FLUKE®

A40B

Precision AC Current Shunt Set

Instruction Manual

July 2008 Rev. 1, 7/09

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Introduction and Specifications

About the Manual

This is the Instruction Manual for the A40B Precision AC Current Shunt Set (hereafter referred to as the Current Shunt or Current Shunts). It contains all of the information a Calibration Technician needs to operate and maintain the Current Shunts. The manual is divided into the following sections:

- Introduction and Specifications
- Preparing for Operation
- Operation Instructions
- Theory of Operation
- Service Instructions

Safety Information

This section addresses safety considerations and describes symbols that may appear either in this manual or on the Current Shunts.

A ⚠ **Caution** statement identifies conditions or practices that could result in damage to the Current Shunts or equipment to which it is connected.

A ⚠⚠ **Warning** statement identifies conditions or practices that could result in injury or death.

⚠⚠ Warning

To avoid electric shock, personal injury, or death, carefully read the information under *General Safety Summary* before attempting to install, use, or service the Current Shunts.

General Safety Summary

This manual contains information and warnings that must be observed to keep the Current Shunts in a safe condition and ensure safe operation. Using or servicing the Current Shunts in conditions other than as specified in the Instruction Manual could compromise your safety.

To use the Current Shunts correctly and safely, read and follow the precautions on the next few pages, as well as, the safety instructions or warnings given throughout this manual. In addition, follow all generally accepted safety practices and procedures when working with and around electricity.

⚠⚠ Warning

To avoid electric shock, personal injury, fire, or death, read the following warnings before using the Current Shunts:

- **Use the Current Shunts only as specified in this manual.**
- **To avoid damage to eyes, skin, and the respiratory system, do not significantly exceed the maximum current rating of a shunt. Doing so may cause tracks on the printed circuit boards to vaporize. (See Maximum Overload Current in the Electrical Specifications.)**
- **Do not use the Current Shunts in wet environments.**
- **Inspect each Current Shunt before using it. Do not use the Current Shunt if it appears damaged.**
- **Do not use a Current Shunt if it operates abnormally. If in doubt, have the Current Shunt serviced.**
- **Have the Current Shunts serviced only by qualified service personnel.**
- **Do not use the Current Shunts with voltages above 30 V ac rms, 42 V ac peak, or 42 V dc. These voltages pose a shock hazard.**
- **When servicing the Current Shunts, use only specified replacement parts.**
- **Do not dispose of batteries in fire. Do not heat, deform, solder, dissemble or modify the batteries**
- **If batteries are removed from the shunt, ensure they are re-inserted with the correct polarity.**
- **Use only the battery charger provided to charge the 1 mA active shunt.**
- **Always connect the Battery Charger / Power Adapter to the AC outlet before connecting it to the shunt.**
- **When replacing the batteries, replace them all together. Use only Nickel Metal Hydride (NiMH) batteries.**
- **Do not operate the batteries together with other types of batteries, or batteries with different charge levels.**
- **The batteries in the 1 mA Current Shunt are always connected to the charging socket, even when the Current Shunt is turned off.**

Symbols

The following safety and electrical symbols may appear on the Current Shunt or in this manual.

⚠	Risk of danger. Important information. See manual.		Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.
⎓	DC (Direct Current)		Warning. Hot or burn hazard
O	Power Off setting		Recycle
I	Power on setting	⏚	Earth ground

Product Description

The A40B Precision AC Current Shunt Set consists of 14 Current Shunts, a complement of adapters, and a rugged transit/storage case. The Current Shunts are designed for laboratory use in making AC-DC current measurements or absolute AC or DC current measurements. They exhibit outstanding resistance value stability, excellent self-heating power coefficient, and a low temperature coefficient. Five configurations of Current Shunts comprise the set. They are as follows:

- One boxed *active* shunt — 1 mA
- Three boxed passive shunts — 10 mA, 20 mA 50 mA
- Five small size coaxial shunts — 100 mA, 200 mA, 500 mA, 1 A, 2 A
- Three medium size coaxial shunts — 5A, 10 A, 20 A
- Two large size coaxial shunts — 50 A, 100 A

The physical construction and the components used in the Current Shunts ensure that amplitude displacement (error relative to DC resistance) and phase displacement at 100 kHz are small enough to be neglected in all but the highest accuracy measurements.

Voltage output is nominally 0.8 V for nominal current input. The 1 mA boxed active Current Shunt is shown in Figure 1.

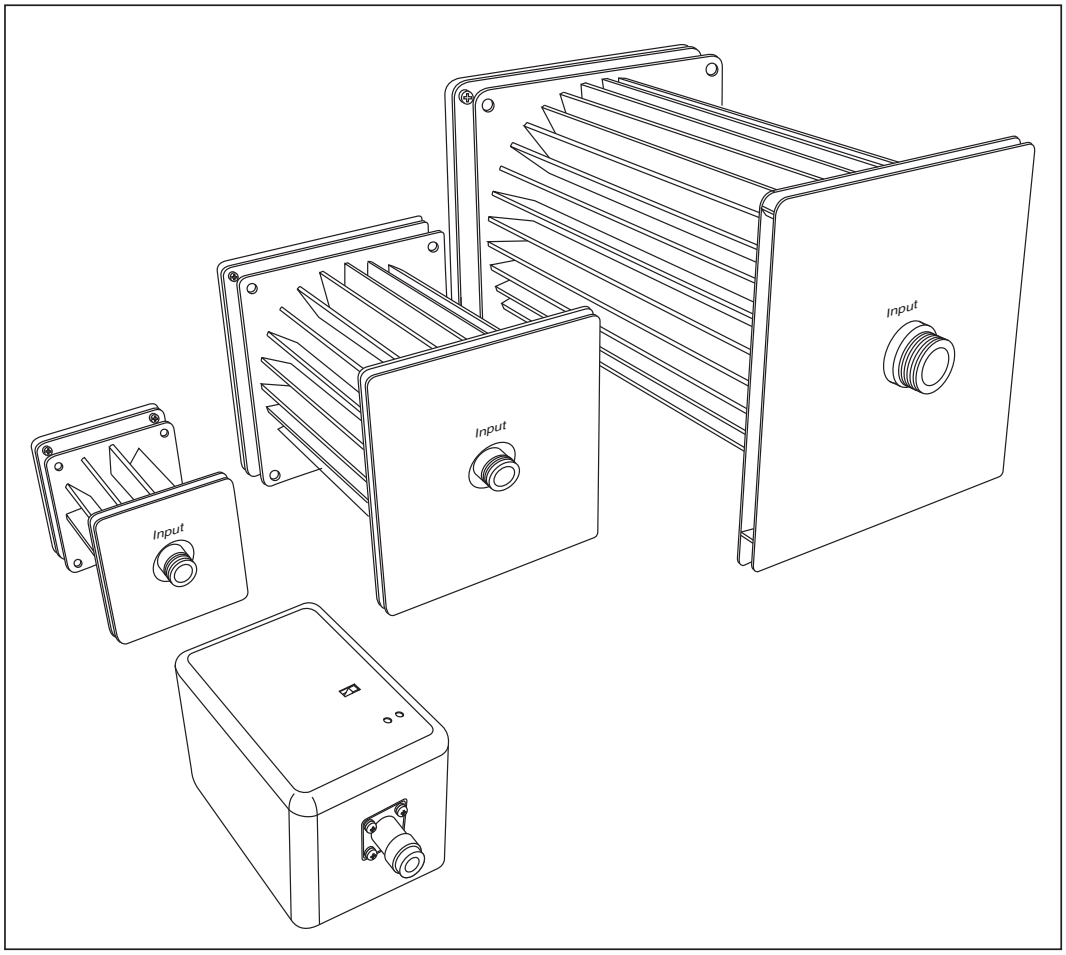

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Figure 1. Current Shunt Configurations

Electrical Specifications

Current Shunt Absolute Accuracy

The following table shows the 1-year absolute accuracy specification stated at k=2, approximately 95% confidence for the calibrated value. The specifications include 1-year stability, temperature effects over TCal ± 1 °C, and the measurement uncertainty of the calibrated value.

Shunt Nominal Current	Nominal Resistance (Ohms)	Specification ±µA/A, TCal ±1 °C, ≤50% RH [1][2][3][5]				
		DC	1 kHz	10 kHz	30 kHz	100 kHz
1 mA [4]	800	20	55	75	75	150
10 mA	80	20	26	26	26	26
20 mA	40	20	26	26	26	26
50 mA	16	20	23	23	23	23
100 mA	8	20	24	24	24	24
200 mA	4	20	26	26	26	26
500 mA	1.6	21	27	27	27	28
1 A	0.8	21	27	28	28	31
2 A	0.4	21	27	30	30	48
5 A	0.16	21	31	32	40	71
10 A	0.08	26	37	60	61	92
20 A	0.04	26	43	52	70	113
50 A	0.016	32	55	80	81	144
100 A	0.008	35	65	90	98	174

[1] The measured current is determined from:
$I = (V / R_{calibrated}) \times (1 + (AC\text{-}DC_{calibrated} / 1{,}000{,}000))$; where $AC\text{-}DC_{calibrated}$ is expressed in ppm

[2] Above 1 kHz interpolate the specification (s_i) between frequencies f_{upper} and f_{lower} using:

$$s_i = s_{lower} + (f_i - f_{lower}) \times (s_{upper} - s_{lower}) \div (f_{upper} - f_{lower})$$

[3] add 20 µA/A if relative humidity is outside specification limits.

[4] 1 mA specifications apply with the battery charger disconnected.

[5] Specifications assume no loading effects due to the voltage-sensing device. See *Output Voltage Measurement - Loading Effects* in the operating information.

Resistance Specifications

Shunt Nominal Current	Nominal Resistance (Ohms)	Maximum Deviation from Nominal Resistance (±μΩ/Ω) [2]	Uncertainty of Calibrated Value at 95% Confidence (±μΩ/Ω) TCal ±1°C	12 Month Stability (±μΩ/Ω) [1][2]	Temperature Coefficient (±ppm/°C) [2]	Power Coefficient Multiplier (±ppm) [2][3]
1 mA	800	250	8.2	18	5	1
10 mA	80	250	6.8	18	2.5	1
20 mA	40	250	8.2	18	4.5	1
50 mA	16	250	8.3	18	4.5	1
100 mA	8	250	8.3	18	2.5	2
200 mA	4	250	8.6	18	3.5	4
500 mA	1.6	250	9.6	18	4.5	13
1 A	0.8	250	9.3	18	4.5	26
2 A	0.4	250	9.4	18	4.5	26
5 A	0.16	250	9.9	18	4.5	30
10 A	0.08	250	15	18	4.5	65
20 A	0.04	250	14	18	4.5	78
50 A	0.016	250	24	18	4.5	105
100 A	0.008	250	28	18	4.5	105

[1] Stability specification combines long term change due to aging (permanent) and short term fluctuation due to humidity changes when shunts are used and stored within specified humidity limits. Add 20 ppm if humidity is >50 % RH)

[2] Assume rectangular distribution when combining with other uncertainty contributions.

[3] Calibrated resistance values include the effects of power coefficient at the nominal current. For currents other than nominal, apply the correction for power coefficient from:

$$Correction = Power\_Coefficient\_Multiplier \times \left[1 - \left(\frac{I_{Applied}}{I_{Nominal}}\right)^2\right]$$

[4] TCal = ambient temperature at calibration

Maximum AC-DC Difference

Shunt Nominal Current	Maximum AC-DC Difference (±ppm) [1][2]			
	1 kHz	10 kHz	30 kHz	100 kHz
1 mA [3]	53	72	72	150
10 mA	20	20	20	40
20 mA	18	18	19	30
50 mA	13	13	14	16
100 mA	14	15	17	27
200 mA	17	17	18	28
500 mA	17	17	17	21
1 A	17	19	19	23
2 A	17	22	22	44
5 A	23	24	34	69
10 A	28	55	58	98
20 A	37	51	80	150
50 A	47	75	79	180
100 A	60	90	120	300

[1] Specifications indicate the maximum flatness deviation from DC, and include both measured AC-DC difference and the uncertainty of measurement. They are stated at k=2, approximately 95 % confidence
[2] Includes 1-year stability of the AC-DC difference
[3] Specifications for the 1 mA Current Shunt are for TCal ±1 °C

Maximum Overload Current

Shunt Nominal Current	Maximum Current < 5 Seconds [1]	Maximum Sustained Current [2]
1 mA	3 mA	2 mA [3]
10 mA	150 mA	20 mA
20 mA	250 mA	40 mA
50 mA	450 mA	100 mA
100 mA	1.2 A	200 mA
200 mA	1.7 A	400 mA
500 mA	2.7 A	1 A

Shunt Nominal Current	Maximum Current < 5 Seconds [1]	Maximum Sustained Current [2]
1 A	3.9 A	1.3 A
2 A	5.5 A	2.2 A
5 A	17 A	5.5 A
10 A	24 A	11 A
20 A	42 A	22 A
50 A	95 A	55 A
100 A	190 A	110 A

[1] Longer than 5 seconds may cause permanent damage to the shunt. The output voltage may be considerably higher than 0.8 V.
[2] Exceeding maximum sustained current may cause a resistance value step change
[3] 1 mA shunt batteries should be fully charged to ensure performance at 2 mA

Typical Phase Displacement

Typical Phase Displacement			
Shunt Nominal Current	**1 kHz**	**10 kHz**	**100 kHz**
1 mA to 200 mA	< 0.001 °	< 0.006 °	< 0.060 °
500 mA to 2 A	< 0.003 °	< 0.030 °	< 0.300 °
2 A to 20 A	< 0.008 °	< 0.075 °	< 0.750 °
20 A to 100 A	< 0.013 °	< 0.125 °	< 1.250 °

General Specifications

Dimensions (maximum)

Shunt Value	Height mm (inches)	Width mm (inches)	Overall Length [1] mm (inches)
1 mA to 2 A	70 (2.75)	70 (2.75)	124 (4.9)
5 A to 20 A	130 (5)	130 (5)	210 (8.25)
50 A and 100 A	200 (7.9)	200 (7.9)	343 (13.5)

[1] includes input and output connectors; subject to change by component vendor.

Physical/Mechanical Parameters

Shunt Value	Weight (maximum) kg (lb)	Input Connector	Output Connector
1 mA to 20 A	0.7 (1.6)	Type-N (female)	Type-N (female)
50 A and 100 A	3.4 (7.5)	Type-LC (female)	Type-N (female)

Operating Environment

Temperature ..... 13 ºC to 33 ºC

Calibration Temperature (TCal) Range..... 18 ºC to 28 ºC

Humidity Range for best specification [1][2] ..... ≤50 % RH

Altitude ..... 0 m to 3,000 m

[1] Resistance stability is affected by humidity, but changes are reversible.

[2] If the shunts are calibrated outside this RH, stability specifications will be met as long as the shunts are stored and used at the same relative humidity ±10% RH.

Storage and Transit Environments (for models other than the 1 mA Current Shunt)

Temperature to avoid damage..... -20 ºC to 140 ºC

Temperature and Humidity to maintain performance [1] ..... 5 ºC to 45 ºC; 15% to 80 % RH

Non-operating Altitude ..... 0 m to 12,000 m

[1] Storage at extremes of temperature or humidity will cause a temporary change of shunt resistance by up to ±20 ppm. When subsequently stored or used within the limits of the operating environment, the shunts will recover to their original resistance value within 30 days.

Additional 1 mA Current Shunt Specifications

Output Resistance ..... 8 mΩ

Maximum Safe Output Current ..... 11 mA (e.g., 1 V output into 90 Ω)

Maximum Capacitive Load ..... 800 pF

Output Voltage Regulation ..... 15 ppm / 100 pF

Maximum Output DCV Offset ..... ±100 µV (typical ± 25 µV)

Typical Error @ 1 MHz..... <2%

Battery Specifications

Battery Size ..... AAA (44.5 x 10.5 mm)

Battery Technology ..... Nickel-Metal Hydride (NiMH)

Number of Batteries Required ..... 8 (in 2 groups of 4)

Nominal Battery Voltage ..... 1.2 V (4.8 V per group of 4)

Typical Battery Capacity ..... 800 mAh

Charging Time (from fully discharged) ..... 100 minutes

Maximum Operating Time Between Charges:

Maximum Output Load (11 mA) ..... 18 hours

High Impedance Load ..... 24 hours

Recommended cooling period after charging the batteries ..... 100 minutes

Storage and Transit Environment to preserve the batteries

Less Than 90 days ..... -20 ºC to 40 ºC

Less Than 1 year ..... -20 ºC to 30 ºC

To prevent loss of battery capacity recharge at least twice per year.

Preparing for Operation

This section of the manual describes how to unpack and prepare the Current Shunts for operation.

Unpacking and Inspecting the Shunts

Note

The coaxial Current Shunts are robust when handled correctly by their ends. Take care not to damage the horizontal struts of the coaxial shunts.

Upon receiving the Current Shunts from the carrier, carefully unpack and inspect them for damage. If there is any sign of physical damage, notify the carrier immediately.

As part of the inspection process, check the contents against the list shown in Table 1. Report any shortages to the nearest Fluke Technical Service Center. See *Contacting Fluke*.

Save the container and any packing material for future use in storing or shipping the Current Shunts

Table 1. Contents of the Current Shunt Set Packaging

Description	Quantity
A40B-Case ..... Transit/storage case for the A40B Current Shunts	1
Packing List of Items ..... Includes the serial number of the Current Shunts	1
Current Shunts one boxed *active* shunt with battery charger ..... 1 mA three boxed passive shunts ..... 10 mA, 20 mA 50 mA five small size coaxial shunts ..... 100 mA, 200 mA, 500 mA, 1 A, 2 A three medium size coaxial shunts ..... 5A, 10 A, 20 A two large size coaxial shunts ..... 50 A, 100 A	14
Connector Adapters	
A40B-ADAPT/LC ..... LC Male to LC Male adapter	1
A40B-ADAPT/LCN ..... LC Female to N Male inter-series adapter	1
A40B-LEAD/N ..... N Male to N Male lead	1
A40B-LEAD/4mm ..... N to 4 mm double banana connector	2
Battery charger for 1 mA active shunt	1
CD containing the Instruction Manual (PDF)	1

Accessories

The LC and N adapters described in Table 2 are available as accessories:

Table 2. A40B Accessories

Accessory	Description
A40B-CAL/LC	High current adapter to connect two shunts in series for measurement (LC to LC)
A40B-CAL/N	Low current adapter to connect two shunts in series for measurement (N to N)

Contacting Fluke

- Technical Support USA: 1-800-44-FLUKE (1-800-993-5853)
- Calibration/Repair USA: 1-888-99-FLUKE (1-888-993-5853)
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31 402-675-200
- Japan: +81-3-3434-0181
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at www.fluke.com.

To register your product, visit http://register.fluke.com.

To view, print, or download the latest manual supplement, visit http://us.fluke.com/usen/support/manuals.

Shipping Information

To prepare the Current Shunt Set for shipping, place them in the appropriate pre-cut foam insert positions in the transit/storage case and secure the lid.

When shipping individual Current Shunts, completely enclose them within at least 5 cm (2 inches) of polyurethane foam cushioning and pack them in a crush-proof container.

Storage Information

To prepare the Current Shunts for storage, place them in their transit/storage case, and secure the lid. Then, store the container in a location that complies with the environmental specifications described earlier in the *General Specifications*. Storage outside these conditions may reduce the battery life of the 1 mA shunt or cause a temporary change in the resistance of the Current Shunts by up to ±20 ppm. When returned to an acceptable operating environment, the Current Shunts will recover to their original resistance value within 30 days.

Acceptance Test

Upon initial receipt of the Current Shunts, perform the following acceptance test to ensure that they are functional:

1. Inspect the physical condition of the Current Shunts for obvious physical damage, including connector damage as described under *General Maintenance/Cleaning*. Repair any damage before proceeding.

   Instructions for contacting Fluke are provided earlier in this manual.

2. Functionally test each Current Shunt by applying the nominal current to its input. At nominal current, the output voltage for each Current Shunt should be approximately 0.8 volts.

   Note

   Each Current Shunt produces 0.8 volts output for an input at nominal operating current. The highest current shunts (10 A and above) get warm when operating at full current. The 50 A and 100 A shunts may become uncomfortable to touch; their operating temperature can be as high as 70 ºC (158 ºF).

General Maintenance/Cleaning

For General Cleaning, wipe the Carrying Case and Current Shunts with a damp cloth and mild detergent. Do not use abrasives, isopropyl alcohol, or solvents.

⚠ Caution

To prevent damage to the instrument:

- **Do not use aromatic hydrocarbons or chlorinated solvents for cleaning the Current Shunts.**
- **Do not spray liquid on or immerse the Current Shunts.**

Other than calibration, the only maintenance the Current Shunts require is inspection of the input and output connectors for wear or damage. The LC-type input connectors of the 50 A and 100 A shunts are robust, but the N-type connectors on the medium and small shunts are easily damaged by misuse or mating with out-of-tolerance N-type male connectors. The center pins of male N-type connectors are prone to moving, particularly when assembled onto cables. If a center pin on an N-type connector protrudes too much, the female connector on the shunt will be damaged by splaying the inner connector. If there is any doubt about connector condition, gauge the connectors (see MIL-C-39012 for details). Defective connectors can be replaced but it is recommended the work be performed at a Fluke Service Center.

Operating Information

This section of the manual contains practical information the user needs to know before and after making a current measurement. The material is intended to help the user make high quality precision measurements.

Feature Descriptions

The features and connectors of the Current Shunts are shown in Figure 2 and described in Table 3.

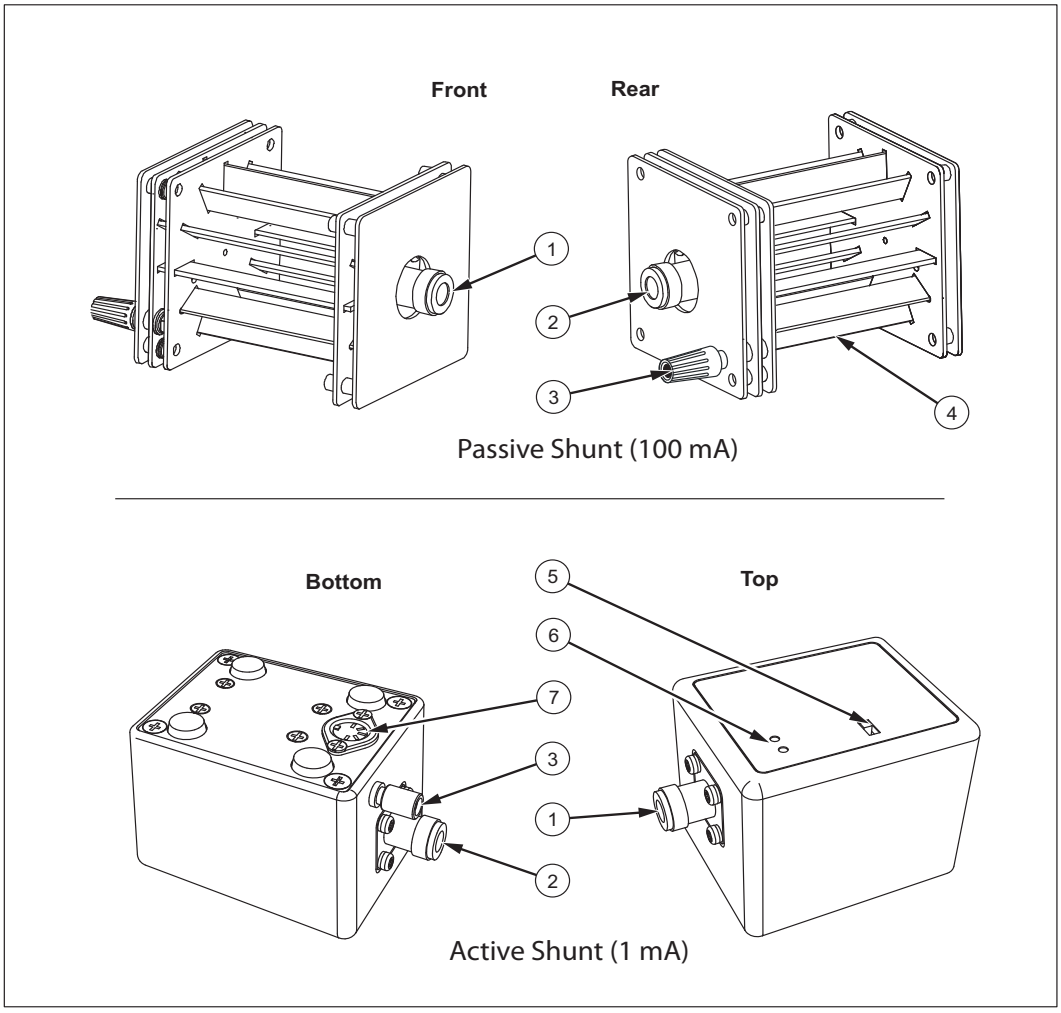

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Figure 2. Features and Connectors

Table 3. Features and Connectors

Item	Feature	Description
①	Current Input Connector	Connector for applying current to the shunt. All of the shunts use the N-type female connectors except the 50 A and 100 A versions which use type LC female Connectors.
②	Voltage Output Connector	Connector for measuring voltage drop across the shunt. The output connectors are all N-type female.
③	Guard Connection	Binding post terminal for making a guard connection to Shunt Lo.
④	PCB Struts	Low inductance connections carrying current to and from the shunt resistors.
⑤	Power on/off switch	Switches power for the current Shunt on or off.
⑥	LED indicators	Green indicates power on. Red indicates low battery.
⑦	Battery charger connector	Input connector for the external battery charger.

Input/Output Connectors

⚠⚠ Warning

To avoid skin burns and possible damage to the 50 A and 100 A Current Shunts, make sure the current-carrying input connectors are undamaged and fully tightened before applying current to them.

The input connectors on the 50 A and 100 A shunts are of the LC-type. Under full current conditions, the connectors will get hot to the touch. This is normal because of contact resistance. If the connectors are not fully tightened, they will get hot enough to burn skin and damage the shunt.

⚠ Caution

To avoid pin damage to N-Type connectors on the Current Shunts, make sure the male pin of a mating connector is in tolerance and does not protrude.

All other coaxial connectors on the Current Shunts are 50 Ω, female, N-type. These connectors are especially vulnerable to damage while being connected to a male N-type connector. If the male connector is out-of-tolerance or its center pin protrudes too far, it will splay the center pin of the female connector and lead to a poor connection. If there is any doubt about the condition of the center pin in a female N-type connector, gauge the connector (see MIL-C-39012 for details).

In extreme cases of connector damage, the connection resistance may be high enough to prevent some current sources from driving the additional compliance voltage, particularly at higher frequencies.

Another potential compliance voltage problem occurs when a Current Shunt is in series with an inductance. The inductance can also burden current sources beyond their capability. To help counter the effect, make sure the current connections are coaxial and as short as possible.

A defective connector on a Current Shunt is replaceable. However, Fluke recommends the work be done at a Fluke Service Center.

Maximum Current

Each Current Shunt is marked at the input connector with its nominal (rated) current. Similarly, markings at the voltage output connector indicate the nominal voltage out for nominal current in. A table in the specifications section provides maximum currents to maintain performance and to avoid irreversible damage.

⚠⚠ Warning

To avoid electrical shock hazard, use standard recommended safety practices when the Current Shunt is connected in a circuit which will create voltages above 30 V ac rms, 42 V ac peak, or 42 V dc. Voltages above these levels pose a shock hazard to the user.

⚠ Warning

To avoid damage to eyes, skin, and the respiratory system, do not significantly exceed the maximum overload current rating of a Current Shunt. Doing so may cause tracks on the printed circuit boards to vaporize. (See Maximum Overload Current in the Electrical Specifications.)

⚠ Caution

To avoid irreversible damage to the sense shunt resistors, do not exceed the maximum sustained current for a Current Shunt as shown earlier in the Electrical Specifications. (See Maximum Overload Current.)

Operating Environment

The Current Shunts are designed to operate in a controlled environment such as calibration and measurement laboratories. Temperature and humidity outside specified storage and transit environment may affect their performance and, in the extreme case, damage them.

The *open* coaxial shunts rely on natural convection for cooling. Adverse performance will result if airflow is restricted.

Correcting for Current Shunt Error Contributions

The Current Shunts are designed for use with a voltage-measuring device to measure current. When making a measurement, both instruments contribute known measurement errors and usually require a measurement correction to achieve the best accuracy. The Current Shunt can be used to directly measure current without the need to make AC-DC difference comparisons to a DC current reference. The Current Measurement Specifications table gives the specification for a measurement where the calibrated DC resistance value and AC-DC difference are corrected for and allowance is made for the shunt's 12 month stability.

Use the following formula to determine a measured current, I, from voltage, and calibrated resistance ($R_{calibrated}$) and AC-DC difference ($AC\text{-}DC_{calibrated}$) values:

Where: $AC\text{-}DC_{calibrated}$ is expressed in ppm.

$$I = \left(\frac{V}{R_{calibrated}} \right) \times \left(1 + \frac{AC\text{-}DC_{calibrated}}{1{,}000{,}000} \right)$$

The formula above is based on the assumption that the voltmeter has infinite input impedance at the frequency of interest.

Output Voltage Measurement – Loading Effect

The published specifications for a Current Shunt represent its performance under ideal conditions. In practical use, placing the input of the voltage measurement device in parallel with the Current Shunt introduces an additional impedance (loading effect) which will result in a measurement error. See Figure 3. The 1 mA boxed Current Shunt has less than 8 mΩ output resistance, so resistive loading effects are negligible. The capacitive loading effect is less than 15 ppm per 100 pF at 100 kHz. For the non-active Current Shunts, the loading effect becomes more significant as the resistance value of the Current Shunt increases, that is, as the nominal current value decreases. For the most accurate measurements, the error due to this loading effect must be calculated and used as a measurement correction.

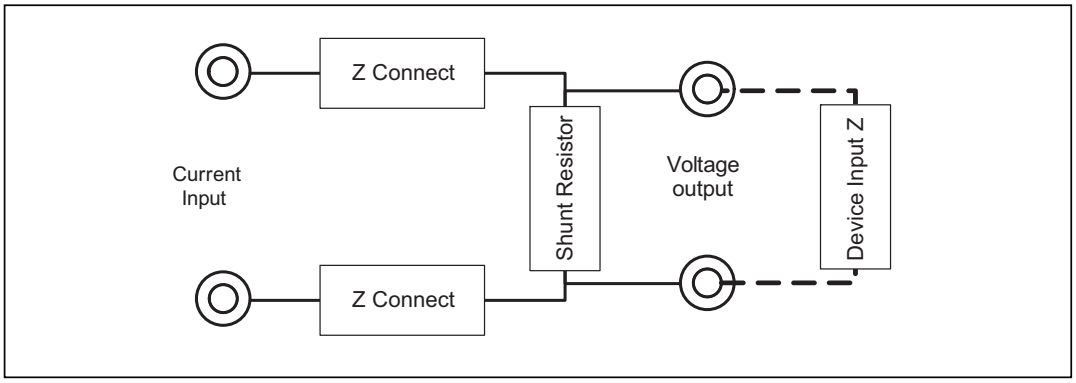

Figure 3. Loading Effect of the Measurement Device

Output Voltage Measurement Using a Fluke 5790A

The typical input impedance of a 5790A (input 1 or 2) is >10 MΩ (dc) in parallel with 70 pF. The 10 MΩ in parallel with the shunt resistance has a small effect on the lowest current value Current Shunts at DC. The 5790A impedance typically decreases to approximately 1.5 MΩ in parallel with 70 pF at 100 kHz, and, at this frequency, the loading effect is more pronounced. For the lower value shunts, the loading error is comparable with or exceeds the shunt error when used to measure current directly.

Table 4 shows the loading effect of the 5790A on Current Shunts in the range of 10 mA to 200 mA.

Table 4. Typical Loading Effect of a 5790A, 2.2 V Range

Current (mA)	DC	1 kHz		10 kHz		30 kHz		100 kHz	
	Loading Error (ppm)	Loading Error (ppm)	AC-DC Diff. (ppm)	Loading Error (ppm)	AC-DC Diff. (ppm)	Loading Error (ppm)	AC-DC Diff. (ppm)	Loading Error (ppm)	AC-DC Diff. (ppm)
1	0	0	0	-1	+1	-3	+3	-11	+11
10	-6	-6	0	-8	+2	-16	+10	-56	+49
20	-3	-3	0	-4	+1	-8	+5	-26	+23
50	-1	-1	0	-2	0	-3	+2	-10	+9
100	-1	-1	0	-1	0	-2	+1	-5	+4
200	0	0	0	0	0	-1	0	-2	+2