DATA SHEET

DS-11002

OBSOLETE

Voltage/Current Forcing Module [VFIF-12]

- **Output Voltage: ±100V**
- **Output Current: ±200mA**
- **Output Power: 20W**
- **12-Bit Precision DACs**
- **Programmable Bipolar Current & Voltage**
- **8 Current Ranges: 100nA to 1A**
- **6 Voltage Ranges: 2.5V to 100V**
- **Indefinite Short Circuit Protection**
- **Kelvin Sensing**
- **Connects to All DUT Pins**
- **Low Quiescent Current**

Analog Circuitry

The VFIF is a programmable voltage/current source, which can supply a load current of ± 200mA at voltages of ±100VDC. The analog circuitry consists of two precision DAC's, an error amplifier, a precision voltage clamp, a voltage controlled current source (VCCS), a power output stage, a sense buffer amplifier, and precision feedback components.

Output Voltage

Referring to the block diagram of Figure 1, the voltage reference for the VFIF is produced by a 12-bit precision VDAC that outputs voltage on three different full scale ranges which are 2.5, 5, and 10 volts, respectively.

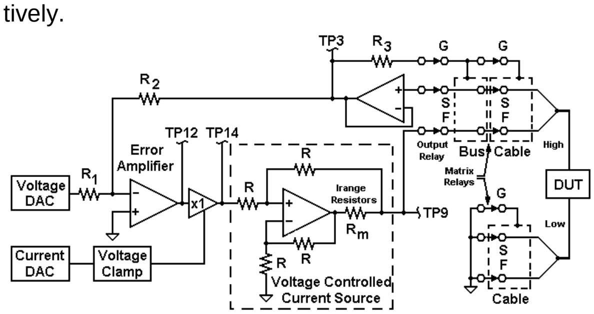

Figure 1 - VFIF Block Diagram

Specifications (18°≤T_A≤28°C)

Mode	Range	Source Error		Resolution
		Offset	% of Value	
Voltage	2.5V	2.5mV	0.05	1.25mV
	5V	5mV	0.05	2.5mV
	10V	10mV	0.05	5mV
	25V	25mV	0.05	10mV
	50V	50mV	0.05	25mV
	100V	100mV	0.05	50mV
Current	100nA	200pA	0.2	25pA
	1µA	700pA	0.15	250pA
	10µA	5nA	0.05	2.5nA
	100µA	50nA	0.05	25nA
	1mA	500nA	0.05	250nA
	10mA	5µA	0.05	2.5µA
	100mA	50µA	0.05	25µA
	1A	500µA	0.1	250µA

Comments:

1. Current specifications apply up to 200mA. Limit occurs at approximately 240mA.
2. CMRR: <0.002% of range per output volt in current.
3. Accuracy on lowest two current ranges is measured with line cycle integration.
4. Accuracy of current forced on a given range is proportional to range error and a percentage of value forced. For example, forcing 100µA on 100µA range:

   Iout=100µA ± (50nA + 0.05% of 100µA)
   Iout=100µA ±100nA
5. Accuracy of voltage forced on a given range is proportional to range error and a percentage of value forced, i.e., ±(Range error + percentage of value error). For example, forcing 1V on 2.5V range:

   Iout=1V ±(2.5mV + 0.05% of 1V)
   Iout=1V ± 3mV

The error amplifier provides sufficient gain in the control loop to ensure that its negative input will remain at virtual ground unless the load current attains the programmed limit level. Thus, for the condition of no current limit, output voltage is determined by the ratio R_2/R_1. Since this ratio can be programmed for 1 or 10, there are a total of six possible voltage ranges from 2.5 volts to 100 volts.

Output Current

The reference for the voltage clamp is produced by the 12-bit precision IDAC which outputs a programmable voltage between 0 and 5V. This output in turn ensures that the input to the VCCS can never exceed the magnitude of the IDAC voltage. Therefore, the maximum output current is proportional to the IDAC level.

Voltage Controlled Current Source

Within the VCCS is a selection of eight precision resistors which correspond to the eight current ranges and determine the transconductance of the VCCS. The output current maximum is determined by the product of the IDAC output voltage and the VCCS transconductance.

Sense Buffer

The sense buffer ensures that the compliance voltage is not affected by any voltage which may be dropped down the force(F) line, and, because no current flows down the sense(S) line, it ensures that all of the VCCS output current flows to the DUT load.

In addition to providing a voltage reference, the sense buffer output serves to drive the output guard through R3.

Kelvin Sensing

Finally, the VFIF is connected to any of the five analog nodes on the backplane via a three pole switch which allows the accuracy enhancing feature of Kelvin sensing within a fully encompassing driven guard.

Short Circuit Protection

Although the VFIF can supply up to 200mA to a load, it is fully protected against output short circuits because the output current can exceed neither the programmed level nor the maximum level of 240mA under any circumstances. During such a condition, heat dissipaters on the output stage transistors are sufficient to allow the short to continue indefinitely.

Current Step Response

The VFIF short circuit output current step response is independent of range as shown in Figure 2.

Voltage Step Response

The VFIF voltage step response is heavily dependent on the load and current range. This dependence is explained by the fact that loop gain of the control loop is directly determined by the ratio RM/RL, the ratio of the metering resistance within the aforementioned VCCS to the DUT load resistance. The loop gain is reduced by the factor, 1+RM/RL. Therefore, the bandwidth is reduced and step response time is increased by like amounts as can be seen by referring to Figures 3, 4, 5, 6, and 7.

Normalized Short Circuit Output Current Step Response

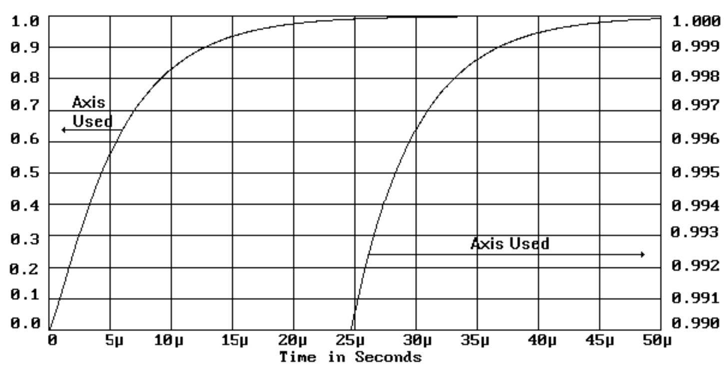

Figure 2 - All Ranges

Normalized Output Voltage Step Response vs. Load Resistance R_L

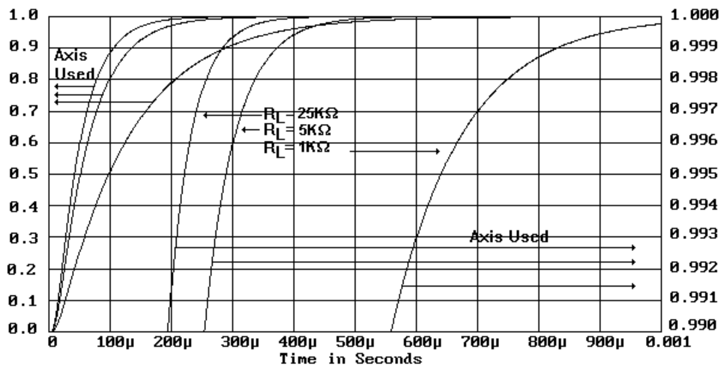

Figure 3
1mA Range, R_M = 5kΩ
10mA Range, R_M = 500Ω
100mA Range, R_M = 50Ω
1A Range, R_M = 5Ω

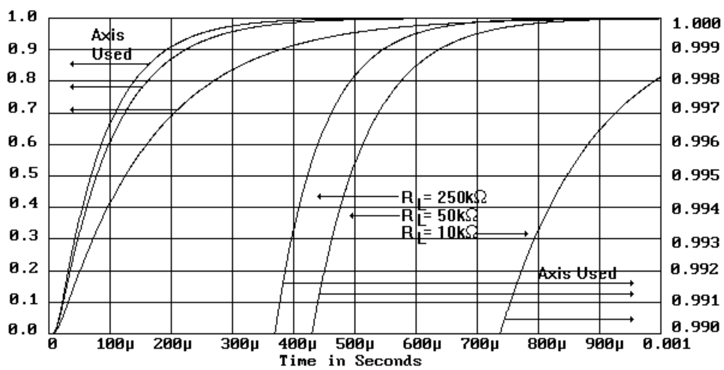

Figure 4 – 100µA Range, R_M =50kΩ

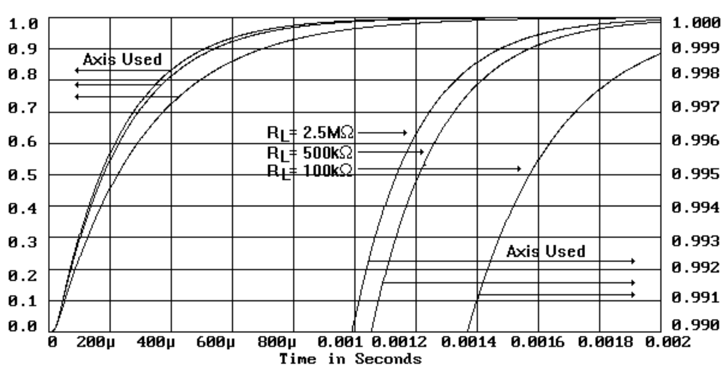

Figure 5 - 10mA Range, R_M = 500kΩ

Normalized Output Voltage Step Response vs. Load Resistance R_L

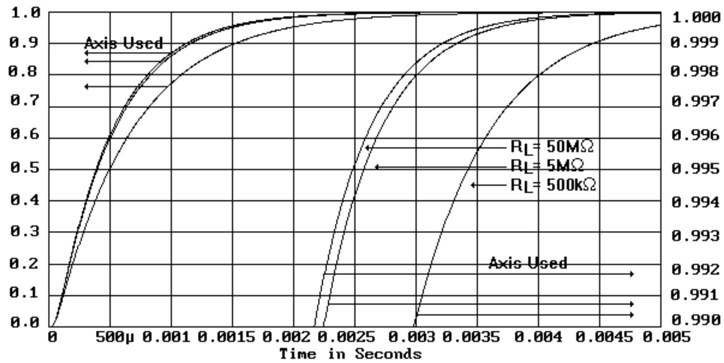

Figure 6 – 1µA Range, R_M = 5MΩ

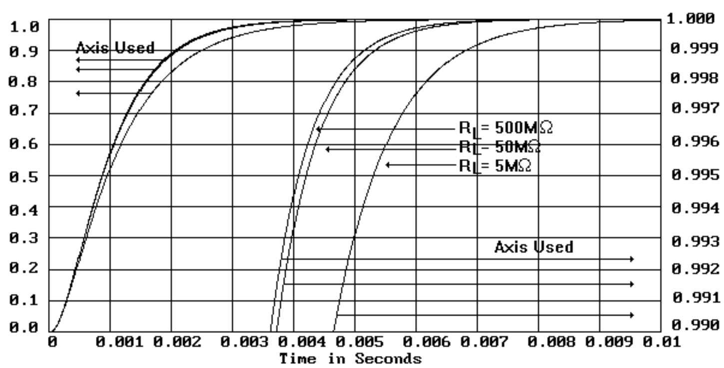

Figure 7 - 100nA Range, R_M = 50MΩ