

Testing Non-Typical Horizontal Output Stages with the HA325 Load Test

Testing Horizontal Output Stages

Most horizontal output stages in CRT video displays operate within a typical DCV range, peak-to-peak flyback pulse voltage range and flyback pulse time in microseconds (μ S). The HA325 Load Test is designed with setup options and good/bad readouts for fast, easy testing of these typical and common horizontal output stages.

Occasionally, when testing horizontal output stages with the HA325, you may encounter a stage that normally with a DC voltage, flyback VPP, or μ S timing parameters above or below the typical. When you do, it is important to recognize this difference and properly set up and interpret the HA325 load test results.

This Tech Tip defines a common range of DC, PPV, and μ S timings among horizontal output stages. It further explains how to recognize when a horizontal output stage differs from these common ranges and how to test them with the HA325. An example of a modern multi-media display by TCE (Thomson Consumer Electronics) is used as a reference in this Tech Tip.

Typical DCV, VPP & μ S Parameters in a Horizontal Output Stage

Horizontal Output stages commonly include a transformer, transistor, timing capacitor and damper diode in a common circuit configuration. (See figure 1). If the output stage produces horizontal deflection, a yoke coil and capacitor in series with it are part of the stage.

An operating horizontal output stage produces a flyback pulse waveform at the collector of the horizontal output transistor. The amplitude of the pulse, measured in peak-to-peak volts (PPV or VPP), is determined by the horizontal output stage components and the DCV or “B+” applied to the stage. The flyback pulse VPP directly relates to the output HV and/or the horizontal yoke deflection current produced by the horizontal output stage.

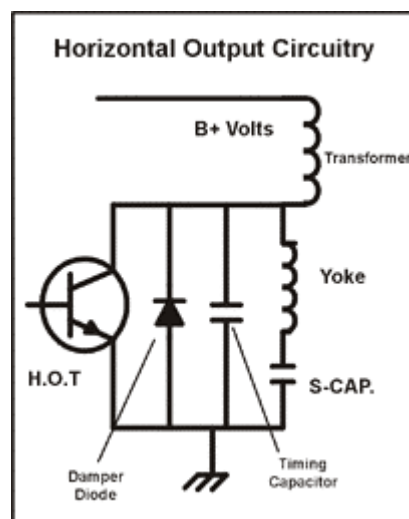


Fig. 1 - Typical horizontal output stage. Flyback pulses typically range from 800-1150 VPP.

A typical horizontal output stage has a DC voltage input that produces a flyback pulse peak-to-peak voltage from 800 to 1150 volts. NTSC televisions typically operate with B+ voltages ranging from 120-140 volts. The most popular DC voltage is 130 volts. Peak-to-peak voltages produced by TV horizontal output stages typically range from 950 to 1150 VPP. Monitors that display multiple video formats often operate with less DC voltage (80-120 VDC) producing flyback pulses ranging from 800 to 1000 VPP.

The flyback pulse produced by a horizontal output stage has a duration or time from its start to end measured in microseconds (μS). The inductance and capacitance of the output stage determines the time duration of the flyback pulse waveform. The timing of the flyback pulse is important because it represents the time of horizontal retrace when the CRT's electron beam is deflected from the right side of the CRT quickly back to the left edge.

The flyback pulse time (retrace) must permit horizontal retrace in the time of the horizontal blanking interval of the video to be displayed. An over-scanned display, such as a television, has a flyback pulse time slightly longer than the NTSC signal blanking interval time of approximately 10.9 μS . Typical TV flyback pulse times range from 11-15 μS .

In under-scanned video displays, such as computer monitors, the flyback pulse is slightly less than the horizontal blanking interval of the video to be displayed. For example, a computer monitor that only displays a VGA format with a video blanking interval of about 6 μS , typically has a flyback pulse time of 4.5 – 6.0 μS . If the monitor must display many different video signals or resolution formats, the flyback pulse must be narrowed or shorter to properly display the video with the shortest horizontal blanking time interval. The highest resolution format generally has the highest horizontal scanning frequency and displays the video with the shortest horizontal blanking interval. Figure 2 shows the normal ranges of flyback pulse times for compatibility with video retrace times.

Horizontal output stages that are not required to comply with horizontal retrace requirements to accommodate the video can deviate from the normal expected flyback pulse timing.. For example, a horizontal output stage that only produces high voltages for the CRT can deviate from the normal flyback pulse times required for compatibility with horizontal retrace.

Testing Typical Horizontal Output Stages with the HA325 Load Test

Most horizontal output stages found in CRT video displays operate within these typical values of voltages and μS times. However, occasionally a

horizontal output stage may deviate from the expected. The DCV or “B+ voltage may be higher or lower, the flyback pulse VPP may be higher or lower, or the μS timing may be outside of an expected time range. These variations will impact the HA325's Horizontal Output Load Test setup, tests and good/bad indications.

The HA325's Horiz Output Load Test operates the horizontal output stage by applying a horizontal switched drive signal and applying B+ voltage to the horizontal output stage. The frequency of the switching drive signal and level of the B+ voltage (DCV) is adjustable to match the requirements of the horizontal output stage to be tested. The process of setting the frequency and DCV with the HA325 is called “SETUP.”

Scan Format	Horiz. Freq.	Horiz. Blanking Time	Typical μS Range
TV-NTSC	15.7 kHz	11 μS	11.0 - 15 μS
VGA	31.5 kHz	6.35 μS	5.0 - 7.0 μS
VESA	38 kHz	6.1 μS	4.8 - 7.0 μS
XGA	35.5 kHz	5.3 μS	4.2 - 6.0 μS
VESA	46.88 kHz	5.17 μS	4.1 - 5.5 μS
VESA	60.02 kHz	3.56 μS	2.8 - 4.5 μS
VESA	63.98 kHz	3.78 μS	3.0 - 4.5 μS
VESA	75.0 kHz	3.46 μS	2.8 - 4.0 μS
VESA	79.98 kHz	3.0 μS	2.4 - 3.5 μS
VESA	81.25 kHz	3.2 μS	2.5 - 3.5 μS
VESA	93.75 kHz	2.765 μS	2.2 - 3.5 μS
VESA	106.25 kHz	2.44 μS	2.0 - 3.5 μS

Fig. 2 - Normal flyback pulse times in μS among CRT displays for compatibility with video retrace times.

When using the HA325 you must select a horizontal test frequency that is near the normal operating frequency of the horizontal output stage. If the display's horizontal output stage operates at several frequencies, select a test frequency that is near the horizontal frequency used by the highest video resolution format. When selecting a DCV you should select a voltage that is approximately 1/10 of the normal B+ voltage to the horizontal output stage. If this level is unknown, you can select and adjust the applied DCV to produce flyback pulse PPV readings that are approximately 1/10 of the normal level produced at the collector of the horizontal output transistor.

You can manually adjust the frequency and DCV for setup with the HA325, but for faster setup, a menu of options are available when the Horiz. Output Load Test is selected. The setup options provide a test frequency and DC voltage that would near a 1/10

level setup in many TVs, HDTV, and computer monitor horizontal output stages. Chart 1 lists the Setup Options or combinations of frequency and DC voltages available on the HA325.

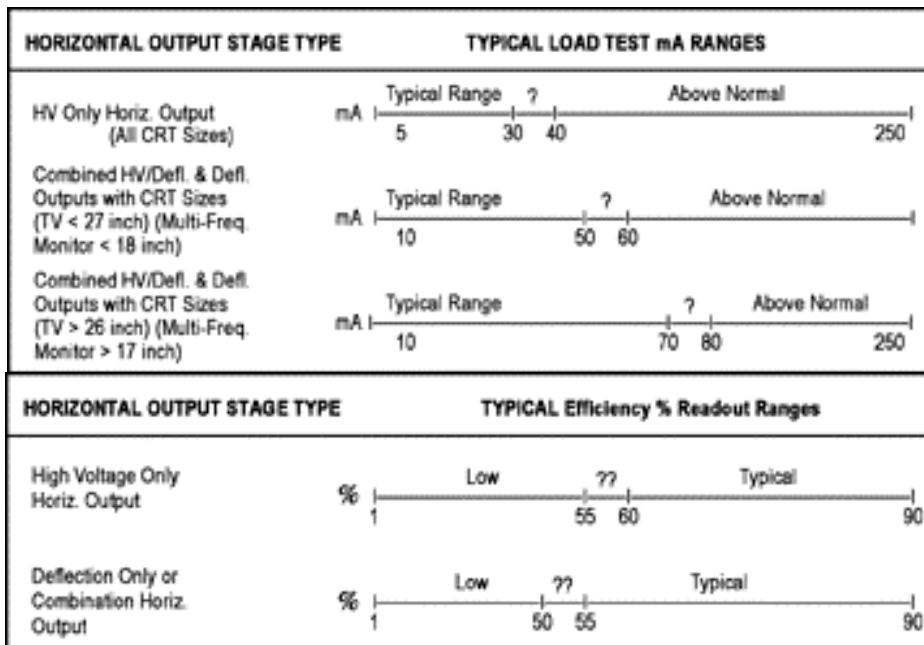
SETUP OPTIONS (HORIZ. OUTPUT)	FREQUENCY	VDC
AUTO	Auto selected	Auto selected
TV 16 kHz	Fixed 16 kHz	Fixed 13 VDC
HD1080 33 kHz	Fixed 33 kHz	Fixed 11.5 VDC
HD720 45 kHz	Fixed 45 kHz	Fixed 12 VDC
VESA 38 kHz	Fixed 38 kHz	Fixed 10 VDC
VESA 48 kHz	Fixed 48 kHz	Fixed 10 VDC
VESA 64 kHz	Fixed 67 kHz	Fixed 10 VDC
VESA 75 kHz	Fixed 75 kHz	Fixed 12 VDC
VESA 88 kHz	Fixed 88 kHz	Fixed 12 VDC
MANUAL	Adjust from 30 kHz	Adjust from 1V

Chart 1 - Setup options provide combinations of frequencies and DC voltages that near the 1/10 setup level for TVs, HDTVs, computer monitors, etc.

The objective of the HA325's Horiz. Output Load Test is to simulate the operation of the horizontal output stage to be tested at the proper frequency and 1/10 of the normal B+ voltage. A SETUP HORIZ. OUTPUT display indicates the test frequency and DCV applied to the horizontal output stage and the resulting flyback pulse PPV.

Horiz, Output Load Test mA, % EFF. and μ S results are displayed by the HA325 for analyzing the

horizontal output stage for defects. Good/Bad readouts are provided by the HA325 when analyzing typical horizontal output stages with flyback pulses ranging from 80-110 VPP. For horizontal output stages with normal chassis VPP under 800 or above 1100 VPP require manual interpretation. The normal ranges of the mA and % EFF reading on horizontal output stages is shown in figure 3.



Example: Deflection Horizontal Output Stage in MM101 Chassis

An example of a horizontal output stage that has a higher flyback VPP than is typical of most horizontal output stages (800-1150VPP) is shown in figure 4. This horizontal output stage produces deflection only and is found in the Thomson Consumer Electronics MM101 chassis. The MM101 multi-media chassis displays multiple signal formats including NTSC, VGA, SVGA, VESA, SDTV and HDTV. The horizontal output stages in the MM101 chassis operates at the native scanning frequencies to properly display these signal formats.

Fig. 3 - Normal ranges of mA and % EFF. readings for different types of horizontal output stages.

Operation of this horizontal output stage is the same as other horizontal output stages. Transformer T451 is simply a transformer required by the circuit for normal operation and is not a flyback transformer to produce high voltage as found in other horizontal stages. B+ voltage is applied to a primary winding at pin 1 and the other side of the primary winding is pin 4. The stage contains a horizontal output transistor (Q451), damper diode (CR452), timing capacitors (C456, C453), yoke and S-correction capacitors (s) or S-capacitors.

In multi-format displays, such as the MM101, the yoke is matched with different S-correction capacitors as the horizontal scanning frequency changes between input signal formats. Transistor switches, controlled by the system as different input signal formats are selected, switch in an appropriate S-capacitor value with the yoke for proper shaping of the current in the yoke. The MM101 uses two switching transistors to add or remove two S-capacitors in parallel with S-capacitor C454.

The switched S-capacitors in a multi-frequency horizontal output stage are important when considering what frequency to choose on the HA325 to Load Test the stage. Since the Horizontal Output Load Test is performed with no power to the chassis

or horizontal output stage, the transistors used to add or remove S-capacitors are switched open. The horizontal output stage has the least amount of S-correction capacity in the stage. This corresponds with the condition of the horizontal output stage for displaying the highest horizontal scanning frequency or resolution format of the display. In the MM101 chassis this is the 2.4H scanning rate or approximately 38kHz. When testing with the HA325's Load Test, a frequency near 38 kHz should be selected.

The DCV or B+ voltage to the deflection horizontal output stage of the MM101 chassis also varies depending on the scanning frequency. The DC volts applied to the stage for NTSC video, scanning at 15,734 Hz, is approximately 70 volts. As the scanning frequency increases the B+ voltage increases to maintain the same level of deflection current in the yoke. In this manner, the scan B+ regulator stage automatically adjusts the B+ input voltage to regulate the picture width. At 2.4H or 38 kHz, the B+ voltage to the stage is approximately 160 VDC. When testing with the HA325's Load Test, a voltage of 16 volts would be approximately 1/10 of the normal B+ input voltage.

MM101 Deflection ONLY Horizontal Output Stage

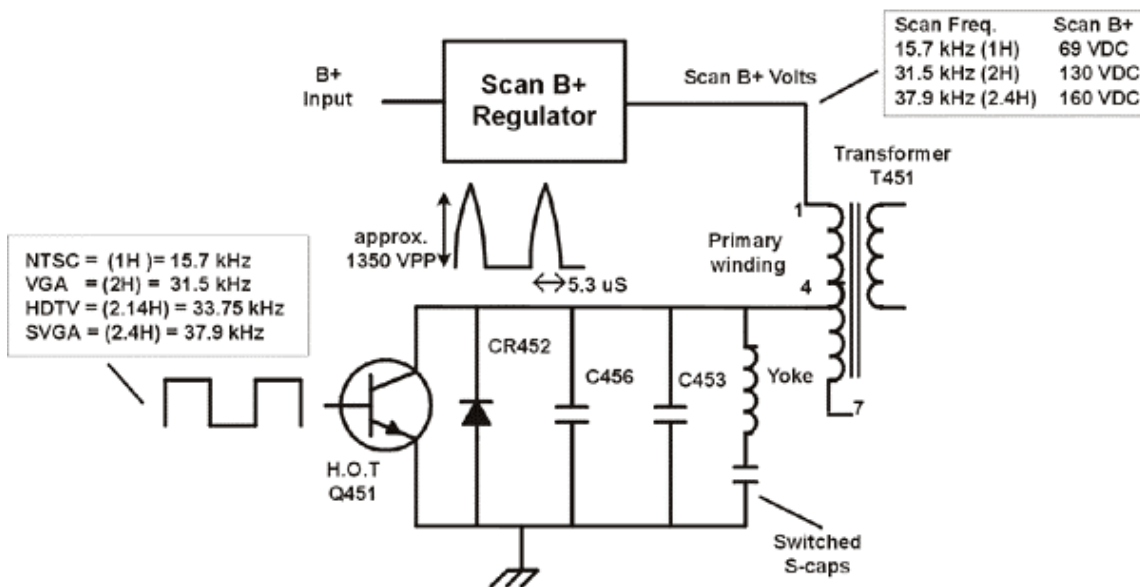


Fig. 4 - MM101 Deflection Only Horizontal Output Stage

The MM101 deflection horizontal output stage produces flyback pulses that are approximately 1300 VPP. This is slightly higher than the VPP found in most horizontal output stages. When simulated the

operation of the horizontal output stage at 1/10 of normal, the HA325 produces flyback pulses that are approximately 1/10 of this or 130 VPP.

Load Testing the Deflection Output in the MM101

The Horiz. Output Load Test properly simulates the operation of the deflection output in the MM101 for detecting loading and timing defects. The Load Test clips are connected to the horizontal output stage as shown in figure 5.

To properly simulate the operation of the deflection horizontal output stage, the setup frequency applied with the HA325 should be near 38 kHz. This frequency is chosen because with the chassis powered off the S-correction capacity tunes the yoke circuit for the highest horizontal operating frequency. Load Testing at a lower frequency increases the mA reading and lowers the % EFF. readings because of the improperly tuned yoke circuit.

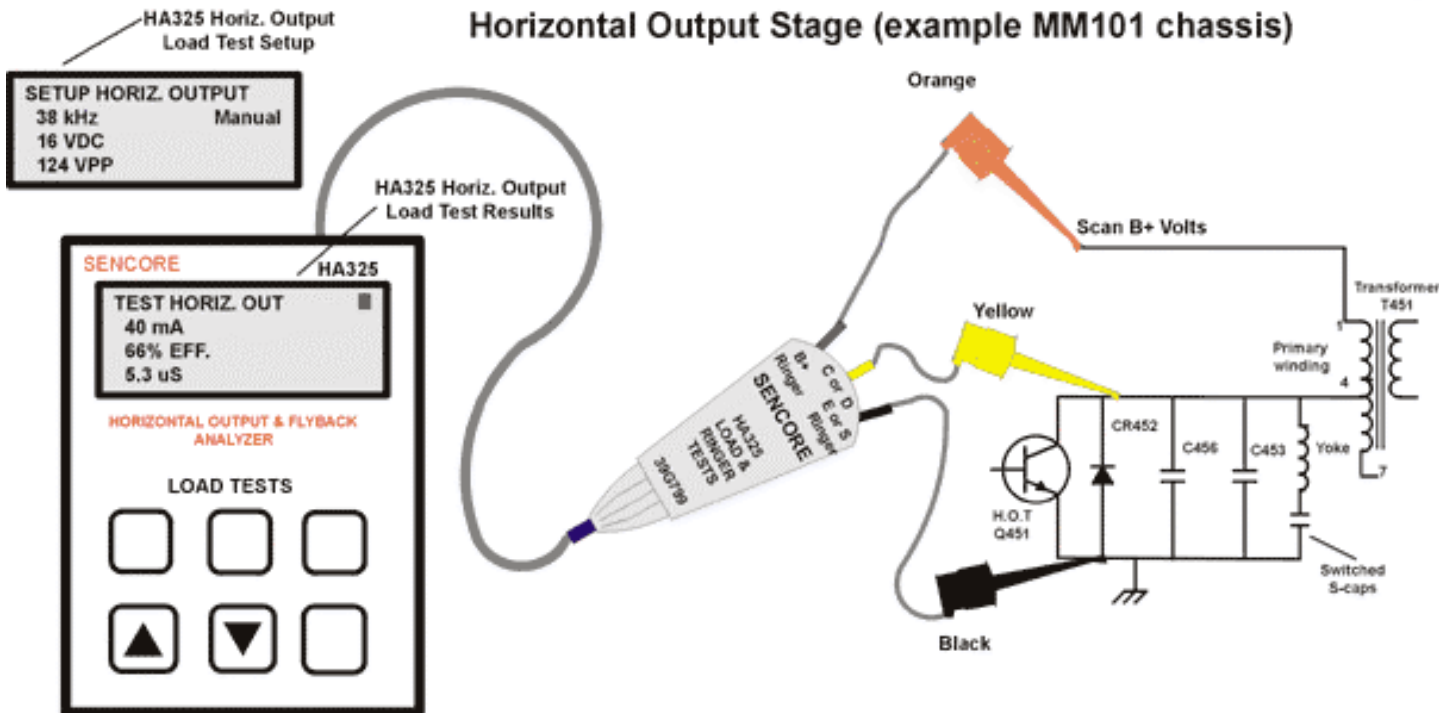
To properly simulate the operation of the deflection output stage at 1/10 of the normal power, the setup DCV applied with the HA325 Load Test should be approximately 16 VDC. This is approximate 1/10 of the B+ voltage that is applied to the stage during operation at 38 kHz. If the horizontal output stage is operational, flyback pulses that are approximately

1/10 of the chassis normal should be produced by the HA325's Horiz. Output Load Test.

A "VESA 38 kHz" setup option of the HA325 provides ease in selecting a test frequency and DC voltage. You select this preset by pushing the HORIZ OUTPUT pushbutton and the down arrow pushbutton to position the cursor. Pressing the ENTER pushbutton applies a 38 kHz drive and 10 VDC to the horizontal output stage being tested. The 10 VDC can be increased to 16 volts to properly test the MM101 chassis by pressing the TEST/SETUP pushbutton and pushing the up arrow pushbutton to increase the DCV output to 16 VDC. Pressing the TEST/SETUP pushbutton returns to the Load Tests mA, %EFF, and μ S readings.

Normal Horiz. Output Load Test readings on the deflection horizontal output stage of the MM101 are approximately 40 mA, 65 % EFF, and 5.2 μ S. These readings are within the ranges for a large CRT size display as shown in figure 3. The μ S pulse time is within the range required for displays in the 30-38 kHz range.

Horizontal Output Load Test with the HA325 on a Deflection-only Horizontal Output Stage (example MM101 chassis)



To Load Test the MM101 Deflection Horiz. Output Stage:

1. Remove Power to the Chassis – Connect test clips as shown in figure 5.
2. Press HORIZ. OUTPUT Pushbutton.
3. Push Arrow Down Pushbutton to select “VESA 38 kHz”. Press ENTER Pushbutton.
4. Press TEST/SETUP Pushbutton to show SETUP HORIZ. OUTPUT Display.
5. Push Up Arrow Pushbutton to increase DCV to approx. 16 VDC
(Note: VPP readings should be near 130 VPP)
6. Push TEST/SETUP Pushbutton to display the Load Test readings.

Normal Load Test readings are approx. 40 mA, 65% EFF, and 5.2 μ S.

Note: No Good/Bad indicators are shown by the HA325 because the VPP is > 110 VPP.

Example: High Voltage Horizontal Output Stage in the MM101 Chassis

An example of a horizontal output stage where the μ S timing does not conform to the typical horizontal output stage timing required by the video signal is shown in figure 6. This is a high voltage only horizontal output stage in a Thomson Consumer Electronics MM101 chassis. This horizontal output stage has a flyback VPP that is also slightly less than the typical 800-1150 VPP range.

The high voltage only horizontal output stage is basically a high voltage generator producing high voltage(s) for the CRT. It operates like a horizontal output stage using two parallel MOSFET switching transistors as horizontal output transistors. These transistors are driven on and off simultaneously by the horizontal drive signal. Conduction current builds and collapses in the primary winding of the flyback transformer (T700). A timing capacitor (C702) is part of the horizontal output stage producing a flyback pulse as shown in figure 6.

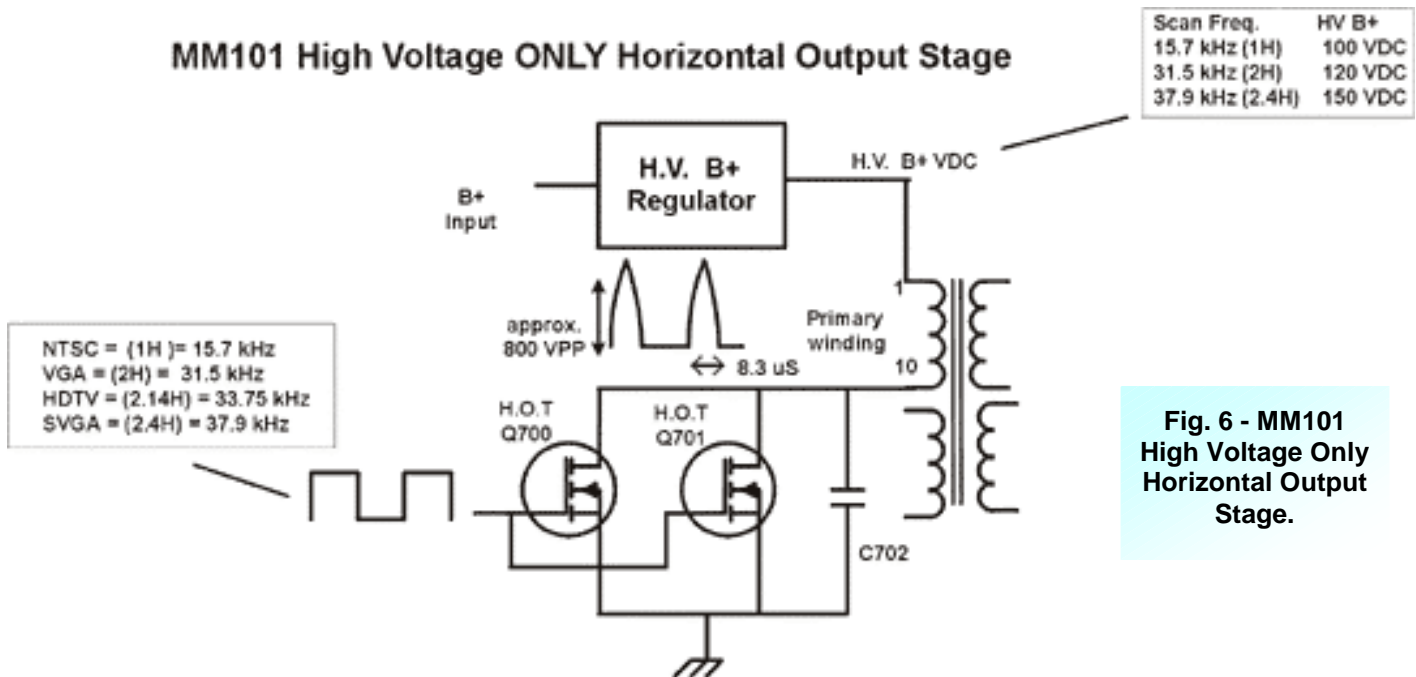


Fig. 6 - MM101 High Voltage Only Horizontal Output Stage.

The timing of the flyback pulses in a high voltage only horizontal output stage are not bound by retrace time requirements for the video. Blanking signals for video and retrace time requirements apply to horizontal stages that produce horizontal deflection.

Therefore, the time and shape of flyback pulses found in high voltage only horizontal output stages can and often do vary from those in the deflection output stages.

In the MM101 high voltage output stage the normal flyback pulse time is approximately 8.6 μ S. In comparison, horizontal output stages producing deflection at 38 kHz would have a μ S timing typically ranging from 3.7-6.9 μ S. The Horiz. Output Load Test properly simulates the operation of the high voltage output stage producing flyback pulses that mirror the chassis normal operation at approximately 8.6 μ S.

The DCV or B+ voltage to the high voltage only horizontal output stage of the MM101 chassis varies depending on the scanning frequency. The DC voltage applied to the stage for NTSC video, scanning at 15,734 Hz, is approximately 100 volts. As the scanning frequency increases the B+ voltage

increases to maintain the same level of high voltage. In a manner similar to the deflection output stage, the HV B+ Regulator stage automatically adjusts the B+ input voltage to regulate the picture width. At 2.4H or 38 kHz, the B+ voltage to the stage is approximately 150 VDC. When testing with the HA325's Load Test, a voltage of 15 volts would be approximately 1/10 of the normal B+ input voltage.

The flyback pulses in the HV horizontal output stage in the MM101 are at the bottom edge of what would be considered a typical range of VPP. When simulated the operation of the horizontal output stage at 1/10 of normal, the HA325 produces flyback pulses that are approximately 1/10 of this or 80 VPP.

Load Testing the High Voltage Output in the MM101

The HA325's Horiz. Output Load Test can be used to analyze the operation of a high voltage only horizontal output stages. Because these stages do not have to comply with retrace times or horizontal blanking times of the video, you should expect some variation in the VPP and μ S readings. For example, the Load Test properly simulates the operation of the high voltage output in the MM101 for detecting loading and timing defects. The Load Test clips are connected to the horizontal output stage as shown in figure 7.

If there are no components switched in or out of the high voltage only horizontal output stage you could test at any of the operating frequencies it supports. However, when Load Testing a high voltage output stage similar to the MM101 chassis, the mA and efficiency readings will improve or worsen as you test between the highest and lowest scanning frequencies that the stage supports. This is normal as you change the operating frequency of the stage closer or farther from a natural resonating LC frequency. In the MM101 chassis the mA and %EFF readings indicate a natural resonance in the range of 31-38 kHz.

To properly simulate the operational currents of the high voltage output stage at 1/10 of the normal power, the setup DCV applied with the HA325 Load Test should be approximately 15 VDC at 38 kHz. The DCV applied at 33kHz would be approximately 12 volts to be 1/10 of normal. The horizontal output stage produces flyback pulses that are approximately 1/10 of normal or 800 VPP.

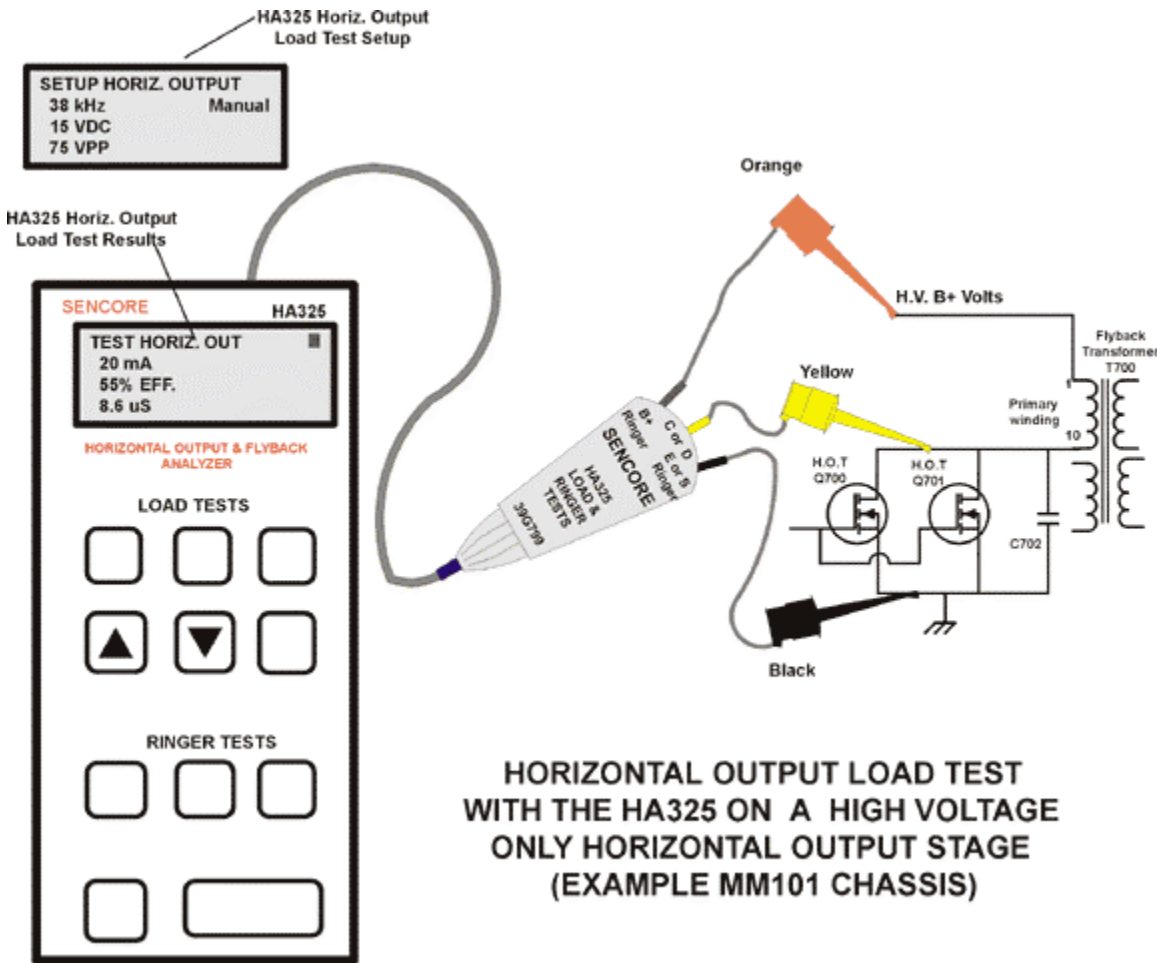
Normal Horiz. Output Load Test readings on the high voltage horizontal output stage of the MM101 are approximately 24 mA, 55 % EFF, and 8.6 μ S. The mA and %EFF readings are within or near the typical ranges for a high voltage only horizontal output stage as shown in figure 3. HV only stages have mA readings that typically vary from 5-35 mA and have efficiency readings of 55% or greater.

In horizontal output stages that produce deflection, unusual or "BAD" Load Test μ S times suggest you should question the test frequency you have chosen for the Load Test. Often the μ S timing alerts you to the fact the horizontal output stage is designed to work at a lower or higher scanning frequency. Other times it may alert you to an unplugged or open yoke current path that increases the μ S time.

The 8.6 μ S timing of the MM101 chassis suggests an operating frequency of 20-30 kHz. While the MM101 HV output stage can operate at a lower frequency typical of the 8.6 μ S timing, it is not tuned for efficient operation in that frequency range.

Normal Horiz. Output Load Test μS readings in the HV output of the MM101 are approximately 8.6 μS . This varies from μS times found among other horizontal output stages operating in the 31-38 kHz. When an unusual or “BAD” μS time is indicated by a high voltage only horizontal output stage, check the mA and %EFF. readings. If readings are in the typical range for a high voltage only horizontal output stage, then the stage likely has no defects and the μS timing simply does not comply with typical retrace timing requirements.

Fig. 7 - Setup and Load Test results on an MM101 Chassis.



You can verify a normal variation of the flyback μS pulse time by looking at the scope waveform taken at the collector or drain of the output stage as shown in the service literature. Look at the time/division setting of oscilloscope and approximate the μS time of the pulse. The Load Test μS reading should be approximately the same if the HV output stage is working properly. You may also view the waveshape with an oscilloscope during the HA325's Horiz. Output Load Test. An oscilloscope waveform that is shaped and timed similar to that of the schematic, indicates a normal flyback pulse.

Load Testing the HV Output in the MM101

1. Remove Power to the Chassis – Connect test clips as shown.
2. Press HORIZ. OUTPUT Pushbutton to begin setup.
3. Push Arrow Down Pushbutton to position cursor by VESA 38 kHz. Press ENTER Pushbutton
4. Press TEST/SETUP Pushbutton to show SETUP HORIZ. OUTPUT Display.
5. Push Up Arrow Pushbutton to increase DCV to approx. 15 VDC (VPP readings should be approx. 75VPP)
6. Push TEST/SETUP Pushbutton to display the Load Test readings.

Normal Load Test readings are approx. 20 mA, 55% EFF, and 8.6 μ S. The μ S reading agrees with the schematic and normal chassis operation.

Note: *No Good/Bad indicators are shown by the HA325 because the VPP is < 80 VPP.*

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