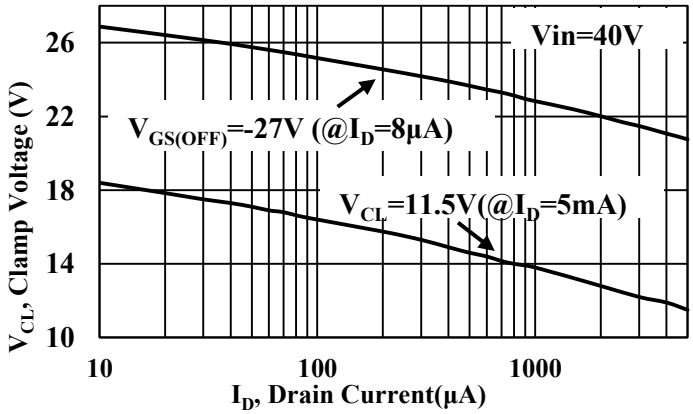
Figure 6. Circuit with HM1010E

At room temperature and under 2~4mA working current (most IC's working current), the output voltage of HM1010E is between 12~22V.

Due to strict design and process control, HM1010E parameters have good consistency, but there are still some $V_{GS(OFF)}$ parameter distribution range, so we strictly control the final testing standard, the upper limit is $|V_{GS(OFF)}|$=27V (under normal temperature I_D=8μA), the lower limit is V_{CL}=11.5V of clamping voltage (under room temperature I_D =5mA), so as to ensure under normal working condition and the working current

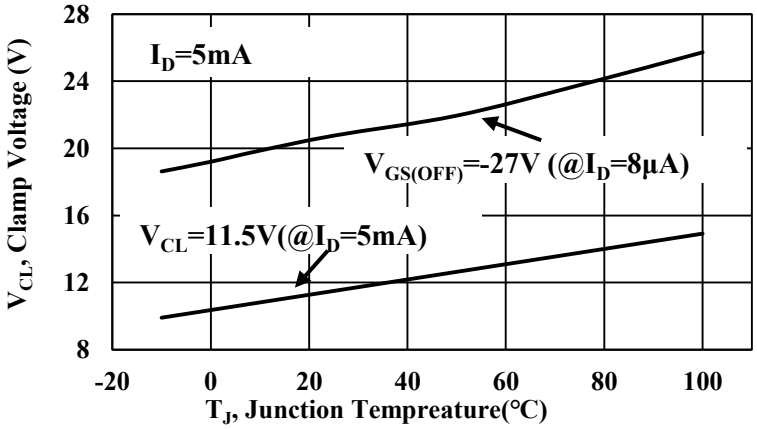
8μA≤I_D≤5mA, the clamping voltage: 11.5V≤V_{CL}≤27V. Figure 7 shows the clamping voltage V_{CL} lower limit of 11.5V and the threshold voltage $V_{GS(OFF)}$ upper limit of $V_{GS(OFF)}$ =-27V, and the clamping working voltage distribution when the working current does not exceed 5mA.

Figure 7. Clamp Voltage vs. Drain Current



The clamping voltage will also change with the temperature. When the working temperature increases, the clamping voltage will increase; when the working temperature decreases, the clamping voltage will also decrease.

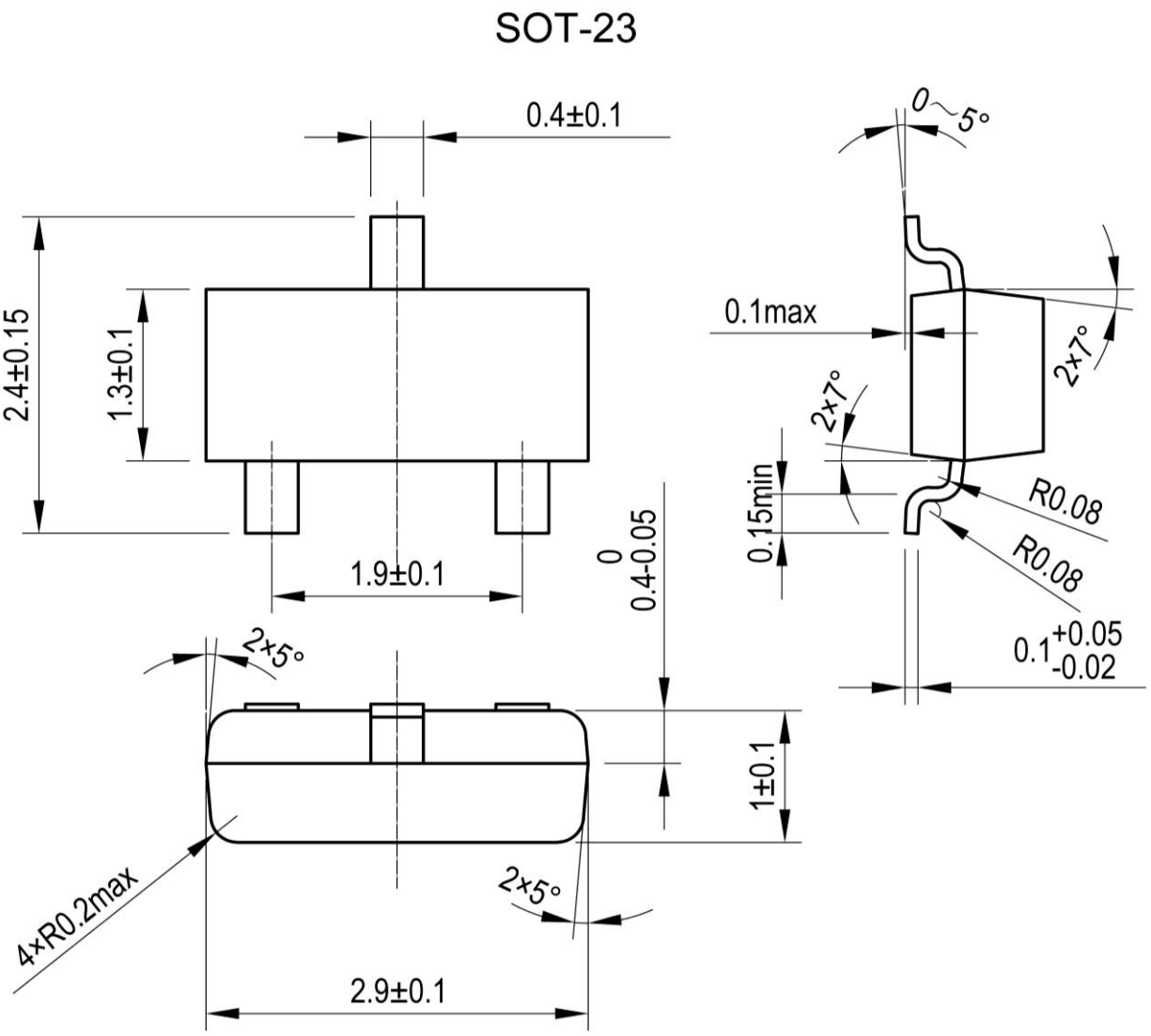
Figure 8. Clamp Voltage vs. Junction Temperature



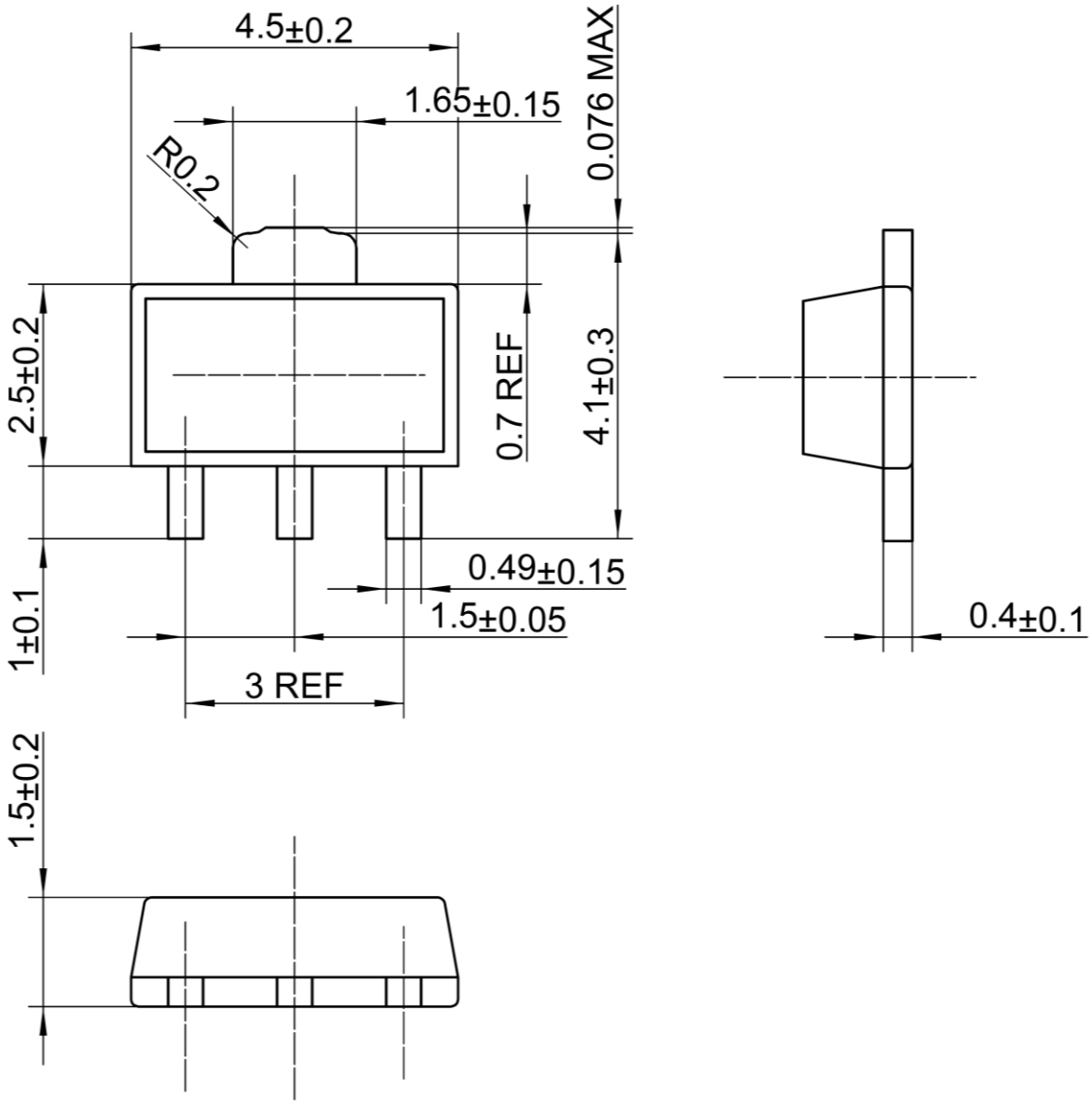
As shown in Figure 8, in the practical application of HM1010E , with the increase of device temperature, its output voltage will also increase, and the drain-source voltage will decrease, so that the device's power consumption will also decrease. In this way, the temperature of HM1010E will decrease. This negative feedback mechanism enables HM1010E to reach a stable thermal equilibrium state.

Ultra-high threshold voltage depletion mode MOSFET and its application were first proposed by SHENZHEN H&M SEMICONDUCTOR CO.,LTD. Design engineers can determine the applicable range of HM1010E according to the product specifications of HM1010E and this application note.

Package Dimensions



SOT-89


4.5±0.2
1.65±0.15
0.076 MAX
R0.2
2.5±0.2
0.7 REF
4.1±0.3
0.49±0.15
1.5±0.05
1±0.1
3 REF
0.4±0.1
1.5±0.2