Verifying Caller ID Simulator Performance

using the CID1500 Software

Introduction

This application note outlines a procedure for verifying the performance of the AI 150 Caller ID Simulator using the CID1500 software. The AI 150 undergoes an extensive computerized testing and alignment procedure at the factory and normally should be re-calibrated at an interval of one year. However, sometimes it is desirable to perform more regular checks of key operational aspects of the simulator at the user's location without a large amount of sophisticated test equipment. This application note describes such a procedure.

Equipment Required

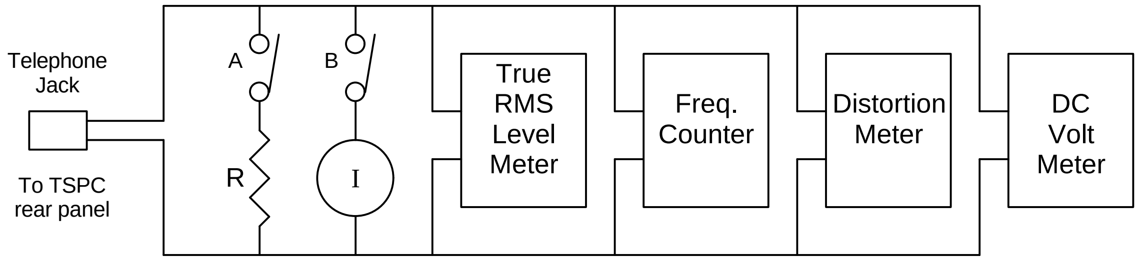
The equipment needed to perform the following tests consists as follows:

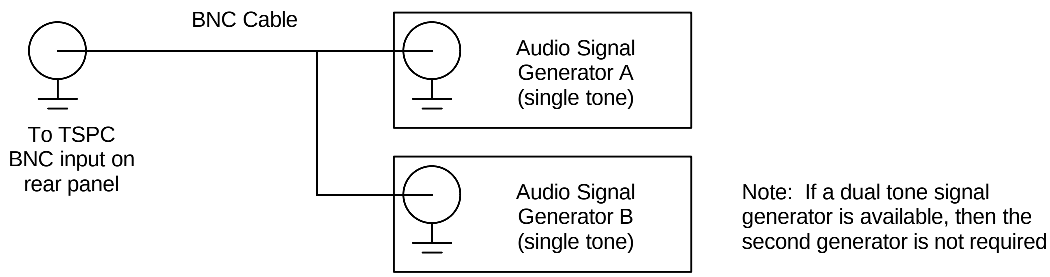
- **True RMS Audio Signal Level Meter** The meter must have a bandwidth up to at least 20 kHz, with balanced floating inputs. The input impedance of the meter must be at least 100 Kohms.
- **Frequency Counter** The frequency counter should have balanced floating inputs and an input impedance of at least 1 M ohms.
- **Audio Signal Distortion Meter** The distortion meter should have balanced floating input and an input impedance of at least 100 Kohms. Also, it should have the option of inserting a C-message weighted filter in the signal path.
- **DC Volt Meter and DC current Meter** The DC Volt meter must have at least a 1 M ohm input impedance.
- **Audio Signal Generators** Two signal generators are required that can produce an audio tone at a given frequency and level. The output impedance of the signal generators should be set to 600 ohms. If a dual tone signal generator is available, that may be used instead of two single tone generators.
- **A 600 ohm 2 Watt Resistor** This should be a high precision resistor with a low temperature coefficient. The value of the resistor should be measured before inserting into the test setup. Knowing the exact value of the resistor will improve the accuracy of the test setup, as a correction factor can then be calculated.

Many of the instruments listed above are generally available combined together into one instrument. For example, the HP34401A True RMS Multimeter can serve as the audio level meter, frequency counter, DC voltage meter, and DC current meter. Likewise the HP8903B Audio Analyzer can be used as the audio level meter, distortion meter, and audio signal generator.

Test Setup

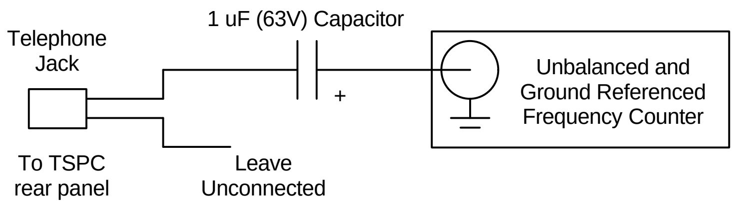
The following diagram shows the test setup required to perform the following tests. Two switches label A and B are used to place the 600 ohm resistor R or a DC current meter across the tip and ring lines respectively. The other four instruments are also placed across the tip and ring lines, and can remain connected for the entire test. However it is important that the input impedance's of the instruments be very high. The loading of an extra 100 kohms will reduce the measured level by only 0.03 dB. However, two instruments at 100 kohms will reduce the measured level by 0.06 and three by 0.09 dB, which is becoming a significant amount. As such, it is important to be aware of the effect of the measuring equipment when attempting to take accurate measurements.





It is also important that the meters and frequency counters used have balanced and floating inputs. If this is not the case, then the CID1500 will display "line unbalanced", indicating the lack of balanced floating inputs on the test equipment. While most meters have balanced floating inputs, it may be more difficult to locate a frequency counter with a balanced floating input. However, most often the audio signal meter includes the capability to measure signal frequencies.

If the frequency counter does not have balanced floating inputs, then for **only** the frequency measurements, use the following test setup.



Note: In this setup,if the frequency counter and PC that contains the TSPC are not **both** properly connected to earth ground, a large amount of 50/60 Hz hum noise can effect the measurements.

Testing Procedure

CID1500 Program Setup

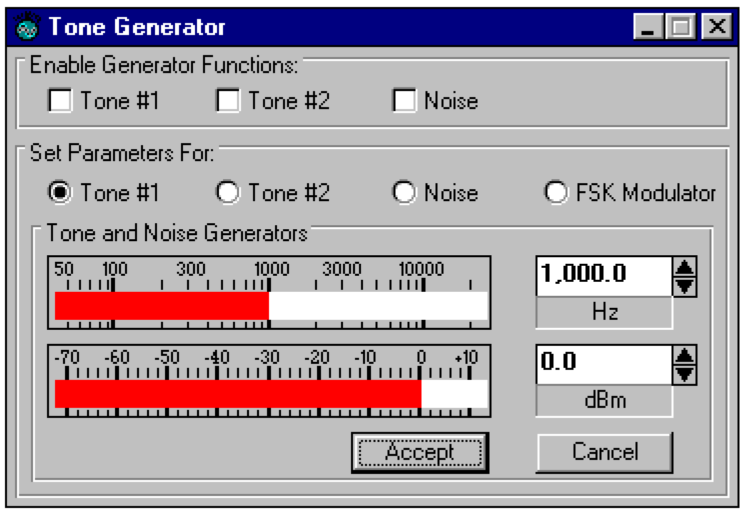
The first step in performing the tests is to properly setup the CID1500 program. To accomplish this, follow these steps:

1) Run the CID1500 program, by using either the Windows Program Manager, File Manager, or the Win95 Start button.

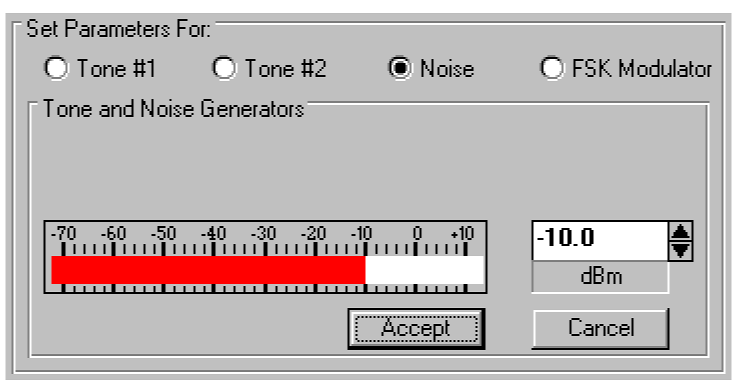
2) If the current operational standard is not set to Bellcore, then select the menu command [Configuration] [Caller ID Standard] [Bellcore]. This will then change the standard to the Bellcore setting.

On the Main Settings Window, the Bellcore caller ID standard should be displayed as below.

3) Select the Tone Generator Window by either clicking on the Tone Generator icon, or selecting the [Window] [Tone Generator] menu command. Then set the Tone Generator #1 to a level of 0 dBm and frequency of 1 kHz, and press the “Accept” button. Do not enable the tone generator at this time.



4) Next set the parameters for the Noise Generator, to a noise level of -10 dBm, and then press the “Accept” button.



Part A: FSK/Tone Generator

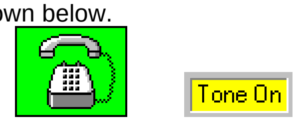
The proper calibration of the FSK/Tone Generator is verified by measuring its absolute level accuracy, flatness over frequency, frequency accuracy, and distortion. The specifications are as follows:

Specifications:

Measurement	***Specification***
Absolute Level Accuracy at 1 kHz, 0 dBm	+/- 0.3 dB
Level Flatness from 100 Hz to 5 kHz at 0 dBm	+/- 0.1 dB
Level Flatness from 50 Hz to 10 kHz at 0 dBm	+/- 0.3 dB
Frequency Accuracy at 1 kHz, 0 dBm	+/- 0.015 %
C-message Weighted Distortion at 1 kHz, 0 dBm	< 0.09 %

Procedure:

1) Terminate the telephone into 600 ohms by closing switch A in the test setup. Then enable Tone Generator #1 by clicking the mouse on the appropriate checkbox in the Tone Generator window. The CID1500 program should indicated that the telephone line is "off-hook" in the Main Settings window. Also, the status line will show that the tone generator has been enabled, as shown below.



2) Record the level being measured by the Audio Signal Level Meter. If the resistor R has an impedance of exactly 600 ohms, then the measured level must be within +/- 0.3 dB of 0 dBm. If the resistor R is not exactly 600 ohms, use the following formula. The result must be within +/- 0.3 dBm. This result is the absolute level accuracy at 1 kHz.

$$Vmeas(dbm) - 7.959 - 20 \cdot \log\left[\frac{R}{R + 900}\right]$$

3) Zero the Audio Signal Level Meter, or if the meter does not support that option, record the level at 1 kHz. Change the frequency of the tone being produced to each of the following frequencies. Then record the reading of the level meter, assuming the level meter has been zeroed. If not, record the difference between the level meter reading and the recorded reading taken at 1 kHz.

Frequency	***Level Relative to 1 kHz (dB)***	***Flatness Spec***
50 Hz		B
100 Hz		A
200 Hz		A
400 Hz		A
1000 Hz	0.00	A
1500 Hz		A
2000 Hz		A
5000 Hz		A
7000 Hz		B
10000 Hz		B

In the region of 100 Hz to 5 kHz (flatness spec A), the absolute maximum value recorded in the above table must not exceed +/- 0.1 dB.

Likewise in the region of 50 Hz to 10 kHz (flatness spec B), the absolute maximum value recorded in the above table must not exceed +/- 0.3 dB.

4) Return the frequency of the tone to 1 kHz.

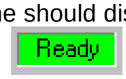
5) Using the frequency counter measure the frequency of the tone. The error in the frequency is given by the following formula. The result must not exceed the specification of +/- 0.015 %.

$$\left[\frac{Fmeas - 1000}{1000}\right] \cdot 100\%$$

Note: Verify that the frequency counter used provides at least resolution to 0.01 Hz. Otherwise the measurement will have a high degree of uncertainly.

6) Using the distortion meter, with the C-message filter engaged, measure the THD+N (total harmonic distortion plus noise) of the 1 kHz signal. The measurement must be below 0.09% or -61 dBc.

7) Turn off the Tone Generator #1 by clicking on the appropriate checkbox in the Tone Generator window. The status line should display the following.



Part B: Noise Generator

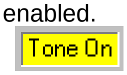
The broadband noise generator is verified by measuring its output level with the audio level meter. It is important to understand that the noise level specified in the Tone Generator window relates to not the total noise power generated, but rather the noise power in the band of 200 Hz to 3200 Hz, as defined in Bellcore document TSV-SR-3004. As such, without the use of a audio spectrum analyzer, a correction factor must be applied to relate the total power seen by the audio level meter to the noise level specified in the Tone Generator window.

Specifications:

Measurement	***Specification***
Absolute Level Accuracy	+/- 0.3 dB

Procedure:

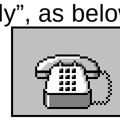
1) Continuing from the setup in the previous test, the CID1500 program should be indicating an "off-hook" state. Enable the noise generator , at a level of -10 dBm, by clicking the mouse on the appropriate checkbox in the Tone Generator window. The status line should show that the tone generator had been enabled.



2) Record the level indicated by the audio level meter. Using the following formula, where R is the terminating impedance, the result of the calculation should be in the range of +/- 0.3 dB for the Noise Generator

$$Vmeas(dbm) - 7.959 - 20 \cdot \log\left[\frac{R}{R+900}\right] - 8.053$$

3) Disable the noise generator and open switch A as shown in the test setup diagram. The Main Settings window should indicate the telephone line as being "on-hook", and the status line should indicate "Ready", as below.



Part C: Ringing Generator

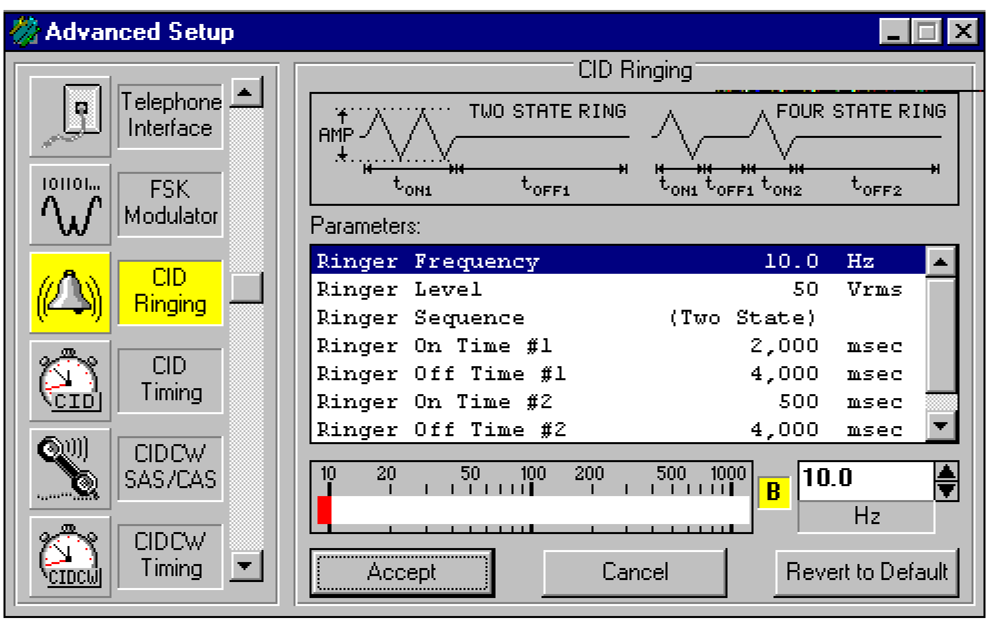
The proper calibration of the Ringing Generator is verified by measuring its level, flatness, and distortion. The specifications are as follows:

Specifications:

Measurement	***Specification***
Absolute Level Accuracy from 10 to 600 Hz at 50 Vrms	+/- 0.2 dB
Distortion at 22 Hz at 50 Vrms	< 0.1 %

Procedure:

1) Using the Advanced Setup window, set the ringing frequency to 10 Hz, as shown below.



2) Start a Caller ID transmission by either clicking on the "Start" icon or by pressing the F5 key. During the ringing cycle, record the level of the signal in the table below. If the ringing time is not long enough for an accurate measurement, then increase the Ringer On Time #1 in the Advanced Setup window. Repeat this procedure with all of the other frequencies shown in the table.

Frequency (Hz)	*Measured Level (Vrms)*	*Lower Limit (Vrms)*	*Upper Limit (Vrms)*
10		48.86	51.16
20		48.86	51.16
40		48.86	51.16
60		48.86	51.16
100		48.86	51.16
200		48.86	51.16
400		48.86	51.16
600		48.86	51.16

3) All of the recorded levels must be between the upper and lower limits shown in the above table. The upper limit represents 50 Vrms + 0.2 dB, while the lower limit represents 50 Vrms - 0.2 dB.

4) Using the Advance Setup window, set the ringing frequency to 22 Hz. Start a Caller ID transmission be clicking the mouse on the “Start” icon or by pressing the F5 key. During the ringing cycle, measure the distortion of the ringing with the distortion meter. If the ringing cycle is not long enough for an accurate measurement, then increase the ringing time. The distortion meter should not have any filters enabled, for a proper measurement. The distortion value measured should be less than 0.1% or -60 dBc.

Part D: Level Meter

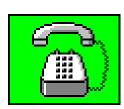
The simulator’s level meter is used to measure the amplitude and frequency of the DTMF ACK tone used in Type II Caller ID transmissions. To verify that the level meter is calibrated properly, it is checked for its level and frequency accuracy. This test requires the use of the two signal generators.

Specifications:

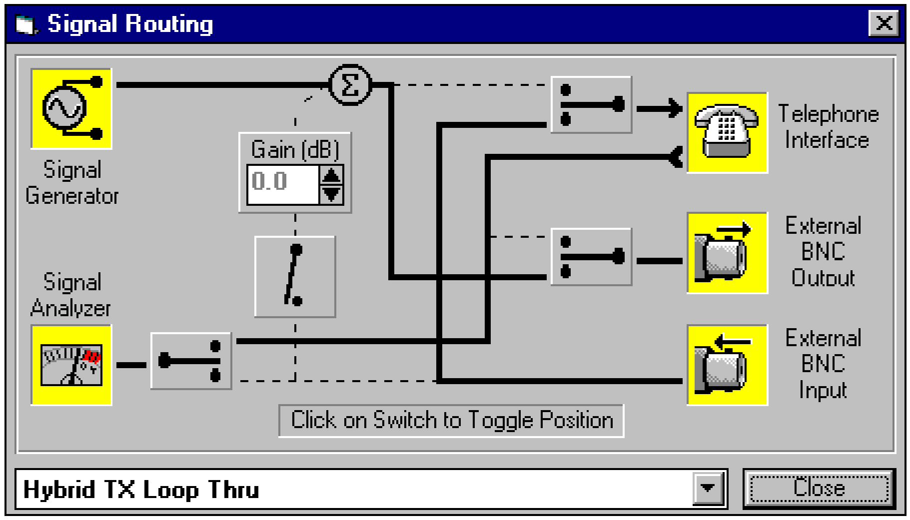
Measurement	*Specification*
Low Tone Group Level Accuracy	+/- 0.2 dB
High Tone Group Level Accuracy	+/- 0.2 dB
Low Tone Group Frequency Accuracy	+/- 1Hz
Low Tone Group Frequency Accuracy	+/- 1Hz

Procedure:

1) Terminate the telephone into 600 ohms by closing switch A in the test setup. The CID1500 program should indicated that the telephone line is “off-hook” in the Main Settings window, as shown below.



2) Using the Signal Routing window, click the mouse on the top most switch that selects the signal source for the telephone interface, or select “Hybrid TX Loop Thru” from the drop-down list box. The resulting window should look as follows.



3) Enable Audio Signal Generator A as shown in the test setup diagram. Set the frequency to 941 Hz at a level of -4.08 (open circuit). Due to the loading of the Audio Signal Generator B, the actual level at the BNC input should be -10.08. This assumes that the output impedance’s of the two signal generators are the same.

4) Measure the signal level present at the Audio Level Meter, and record this value (VsetA). This level should be very close to -4.08 assuming that the resistor R value is close to 600 ohms.

5) Now disable, but don’t disconnect, Audio Signal Generator A, and enable Audio Signal Generator B. Set the active generator to a frequency of 1633 Hz at a level of - 6 dBm (open circuit).

6) Measure the signal level present at the Audio Level Meter, and record this value (VsetB). As with the previous tone, this level should be very close to -6 dBm.

7) Now enable Audio Signal Generator A, such that both signal generators are operating. Then start a Type II Caller ID transmission by clicking the mouse on the “Start” icon or by pressing F5. View the Data Log window, and record the low group level and frequency, and the high group level and frequency.

8) The difference between the low group level and VsetA (recorded in step 4) should be less than +/- 0.2 dB. Likewise the difference between the high group level and VsetB (recorded in step 6) should be less than +/- 0.2 dB. Also the low group frequency should be within 1 Hz of 941 Hz, and the high group frequency should be within 1 Hz of 1633 Hz.

10) Return the Signal Routing window to its previous setting by clicking on the top most switch, or by selecting “Monitor Hybrid TX on BNC out” from the drop-down list.

11) Open switch A as shown in the test setup diagram. The Main Settings window should indicate the telephone line as being “on-hook, as below.

Part E: Telephone Interface

The telephone interface is characterized in terms of its DC parameters and its AC source impedance. The DC parameters consists of the open circuit voltage present on Tip and Ring, and the short circuit current flowing between Tip and Ring. For these two measurements, the DC voltage meter and DC current meter are needed. The AC source impedance is verified by measuring the AC signal change between terminated and unterminated conditions.

Specifications:

Measurement	*Specification*
Line Voltage Accuracy from 20 V to 52 V	+/- 1 V
Loop Current Accuracy from 20 mA to 40 mA at 48V*	+/- 10 %
600 Ohm Source Impedance Accuracy at 1 kHz	+/- 2 %
900 Ohm Source Impedance Accuracy at 1 kHz	+/- 2 %

* After two minutes in order to stabilize thermal drifts

Procedure:

1) Using the Advanced Setup window, set the Line Voltage to 20 Volts. Record the measurement of the DC voltage meter in the table below. Repeat the procedure for all of the different voltage points. The measured voltage should be between the given minimum and maximum values. Note, that depending on the polarity of the DC voltage meter, the measured value may be negative in value. In that case reverse the leads of the voltage meter.

Voltage Setting (V)	*Measured Voltage (V)*	*Lower Limit (V)*	*Upper Limit (V)*
20		19	21
30		29	31
40		39	41
48		47	49
52		51	53

2) Now, reverse the polarity of the telephone interface and verify that the voltage changes polarity from positive to negative and is between the values of -51 and -53 volts.

3) Return the polarity back to the normal setting.

4) Set the Line Voltage back to the default setting of 48 Volts. Then set the Loop Current to 40 mA. Close switch B in the test setup. This places the DC current meter across the tip and ring leads, and starts the flow of current. Thermal effects in the telephone interface will cause the current reading to slow drift downward. As such, the reading should be taken after approximately two minutes to allow the thermal effects to stabilize. Repeat this procedure for loop currents of 30 mA and 20 mA. The measured currents should be between the given minimum and maximum values. Note, that like the voltage reading, the DC current meter may be reading a negative value depending on the connection polarity. If so, reverse the leads on the current meter.

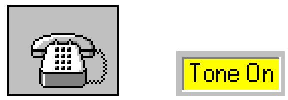
Current Setting (mA)	*Measured Current (mA)*	*Lower Limit (mA)*	*Upper Limit (mA)*
40		36	44
30		27	33
20		18	22

5) Now, reverse the polarity of the telephone interface and verify that the current changes polarity from positive to negative and is between the values of --18 mA and -22 mA.

6) Return the polarity back to the normal setting.

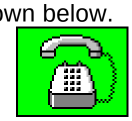
7) Open switch B to disconnect the DC current meter from the Tip and Ring leads.

8) Using the Tone Generator window, set the parameters for Tone #1 to 1 kHz at a level of 0 dBm. Enable tone generator #1 by clicking the mouse on the appropriate checkbox. As shown below, the program should indicate an “on hook” state, with the tone generator enabled.



9) Using the Audio Level meter, measure the signal level across the telephone line. Record this value as Vref. This level should be close to 7.96 dbm.

10) Close switch A to terminate the line into resistor R (600 ohms). The Main Settings window should indicate “off-hook”, as shown below.



11) Using the Audio Level meter, measure the signal level across the telephone line. Record this value as V900. This level should be close to 0 dBm.

12) Using the formula below, calculate the value of Imp900. It should be within 2 % (18 ohms) of 900 ohms. Note that for the following formula, the units of V900 and Vref are dBm.

$$IMP900 = \frac{R \cdot \left[1 - 10^{\left[\frac{V900 - Vref}{20}\right]}\right]}{10^{\left[\frac{V900 - Vref}{20}\right]}}$$

12) Using the Advance Setup window, change the Telephone Source Impedance Setting to 600 ohms. Again measure the signal level with the Audio Level meter. Record this value as V600. This level should be close to 0 dBm.

12) Using the formula below, calculate the value of Imp600. It should be within 2 % (12 ohms) of 600 ohms. Note that for the following formula, the units of V600 and Vref are dBm.

$$IMP600 = \frac{R \cdot \left[1 - 10^{\left[\frac{V600 - Vref + 1.94}{20}\right]}\right]}{10^{\frac{V600 - Vref + 1.94}{20}}}$$