PUTSI™ WiFi
Application Notes

AN002: Measuring PA Current

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Document Revision History

Date	Rev	Description
Sept, 2023	0.2a	Initial draft, companion to rev 0.2a manual

Table 1 Revision History

Distribution

Rev	Distribution
All	For amateur use only.

Table 2 Distribution

Reference Documents

[1] gnu.org, "General Public Licence," [Online]. Available: https://www.gnu.org/licenses/gpl-3.0.en.html. [Accessed 25th February 2018].

[2] Analog Devices Inc, "Low Voltage Temperature Sensors," [Online]. Available: https://www.analog.com/media/en/technical-documentation/data-sheets/TMP35_36_37.pdf. [Accessed 20 09 2023].

[3] Texas Instruments, "TMP61," [Online]. Available: https://www.ti.com/product/TMP61. [Accessed 20 09 2023].

Glossary of Terms

PBX	Private Branch Exchange. A node in a telephone network that provides connectivity for a series of local extensions to a set of trunks.
VOIP	Voice over Internet Protocol. A system where telephone calls are placed, and audio is exchanged using the Internet Protocol.
PUTSI	PIC USB Telemetry System Interface
Wi-Fi	Wireless Fidelity implementing the IEEE 802.11x standards.

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This document is a preliminary release for a product still in development and may be subject to change in future revisions. The software may be subject to unpredictable behaviour without notice. You are advised to keep a can of RAID™ Ant, Roach and Program Bug killer handy. Spray liberally on the affected area when needed.

Introduction

Measuring PA current requires an external circuit to first sense the current and then convert it to an analog voltage in the range of 0-3.3V.

The recommended device is an ACS770LCB-050U from Allegro Microsystems. It has as self-contained shunt and differential amplifier, and retails for around $15. The suffix is important as it determines the output voltage from the device. It can handle currents up to 50A. An external circuit board has been developed to accommodate the device, which only requires connection to the power leads of the amplifier and to a voltage input.

X050U PERFORMANCE CHARACTERISTICS [1]: T_{OP} = –40°C to 150°C, C_{BYP} = 0.1 µF, V_{CC} = 5 V, unless otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Primary Sampled Current	I_P		0	–	50	A
Sensitivity [2]	$Sens_{TA}$	Measured using full-scale I_P, T_A = 25°C	78.08	80	81.92	mV/A
	$Sens_{(TOP)HT}$	Measured using full-scale I_P, T_{OP} = 25°C to 150°C	78.08	80	81.92	mV/A
	$Sens_{(TOP)LT}$	Measured using full-scale I_P, T_{OP} = –40°C to 25°C	77.2	80	82.8	mV/A
Sensitivity Drift Over Lifetime [3]	$\Delta Sens_{LIFE}$	T_{OP} = –40°C to 150°C, shift after AEC-Q100 grade 0 qualification testing	–1.44	±0.48	1.44	mV/A
Noise [4]	V_{NOISE}	T_A= 25°C, 10 nF on VIOUT pin to GND	–	20	–	mV
Nonlinearity	E_{LIN}	Measured using full-scale and half-scale I_P	–1	–	1	%
Electrical Offset Voltage [5][6]	$V_{OE(TA)}$	I_P = 0 A, T_A = 25°C	–10	±4	10	mV
	$V_{OE(TOP)HT}$	I_P = 0 A, T_{OP} = 25°C to 150°C	–10	±6	10	mV
	$V_{OE(TOP)LT}$	I_P = 0 A, T_{OP} = –40°C to 25°C	–20	±6	20	mV
Electrical Offset Voltage Drift Over Lifetime [3]	$\Delta V_{OE(LIFE)}$	I_P = 0 A, T_{OP} = –40°C to 150°C, shift after AEC-Q100 grade 0 qualification testing	–5	±2	5	mV
Magnetic Offset Error	I_{ERROM}	I_P = 0 A, T_A = 25°C, after excursion of 50 A	–	120	300	mA
Total Output Error [7]	$E_{TOT(TA)}$	Measured using full-scale I_P, T_A = 25°C	–2.4	±0.5	2.4	%
	$E_{TOT(HT)}$	Measured using full-scale I_P, T_{OP} = 25°C to 150°C	–2.4	±1.5	2.4	%
	$E_{TOT(LT)}$	Measured using full-scale I_P, T_{OP} = –40°C to 25°C	–3.5	±2	3.5	%
Total Output Error Drift Over Lifetime [3]	$\Delta E_{TOT(LIFE)}$	T_{OP} = –40°C to 150°C, shift after AEC-Q100 grade 0 qualification testing	–1.9	±0.6	1.9	%

Figure 1 Allegro Microsystems ADC770 Hall Effect Sensor

Circuit Board

Figure 2 shows the schematic diagram of the current monitor. It contains the ACS770, a +5v regulator, and screw terminals for connection. No other external components are required.

The polarity of the ACS770 is important, as the device is designed for DC applications. The IP+ input must connect to the power supply, and the IP- to the downstream device. Reversing these connections may damage the device.

The maximum recommended current flow is 40A, to maintain the output voltage within range of the A/D converter.

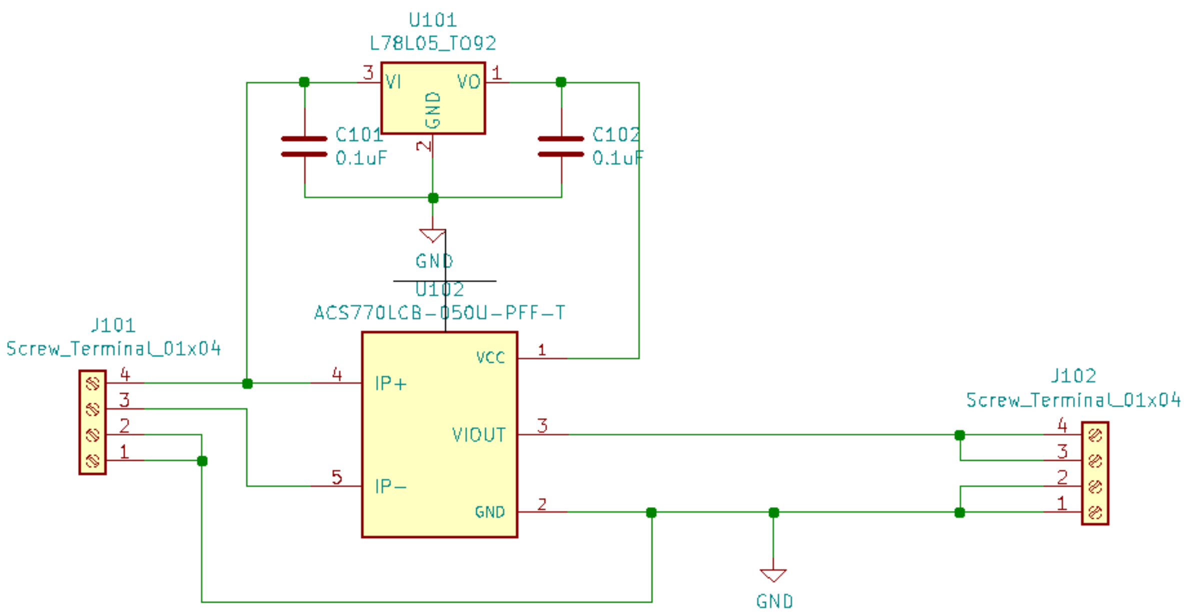

Figure 2 Current monitor Schematic diagram

Figure 3 illustrates the circuit board for the Allegro ACS770.

On the left side are the connections to the power supply and radio, and on the right side is the output voltage that can be connected to any analog input.

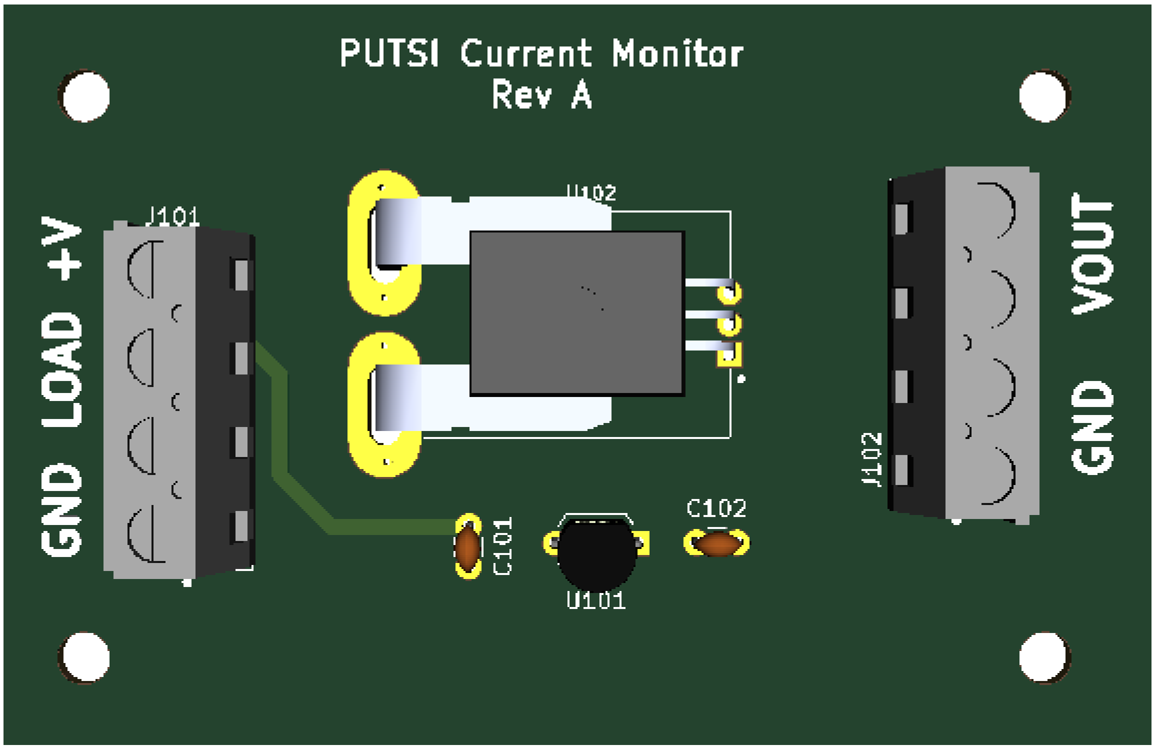

Figure 3 Current Monitor Circuit Board

Table 3 illustrates how the device should be connected in a repeater system.

Connections

Name	Location	Connect to
+V	J101-4	The positive of the power supply
LOAD	J101-3	The positive supply to the power amplifier
GND	J101-1,2	Connect to the power supply ground
VOUT	J102-3,4	Connect to an unused analog input
GND	J102-1,2	Connect to a ground on the telemetry board

Table 3 PCB Connections

Measurement

Table 4 shows the measurements that can be expected from various currents. The output of the ACS770 is 80mv/A, and each count of the A/D is approximately 3.2mV.

The USRP mode uses a 10 bit resolution, Allstar only uses 8, so the values read by allstar are ¼ of the USRP readings.

Current (A)	Voltage	USRP Reading	Allstar Reading
1	0.08	24	6
5	0.4	124	31
10	0.8	248	62
15	1.2	372	93
20	1.6	496	124
25	2	620	155
30	2.4	744	186
35	2.8	868	217
40[1]	3.2	992	248

Table 4 Expected readings from current flow

Configuring Allstar

Configuring Allstar requires a meter face entry to conver the A/D reading back into amps. Usign a divisor of 6.2 will convert the reading back to Amps.

```
[meter-faces]
paCurrent = scale(0,6.2,0),?,ha/amps
```

USRP configuration

In the USRP mode, the divisor becomes 24.8 (four times the Allstar value).

Calibration

No calibration is required.

[1] Recommended Maximum to stay within maximum A/D Input voltage range