

2A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

PRELIMINARY DATA SHEET

FEATURES

- **Stable with ceramic capacitor**
- Guaranteed < 1.3V Dropout at Full Load Current
- Fast Transient Response
- 2% Voltage Reference Initial Accuracy
- Output Current Limiting
- Built-In Thermal Shutdown

APPLICATIONS

- High Efficiency Linear Regulator
- Hard Disk Drivers, CD-ROMs, DVDs
- ADSL and Cable Modems

DESCRIPTION

The IRU1120 is an adjustable linear voltage regulator. It is packaged in a 5-pin ultra thin-pak surface mount package. The adjustable output voltage can be set from 1.25V and up using a simple resistor divider. The input power can be supplied by a single 5V supply. The regulator is capable of supplying 2 Amps of continuous current with an input voltage of 5V. The output is protected by both current limit and thermal shutdown circuits.

TYPICAL APPLICATION

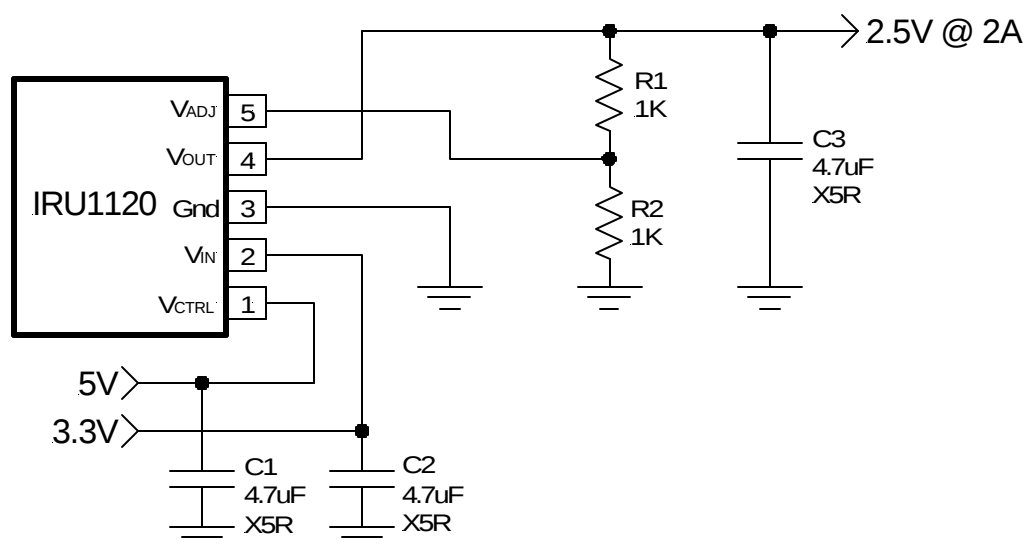


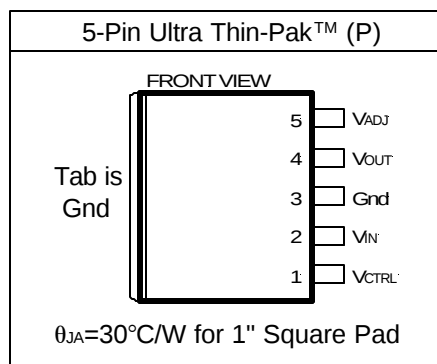
Figure 1 - Typical application of IRU1120.

PACKAGE ORDER INFORMATION

T _A (°C)	DEVICE	PACKAGE	OUTPUT
0 To 125	IRU1120CP	5-Pin Ultra Thin-Pak™ (P)	Adjustable

ABSOLUTE MAXIMUM RATINGS

Input Voltage (V_{IN})	10V
Input Voltage (V_{CTRL})	10V
Operating Junction Temperature Range	-40°C To 150°C
Operating Ambient Temperature Range	-40°C To 125°C
Storage Temperature Range	-65°C To 150°C

PACKAGE INFORMATION**ELECTRICAL SPECIFICATIONS**

Unless otherwise specified, these specifications apply over $C_{IN}=C_{CTRL}=C_{OUT}=4.7\mu\text{F}$. Typical values refer to $T_J=25^{\circ}\text{C}$ unless otherwise noted. $I_{FL}=2\text{A}$. V_{ADJ} is connected to V_{OUT} and $V_{IN}=V_{CTRL}=5\text{V}$ unless otherwise noted.

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	$I_O=10\text{mA}$, $T_J=25^{\circ}\text{C}$ $I_O=10\text{mA}$, $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$	1.225 1.213	1.25 1.25	1.275 1.287	V
Line Regulation	Reg_{LINE}	$I_O=10\text{mA}$, $V_O+1.3\text{V} < V_{IN}=V_{CTRL} < 10\text{V}$ $I_O=10\text{mA}$, $V_{IN}=V_{CTRL}=2.6$ to 10V for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		0.5 1.13 1.4	0.7 1.25	% V_O % V_O
Load Regulation	Reg_{LOAD}	Note 1, $10\text{mA} < I_O < 2\text{A}$ for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		0.2 0.3	0.4	% V_O
Dropout Voltage	V_{DO1}	Note 2, $I_O=1\text{A}$, $V_{CTRL}=5\text{V}$, $V_O+V_{DO1} < V_{IN} < 3.3\text{V}$ for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		0.48 0.6	0.63	V
Dropout Voltage	V_{DO2}	Note 2, $I_O=1.5\text{A}$, $V_{CTRL}=5\text{V}$, $V_O+V_{DO2} < V_{IN} < 3.3\text{V}$ for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		0.75 0.94	0.9	V
Dropout Voltage	V_{DO3}	Note 2, $I_O=2\text{A}$, $V_{CTRL}=5\text{V}$, $V_O+V_{DO3} < V_{IN} < 3.3\text{V}$ for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		1.1 1.27	1.25	V
Dropout Voltage	V_{DO4}	Note 2, $I_O=1\text{A}$, $V_{CTRL}=V_{IN}$ for the following: $0^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_J < 125^{\circ}\text{C}$		1.05 1.2	1.2	V

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Dropout Voltage	V _{DO5}	Note 2, I _o =1.5A, V _{CTRL} =V _{IN} for the following: 0°C < T _J < 125°C -40°C < T _J < 125°C		1.2 1.3	1.35	V
Dropout Voltage	V _{DO6}	Note 2, I _o =2A, V _{CTRL} =V _{IN} for the following: 0°C < T _J < 125°C -40°C < T _J < 125°C		1.35 1.44	1.5	V
Current Limit	I _{OL}	ΔV _{O1} =10% Below Regulation	2.3	3	4	A
Minimum Load Current	I _{O(min)}	Note 3, 5		1	5	mA
Thermal Regulation	Reg _{THERM}	Note 5, 30ms pulse, I _o =I _{FL}		0.1		%/W
Ripple Rejection (V _{CC} to Output)	PSRR	Note 5, 100Hz < f < 100KHz, I _o =20mA		32		dB
Temperature Stability	Stab _{TEMP}	Note 4, 5, I _o =10mA		0.5		%V _o
Long Term Stability	Stab _{LONG}	Note 5		0.3		%V _o
RMS Output Noise	V _N	Note 5, 10Hz < f < 10KHz		0.003		%V _o
V _{CC} Quiescent Current	I _{Q1}	I _o =0mA		1	3	mA

Note 1: Low duty cycle pulse testing with Kelvin connections is required in order to maintain accurate data.

Note 2: Dropout voltage is defined as the minimum differential voltage between V_{IN} and V_{OUT} required to maintain regulation at V_{OUT}. It is measured when the output voltage drops 1% below its nominal value.

Note 3: Minimum load current is defined as the minimum current required at the output in order for the output voltage to maintain regulation.

Note 4: Temperature stability is the change in output from nominal over the operating temperature range.

Note 5: Guaranteed by design, but not tested in production.

PIN DESCRIPTIONS

PIN #	PIN SYMBOL	PIN DESCRIPTION
1	V _{CTRL}	The control input pin of the regulator. This pin is connected to the 5V supply to provide base current for the pass transistor of the regulator. This allows the regulator to have very low dropout voltage, enabling use with low values of V _{IN} . A 1μF high frequency capacitor is connected from this pin to V _{IN} to ensure stability.
2	V _{IN}	The power input pin of the regulator. A minimum of input capacitance must be connected from this pin to ground to insure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be higher than the V _{OUT} pin by the amount of dropout voltage (see data sheet) in order for the device to regulate properly.
3	Gnd	This pin is connected with ground. It is also the tab of the package.
4	V _{OUT}	The output of the regulator. A minimum of output capacitance must be connected from this pin to ground to insure stability.
5	V _{ADJ}	A resistor divider from this pin to the V _{OUT} pin and to ground sets the output voltage. See application section for divider setting recommendations and a circuit example.

BLOCK DIAGRAM

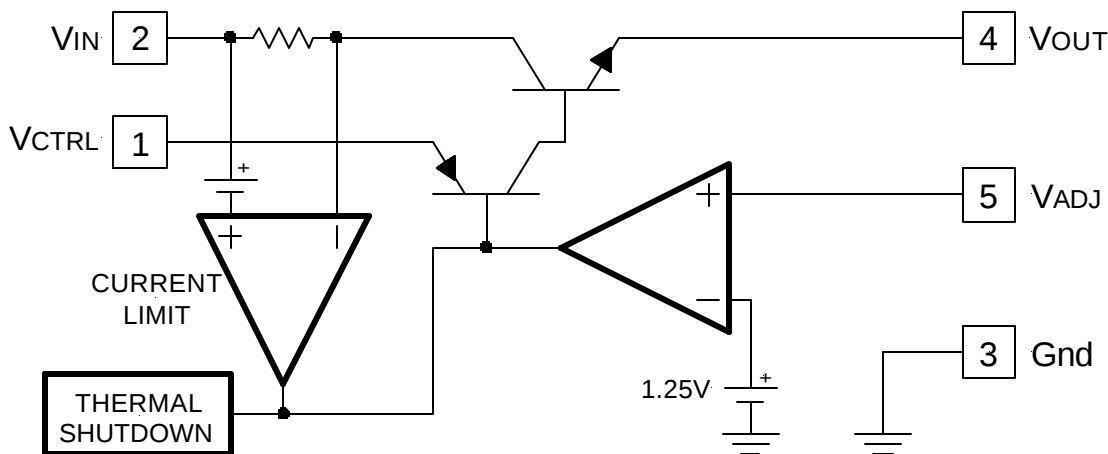


Figure 2 - Simplified block diagram of the IRU1120.

APPLICATION INFORMATION

Introduction

The IRU1120 adjustable regulator is a five-terminal device designed specifically to provide extremely low drop-out voltages comparable to the PNP type without the disadvantage of the extra power dissipation due to the base current associated with PNP regulators. This is done by bringing out the control pin of the regulator that provides the base current to the power NPN and connecting it to a voltage that is greater than the voltage present at the V_{IN} pin. This flexibility makes the IRU1120 ideal for applications where dual inputs are available such as a computer mother board with an ATX style power supply that provides 5V and 3.3V to the board.

The IRU1120 is specifically designed to meet the fast current transient needs as well as providing an accurate initial voltage, reducing the overall system cost with the need for fewer number of output capacitors.

Output Voltage Setting

The IRU1120 can be programmed to any voltage in the range of 1.25V to 5.5V by using two external resistors. The output voltage is defined as:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right) - I_{ADJ} \times R_1$$

Where:

$V_{REF} = 1.25V$ Typically

$I_{ADJ} < 1\mu A$ Typically

R_1 and R_2 as shown in Figure 3:

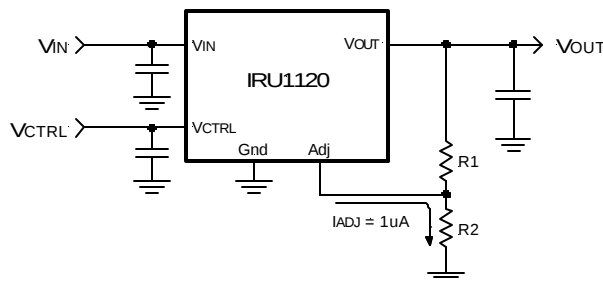


Figure 3 - Typical application of the IRU1120 for programming the output voltage.

The IRU1120 keeps a constant 1.25V between the adjust pin and the ground pin. By replacing a resistor (R_2), between these two pins, a constant current flows through R_1 , subtracting the I_{ADJ} current out of the R_1 to set the overall output voltage. Notice that since the I_{ADJ} is typically in the range of $1\mu A$, it only adds a small error to the output voltage which is negligible.

Thermal Protection

When the junction temperature exceeds 150°C, the internal thermal protection shuts the IRU1120 down.

Current Limit Protection

The IRU1120 provides Over Current Protection when the output current exceeds typically 3A. The output decreases to limit the power dissipation.

Stability

The IRU1120 requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. A minimum input capacitance of 4.7μF and a minimum output capacitance 4.7μF Ceramic capacitor is needed for regulator stage as well as the specified minimum loads to guarantee stability.

Transient Response and PSRR

The input and output capacitors are critical in order to ensure good transient response and PSRR. The most important aspects of this are capacitor selection, placement and trace routing. Place each capacitor as close as physically possible to its corresponding regulator pin. Use wide traces for a low inductance path. Couple directly to the ground and power planes as possible. The use of low ESR capacitors is crucial to achieving good results. Larger capacitance and lower ESR will improve both PSRR and transient response.

Thermal Design

The IRU1120 incorporates an internal thermal shutdown that protects the device when the junction temperature exceeds the allowable maximum junction temperature. Although this device can operate with junction temperatures in the range of 150°C, it is recommended that the selected heat sink be chosen such that during maximum continuous load operation the junction temperature is kept below this number. The example below shows the steps in selecting the proper surface mount package.

Assuming, the following conditions:

$$V_{OUT} = 2.7V$$

$$V_{IN} = 3.3V$$

$$V_{CTRL} = 5V$$

$$I_{OUT} = 1A \text{ (DC Avg)}$$

Calculate the maximum power dissipation using the following equation:

$$P_D = I_{OUT} \times (V_{IN} - V_{OUT}) + \frac{I_{OUT}}{60} \times (V_{CTRL} - V_{OUT})$$

$$P_D = 1 \times (3.3 - 2.7) + \frac{1}{60} \times (5 - 2.7) = 0.63W$$

For Ultra Thin package we have:

$$R_{THJA} = 25^{\circ}C/W$$

$$T_A = 45^{\circ}C$$

$$\Delta T = P_D \times R_{THJA} = 0.63 \times 25 = 15.75^{\circ}C$$

$$T_J = T_A + \Delta T = 60.75^{\circ}C$$

Layout Consideration

The IRU1120, like many other high-speed regulators, requires that the output capacitors be close to the device for stability. For power consideration, a ground plane pad of approximately one-inch square on the component side must be dedicated to the device where all Gnd pins are connected to dissipate the power. If a multilayer board is used, it is recommended that the inner layers of the board are also dedicated to the size of the pad for better thermal characteristics.

TYPICAL CHARACTERISTICS

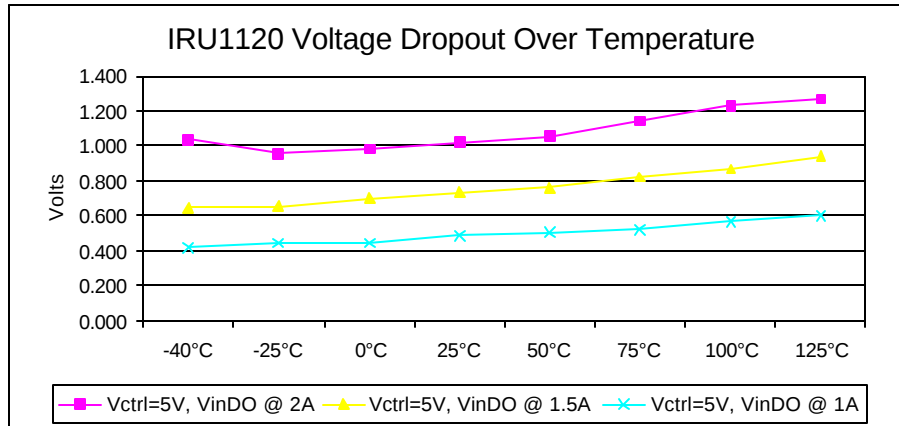


Figure 4 - Voltage dropout over temperature @ $V_{CTRL}=5V$.

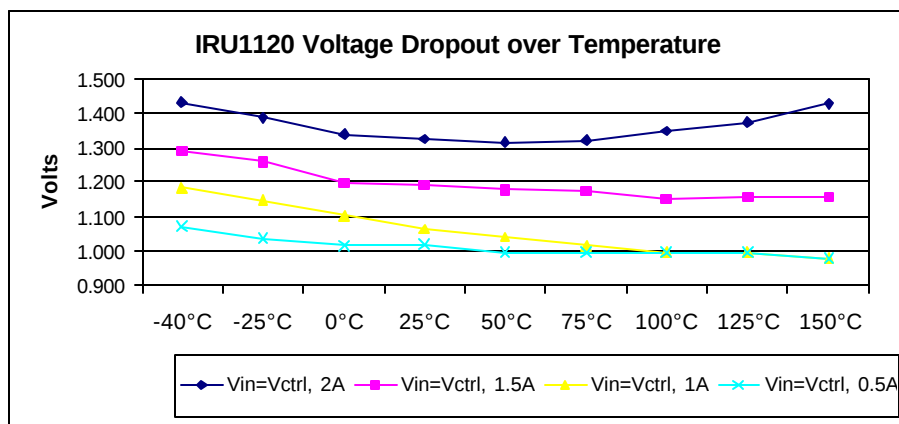


Figure 5 - Voltage dropout over temperature @ $V_{IN}=V_{CTRL}$.

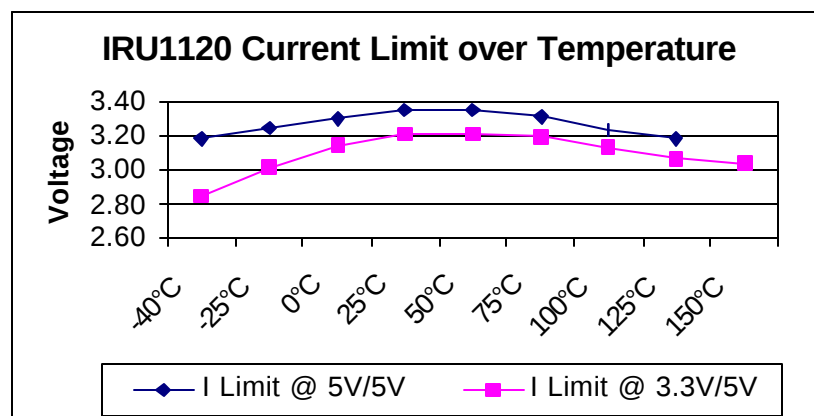


Figure 6 - Current limit over temperature @ $V_{CTRL}=V_{IN}=5V$ and $V_{CTRL}=5V$ and $V_{IN}=3.3V$

TEST DATA FOR IRU1120

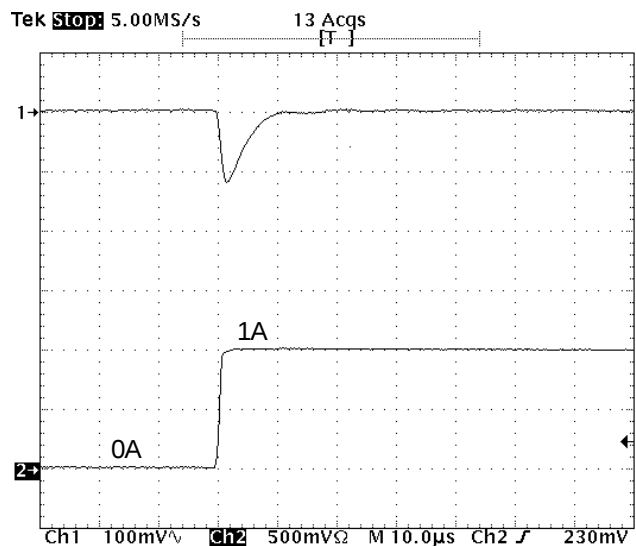


Figure 7- Load transient response @ I_{OUT} 0 to 1A,
 $V_{IN}=V_{CTRL}=5V$, $V_{OUT}=2.5V$,
 $C_{IN}=C_{CTRL}=C_{OUT}=4.7\mu F$, Ceramic.
 Ch1: V_{OUT} (100mV/Div).
 Ch2: I_{OUT} (0.5A/Div).

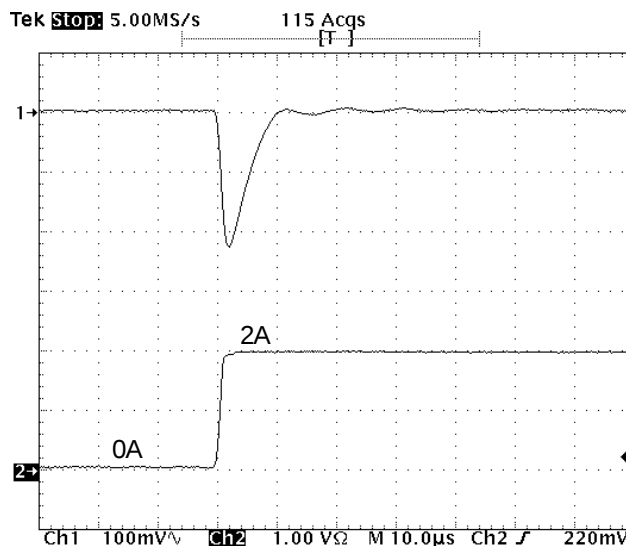


Figure 8- Load Transient response @ I_{OUT} 0 to 2A,
 $V_{IN}=V_{CTRL}=5V$, $V_{OUT}=2.5V$,
 $C_{IN}=C_{CTRL}=C_{OUT}=4.7\mu F$, Ceramic.
 Ch1: V_{OUT} (100mV/Div).
 Ch2: I_{OUT} (1A/Div).

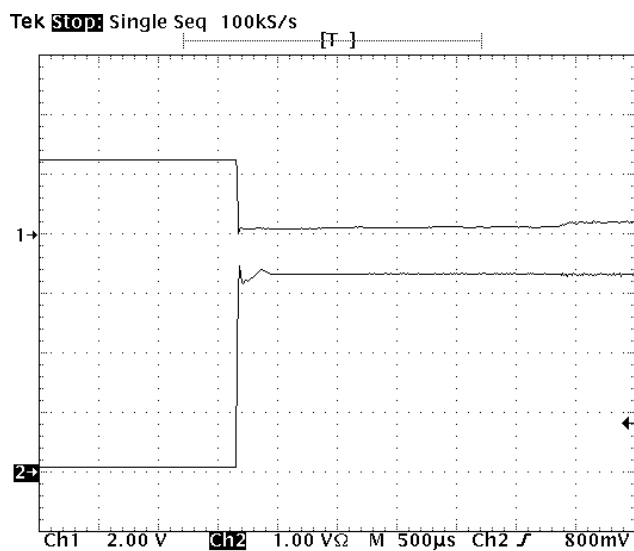


Figure 9- Current Limit Characteristic, $V_{IN}=V_{CTRL}=5V$,
 $V_{OUT}=2.5V$, $C_{IN}=C_{CTRL}=C_{OUT}=4.7\mu F$, Ceramic.
 Ch1: V_{OUT} (2V/Div).
 Ch2: Shorted Current (I_{OUT}) (1A/Div).

