Tektronix®

SC 502 OSCILLOSCOPE

Francais Deutsch 日本語

INSTRUCTION MANUAL

Tektronix®
COMMITTED TO EXCELLENCE

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SC 502 OSCILLOSCOPE

Francais Deutsch 日本語

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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Product Group 75

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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag, or stamped on the chassis. The first number or letter designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B000000	Tektronix, Inc., Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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WARNING

THE FOLLOWING SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

Terms In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols As Marked on Equipment


DANGER — High voltage.


Protective ground (earth) terminal.


ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate In Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Operate Without Covers

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

CONSIGNES DE SECURITE

Ce rappel des consignes générales de sécurité s'adresse aux utilisateurs et au personnel de maintenance. Les avertissements et précautions à respecter sont annotés dans ce manuel à chaque fois que l'utilisation du châssis d'alimentation l'exige. Il est à noter que ceux-ci peuvent ne pas figurer dans cette rubrique de rappel.

Termes utilisés dans ce manuel

Les paragraphes intitulés ATTENTION identifient les circonstances ou opérations pouvant entraîner la détérioration de l'appareil ou de tout autre équipement.

Les paragraphes intitulés AVERTISSEMENT indiquent les circonstances dangereuses pour l'utilisateur (danger de mort ou risque de blessure).

Repères gravés sur l'appareil

CAUTION (ATTENTION) : ce mot identifie les zones de risque de blessure non perceptibles immédiatement ou un risque éventuel de détérioration de l'appareil.

DANGER (DANGER) : ce mot indique les zones de risque immédiat pouvant entraîner blessures ou mort.

Symboles gravés sur l'équipement


DANGER — Haute tension


Borne de masse de protection (terre)


ATTENTION — se reporter au manuel

Source d'alimentation

L'appareil est conçu pour fonctionner à partir d'une source d'alimentation maximale de 250 V efficaces entre les conducteurs d'alimentation ou entre chaque conducteur d'alimentation et la terre. Pour utiliser l'appareil en toute sécurité, une connexion à la masse, réalisée au moyen d'un conducteur prévu dans le cordon d'alimentation, est indispensable.

Mise à la masse de l'appareil

Une fois installé dans le châssis d'alimentation, l'appareil est relié à la masse à l'aide d'un conducteur du cordon d'alimentation. Pour éviter tout choc électrique, insérer la prise du cordon d'alimentation dans une prise de distribution correspondante avant de connecter l'entrée ou les sorties de l'appareil. Pour utiliser l'appareil en toute sécurité, une connexion à la masse, réalisée au moyen d'un conducteur prévu dans le cordon d'alimentation, est indispensable.

Danger provoqué par la coupure de connexion de masse

En cas de coupure de la connexion de masse, tous les éléments conducteurs accessibles (y compris boutons et commandes apparaissant isolants) peuvent provoquer un choc électrique.

Utiliser le cordon d'alimentation approprié

N'utiliser que le cordon d'alimentation et la prise recommandés pour votre appareil. Utiliser un cordon d'alimentation en parfait état. Seul, un personnel qualifié peut procéder à un changement de cordon et prises.

Utiliser le fusible approprié

Pour éviter tout risque d'accident (incendie...) n'utiliser que le fusible recommandé pour votre appareil. Le fusible de remplacement doit toujours correspondre au fusible remplacé : même type, même tension et même courant. Un remplacement de fusible ne doit être effectué que par un personnel qualifié.

Ne pas utiliser l'appareil en atmosphère explosive

Pour éviter toute explosion, ne pas utiliser cet appareil dans une atmosphère de gaz explosifs.

Ne pas démonter les capots

Pour éviter toute blessure, ne pas utiliser ce produit sans capots ou panneaux. Ne pas alimenter le tiroir à travers un prolongateur.

CONSIGNES DE SECURITE

UNIQUEMENT DESTINEES AU PERSONNEL DE MAINTENANCE

Ne pas dépanner tout seul

Ces consignes s'adressent exclusivement à un personnel qualifié. Il est également indispensable de se reporter aux consignes de sécurité précédentes Toute intervention interne ou réglage doit s'effectuer en présence d'une autre personne capable d'assurer les premiers secours en cas de danger.

Agir avec précaution lorsque l'appareil est sous tension

Des potentiels dangereux existent en différents points de l'appareil. Pour éviter toute blessure, ne pas intervenir sur les connexions et les composants alors que l'appareil est sous tension. Débrancher l'alimentation avant le démontage des panneaux, soudure ou remplacement de composants.

Source d'alimentation

Cet appareil est conçu pour fonctionner à partir d'une source d'alimentation qui n'applique pas plus de 250 V efficaces entre les conducteurs d'alimentation ou entre un conducteur et la masse. Pour utiliser l'appareil en toute sécurité, une connexion à la masse réalisée au moyen d'un conducteur prévu dans le cordon d'alimentation est indispensable.

SICHERHEITSANGABEN FÜR DEN ANWENDER

Die allgemeinen Sicherheitsinformationen in diesem Teil der Angaben dienen dem Anwender- und Servicepersonal. Spezielle Warnungen und Hinweise sind überall im Handbuch zu finden, müssen jedoch in diesen Angaben nicht erscheinen.

BEGRIFFE

In diesem Handbuch

VORSICHTSHINWEISE erläutern Bedingungen, die zur Zerstörung des Gerätes oder anderer Gegenstände führen können.

WARNUNGSHINWEISE erläutern Bedingungen, die zu Personenschäden führen können oder lebensgefährlich sind.

Markierungen auf dem Gerät

CAUTION – VORSICHT weist darauf hin, daß durch zufälliges Berühren an einer nicht unmittelbar zugänglichen Stelle Personenschaden entstehen kann, oder Schaden am Gerät selbst.

DANGER - GEFAHR weist darauf hin, daß durch zufälliges Berühren an einer zugänglichen Stelle Personenschaden entstehen kann.

SYMBOLE

In diesem Handbuch

Dieses Symbol zeigt an, wo Vorsicht walten zu lassen ist, oder wo Informationen zu finden sind.

Markierungen auf dem Gerät

GEFAHR – Hochspannung.

Schutzerdungskontakt.

ACHTUNG – beziehen Sie sich auf das Handbuch.

Netzspannungsversorgung

Die Betriebsspannung für dieses Gerät darf 250 V_{eff} nicht überschreiten und ist an die Versorgungsleitungen bzw. an eine Versorgungsleitung und Masse anzulegen. Innerhalb des Netzanschlußkabels muß ein Schutzleiter vorhanden sein, der mit Gerätemasse verbunden ist.

Masseanschluß des Gerätes

Dieses Gerät wird über den Schutzleiter der Versorgungseinheit mit Erdpotential verbunden. Zur Vermeidung von elektrischen Schlägen vor der Beschaltung der Ein- und Ausgänge ist der Netzstecker in eine korrekt verdrahtete Steckdose einzustecken. Verwenden Sie den Schutzleiter nicht als einzige Verbindung zwischen zwei oder mehreren Geräten. Zur Vermeidung von elektrischen Schlägen sind die Geräte untereinander mit separaten Leitungen zu verbinden.

Gefahr durch fehlende Schutzerde

Durch eine fehlende Schutzerde können alle berührbaren, leitenden Teile (einschließlich Knöpfe und andere Bedienungselemente, die isoliert sind) einen elektrischen Schlag bei der Berührung auslösen.

Verwendung eines richtigen Netzkabels

Verwenden Sie nur Netzkabel, die für die Versorgungseinheit geeignet sind und die sich in gutem Zustand befinden.

Für detaillierte Informationen über Kabel und Stecker beziehen Sie sich bitte auf Abbildungen innerhalb des Handbuches.

Ein Austausch von Kabeln und Steckern ist nur von geschultem Personal vorzunehmen.

Verwendung einer richtigen Sicherung

Zur Vermeidung von Brandschäden sind nur Sicherungen zu verwenden, die in den Teilelisten dieses Gerätes aufgeführt sind und die in Spannungs- und Stromwert entsprechend sind.

Ersatz von Sicherungen ist nur von geschultem Personal vorzunehmen.

Arbeiten Sie nicht in explosiver Umgebung

Zur Vermeidung von Explosionen ist die Inbetriebnahme dieses Gerätes in explosiver Umgebung zu unterlassen, wenn das Gerät nicht dafür geeignet ist.

Entfernen Sie keine Gehäuseabdeckungen

Zur Vermeidung von Personenschäden sind keine Gehäuseteile zu entfernen. Auch ist das Gerät ohne Gehäuse nicht in Betrieb zu nehmen.

Arbeiten Sie nicht ohne Gehäuseabdeckung

Zur Vermeidung von Personenschäden ist das Gerät nicht ohne Gehäuse in Betrieb zu nehmen. Der Einschub sollte nicht über einen Verlängerungsadapter betrieben werden.

SICHERHEITSANGABEN FÜR DEN SERVICE

NUR FÜR GESCHULTES PERSONAL

Beziehen Sie sich auch auf die vorangehenden Sicherheitsangaben für den Anwender.

Führen Sie keine Servicetätigkeiten alleine durch

Nehmen Sie an dem Gerät keine Service- oder Einstellarbeiten vor, wenn nicht eine andere Person verfügbar ist, um im Bedarfsfall Erste Hilfe oder Wiederbelebungsversuche zu leisten.

Lassen Sie besondere Vorsicht walten, wenn Sie an einem unter Spannung stehenden Gerät arbeiten

An verschiedenen Stellen im Gerät liegen hohe und damit gefährliche Spannungen. Zur Vermeidung von Personenschäden sind solche Stellen und Bauteile nicht zu berühren, während Betriebsspannung anliegt.

Vor dem Entfernen von Gehäuseteilen, Löten oder Ersetzen von Bauteilen ist immer die Betriebsspannung zu entfernen.

Netzspannungsversorgung

Die Betriebsspannung für dieses Gerät darf 250 V_{eff} nicht überschreiten und ist an die Versorgungsleitungen bzw. an eine Versorgungsleitung und Masse anzulegen. Innerhalb des Netzanschlußkabels muß ein Schutzleiter vorhanden sein, der mit Gerätemasse verbunden ist.

ご使用の前に

この章では操作する方およびサービス・エンジニアの方に安全にお取扱いいただくための注意事項が述べられています。

用語

マニュアル中の用語

注意の項は本機器または他の接続機器に損傷を及ぼす恐れのある場合の注意です。

警告の項は人体に損傷を与えたり生命に危険を及ぼす恐れのある場合の注意です。

機器上に記されている用語

CAUTIONは人体および本機器または周辺機器に損傷を及ぼす恐れがある部分を示しています。

DANGERは人体に損傷を及ぼしたり生命に危険を与える恐れがある部分を示しています。

記号

この取扱説明書に出てくる記号

このマークは適切な注意、または他の項目を参照する必要がある場合を指示しています。

機器に記された記号

危険——高電圧

保護用接地端子

注意——取扱説明書参照

電源

本機器は電源コードの線間、あるいは電源コードとグラウンド間が250Vrms以内の範囲の電源で作動します。安全のために電源コードのアース線で接地して下さい。

機器の接地

本機器は電源コードのアース線で接地されます。電気的ショックを避けるために、電源コードをコンセントに差し込んでから、機器の入、出力端子への接続を行って下さい。電源コード中のアース線は必ず接地して下さい。

電源本体の接地

電気的ショックを防止するため、電源本体は確実に接地して下さい。接地が行われていないと、導体の部品（絶縁処理されたノブおよびコントロールつまみを含む。）により電気的ショックを受けることがあります。

電源コード

電源コードとコネクタは機器に適合するものをお使い下さい。

電源コードに損傷がないことをお確め下さい。

電源コードとコネクタに関する詳細は本体取扱説明書をご参照下さい。

電源コードとコネクタの交換については当社エンジニアにおたずね下さい。

ヒューズ

危険防止のため、マニュアルに記載されている仕様に適合するヒューズをご使用下さい。

ヒューズの交換に関する詳細は、当社フィールド・エンジニアにおたずね下さい。

爆発防止

危険防止のため、爆発性のガスが周囲にあるような所では作動させないで下さい。

カバー、パネルについて

プラグインのカバーやパネルを取りはずしたまま作動させないで下さい。

修理上の注意

サービス・エンジニアの方へ

“操作上の注意”を先にお読み下さい。

1人でサービスを行わないで下さい。

機器の内部点検または修理は、万一の場合に備えて応急処置のできる人がいる所で行って下さい。

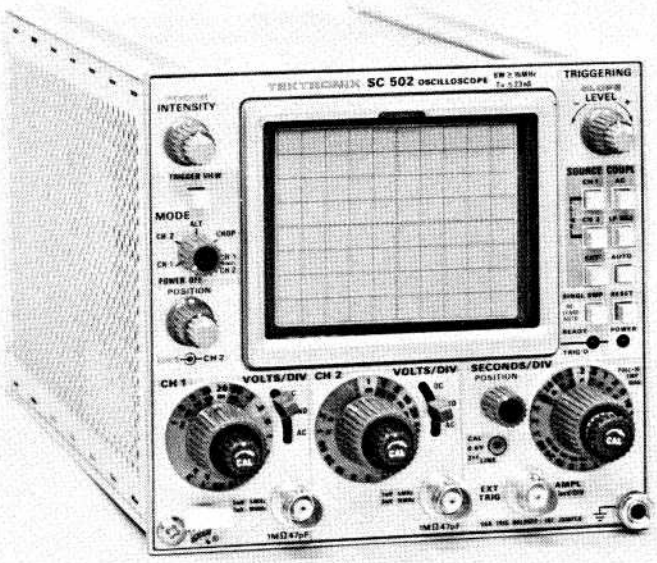
電源を入れた場合の注意

機器内部には高電圧の部分があります。人体への危険を防止するため、電源がはいっている時は、露出している接続部分や部品には手を触れないで下さい。

パネルの取りはずし、ハンダ付、部品の交換を行う前には、電源を必ず切って下さい。

電源

本機器は電源コードの線間、あるいは電源コードとグラウンド間が250Vrms以内の範囲の電源で作動します。安全のために電源コードのアース線できちんと接地して下さい。



1878-1

The SC 502 Oscilloscope

SPECIFICATION

Performance Conditions

The electrical characteristics in this specification are valid with the following conditions:

1. The instrument must have been adjusted at an ambient temperature between +20°C and +30°C.
2. The instrument must be in a non-condensing environment whose limits are described under Environmental.
3. Allow twenty minutes warm-up time for operation to specified accuracy; sixty minutes after exposure to or storage in a high humidity (condensing) environment.

Any conditions that are unique to a particular characteristic are expressly stated as part of that characteristic.

The electrical and environmental performance limits together with their related validation procedures are a complete statement of the electrical and environmental performance of a calibrated instrument.

Table 1-1
VERTICAL DEFLECTION SYSTEM

Characteristics	Performance Requirements	Supplemental Information
Deflection Factor		
Calibrated Range	1 mV/div to 20 V/div in 14 steps in a 1-2-5 sequence.	
Variable Range	At least 2.5 to 1.	Continuously variable between calibrated steps and extends maximum uncalibrated deflection factor to at least 50 V/div.
DC Balance (+15°C to +35°C)	0.5 div + 1 mV.	
Accuracy		
+15°C to +35°C		
5 mV/div to 20 V/div	±2%	
1 mV/div to 2 mV/div	±5%	
0°C to +50°C	Derated accuracy by an additional 1%.	
Linearity	0.1 div or less of compression or expansion as a 2 div signal is positioned between the graticule limits.	
HF Bandwidth		
5 mV/div to 20 V/div	At least 15 MHz.	
Risetime (calculated)		23 ns or less.
Typical step response aberrations		±2%, 3% peak-to-peak or less. Signal limited to 5 major divisions.
2 mV/div	At least 10 MHz.	
1 mV/div	At least 5 MHz.	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
AC LF Response	10 Hz or less with ac coupling	1 Hz or less with X10 probe.
Common Mode Rejection Ratio (CH1-CH2 Display Mode)	At least 30 to 1 at 1 MHz or less with same deflection factor settings.	Common mode signal limited to ±5 divisions, 10 div peak-to-peak. With X10 probes CMRR above 1 kHz is limited by probe compensation matching.
Channel Isolation	2% or less display related crosstalk to 15 MHz.	Input signal related crosstalk is typically less than 0.01%.
Displayed Noise	0.2 mV or less peak-to-peak at 1 mV.	
Typical Trace Drift (after 1 hour warm-up, constant line voltage)		
5 mV/div to 20 V/div		Less than 0.1 div/hr. and 0.03 div/°C.
1 mV/div to 2 mV/div		Less than 0.3 mV/hr. and 0.1 mV/°C.
CH1 or CH2 Input		
Impedance	1 MΩ ±1%.	Paralleled nominally by 47 pF.
Maximum Input Voltage		350 V (dc + peak ac), 700 V peak-to-peak ac at 1 kHz or less. Above 1 kHz recommended peak-to-peak ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.
Position Range	At least ±6 divisions.	
Delay Line		Nominally 140 ns. Permits viewing the leading edge of the triggering waveform.
Display Modes		
CH1 or CH2	Selected input is displayed.	
ALT	Alternates display of CH1 and CH2 every other sweep.	
CHOP	Chops display of CH1 and CH2.	Chop rate at least 250 kHz.
CH1 minus CH2	Displays algebraic difference between CH1 and CH2.	
Trigger View	Triggering waveform is displayed instead of selected Display Mode when TRIG VIEW button is depressed.	Triggering point on the displayed waveform is nominally at CRT vertical center.

Table 1-2

HORIZONTAL DEFLECTION SYSTEM

Characteristics	Performance Requirements		Supplemental Information
Sweep Rates			
Calibrated Range	0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. X10 Horizontal Magnifier extends fastest calibrated rate to 20 ns/div.		
Variable Range	At least 2.5 to 1.		Continuously variable between calibrated sweep rates and extends slowest uncalibrated rate to at least 1.25 s/div. The variable control is internally selectable between the Variable Sweep Rate or Variable Holdoff functions.
Accuracy			
+15°C to +35°C	**Unmagnified**	**Magnified X10**	
0.5 s/div to 0.1 s/div	±3%	±4%	Measured over center 8 displayed divisions excluding the first 50 ns and magnified sweep beyond the 100th division.
50 ms/div to 1 μs/div	±2%	±3%	
0.5 μs/div to 0.2 μs/div	±3%	±4%	
0°C to +50°C	Derate accuracy by an additional 1%.		
Linearity			Typically 5% (0.1 div) or less change in timing over any 2 div internal within the center 8 divisions.
MAG Registration	0.5 divisions or less.		
Sweep Length	At least 10.0 divisions.		
Position Range			
Fully CW	Start of 1 ms/div sweep positions to right of center graticule line.		
Fully CCW	10th division of 1 ms/div sweep positions to left of center graticule line.		
External Horizontal Input			
Bandwidth	At leasts 2 MHz.		Low frequency response determined by trigger coupling selection, 50 Hz or less with ac coupling.
Deflection Factor	50 mV/div ±5%.		
Phase Difference	3° or less to 50 kHz.		
Input Impedance	1 MΩ ±2%.		Paralleled nominally by 47 pF.
Maximum Input Voltage			350 V (dc + peak ac), 350 V peak-to-peak at 1 kHz or less.

Table 1-3
TRIGGERING SYSTEM

Characteristics	Performance Requirements		Supplemental Information
Trigger Sensitivity (Minimum peak-to-peak signal required)			
	CH1 or CH2	**External**	
5 MHz or less	0.4 div	60 mV	
5 MHz to 15 MHz	1.0 div	150 mV	
Coupling			
DC			Minimum signal requirements extend to dc.
AC			Minimum signal requirements increase below 50 Hz.
AC LF REJ			Minimum signal requirements increase below 5 kHz.
Trigger Level Range (Normal and Single Sweep modes only)	At least ±8.0 divisions, CH1 or CH2, and at least ±1.2 V external.		
External Trigger Input (Same as Ext. Horizontal input)			
Impedance	1 MΩ ±2%.		Paralleled nominally by 47 pF.
Maximum Input Voltage			350 V (dc + peak ac), 350 V peak-to-peak at 1 kHz or less.
Modes			
Auto	Sweep free-runs in the absence of a triggering signal.		TRIGGER LEVEL range automatically varies with the triggering signal peak-to-peak range. Not recommended for frequencies below 30 Hz. Below 100 Hz minimum signal requirements increase.
Normal (Auto button out)	Sweep will not run unless triggered.		
Single Sweep	Upon triggering, sweep runs once and will not run again unless reset by pushing Reset button.		
Holdoff Time			Measured at rear interface pins 20B-21B. Select Auto mode and free run sweep.
0.5 s/div to 1 ms/div			Nominally 10 ms.
0.5 ms/div to 10 μs/div			Nominally 100 μs.
5 μs/div to 0.2 μs/div			Nominally ≤2 μs.
Variable Holdoff Range			At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

Table 1-4
CATHODE RAY TUBE

Characteristics	Performance Requirements	Supplemental Information
CRT Type		T3350.
Graticule		8 X 10 divisions with 0.25 inch/division (0.64 cm/division).
Phosphor		P31.
Acceleration Potential		12 kV (−1.9 kV cathode).
Geometry and Orthogonality (exclude 4 corners)	Bowing or tilt is 0.1 division or less with respect to graticule lines.	
Intensity Control Function		When Intensity control is rotated fully clockwise and Single Sweep mode is selected, the sweep baseline spot is clearly visible.

Table 1-5
CALIBRATOR

Characteristics	Performance Requirements	Supplemental Information
Voltage	0.6 V peak-to-peak, ±1%.	
Frequency	Twice the power line frequency.	
Rise and Falltimes		Less than 1 μs.
Output Impedance		Approximately 120 Ω.

Table 1-6
POWER SUPPLIES

Characteristics	Performance Requirements	Supplemental Information
+20 V		20.0 V ±0.05 V.
−20 V		−20.0 V ±0.05 V.
+5 V		+5.07 V ±0.08 V.
−5 V		−5.00 V ±0.20 V.
+70 V		+70 V −3 V, +4 V.
−70 V		−69 V +3 V, −4 V
Power Module Supply Currents		
+33.5 V		Typically 420 mA.
−33.5 V		Typically 400 mA.
+11.5 V		Typically 400 mA.
25 VAC		Typically 10 mA.
Fuse Data		
F800		0.3A, 3AG, slow blow.
F970		0.75A, 3AG, fast blow.

Table 1-6 (cont)

Characteristics	Performance Requirements	Supplemental Information
Mainframe Power Line Draw		Typically 29 watts or less operating, less than 1 watt with mode switch set to POWER OFF.
Recommended Adjustment Interval		1000 hours or 6 months.
Warmup Time		20 minutes, 60 minutes after exposure to or storage in high humidity (condensing) environment.

Table 1-7
REAR INTERFACE

Characteristics	Performance Requirements	Supplemental Information
External (Delayed) Gate Input		Pins 23B-22B. ECL balanced input operating between +5 V and ground. Nominally 100 Ω. Upon transition to logical high state sweep will free-run once and reset if GATE SELECT INPUT is grounded. A transition from logical high to low state will truncate sweep if it is running.
Gate Select Input		Pin 24B. Ground (1 kΩ or less) selects the external gate as the sweep controlling signal. Open circuit causes normal operation.
Intensify Input		Pin 19B. Single ended ECL input operating between +5 V and ground. A logical low state causes noticeable intensification. Open circuit defaults to logical high state.
CH1 Trigger Output		Pins 27B-28B. Analog output with source resistance of approximately 100 Ω. Sensitivity is typically 50 mV/div and bandwidth is typically 4 MHz.
Triggered Gate Output		Pins 25B-26B. ECL balanced output operating between +5 V and ground. A logical high state indicates a holdoff condition and sweep can not be triggered or gated.
Holdoff Output		Pins 20B-21B. ECL balanced output operating between +5 V and ground.
Ramp Output		Pin 18A. Analog output of positive going sweep ramp. Typically 0 V to at least +6.4 V. Output resistance is approximately 1 kΩ. Not recommended at sweep rates faster than 1 μs/div.

Table 1-8
ENVIRONMENTAL[a]

Characteristics	Description	
Temperature		Meets MIL-T-28800B, class 5.
Operating	0°C to +50°C.	
Non-operating	−55°C to +75°C.	
Humidity	95% RH, 0°C to +30°C. 75% RH, to +40°C. 45% RH, to +50°C.	Exceeds MIL-T-28800B, class 5.
Altitude		Exceeds MIL-T-28800B, class 5.
Operating	4.6 km (15,000 ft).	
Non-operating	15 km (50,000 ft).	
Vibration	0.38 mm (0.015") peak-to-peak, 5 Hz to 55 Hz, 75 minutes.	Exceeds MIL-T-28800B, class 5, when installed in qualified power modules[b].
Shock	30 g's (1/2 sine) 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5, when installed in qualified power modules[b].
Transportation[c]	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.	

[a] **With power module.**

[b] **Refer to TM 500 power module specifications.**

[c] **Without power module.**

Table 1-9
MECHANICAL

Characteristics	Description
Finish	Anodized aluminum panel and chassis.
Net Weight	2.5 kg (5.56 lbs).
Nominal Dimensions	12.2 in. long (30.988 cm) X 5.30 in wide (13.46 cm) X 5.0 in. high (12.700 cm)

OPERATING INSTRUCTIONS

INTRODUCTION

The SC 502 Oscilloscope is a general purpose, 15 MHz, dual trace oscilloscope designed to operate in two compartments of a TM 500 Series Power Module. Recommended probes for use with the SC 502 are the P6105, P6062B, and P6060. The P6062B probe has a selectable 1X or 10X attenuation while the attenuation of P6105 is 10X.

Installation

The SC 502 is calibrated and ready to use as received. Referring to Fig. 2-1, install the Oscilloscope and turn the SC 502 MODE control to ALT to apply power. Check that the POWER indicator light on the front panel comes on.

CAUTION

Turn the Power Module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry.

BASIC OPERATION

A brief description of the function of the front panel controls and connectors is given on the following pages.

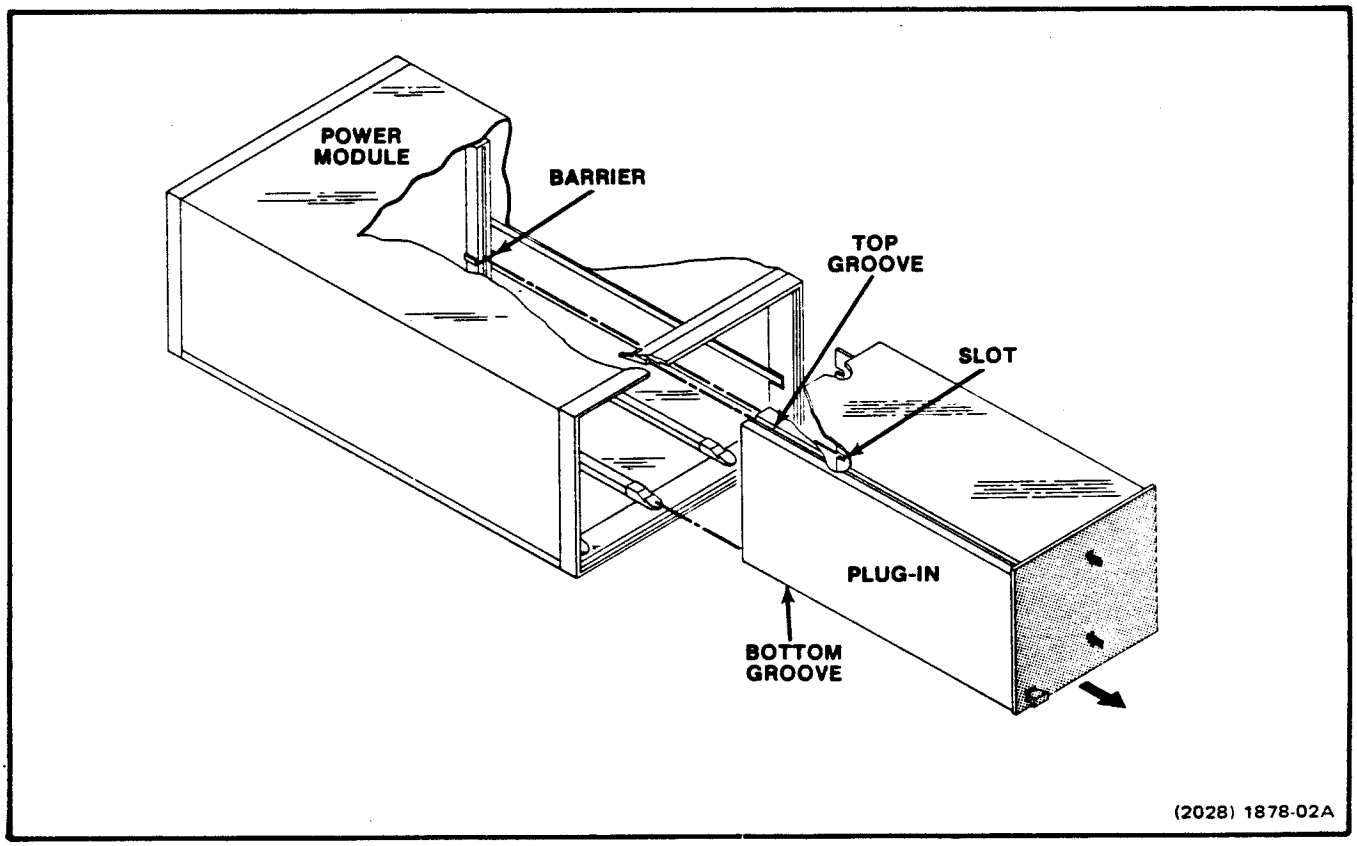


Fig. 2-1. Plug-in installation/removal.

NOTE

The vertical lightly shaded areas on the front panel behind the VOLTS/DIV and SECONDS/DIV knob skirts highlight the basic sensitivity and sweep rate selected. The darker gray shaded areas (located at 2 o'clock) behind the VOLTS/DIV knob skirts highlight the sensitivity when a 10X probe is used. The shaded colored area (located at 10 o'clock) behind the SECONDS/DIV knob indicates the sweep rate when the SWP MAG is activated. These shaded areas and additional values printed on the knob skirts are for operator convenience only. Do not force these knobs beyond their mechanical stops.

Setup Information

1. Set the SC 502 MODE switch to PWR OFF. Turn the TM 500 Series Power Module switch to off and install the SC 502 into a Power Module compartment. Make sure the Power Module is connected to a power source that meets the voltage and frequency requirement, then turn on the Power Module Power switch.

2. Set the SC 502 controls as follows:

INTENSITY	Fully ccw
FOCUS	As is
MODE	CH 1
POSITION	
CH 1	Midrange
CH 2	Midrange
CH 1 VOLTS/DIV	.2
Variable	Fully cw
CH 1 AC-GND-DC	DC
CH 2 VOLTS/DIV	.2
Variable	Fully cw
CH 2 AC-GND-DC	DC
POSITION (Horizontal)	Midrange
SECONDS/DIV	5 m
CAL/SWP MAG	Fully cw and pushed in
SINGL SWP	Off (Button out)
TRIGGERING	
SLOPE	+
LEVEL	Midrange
SOURCE	CH 1
COUPL	AUTO

3. Advance the INTENSITY control until the trace is at the desired viewing level. The trace should appear near the graticule center.

4. Connect a 1X probe or test lead from the CAL connector to the CH 1 input connector.

5. Adjust the channel and horizontal POSITION controls so that the display is centered vertically and starts at the left edge of the graticule.

6. Adjust the FOCUS control for a sharp, well-defined display over the entire trace length.

7. Disconnect the input signal and position the trace vertically so that it coincides with the center horizontal line of the graticule.

Calibration Check

8. Move the trace 1.5 divisions below graticule center and reconnect the calibrator signal to the CH 1 input connector.

9. The display should be 3 divisions in amplitude with six complete cycles (five complete cycles for 50 Hz line frequency) shown horizontally.

Trigger View

10. Press the TRIGGER VIEW button and observe the triggering waveform. The start of the waveform at the horizontal graticule centerline is the triggering point.

External Intensity Input

11. Connect a 5 V, 1 kHz sine-wave or square-wave signal to pin 24A (if it has been connected as the external Z-axis input) on the rear interface connector.

12. Slowly rotate the INTENSITY control counterclockwise until the trace appears to be a series of dimmed and brightened segments. The brightened segments correspond with the tops of the sinewaves or squarewaves.

This completes the description of the basic operating procedure for the SC 502. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

CONTROLS AND CONNECTORS

(1) FOCUS Control. Provides adjustment for obtaining a well defined display.

(2) INTENSITY Control. Controls the display brightness.

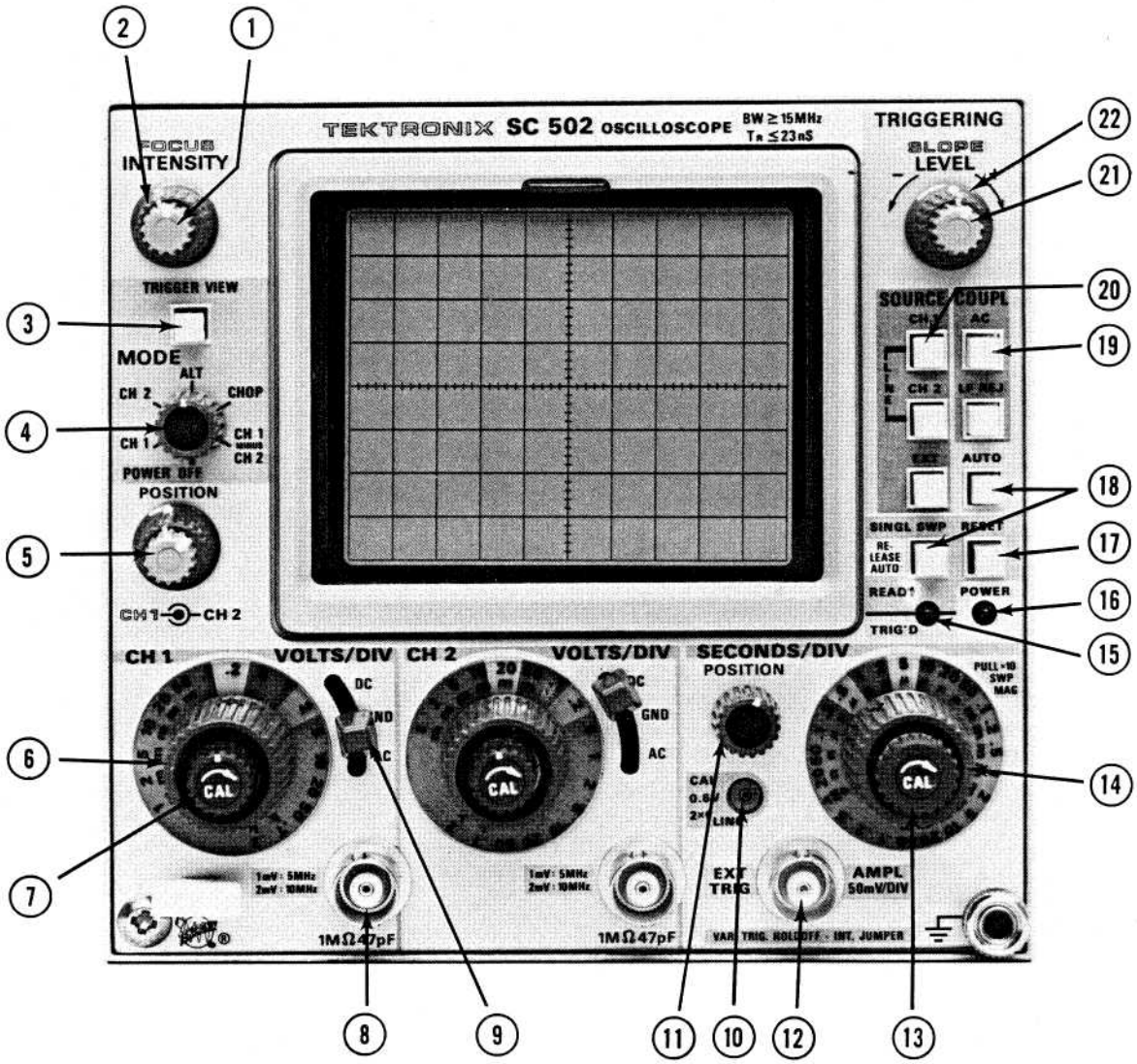


Fig. 2-2. Controls and connectors.

(3) TRIGGER VIEW Pushbutton. Causes the sweep triggering signal to be displayed on the crt.

(4) MODE Switch. Selects the vertical amplifier mode of operation and turns the instrument on and off.

PWR OFF. The internal instrument power is off.

CH 1. Channel 1 is displayed.

CH 2. Channel 2 is displayed.

ALT. Dual trace display of both channels. Display is switched between channels at the end of each sweep. Generally used for sweep speeds above 1 ms/cm.

CHOP. Dual trace display of both channels. Display is switched between the channels at ≥250 kHz. Generally used for sweep speeds below 1 ms/cm.

CH 1 MINUS CH 2. The input of channel 2 is inverted and algebraically added to channel 1.

(5) CH 1 and CH 2 POSITION. Controls the vertical position of the displayed signals.

(6) VOLTS/DIV Switch. Selects the vertical deflection factor in a 1-2-5 sequence. The variable control (CAL) must be fully cw for the indicated deflection factor. Read the deflection factor over the lightly shaded area when using a 1X probe. Read the deflection factor over the grey area when using a 10X probe.

(7) CAL Variable Control. Provides variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.

(8) Input Connector. Bnc connector for applying vertical input signal.

(9) AC-GND-DC Switch. Selects the vertical amplifier input coupling. In the AC position, signals are capacitively coupled to the vertical amplifier, blocking the dc component of the signal. In the GND position, the input of the vertical amplifier is disconnected from the input connector and grounded. This allows precharging of the input coupling capacitor. In the DC position, all components of the input signal are passed to the input amplifier.

(10) Calibrator Jack. Provides a positive going 0.6 V square wave at twice the line frequency for calibration of gain and probe compensation.

(11) POSITION control. Positions the display horizontally on the crt.

(12) EXT TRIG/AMPL. External input connector for horizontal amplifier or for external trigger signal. The external amplifier ac-dc coupling is controlled by the trigger AC pushbutton.

(13) CAL (Variable)/PULL X10 SWP MAG. The CAL control provides continuously variable sweep rates between the calibrated settings of the SECONDS/DIV switch or when selected by an internal jumper, provides a variable trigger holdoff time.

When the CAL knob is pulled out, the displayed sweep rate/division is increased by a factor of ten.

(14) SECONDS/DIV Switch. Selects the horizontal sweep rate or the AMPL mode for an external input to the horizontal amplifier. The VARiable control must be fully cw for calibrated sweep rates. The light shaded area under the knob skirt indicates the unmagnified sweep rate. The colored area at 10 o'clock shows the magnified sweep rate.

(15) TRIG'D READY Indicator. The light indicates that the single sweep is armed or that the sweep is triggered.

(16) POWER Indicator. The light indicates that the SC 502 power is turned on.

(17) RESET Pushbutton. Push to arm the sweep in single sweep operation.

(18) Trigger Mode Pushbuttons.

AUTO Pushbutton In. The Sweep free runs and provides a reference trace when there is no adequate triggering signal.

AUTO Pushbutton Out. The sweep is initiated by the applied trigger signal. When there is no adequate triggering signal, there is no trace.

SINGLE SWP Pushbutton In. When this pushbutton is in and the AUTO pushbutton is

out, the sweep operates in the single sweep mode. After the sweep runs once, further sweeps cannot be displayed until the RESET button is pushed. The triggering LEVEL control adjustment for single sweep operation must be made with the AUTO pushbutton in the out position.

(19) COUPLing Pushbuttons. Determine the coupling of the trigger signal to the trigger generator circuit.

AC Pushbutton In. Signals are capacitively coupled to the input of the trigger generator circuit. DC is rejected and signals below about 50 kHz are attenuated.

AC Pushbutton Out. (DC) All components of a trigger signal are coupled to the input of the trigger generator circuit.

LF REJ Pushbutton In. Signals are capacitively coupled to the input of the trigger circuit. DC is rejected and signals below about 5 kHz are attenuated.

(20) SOURCE Pushbuttons. Determine the source of the signal coupled to the input of the trigger circuit.

CH 1 Pushbutton In. A sample of the Channel 1 signal is coupled to the triggering circuit.

CH 2 Pushbutton In. A sample of the Channel 2 signal is coupled to the triggering circuit.

LINE. (Both CH 1 and CH 2 pushbuttons depressed.) A sample of the power line signal is coupled to the triggering circuit.

EXT Pushbutton In. Signals connected to the EXT TRIG connector are coupled to the triggering circuit.

(21) SLOPE Switch. Selects the rising or falling slope of the trigger signal to trigger the sweep.

(22) LEVEL Control. Selects the amplitude point on the trigger signal at which the sweep is triggered.

GENERAL OPERATING INFORMATION

Graticule

The graticule of the SC 502 is internally marked on the faceplate of the crt to provide accurate, parallax-free measurements. The graticule is marked with eight vertical and ten horizontal divisions. Each division is 0.25 inch by 0.25 inch. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing are calibrated so that accurate measurements can be made from the graticule.

Intensity Control

The intensity of the display on the crt is controlled by the INTENSITY control. This control is normally adjusted so the display is easily visible but not overly bright. It will probably require readjustment for different displays or sweep rates. Be careful when only a spot is displayed. A high-intensity spot may burn the crt phosphor and cause permanent damage to the crt if allowed to remain too long.

Display Focus

If a well-defined display cannot be obtained with the FOCUS control, even at low intensity settings, adjustment of the internal astigmatism control may be required. This should only be done by qualified personnel.

To check for proper setting of the Astig control, slowly turn the FOCUS control through the optimum setting with a signal displayed on the crt screen. If the Astig control is correctly set, the vertical and horizontal portions of the trace will come into sharpest focus at the same position of the FOCUS control.

Trace Alignment Adjustment

This is an internal adjustment and should be done only be a person qualified to do so.

Intensity Modulation (Applies only if pin 24A of Interface Connector has been connected)

Intensity (Z-Axis) modulation can be used to relate a third item of electrical phenomena to the vertical (Y-Axis) and the horizontal (X-Axis) coordinates without affecting the waveshape of the displayed signal. The Z-Axis modulating signal, applied to pin 24A of the rear interface connector, changes the intensity of the displayed waveform to provide this type of display. The voltage amplitude required for visible trace modulation depends on the setting of the INTENSITY control. About +5 V will turn on the display to a normal brightness level from an off level, and about −5 V will turn the display off from a normal brightness level. "Gray scale" intensity modulation can be obtained by applying signals between these levels. Maximum safe input voltage is + or −10 V. Usable frequency range of the Z-Axis circuit is dc to 2 MHz.

Calibrator

The internal calibrator of the SC 502 provides a convenient signal source for checking basic vertical gain and sweep timing. The calibrator signal is also useful for adjusting probe compensation, as described in the probe instruction manual. The output square-wave voltage is 600 mV, within 1%. The frequency of the square-wave signal is twice the power-line frequency.

Vertical Displays

Single-Trace Displays. Either of the input channels can be used for single-trace displays. Apply the signal to the desired input connector and set the MODE switch to display the channel used. The trigger SOURCE switches can select either vertical channel as a trigger signal source.

Dual-Trace Operation (Alternate Mode). The ALT position of the MODE switch produces a display that alternates between Channel 1 and Channel 2 with each sweep of the crt. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 50 μs/div.

In the CH 1 or CH 2 positions of the trigger SOURCE switches, a stable display of two signals will be displayed, showing true time relationship. If the signals are not time related, one of the signals displayed will be unstable.

Dual-Trace Operation (Chopped Mode). The CHOP position of the MODE switch produces a display that is electronically switched between channels. In general, the CHOP mode provides the best display at sweep rates slower than about 50 ms/div, or whenever dual-trace, single-shot phenomena are to be displayed. At faster sweep rates, the chopped switching becomes apparent and may interfere with the display.

Proper external triggering for the chopped mode of operation is obtained by using external triggering from a signal that is time-related to either signal. This provides the same result as triggering internally from Channel 1 or Channel 2.

Two signals that are time-related can be displayed in the chopped mode, showing true time relationship. However, if the signals are not time-related, one signal displayed will appear unstable.

Algebraic Addition. The CH 1 MINUS CH 2 position of the MODE switch can be used to display the difference of two signals, for common-mode rejection to remove an undesired signal, or for dc offset (applying a DC voltage to one channel to offset the dc component of a signal on the other channel).

The following general precautions should be observed:

1. Do not exceed the input voltage rating of the SC 502.

2. Do not apply signals that exceed an equivalent of about eight times the VOLTS/DIV switch setting. For example, with a VOLTS/DIV switch setting of 0.5, the voltage applied to that channel should not exceed about four volts. Larger voltages may distort the display.

3. Use CH 1 and CH 2 POSITION control settings that most nearly position the signal of each channel to midscreen when viewed in either the CH 1 or CH 2 positions of the MODE switch. This ensures the greatest dynamic range for CH 1 MINUS CH 2 mode operation.

4. For similar response from each channel, set the CH 1 and CH 2 AC-GND-DC switches to the same position.

Deflection Factor

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the setting of the VOLTS/DIV switches, and the setting of the VOLTS/DIV variable controls. The calibrated deflection factors indicated by the VOLTS/DIV switches apply only when the VOLTS/DIV variable controls are set to the calibrated position (fully clockwise in detent).

The VOLTS/DIV variable controls provide continuously variable (uncalibrated) vertical deflection factors between the calibrated settings of the VOLTS/DIV switches. The VOLTS/DIV variable controls extend the maximum vertical deflection factor to at least 50 V per division.

Reliable signal measurements cannot be made unless both the oscilloscope and the unit under test are connected together by a common reference (ground) lead in addition to the signal lead or probe. The ground strap on the signal probe provides the best ground. Also, a ground lead can be connected to the post chassis ground to establish a common ground with the signal source.

Input Coupling

The AC-GND-DC switches allow a choice of coupling method for the applied signal. The type of display desired and the applied signal determines the coupling method to use.

In the AC coupling position, the dc component of the signal is blocked by a capacitor in the input circuit. The low-frequency −3 dB point in the AC position is about 10 Hz. Therefore, some low-frequency attenuation can be expected near this frequency limit. Attenuation in the form of waveform tilt will also appear in square waves that have low-frequency components. The AC coupling position provides the best display of signals with a dc component that is much larger than the ac component.

The DC coupling position can be used for most applications. This position allows measurement of the dc component of a signal and must be used to display signals below about 50 Hz to avoid the attenuation that would occur using ac coupling.

The GND position provides a ground reference at the input without the need to externally ground the probe. The signal applied to the probe is internally disconnected from the input circuit and connected to ground through a 1 MΩ resistor. The amplifier input circuit is held at ground potential.

In the GND position, connecting the input signal to ground through a 1 MΩ resistor forms a precharging network. This network allows the input coupling capacitor to charge to the average dc voltage level of the signal applied to the probe. Since this takes place in the GND position of the AC-GND-DC switch, any large voltage transients accidentally generated will not be applied to the amplifier input. The pre-charge network also provides a measure of protection to the external circuit by reducing the current levels that can be drawn from the external circuitry during capacitor charging. The following procedure should be used whenever the probe tip is connected to a signal source having a different dc level than that previously applied.

1. Before connecting the probe tip to a signal source, set the AC-GND-DC switch to GND.

2. Touch the probe tip to oscilloscope chassis ground. Wait several seconds for the input coupling capacitors to discharge.

3. Connect the probe tip to the signal source.

4. Wait several seconds for the input coupling capacitor to charge.

5. Set the AC-GND-DC switch to AC. The display will remain on screen so the ac component of the signal can be measured in the normal manner.

Trigger Source

Internal Triggering. For most applications the sweep can be triggered internally. In the CH 1 and CH 2 positions of the trigger SOURCE switches, the trigger signal is obtained from the vertical deflection system. For dual-trace displays, special considerations must be made to provide the correct display. Refer to the Dual-Trace Operation explanation in the Vertical Display portion of the Basic Operating instructions for dual-trace triggering information.

Line Triggering. LINE position of the SOURCE switch is achieved by simultaneously depressing the CH 1 and CH 2 buttons. The LINE position connects a sample of the power-line voltage to the input of the Trigger generator. Line triggering is useful when the input signal is time-related (multiple) to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

External Triggering. An external signal connected to the EXT IN connector can be used to trigger the sweep in the EXT position of the SOURCE switch. The external signal must be time-related to the displayed signal for a stable display. An external trigger signal can be used to provide a triggered display when the internal signal is too low in amplitude for correct triggering, or contains undesirable signal components. It is also useful when signal tracing in amplifiers, phase-shift networks, wave-shaping circuits, etc. The signal from a single point in the circuit under test can be connected to the external trigger input connector through a cable or signal probe. The sweep is then triggered by the same signal at all times and allows amplitude, time relationship, or waveshape changes of signals at various points in the circuit to be examined without resetting the trigger controls.

Trigger Coupling

Two methods of coupling the trigger signal to the trigger circuits can be selected with the trigger COUPLING switches. Each method permits selection or rejection of certain frequency components of the trigger signal to obtain selective triggering.

AC Coupling. The AC position blocks the dc component of the trigger signal. Signals with low-frequency components below about 50 Hz are attenuated. In general, ac coupling can be used for most applications. However, if the trigger signal contains unwanted frequency components, the LF REJ COUPLING switch may provide a better display.

Low-Frequency Reject. The LF REJ position passes all high-frequency signals above about 5 kHz. Dc is rejected and signals below about 5 kHz are attenuated. When

triggering from complex waveforms, this position is useful for providing a stable display of the high-frequency components.

Trigger Slope

The trigger SLOPE switch determines whether the trigger circuit responds on the positive-going or negative-going portion of the trigger signal. When the SLOPE switch is in the + (positive-going) position, the display starts with the positive-going portion of the waveform; in the − (negative-going) position, the display starts with the negative-going portion of the waveform. When several cycles of a signal appear in the display, the setting of the SLOPE switch is often unimportant. However, if only a certain portion of a cycle is to be displayed, correct setting of the SLOPE switch is important to provide a display that starts on the desired slope of the input signal.

Trigger Level

The trigger LEVEL control determines the voltage level on the triggering waveform at which the sweep is triggered. When the LEVEL control is set in the + region, the trigger circuit responds at a more positive point on the trigger signal. When the LEVEL control is set in the − region, the trigger circuit responds at a more negative point on the trigger signal. To set the LEVEL control, first select the trigger SOURCE, COUPLING, and SLOPE. Then set the LEVEL control fully clockwise and rotate it counterclockwise until the display starts at the desired point.

Trigger Mode

Automatic Triggering. The AUTO position (AUTO button pushed in) of the trigger mode switch provides a stable display when the LEVEL control is correctly set (see Trigger Level portion of General Operating Information) and an adequate trigger signal is present. The TRIG'D light indicates when the sweep generator is triggered.

When the trigger repetition rate is less than about 20 Hz, or in the absence of an adequate trigger signal, the sweep generator free-runs to produce a reference trace. When an adequate trigger signal is again applied, the free running condition ends and the sweep generator is triggered to produce a stable display (with the correct LEVEL control setting).

Normal Triggering. Operation in the normal position (AUTO button is out) of the trigger mode switch is the same as in the AUTO position when a trigger signal is applied. However, when a trigger signal is not present, the sweep generator remains off and there is no display. The TRIG'D light indicates when the sweep generator is triggered.

Use the normal mode to display signals with repetition rates below about 20 Hz. This mode provides an indication of an adequate trigger signal as well as the corrections of trigger control settings, since there is no display without proper trigger. Also, the TRIG'D light is off when the sweep is not correctly triggered.

Trigger Holdoff. By placing the internal HO-SWP jumper in the HO position, the variable sweep control (CAL) is connected as a Trigger Holdoff variable control. In this configuration, the control provides for stable triggering on aperiodic or irregular signals (such as complex digital words). (The internal jumper should only be changed by qualified personnel.)

To use the control, first obtain the most stable presentation possible by adjusting the triggering controls in the normal manner. Now, rotate the Trigger Holdoff variable control counterclockwise until any remaining instability is eliminated.

Single Sweep. When the signal to be displayed is not repetitive or varies in amplitude, shape, or time, a conventional display may produce an unstable presentation. To avoid this, use the single-sweep feature. The single-sweep mode can also be used to photograph a non-repetitive signal.

To use the single-sweep mode, first make sure the Trigger circuit will respond to the event to be displayed. Set the AUTO and SINGLE SWP buttons to the out position and obtain the best possible display in the normal manner (for random signals set the trigger circuit to trigger on a signal which is approximately the same amplitude and frequency as the random signal). Then, depress the SINGL SWP button and press and release the RESET button. The next trigger pulse will initiate the sweep and a single trace will be presented on the screen. After this sweep is complete, the sweep generator is "locked out" until reset. The READY indicator lights when the sweep generator circuit has been reset and is ready to produce a sweep; it goes out after the sweep is complete. To prepare the circuit for another single-sweep display, press and release the RESET button again.

Horizontal Sweep Rates

The SECONDS/DIV switch selects calibrated sweep rates for the sweep generator. The variable control provides continuously variable sweep rates between the settings of the SECONDS/DIV switch. Only when the variable control is in its fully clockwise position are the sweep rates calibrated.

Sweep Magnification

The sweep magnifier expands the sweep by a factor of ten. The center division of the unmagnified display is the portion visible on the screen in magnified form. The equivalent length of the magnified sweep is more than 100 divisions. Any 10 division portion of the magnified sweep can be viewed by adjusting the horizontal POSITION control to bring the desired portion into the viewing area.

To use the magnified sweep, first move the portion of the display which is to be expanded to the center of the graticule. Then pull the SWP MAG switch to its out position. Use the horizontal POSITION control to move the magnified portion to the desired position.

When the SWP MAG switch is set to on, the sweep rate is determined by dividing the SECONDS/DIV switch setting by 10. For example, if the SECONDS/DIV switch is set to .5 μ, the magnified sweep rate is 0.05 μs/div.

X-Y Operation

In some applications, it is desirable to display one signal versus another (X-Y) rather than against the internal time base. The AMP position (fully counterclockwise) of the SECONDS/DIV switch provides a means for applying an external signal to the horizontal amplifier for this type of display.

NOTE

The CHOP position of the MODE switch must be used for dual vertical displays. The ALT position of the MODE switch will not produce a correct display.

Do not exceed the horizontal scan area of the graticule in the X-Y mode of operation. This mode can be used to measure phase differences of signals up to about 50 kHz. Above this frequency, the phase shift in the system makes phase measurement difficult.

BASIC OSCILLOSCOPE APPLICATIONS

The following information describes the techniques for making basic measurements. These applications are not described in detail, since each application must be adapted to the requirements of the individual measurement. Contact your local Tektronix Field Office or representative for additional assistance.

Peak-to-Peak Voltage Measurements—AC

To make peak-to-peak voltage measurements, use the following procedure:

1. Set the desired channel AC-GND-DC switch to GND and connect the signal to the input connector.

2. Set the desired channel AC-GND-DC switch to AC and set the channel VOLTS/DIV switch to display about 5 or 6 vertical divisions of the waveform. Check that the variable VOLTS/DIV control for the channel is in the fully clockwise position.

3. Adjust the time-base triggering controls for a stable display and set the SECONDS/DIV switch to display several cycles of the waveform.

4. Turn the channel POSITION control so that the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the waveform is in the viewing area. Move the display with the horizontal POSITION control so that one of the upper peaks is aligned with the center vertical reference line (see Fig. 2-3).

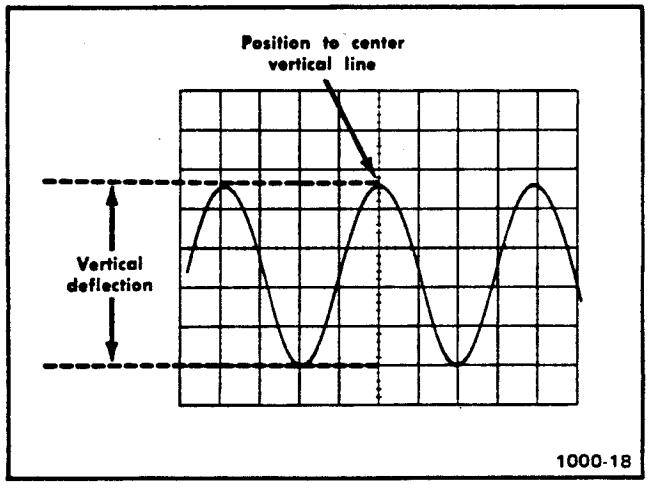


Fig. 2-3. Measuring peak-to-peak voltage of a waveform.

5. Measure the vertical deflection from peak to peak (divisions).

NOTE

This technique may also be used to make measurements between any two points on the waveform, rather than peak to peak.

6. Multiply the distance (in divisions) measured in step 5 by the channel VOLTS/DIV switch setting. Also include the attenuation factor of the probe, if one is used.

EXAMPLE: Assume a peak-to-peak vertical deflection of 4.6 divisions and a channel VOLTS/DIV switch setting of 5 V.

$$\text{Peak-to-peak volts} = 4.6\ (\text{divisions}) \times 5\ (\text{channel VOLTS/DIV setting}) = 23\ \text{volts}$$

NOTE

If an attenuator probe is used, multiply the right side of the above equation by the attenuation factor.

Instantaneous Voltage Measurement—DC

To measure the dc level at a given point on a waveform, use the following procedure:

1. Set the desired channel AC-GND-DC switch to GND and position the trace to the bottom line of the graticule (or other selected reference line). If the voltage to be measured is negative with respect to ground, position the trace to the top line of the graticule. Do not move the channel POSITION control after this reference has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 1: Set the AC-GND-DC switch to DC and apply the reference voltage to the input connector, then position the trace to the reference line.

2. Connect the signal to the input connector. Set the desired channel AC-GND-DC switch to DC (the ground reference can be checked at any time by setting the input coupling to GND).

3. Set the channel VOLTS/DIV switch to display about 5 or 6 vertical divisions of the waveform. Check that the variable VOLTS/DIV control for the channel is in the fully clockwise position. Adjust the time-base triggering controls for a stable display.

4. Measure the distance in divisions between the reference line and the point on the waveform at which the dc level is to be measured. For example, in Fig. 2-4 the measurement is made between the reference line and point A.

5. Establish the polarity. The voltage is positive if the waveform is above the reference line.

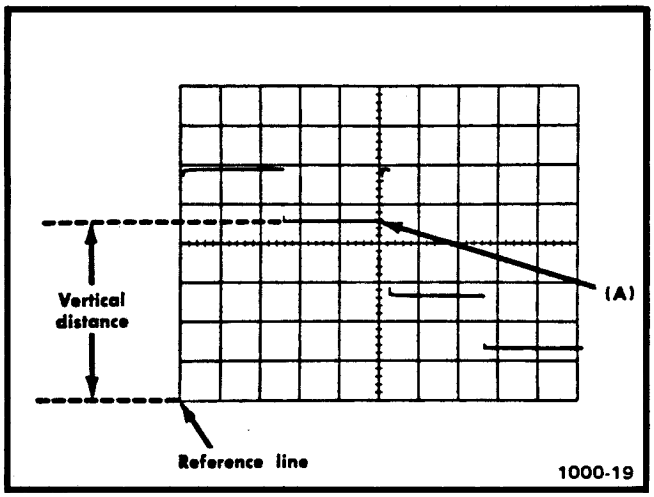


Fig. 2-4. Measuring instantaneous dc voltage with respect to a reference voltage.

6. Multiply the distance measured in step 4 by the channel VOLTS/DIV switch setting. Include the attenuation factor of the probe, if one is used (see the note following the Peak-to-Peak Voltage Measurement example).

EXAMPLE: Assume that the vertical distance measured is 4.6 divisions, the polarity is positive, the channel VOLTS/DIV switch setting is 2 V.

$$\text{Instantaneous Voltage} = 4.6\ (\text{division}) \times 2\ (\text{channel VOLTS/DIV}) = +9.2\ \text{volts}$$

Time Period Measurement

To measure the time (period) between two points on a waveform, use the following procedure:

1. Connect the signal to the vertical input connector, select either ac or dc input coupling, and set the channel VOLTS/DIV switch to display about four divisions of the waveform.

2. Set the time-base triggering controls to obtain a stable display. Set the SECONDS/DIV switch to the fastest sweep rate that will permit displaying one cycle of the waveform in less than eight divisions (some non-linearity may occur in the first and last graticule divisions of display). Refer to Fig. 2-5.

3. Adjust the desired channel POSITION control to move the points between which the time measurement is made to the center horizontal line. Adjust the horizontal

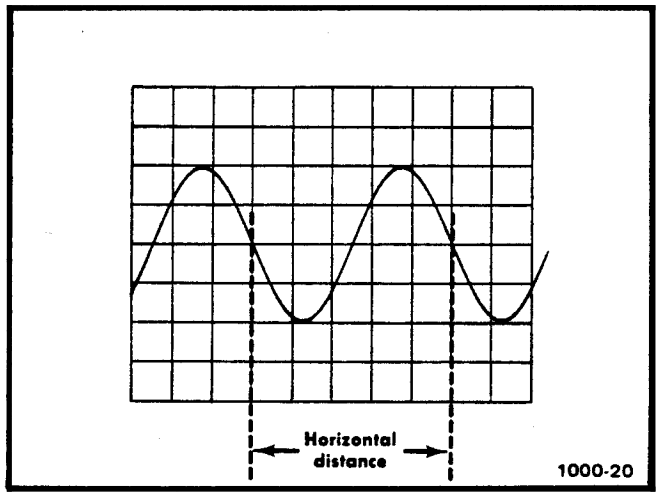


Fig. 2-5. Measuring time duration (period) between points on a waveform.

POSITION control to center the time-measurement points within the center eight divisions of the graticule.

4. Measure the horizontal distance between the time measurement points. Be sure the variable SECONDS/DIV control is fully clockwise.

5. Multiply the distance measured in step 4 by the setting of the SECONDS/DIV switch.

EXAMPLE: Assume that the horizontal distance between the time-measurement points is five divisions and the SECONDS/DIV switch is set to .1 ms. Using the formula:

$$\text{Period} = \text{horizontal distance (divisions)} \times \text{SECONDS/DIV switch setting} = (5)\ (0.1\ \text{ms}) = 0.5\ \text{ms}$$

The period is 0.5 ms.

Determining Frequency

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a periodically recurrent signal is the reciprocal of the time duration (period) of one cycle. Use the following procedure:

1. Measure the period of one cycle of the waveform as described in the previous application.

2. Take the reciprocal of the period to determine the frequency.

EXAMPLE: The frequency of the signal shown in Fig. 2-5, which has a period of 0.5 ms is:

$$\text{Frequency} = \frac{1}{\text{period}} = \frac{1}{0.5\ \text{ms}} = 2\ \text{kHz}$$

Risetime Measurement

Risetime measurements employ basically the same techniques as the time-period measurements. The main difference is the points between which the measurement is made. The following procedure gives the basic method of measuring risetime between the 10% and 90% points of the waveform.

1. Connect the signal to the input connector.

2. Set the desired channel VOLTS/DIV switch and variable VOLTS/DIV control to produce a display exactly five divisions in amplitude.

3. Center the display about the center horizontal graticule line with the channel Position control.

4. Set the time-base triggering controls to obtain a stable display. Set the SECONDS/DIV switch to the fastest sweep rate that will display less than eight divisions between the 10% and 90% points on the waveform (see Fig. 2-6).

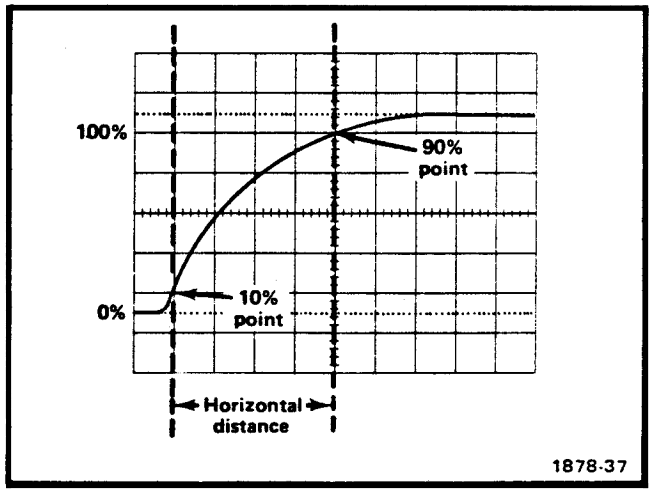


Fig. 2-6. Measuring risetime.

5. Adjust the horizontal Position control to move the 10% point of the waveform to the second vertical line on the graticule.

6. Measure the horizontal distance between the 10% and 90% points. Be sure the variable SECONDS/DIV control is in the fully clockwise position.

7. Multiply the distance measured in step 6 by the setting of the SECONDS/DIV switch.

EXAMPLE: Assume that the horizontal distance between the 10% and 90% points is four divisions and the SECONDS/DIV switch is set to 1 μs.

Using the period formula to find risetime:

$$\text{Rise-time period} = \text{horizontal distance (divisions)} \times \text{SECONDS/DIV switch setting} = (4)(1\,\mu s) = 4\,\mu s$$

The risetime is 4 μs.

Time Difference Measurements

The SC 502 Oscilloscope permits measurement of time difference between two or more separate events. To measure time difference, use the following procedure:

1. Set the AC-GND-DC switches of both channels to either AC or DC.

2. Set the MODE switch to either CHOP or ALT. In general, Chop is more suitable for low-frequency signals. More information on determining the mode is given under Vertical Displays in this section.

3. Set the triggering switches to trigger the display on channel 1 or channel 2, whichever channel provides the most stable and correct triggering for both channels.

4. Connect the reference signal to the channel 1 input connector and the comparison signal to the channel 2 input connector. The start of the reference signal should lead that of the comparison signal. Use coaxial cables or probes that have similar time-delay characteristics to connect the signal to the input connectors.

5. If the signals are opposite polarity, take this into account in the final calculation.

6. Set the channel VOLTS/DIV switches to produce about four divisions of display waveform.

7. Set the triggering controls for a stable display. Set the SECONDS/DIV switch for a sweep rate which shows three or more divisions between the measurement points, if possible.

8. Adjust the channel POSITION controls to bring the measurement points to the center horizontal reference line.

9. Adjust the horizontal POSITION control so the channel 1 waveform (reference) crosses the center horizontal line at a vertical graticule line.

10. Measure the horizontal distance between the two measurement points (see Fig. 2-7).

11. Multiply the measured distance by the setting of the SECONDS/DIV switch.

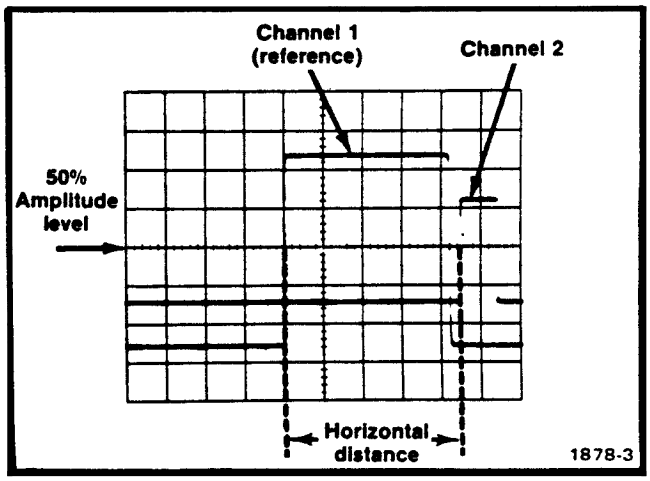


Fig. 2-7. Measuring time difference between two pulses.

EXAMPLE: Assume that the SECONDS/DIV switch is set to 50 μs and the horizontal distance between measurement points is four divisions. Using the formula:

$$\text{Time Delay} = \text{SECONDS/DIV switch setting} \times \text{horizontal distance (divisions)} = (50\,\mu s)(4) = 200\,\mu s$$

The time delay is 200 μs.

Multi-trace Phase Difference Measurement

Phase comparison between two or more signals of the same frequency can be made using both vertical input channels. This method of phase difference measurement can be used up to the frequency limit of the vertical system. To make the comparison, use the following procedure:

1. Set the AC-GND-DC switches of the amplifier channels to either AC or DC.

2. Set the MODE switch to either CHOP or ALT. In general, CHOP is more suitable for low-frequency signals and the ALT position is more suitable for high-frequency signals. More information on determining the mode is given under Vertical Displays in this section.

3. Set the triggering switches to trigger the display on channel 1 or channel 2, whichever channel provides the most stable and correct triggering for both channels.

4. Connect the reference signal to the channel 1 input connector and comparison signal to the channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes that have similar time-delay characteristics to connect the signals to the input connectors.

5. If the signals are of opposite polarity due to 180° phase difference, take this into account in the final calibration.

6. Set the channel VOLTS/DIV switches and the variable VOLTS/DIV controls so the displays are equal and about five divisions in amplitude.

7. Set the triggering controls to obtain a stable display. Set the SECONDS/DIV switch to a sweep rate that displays about one cycle of the waveform.

8. Move the waveforms to the center of the graticule with the channel POSITION controls.

9. Turn the variable SECONDS/DIV control until one cycle of the reference signal (channel 1) occupies exactly eight divisions between the second and tenth vertical lines of the graticule (see Fig. 2-8). Each division of the graticule represents 45° of the cycle (360° ÷ 8 divisions = 45°/division). The sweep rate can be stated in terms of degrees as 45°/division.

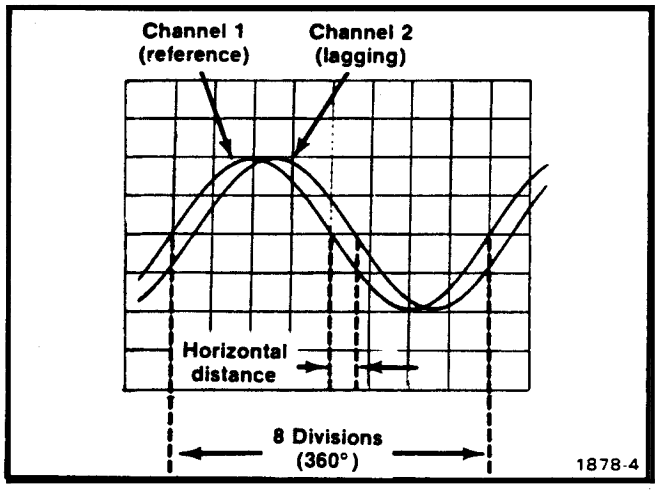


Fig. 2-8. Measuring phase difference.

10. Measure the horizontal difference between corresponding points on the waveforms.

11. Multiply the measured distance (in divisions) by 45°/division (sweep rate) to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.6 division with a sweep rate of 45°/division as shown in Fig. 2-8. Use the formula:

Phase Difference	=	horizontal difference (divisions)	X	sweep rate (degrees/ divisions)	=	(0.6) (45°) = 27°

The phase difference is 27°.

High Resolution Phase Measurement

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the variable SECONDS/DIV control setting). One of the easiest ways to increase the sweep rate is with the X10 sweep magnifier.

EXAMPLE: If the sweep rate were increased 10 times with the magnifier, the magnifier sweep rate should be 45°/division ÷ 10 = 4.5°/division. Fig. 2-9 shows the same signals as used in Fig. 2-8, but with the X10 SWP MAG control pulled out. With a horizontal difference of six divisions, the phase difference is:

Phase Difference	=	horizontal difference (divisions)	X	magnified sweep rate (degrees/ division)	=	(6) (4.5°) = 27°

The phase difference is 27°.

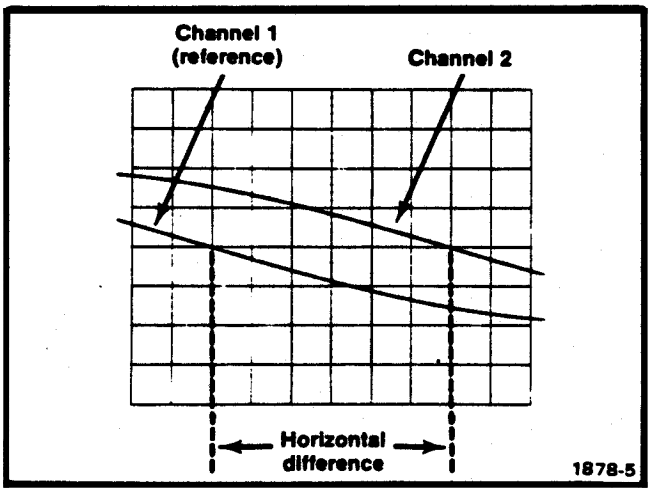


Fig. 2-9. High-resolution phase difference measurement with increased sweep rate.

REAR INTERFACE

Unassigned pins are available at the rear connector for routing signals to and from the SC 502 for specialized applications (see Rear Interface Connector Assignments in Section 5). One or more compartments of a multi-plug-in Power Module can be wired with barriers installed to provide specific functions between compartments. See Power Module instruction manual for additional information.

INSTRUCTIONS D'UTILISATION

INTRODUCTION

Le SC 502 est un oscilloscope 15 MHz, double trace et à usage général, conçu pour fonctionner dans deux compartiments d'un module d'alimentation de la série TM 500. Les sondes recommandées pour être utilisées avec le SC 502 sont la P6105, P6062B et la P6060. La sonde P6062B permet de sélectionner soit une atténuation de 1 X ou 10 X tandis que la P6105 atténue de 10 X.

Mise en place

Le SC 502 est livré étalonné et prêt à être mis en service. Se basant sur la figure 2-1, installer l'oscilloscope et placer la commande MODE du SC 502 sur la position ALT pour mettre l'appareil en service. Vérifier que le voyant secteur à droite du panneau avant s'allume.

REMARQUE

Il est recommandé d'éteindre le module d'alimentation avant d'insérer ou d'extraire le SC 502 de son compartiment. Des arcs électriques peuvent se produire au niveau de la carte enfichable d'interconnexion et abréger sa durée de vie.

FONCTIONNEMENT

Ce chapitre contient une brève description des prises et des commandes du panneau avant.

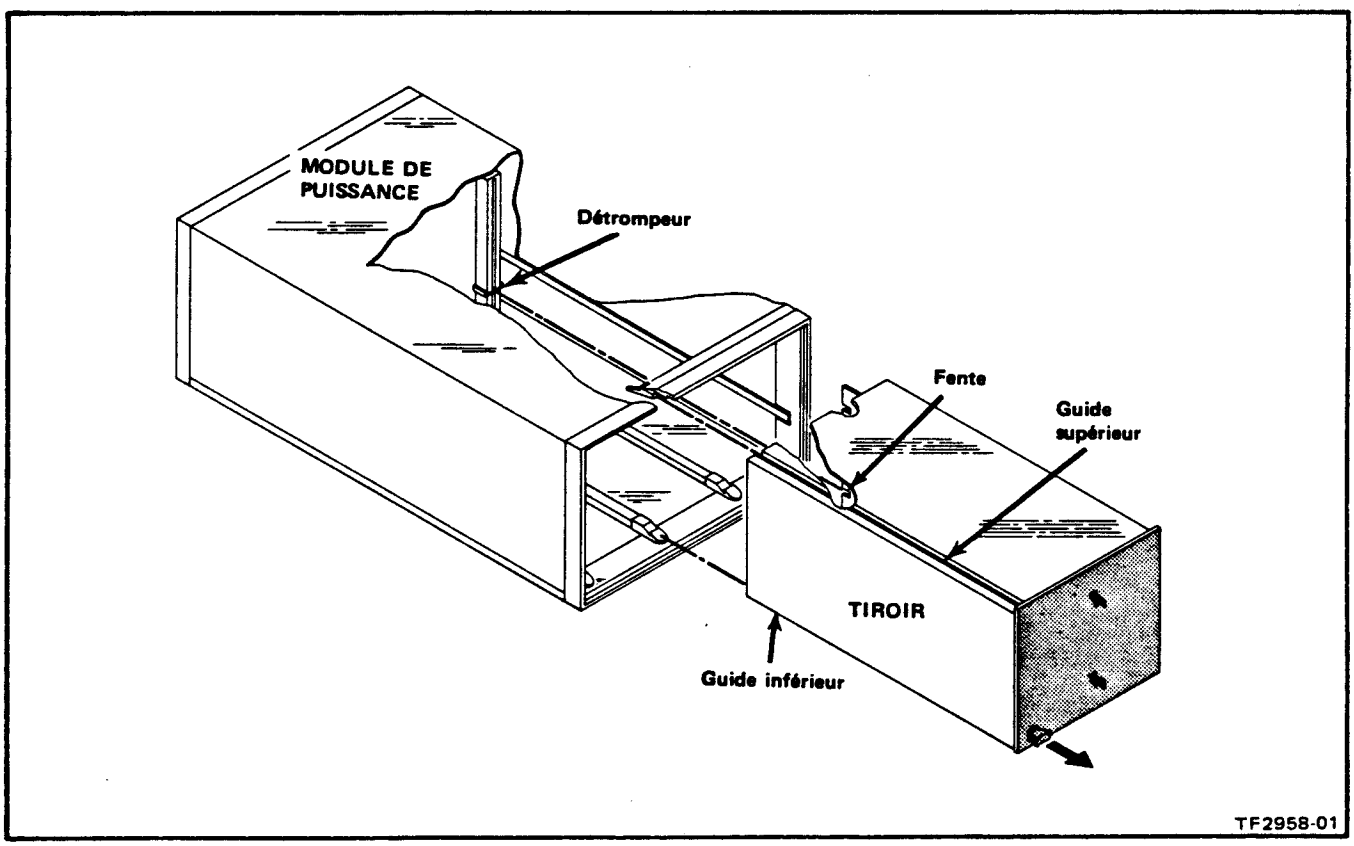


Fig. 2-1. Installation et retrait du tiroir.

NOTE

Sur la face avant et sous chaque jupe des boutons VOLTS/DIV et SECONDS/DIV, une zone nette et lumineuse met en valeur la sensibilité et la vitesse de balayage sélectionnées. Les zones gris foncé (localisées à 2 heures), situées sous les jupes des commandes VOLTS/DIV, font apparaître la sensibilité verticale lors de l'utilisation d'une sonde 10X. De la même façon, la surface colorée (localisée à 10 heures) sous la commande SECONDS/DIV indique la vitesse de balayage expansée utilisée (SWP MAG). Les zones bien délimitées ajoutées aux valeurs imprimées sur les jupes des boutons améliorent le confort d'utilisation. Ne pas forcer les positions mécaniques extrêmes de ces boutons.

Information pour la mise en fonctionnement

1. Couper, d'une part, l'alimentation du boîtier d'alimentation (position POWER OFF) et d'autre part, l'alimentation du SC 502 (commande MODE sur POW OFF).

2. Prépositionnement des commandes :

INTENSITY	à fond à gauche
FOCUS	tel qu'il est
MODE	CH1
POSITION	
CH1	à mi-course
CH2	à mi-course
CH1 VOLTS.DIV	0,2
Variable	en position étalonnée (à fond à droite)
CH1 AC - GND - DC	DC
CH 2 VOLTS/DIV	0,2
Variable	en position étalonnée (à fond à droite)
CH 2 - AC - GND - DC	DC
POSITION (horizontale)	à mi-course
SECONDS/DIV	5 m
CAL/SWP MAG	à fond à droite et enclenché
SINGL SWP	OFF (bouton sorti)
TRIGGERING	
SLOPE	+
LEVEL	à mi-course
SOURCE	CH1
COUPL	AUTO

3. Augmenter la commande INTENSITY jusqu'à ce qu'une trace soit visible. La trace doit apparaître près du centre du réticule.

4. Connecter une sonde 1 X de la sortie du calibreur (CAL) à la prise d'entrée de la voie 1.

5. Ajuster les positions verticale et horizontale de façon à ce que la trace soit au centre de l'écran et commence à gauche du réticule.

6. Régler la commande FOCUS afin d'obtenir une représentation nette et bien définie.

7. Débrancher le signal d'entrée et positionner la trace verticalement de sorte qu'elle coïncide avec la ligne horizontale du milieu de l'écran.

Vérification de l'étalonnage

8. Déplacer verticalement la trace d'une grande division et demi en-dessous du centre de l'écran et reconnecter le signal du calibreur sur la voie 1.

9. La représentation obtenue doit avoir une amplitude de 3 divisions et contenir 5 cycles du signal si la fréquence du réseau est de 50 Hz.

Visualisation du signal de déclenchement

10. Appuyer sur le bouton TRIGGER VIEW et observer le signal de déclenchement. Le départ du signal est le point de déclenchement correspondant à l'intersection du signal et de la ligne horizontale au milieu du réticule.

Commande externe de l'intensité

11. Relier un signal sinusoïdal ou rectangulaire de 5 V, 1 kHz sur la broche 24 A (si celle-ci a été câblée pour être l'entrée Z externe), derrière le connecteur d'alimentation du tiroir.

12. Tourner lentement la commande INTENSITY vers la gauche jusqu'à ce qu'une trace «nacrée» en surbrillance apparaisse. La surbrillance correspond aux sommets du signal.

Ceci achève la procédure de mise en fonctionnement du SC 502. Les commandes de l'instrument non expliquées ici ou les manipulations qui nécessitent de plus amples renseignements sont expliquées dans le chapitre des généralités.

COMMANDES ET CONNECTEURS

(1) Commande FOCUS. Permet d'obtenir une trace nette.

(2) Commande INTENSITY. Agit sur la luminosité de la trace.

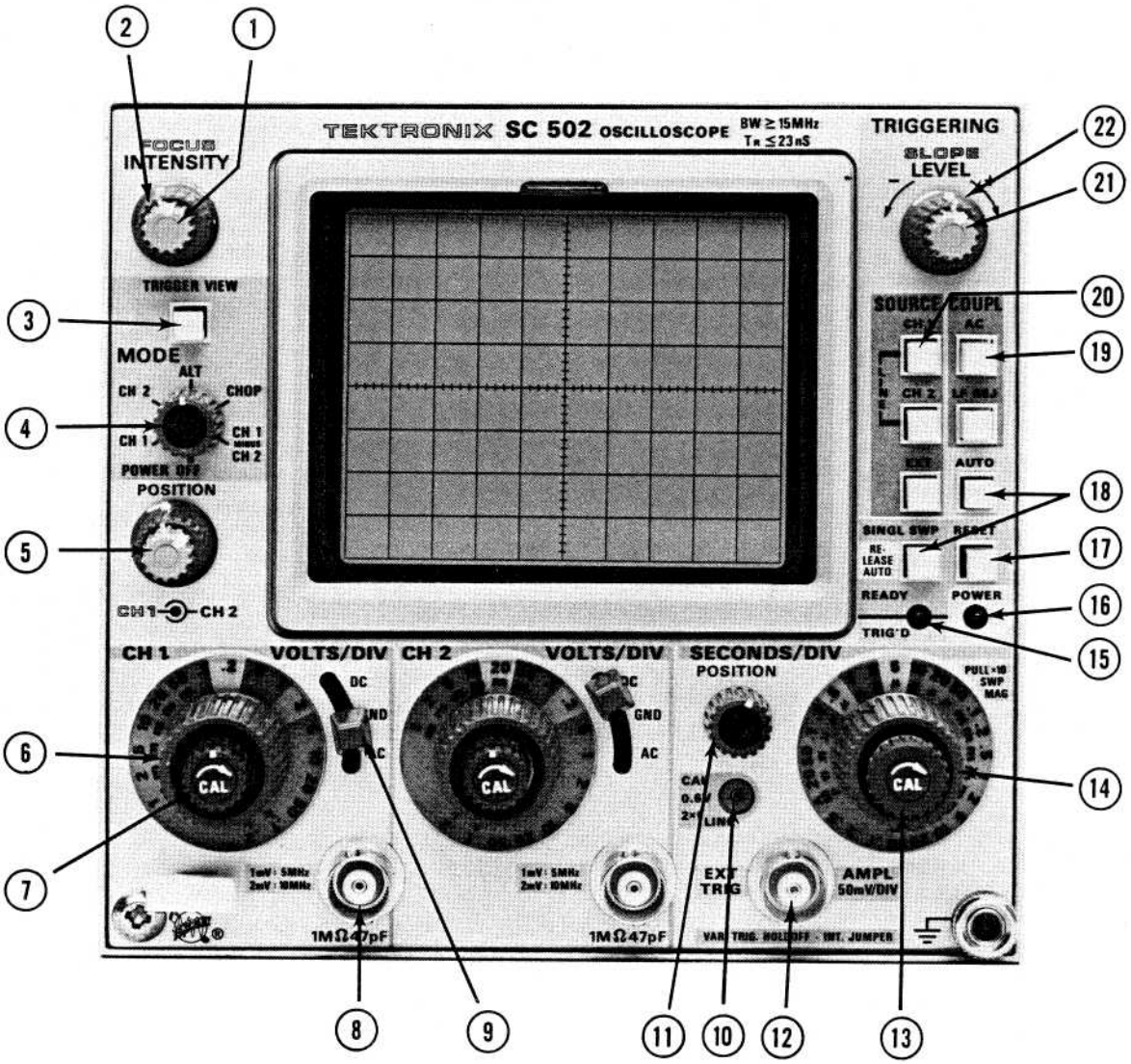


Fig. 2-2. Commandes et connecteurs.

(3) Bouton TRIGGER VIEW. Visualise sur l'écran le signal de déclenchement du balayage.

(4) Commutateur MODE. Sélectionne le mode de fonctionnement de l'amplificateur vertical. C'est aussi l'interrupteur Arrêt/Marche de l'instrument.

PWR OFF. L'alimentation interne du tiroir est coupée.

CH1. La voie 1 est mise en service.

CH2. La voie 2 est mise en service.

ALT. Fonctionnement à deux traces (alterné). La représentation est commutée entre les deux voies à la fin de chaque balayage. Généralement utilisé pour les vitesses de balayages supérieures à 1 ms/div.

CHOP. Fonctionnement à deux traces (découpé). La représentation est commutée entre les voies (≥ 250 kHz). Mode utilisé pour des vitesses de balayages inférieures à 1 ms/div.

CH1 MINUS CH2. L'entrée de la voie 2 est inversée et additionnée algébriquement à la voie 1.

(5) POSITION CH1 et CH2. Commandes da cadrage vertical des voies 1 et 2.

(6) Commutateur VOLTS/DIV. Sélectionne la sensibilité verticale (séquence 1, 2, 5). La commande Variable (CAL) doit être en butée à droite pour un facteur de déflexion étalonné. Lire la sensibilité verticale dans la fenêtre claire avec une utilisation de sonde 1X. Avec une sonde 10X, lire la sensibilité verticale dans la fenêtre grise.

(7) Commande variable CAL. Permet une variation de la sensibilité verticale entre deux positions du commutateur VOLTS/DIV.

(8) Connecteur INPUT. Connecteur BNC sur lequel est appliqué le signal d'entrée.

(9) Commutateur AC-GND-DC. Sélectionne le couplage de l'entrée de l'amplificateur dans la position AC, les signaux sont couplés capacitivement à l'amplificateur. la composante continue du signal est bloquée. Dans la position GND, l'entrée de l'amplificateur est déconnectée de la prise d'entrée, puis mise à la masse. Cela permet de précharger la capacité de couplage d'entrée. Dans la position DC, toutes les composantes du signal sont transmises à l'entrée de l'amplificateur.

(10) Prise du calibreur. Signal rectangulaire de 0,6 V à une fréquence de 100 Hz pour étalonner le gain de l'amplificateur ou compenser les sondes.

(11) Commande POSITION. Cadrage horizontal de la trace sur l'écran.

(12) Connecteur EXT TRIG/AMPL. Accès à l'amplificateur horizontal ou entrée de déclenchement. Le couplage externe AC-DC à l'amplificateur dépend de la position du bouton poussoir AC du déclenchement (19).

(13) Variable (CAL)/PULL X10 SWP MAG. Cette commande CAL permet de faire varier continuellement la vitesse de balayage entre deux positions du commutateur SECONDS/DIV. Un cavalier interne permet un déclenchement avec un retard variable. Lorsque le bouton CAL est tiré, la vitesse de balayage, par division visualisée, est augmentée dans un facteur 10.

(14) Commutateur SECONDS/DIV. Sélectionne la vitesse de balayage horizontale ou le mode Amplification X (AMPL) par l'entrée externe de l'amplificateur horizontal. La commande VAR doit être en butée à droite pour des vitesses étalonnées. La fenêtre claire sous la jupe du bouton indique la vitesse utilisée en balayage normal. La surface colorée à 10 heures met en valeur la vitesse de balayage dilatée (X10).

(15) Voyant TRIG'D READY. Allumé, indique que la base de temps est déclenchée ou que le mode «balayage unique» est armé.

(16) Voyant POWER. Allumé, le SC 502 est alimenté.

(17) Bouton poussoir RESET. Appuyer dessus pour armer la base de temps dans le mode «balayage unique».

(18) Boutons poussoirs des modes de déclenchement.

AUTO. Bouton poussoir enfoncé, le balayage est libre et la trace visualisée sert de référence en l'absence du signal de déclenchement.

AUTO. Bouton poussoir sorti, le balayage est initialisé dès qu'un signal de déclenchement est appliqué. Aucune trace n'est visualisée en l'absence de signal de déclenchement.

SINGLE SWP. Bouton poussoir enfoncé et le bouton AUTO sorti, la base de temps est en mode

«balayage unique». Après la fin du premier balayage, aucun balayage ne peut être visualisé sans presser le bouton RESET. Dans le mode «balayage unique», la commande du niveau de déclenchement LEVEL doit être réglée avec le bouton AUTO sorti.

(19) Boutons poussoirs de couplage (COUPL). Couplent le signal de déclenchement à l'entrée du circuit de déclenchement.

Bouton poussoir AC. Position enfoncée, couplage capacitif des signaux à l'entrée du circuit de déclenchement. La composante continue (DC) est rejetée et les signaux, dont la fréquence est inférieure à 50 Hz, sont atténués.

Bouton poussoir AC. Position sortie, correspond au couplage continu (DC). Toutes les composantes du signal de déclenchement sont transmises à l'entrée du circuit de déclenchement.

Bouton poussoir LF REJ. Position enfoncée, les signaux sont couplés capacitivement à l'entrée du circuit de déclenchement. La composante continue est rejetée et les signaux, dont la fréquence est inférieure à 5 kHz, sont atténués.

(20) Boutons poussoirs SOURCE. Déterminent l'origine du signal qui est couplé à l'entrée du circuit de déclenchement.

Bouton poussoir CH1. Position enfoncée, un échantillon du signal de la voie 1 est couplé au circuit de déclenchement.

Bouton poussoir CH2. Position enfoncée, un échantillon du signal de la voie 2 est couplé au circuit de déclenchement.

Réseau (LINE). Les deux boutons poussoirs CH1 et CH2 sont en positon enfoncée. Un échantillon de la tension du réseau d'alimentation est transmis au circuit de déclenchement.

Bouton poussoir EXT. Position enfoncée, les signaux connectés à la prise EXT TRIG sont couplés au circuit de déclenchement.

(21) Commutateur SLOPE. Sélectionne la pente montante ou descendante sur le signal de déclenchement pour démarrer un balayage.

(22) Commande de niveau. Sélectionne sur le signal de déclenchement le niveau qui déclenchera le balayage.

FONCTIONNEMENT

Réticule

Le réticule du SC 502 est gravé intérieurement sur la face avant du TRC pour permettre de réaliser des mesures précises, non affectées par l'erreur dûe au parallaxe. Le réticule possède huit divisions en vertical et dix divisions en horizontal. Chaque division représente un carré de 6,35 mm de côté. De plus, chaque grande division comprend cinq petites divisions sur les lignes centrales verticale et horizontale. Le gain en vertical et les vitesses en horizontal sont étalonnés d'après le réticule pour pouvoir effectuer des mesures précises sur l'écran du TRC.

Commande d'intensité

La brillance est contrôlée par la commande INTENSITY. La plage de réglage est préréglée de façon que la trace soit visible mais pas trop lumineuse. Il sera nécessaire de retoucher à cette commande suivant la vitesse de balayage ou suivant la forme du signal visualisé. Un point immobile et trop lumineux peut brûler le phosphore du tube cathodique s'il est maintenu trop longtemps.

Réglage de la focalisation

Si l'on ne peut obtenir une représentation bien définie avec la commande FOCUS, même à faible intensité, il est nécessaire d'agir sur le réglage interne ASTIG (réglage effectué par une personne qualifiée).

Pour vérifier le réglage ASTIG, tourner lentement la commande FOCUS, jusqu'à l'obtention du réglage optimal. Si le réglage ASTIG est correctement positionné, les parties verticales et horizontales de la représentation présenteront une finesse extrême pour la même position de la commande FOCUS.

Réglage de l'alignement de la trace

Ce réglage interne doit être effectué par une personne qualifiée.

Modulation d'intensité (s'effectue seulement si la broche 24A a été connectée à cet effet).

La modulation d'intensité (sur l'axe Z) peut être utilisée pour faire apparaître une information supplémentaire sur une représentation obtenue à partir d'un signal de déflexion vertical (axe Y) et d'un signal de déflexion horizontale (axe X) sans toutefois modifier la forme de la représentation. Le signal de modulation de l'axe Z appliqué sur la broche 24A du connecteur modifie l'intensité de la représentation pour traduire cette information. L'amplitude de la tension requise pour une modulation visible dépend de la position de la commande INTENSITY. Environ +5 V pour allumer la trace lorsque celle-ci est éteinte et −5 V pour l'éteindre lorsque celle-ci est allumée. Des modulations en demi-teintes peuvent être obtenues avec des signaux intermédiaires. La tension maximale d'entrée est de ± 10 V et la bande passante sur l'entrée Z de 0 à 2 MHz.

Calibreur

Le calibreur interne du SC 502 constitue une source de signal convenable pour effectuer la vérification de l'étalonnage des sensibilités verticales et des vitesses de balayage. Le calibreur est également très utile pour régler les circuits de compensation des sondes suivant la procédure contenue dans les manuels de sonde. L'amplitude du calibreur est de 600 mV à 1 % près et la fréquence du signal est deux fois la fréquence du secteur.

Représentations verticales

Représentation d'une seule trace. Chacune des deux voies peut être utilisée séparément. Appliquer le signal à l'une des entrées et mettre le commutateur MODE sur la position correspondante. Les commutateurs SOURCE permettent de sélectionner le signal de déclenchement sur l'une ou l'autre des voies verticales.

Représentation de deux traces (mode alterné). Lorsque la commande MODE est placée sur la position ALT, la représentation est obtenue à partir des voies CH1 et CH2 suivant une alternance se produisant après chaque balayage. Bien que le mode alterné puisse être utilisé à toutes les vitesses du balayage, le mode découpé est préférable aux vitesses de balayage inférieures à 1 ms/div.

Dans la position CH1 ou CH2 du commutateur SOURCE, il sera possible de représenter deux signaux respectant la phase. Si les signaux ne sont pas en phase, l'un d'eux sera instable.

Représentation de deux traces (mode découpé). La position CHOP du commutateur MODE permet une représentation obtenue à partir d'une commutation électronique entre les voies. En général, le mode découpé doit être utilisé, aux vitesses inférieures à 1 ms/div environ. C'est le cas d'une visualisation en balayage unique. Aux vitesses de balayage supérieures, les commutations sont visibles et peuvent altérer la représentation.

En mode découpé, un déclenchement externe correct peut être obtenu en utilisant un signal en relation de temps avec les signaux CH1 et CH2. Ce qui donne une représentation identique à celle obtenue par un déclenchement interne.

Le mode découpé permet de visualiser deux signaux synchrones en respectant la relation de temps les liant. Dans le cas contraire (deux signaux indépendants), la représentation de l'un des deux sera instable.

Somme algébrique. Mettre le commutateur MODE sur la position CH1 MINUS CH2. Ceci permet de réaliser la somme ou la différence de deux signaux, de manière à éliminer un signal indésirable (en mode commun) ou à disposer d'une tension de décalage (en appliquant une tension continue à l'une des entrées afin de compenser la composante continue du signal à observer appliqué à l'autre entrée).

Afin d'utiliser au mieux le mode «CH1 minus CH2», les précautions suivantes devront être prises.

1. Ne pas appliquer sur les entrées une tension excessive.

2. Ne pas appliquer de signaux qui excèdent l'équivalent de huit fois la sensibilité verticale. Par exemple, si la sensibilité verticale est 0,5 V/div, la tension du signal ne doit pas être supérieure à 4 V. Des signaux de plus grande amplitude pourraient entraîner des distorsions.

3. Afin d'utiliser la plus grande plage dynamique en somme algébrique, les commandes de cadrage devront être placées de manière que chacune des traces soit centrée, lorsque l'on commute la commande MODE de CH1 à CH2.

4. Pour obtenir une même réponse en fréquence sur les deux voies s'assurer que les commandes AC-GND-DC sont sur la même position.

Sensibilité verticale

L'importance de la sensibilité verticale produite par un signal appliqué sur l'une des voies verticales est déterminée par l'amplitude de ce signal et la position des commandes VOLTS/DIV et VARIABLE. La sensibilité verticale est étalonnée lorsque la commande Variable (CAL) est sur la position enclenchée (à fond à droite).

La commande Variable (CAL) permet de faire varier la sensibilité de façon continue entre les positions étalonnées et de porter la sensibilité à au moins 50 V/div.

Des mesures valables de signaux ne peuvent pas être effectuées tant que l'oscilloscope et l'unité sous test ne sont pas reliés ensemble par une masse commune en plus de la connexion assurée par les sondes ou les câbles amenant les signaux. Le cordon de masse en bout de sonde est la meilleure masse. Il est également possible d'assurer la liaison en réunissant la prise de masse du SC 502 à la masse de l'équipement sous test.

Couplage de l'entrée

Les commandes de couplage d'entrée (AC-GND-DC) permettent le choix du mode de couplage des signaux appliqués. Le type de représentation désiré et la nature du signal appliqué déterminent le mode de couplage à utiliser.

Dans la position AC (couplage alternatif) la composante continue du signal est bloquée par un condensateur se trouvant dans le circuit d'entrée. La réponse du côté basse fréquence est environ 10 Hz à −3 dB. De ce fait il faut s'attendre à une atténuation des composantes voisines de 10 Hz. Dans le cas d'un signal carré comportant des composantes à basses fréquences, cette atténuation se manifeste par une inclinaison des paliers. Le couplage alternatif (position AC)

doit être utilisé pour la représentation de signaux alternatifs comportant une composante continue d'amplitude supérieure à l'amplitude de la composante alternative.

La position DC (couplage continu) est utilisable dans la plupart des applications. Ce mode de couplage permet de mesurer la composante continue du signal et doit être utilisé pour représenter les signaux ayant une fréquence inférieure à environ 50 Hz et qui subiraient normalement une atténuation avec un couplage alternatif.

La position GND permet de disposer d'une référence au niveau de la masse sans devoir relier extérieurement l'entrée de la sonde à la masse. Le signal appliqué à la sonde est déconnecté intérieurement du circuit d'entrée et est relié à la masse par une résistance de 1 MΩ. L'entrée de l'amplificateur vertical est maintenu au niveau de la masse.

Dans la position GND, le fait de connecter l'entrée du signal à la masse à travers une résistance de 1 MΩ est une opération de pré-charge. Cette opération permet de charger le condensateur de liaison à la tension de la composante continue du signal appliqué. De plus, dans la position GND du commutateur AC-GND-DC et quelle que soit la surtension, celle-ci ne sera pas appliquée directement à l'entrée de l'amplificateur. Le circuit de pré-charge limite aussi l'appel de courant se produisant sur la source de signal lors de la charge de la capacité. La procédure suivante devra être utilisée lorsque l'on doit relier l'extrémité de la sonde à une source de signal ayant un niveau continu différent de celui précédemment appliqué.

1. Avant de relier la sonde à une source de signal, placer le commutateur AC-GND-DC sur la position GND.

2. Relier l'extrémité de la sonde à la masse. Attendre quelques secondes que le condensateur de couplage se décharge.

3. Relier la sonde à la source de signal.

4. Attendre quelques secondes que le condensateur de couplage se charge.

5. Placer la commande AC-GND-DC sur la position AC. La représentation demeurera sur l'écran et la composante alternative du signal pourra être mesurée de la manière habituelle.

Sources de déclenchement

Déclenchement interne. Dans la plupart des applications le balayage peut être déclenché intérieurement. Dans les positons CH1 et CH2 du commutateur SOURCE, le signal de déclenchement est prélevé sur le système de déflexion verticale. Pour une représentation à deux traces, l'utilisateur se reportera aux explications faites dans le chapitre «Représentations verticales».

Déclenchement à partir du réseau. Lorsque les boutons CH1 et CH2 du commutateur SOURCE ne sont pas engagés, le déclenchement se fait à partir du réseau. La position LINE connecte une partie du signal du réseau à l'entrée du générateur de déclenchement. Le déclenchement à partir du réseau est utilisé lorsque le signal d'entrée est en relation de temps avec le réseau (multiple ou sous-multiple). Ceci est aussi utilisé pour visualiser la composante 50 Hz sur un signal complexe.

Déclenchement externe. Le signal d'origine externe appliqué à la prise EXT IN peut être utilisé pour assurer le déclenchement du balayage lorsque la commande SOURCE se trouve sur la position EXT. Le signal de déclenchement externe doit se trouver en relation de phase avec le signal à observer pour que l'on puisse obtenir une représentation stable. Un signal peut être utilisé pour déclencher le balayage lorsque le signal de déclenchement interne présente une amplitude insuffisante ou lorsqu'il comporte des composantes sur lesquelles il n'est pas souhaitable que le déclenchement se produise. Il devra également être utilisé lors de relevés de signaux sur les amplificateurs réseaux déphaseurs, circuits de mise en forme etc... Le signal de déclenchement prélevé sur un circuit sous test peut être appliqué à la prise EXT TRIG par un câble 50 Ω ou par une sonde. Dans ce cas le balayage est déclenché continuellement par le même signal, ce qui permet d'examiner les modifications de l'amplitude de la forme ou des relations de temps des signaux en différents points d'un circuit sans avoir à réajuster les commandes de déclenchement.

Couplage de déclenchement

Deux possibilités de couplage peuvent être utilisées grâce au commutateur COUPLING. Chaque possibilité permet de sélectionner ou de rejeter certaines fréquences sur le signal de déclenchement.

Couplage alternatif. Sur la position AC, la composante continue du signal de déclenchement sera éliminée. Des signaux avec des composantes basses fréquences autour de 50 Hz seront atténués. En général le couplage AC est le plus usité. Cependant, si le signal de déclenchement contient des fréquences non désirées, il est préférable de positionner le commutateur sur la position COUPLING LF REJ.

Réjection des basses fréquences. La position LF REJ laisse passer tous les signaux de fréquence supérieure à 5 kHz. La composante continue est rejetée et les signaux de fréquence inférieure à 5 kHz sont atténués. Lors d'un déclenchement sur un signal complexe, cette position est utilisée pour visualiser une représentation stable des composantes hautes fréquences.

Pente de déclenchement

La commande SLOPE détermine la pente positive ou négative du signal de déclenchement sur laquelle a lieu le déclenchement. Lorsque la commande SLOPE est sur la position + (front montant) le départ du balayage se produit sur la pente montante du signal ; sur la positon négative (—) le départ du balayage se produit sur la partie descendante du signal. Si la représentation comporte plusieurs cycles du signal le choix de la pente de déclenchement est souvent sans importance. Par contre, si la représentation ne comporte qu'une fraction d'un cycle, la position de la commande SLOPE est d'importance primordiale car elle permet de placer le départ de la représentation sur la pente désirée du cycle à observer.

Niveau de déclenchement

La commande LEVEL détermine le niveau de tension sur le signal de déclenchement à partir duquel se produira le départ du balayage. Lorsque la commande LEVEL est déplacée vers la partie +, le départ de la représentation se produira à un niveau de tension supérieur sur le signal de déclenchement. Lorsque la commande LEVEL est déplacée vers la partie, le départ de la représentation se produira alors à un niveau de tension inférieur sur le signal de déclenchement. Avant de positionner la commande LEVEL, choisir la source de déclenchement SOURCE, le couplage COUPLING, et la pente SLOPE. Ensuite mettre la commande LEVEL à fond à droite et tourner celle-ci vers la gauche jusqu'à ce que le balayage parte au point désiré.

Mode de déclenchement

Déclenchement automatique. La position AUTO (bouton AUTO enfoncé) du commutateur de déclenchement produit une représentation stable, lorsque la commande LEVEL est correctement positionnée et lorsqu'il y a un signal de déclenchement. La lampe TRIG'D s'allume lorsque la base de temps est déclenchée.

Lorsque la fréquence de répétition du signal de déclenchement est inférieure à 20 Hz ou lorsque le signal de déclenchement est incorrect, la base de temps relaxe et produit une trace de référence. Dès l'application d'un signal de déclenchement correct, la base de temps s'arrête de relaxer et la base de temps est déclenchée afin de produire une représentation stable (avec un positionnement correct de la commande LEVEL).

Déclenchement normal. Dans la position normale (bouton AUTO relaché), le balayage se produit à chaque signal de déclenchement. Sans ce signal, le générateur de balayage ne démarre pas et il n'y a pas de visualisation. Le voyant TRIG'D s'allume lorsque la base de temps est déclenchée correctement.

Utiliser le mode normal pour visualiser des signaux dont la fréquence est inférieure à 20 Hz. Ce mode donne une information sur la «qualité» du signal de déclenchement ainsi que sur les corrections à apporter, car il n'y aura pas de représentation sur l'écran sans un déclenchement correct. Le voyant TRIG'D ne s'allume pas si le déclenchement n'est pas correct.

Retard réglable de déclenchement. En plaçant le cavalier interne (HO-SWP) sur la position HO, la commande de balayage variable (CAL) est utilisée en commande variable de retard de déclenchement. Elle permet de stabiliser le déclenchement sur un signal non périodique ou irrégulier (tel que des séquences numériques complexes). Le déplacement de ce cavalier doit être effectué par une personne qualifiée.

Cette commande s'utilise en deux temps. Premièrement, obtenir la meilleure représentation stable en réglant les commandes de déclenchement. Puis tourner la commande de retard du déclenchement vers la gauche jusqu'à l'élimination de l'instabilité restante.

Balayage unique. Lorsque le signal à observer n'est pas répétitif ou lorsque son amplitude, sa forme ou sa fréquence de répétition varient il n'est pas possible d'obtenir sur l'écran une représentation stable. Une représentation stable peut être obtenue dans ce cas en utilisant le balayage unique. Ce mode (SINGLE SWEEP) permet ainsi de photographier les phénomènes non répétitifs.

Pour utiliser le mode «Balayage unique», s'assurer que le circuit de déclenchement répond au signal à visualiser. Relâcher les boutons AUTO et SINGLE SWP et obtenir la meilleure représentation possible (pour un signal aléatoire, régler les commandes de déclenchement avec un signal dont l'amplitude et la fréquence sont voisines de celles du signal à observer). Enclencher ensuite le bouton SINGLE SWP, presser et relâcher le bouton RESET. La prochaine impulsion de déclenchement démarrera un balayage unique représenté sur l'écran. Après la fin de ce balayage, le générateur de balayage est inhibé jusqu'à la prochaine pression sur le bouton RESET. Le voyant READY s'allume lorsque l'appareil est armé et est prêt à effectuer un nouveau balayage. Ce voyant s'éteindra à chaque fin de balayage. Afin de préparer une autre visualisation en coup unique, presser et relâcher le bouton RESET.

Vitesses de balayage

La commande SECONDS/DIV sélectionne les vitesses étalonnées du générateur de balayage. La commande CAL permet une variation continue de la vitesse de balayage entre deux positions du commutateur SECONDS/DIV. Les vitesses de balayage ne sont étalonnées que lorsque la commande CAL est tournée à fond vers la droite.

Expanseur de balayage

L'expanseur permet de multiplier par dix la vitesse de balayage. La partie du balayage comprise dans la division centrale correspondra à la partie agrandie. La longueur équivalente du balayage expansé est supérieure à 100 divisions. Une fraction quelconque du balayage représentant 10 divisions peut être visualisée en réglant la commande de positionnement horizontal de manière à amener dans l'écran la partie du signal à observer.

Pour utiliser l'expansion du balayage, positionner la partie de la représentation devant être agrandie au centre du réticule puis tirer le bouton SWP MAG. Utiliser la commande POSITION horizontale pour déplacer la représentation.

Lorsque la commande SWP MAG est tirée (X10), la vitesse de balayage équivalente est obtenue en divisant l'indication de la vitesse de balayage par 10. Par exemple, la commande SECONDS/DIV se trouve sur la position 0,5 μs et la vitesse équivalente en mode expansé est 0,05 μs/div.

Fonctionnement en XY

Certaines applications nécessitent la représentation d'un signal par rapport à un autre plutôt que par rapport à un balayage interne. La position AMP (à fond à droite) du commutateur SECONDS/DIV permet d'appliquer un signal externe à l'amplificateur horizontal.

REMARQUE

La position CHOP du commutateur MODE sera utilisée pour la représentation de deux traces, sur la position ALT la visualisation ne serait pas correcte.

Ne pas dépasser la largeur du réticule avec la représentation XY. Cette représentation peut être utilisée pour les mesures de différences de phase de signaux de fréquence inférieure à 50 kHz. Au dessus de cette fréquence, la variation de phase du système rend les mesures difficiles.

APPLICATION

Les paragraphes suivants décrivent les techniques devant être utilisées pour effectuer des mesures classiques. Ces applications ne sont pas décrites en détail car chaque cas de mesure fait appel à des dispositions particulières. S'adresser à l'agence locale Tektronix pour obtenir tout renseignement complémentaire.

Mesures de tension crête-à-crête en alternatif

Pour mesurer une tension crête-à-crête, utiliser la procédure suivante.

1. Positionner le commutateur AC-GND-DC de la voie sélectionnée sur GND et appliquer le signal à la borne d'entrée.

2. Positionner le commutateur AC-GND-DC de la voie choisie sur AC et choisir une position de la commande VOLTS/DIV afin d'obtenir une déflexion verticale de 5 à 6 grandes divisions.

3. Régler les commandes de déclenchement et de vitesse de balayage (SECONDS/DIV) pour obtenir une représentation stable de plusieurs périodes du signal.

4. Agir sur la commande POSITION de la voie de manière à faire coïncider la partie inférieure de la représentation avec l'une des lignes horizontales situées dans la moitié inférieure du réticule, puis agir sur la commande POSITION (horizontale) pour centrer l'une des crêtes supérieures sur la ligne centrale verticale du réticule (voir Fig. 2-3).

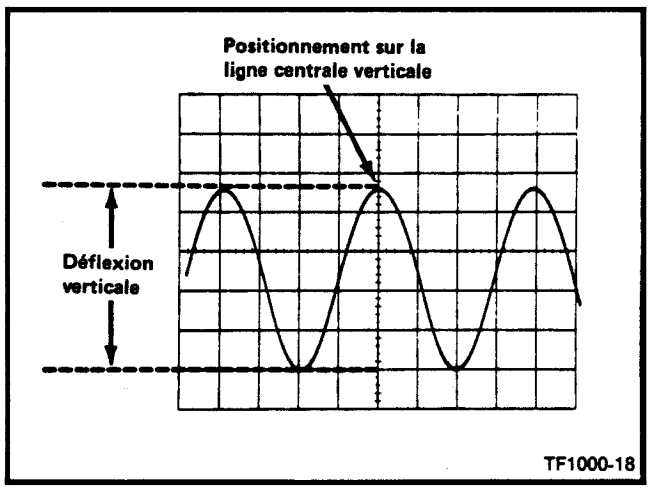


Fig. 2-3. Mesure de la tension crête-à-crête du signal.

5. Mesurer l'amplitude crête-à-crête de la déflexion en divisions après s'être assuré que la commande VARIABLE est sur la position étalonnée.

REMARQUE

Cette méthode permet également de mesurer la tension entre deux points quelconques d'un signal, plutôt que la valeur crête-à-crête.

6. Multiplier la distance mesurée au paragraphe 5 par l'indication de la commande VOLTS/DIV en tenant compte du facteur d'atténuation de la sonde, si une sonde est utilisée.

Exemple : supposons que la déviation verticale soit de 4,6 divisions (voir Fig. 2-2), l'indication de la commande VOLTS/DIV est 5 V

Tension crête-à-crête en volts	=	4,6 (divisions verticales)	X	5 (indication du commutateur en volts/div)	= 23 V

REMARQUE

Si une sonde atténuatrice est utilisée, multiplier le résultat ci-dessus par le rapport d'atténuation.

Mesures d'une tension continue instantanée

Pour mesurer le niveau continu d'un point particulier sur un signal, utiliser la procédure suivante :

1. Positionner le commuateur AC-GND-DC sur GND et faire coïncider la trace sur la ligne inférieure du réticule (ou tout autre signe de référence). Si la tension est négative par rapport à la masse, choisir une ligne de référence située dans la moitié supérieure du réticule. Ne plus agir sur la commande de POSITION (verticale) par la suite.

REMARQUE

Pour mesurer un niveau de tension par rapport à un point dont le potentiel est différent de la masse, apporter les corrections suivantes au paragraphe 1 : placer la commande de couplage sur la position DC et appliquer la tension de référence à la prise d'entrée. Amener alors la trace en coïncidence avec la ligne de référence.

2. Appliquer le signal à la prise d'entrée de l'une des voies de déflexion verticale et positionner le commutateur AC-GND-DC sur DC. (Il est possible de vérifier à tout moment la ligne de référence zéro en plaçant la commande sur GND).

3. Choisir une position VOLTS/DIV de façon à visualiser 5 ou 6 divisions verticales du signal. Vérifier que le variable CAL (bouton rouge) de la voie choisie est à fond à droite. Ajuster les commandes de déclenchement de façon à obtenir une représentation stable.

4. Mesurer la distance en divisions séparant la ligne de référence et le point du signal faisant l'objet de la mesure. Par exemple, dans le cas de la figure 2-4, la mesure est effectuée entre la ligne de référence et le point A.

5. Déterminer la polarité de la tension. La tension est positive si le signal est au-dessus de la ligne de référence.

6. Multiplier la distance mesurée au paragraphe 4 par l'indication de la commande VOLTS/DIV en tenant compte du facteur d'atténuation de la sonde, si une sonde est utilisée.

Exemple : supposons que la distance mesurée est de 4,6 divisions, que la polarité est positive, et que l'indication de la commande VOLTS/DIV est 2 V.

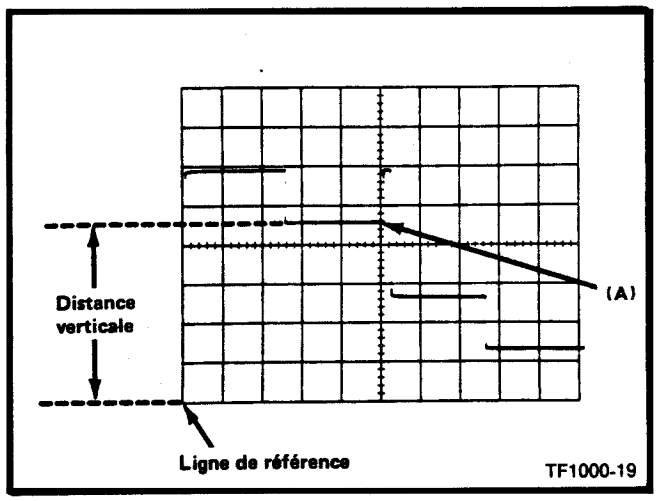


Fig. 2-4. Mesure instantanée d'une tension par rapport à une tension de référence.

Tension instantanée	=	4,6 (divisions verticales)	X	2 (indication du commutateur en volts/div	= +9,2 V

Mesures de temps

Pour mesurer le temps (période) séparant deux points sur un signal, procéder comme suit :

1. Appliquer le signal sur la prise d'entrée verticale et sélectionner un couplage AC ou DC. Régler la commande VOLTS/DIV de manière à obtenir une représentation d'environ 4 divisions.

2. Régler les commandes de déclenchement de la base de temps pour obtenir une représentation stable. Régler la commande SECONDS/DIV de manière que la vitesse de balayage soit la plus rapide possible mais telle que la distance séparant les deux points de mesure soit inférieure à huit divisions de la déflexion horizontale (des problèmes de linéarité peuvent apparaître dans la première et la dernière division du réticule). Voir figure 2-5.

3. Régler la commande POSITION (verticale) de manière à amener les points faisant l'objet de la mesure de temps sur la ligne centrale horizontale du réticule. Agir sur la commande de POSITION (horizontale) pour amener ces deux points dans la zone des huit divisions centrales horizontales.

4. Mesurer la distance horizontale séparant les deux points. S'assurer que la commande variable SECONDS/DIV est à fond à droite.

5. Multiplier la distance mesurée au paragraphe 4 par la vitesse de balayage affichée (SECONDS/DIV).

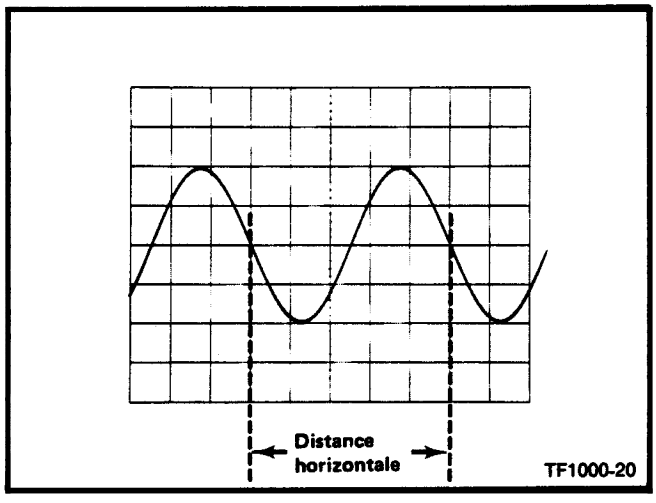


Fig. 2-5. Mesure du temps séparant deux points sur le signal.

Exemple : supposons que la distance horizontale entre les points est de 5 divisions. Le commutateur SECONDS/DIV est positionné sur 0,1 ms. Utiliser la formule suivante :

Période =

Distance horizontale (divisions) X Indication de la commande en SECONDS/DIV = (5). (0,1 ms) = 0,5 ms

La période est de 0,5 ms.

Détermination de la fréquence

Les mesures de temps peuvent servir à déterminer la fréquence d'un signal. La fréquence d'un signal récurrent périodique est l'inverse de la durée (période) d'un cycle complet. Utiliser la procédure suivante :

1. Mesurer la durée d'une période du signal comme indiqué précédemment.

2. Obtenir la fréquence en prenant l'inverse de la période.

Exemple : la période du signal représenté sur la figure 2-5 est 0,5 ms. Sa fréquence est donnée par la relation :

$$\text{Fréquence} = \frac{1}{\text{période}} = \frac{1}{0{,}5\ \text{ms}} = 2\ \text{kHz}$$

Mesures du temps de montée

La mesure du temps de montée s'effectue de la même manière que la mesure d'un intervalle de temps. La principale différence concerne les points délimitant la mesure. La procédure suivante donne les indications utiles pour effectuer une mesure de temps de montée entre les points situés à 10 % et 90 % de l'amplitude du signal.

1. Appliquer le signal à la prise d'entrée.

2. Régler les commandes VOLTS/DIV et CAL de manière que la représentation occupe exactement cinq divisions d'amplitude.

3. Centrer approximativement la représentation sur la ligne centrale horizontale du réticule à l'aide de la commande POSITION (verticale).

4. Régler les commandes de déclenchement du balayage pour obtenir une représentation stable. Régler la commande SECONDS/DIV de manière que la vitesse de balayage soit la plus rapide possible mais telle que la distance séparant les points 10 % et 90 % soit inférieure à 8 divisions de déflexion horizontale (voir Fig. 2-6).

5. Régler la commande POSITION (horizontale) de manière à amener le point 10 % du signal sur la 2ème ligne verticale du réticule.

6. Mesurer la distance horizontale entre les points 10 % et 90 %. S'assurer que le variable SECONDS/DIV (CAL) soit en position étalonnée (à fond à droite).

7. Multiplier la distance mesurée au pragraphe 6 par la valeur indiquée sur le commutateur SECONDS/DIV.

Exemple : supposons que la distance entre les points 10 % et 90 % soit de 6 divisions et que le commutateur SECONDS/DIV soit sur 1 μs. Utiliser la formule de la période pour trouver le temps de montée.

Temps de montée = distance horizontale (divisions) X Indication du commutateur en SECONDS/DIV

= (4).(1 μs) = 4 μs

Le temps de montée est 4 μs.

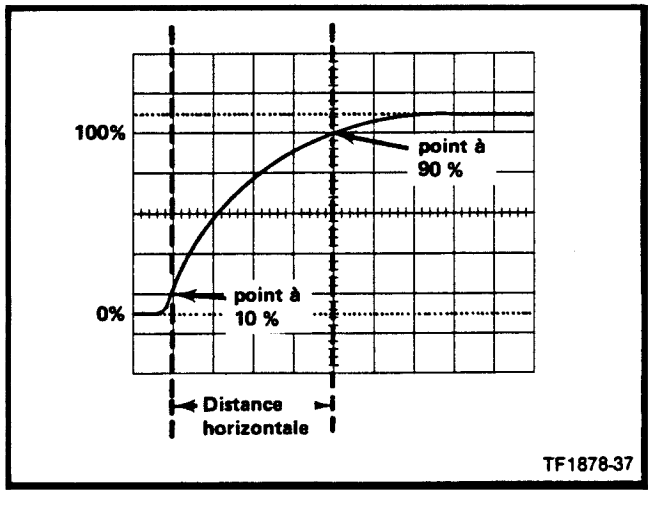


Fig. 2-6. Mesure du temps de montée.

Mesures de l'intervalle de temps entre deux événements

L'oscilloscope SC 502 permet de mesurer le temps existant entre deux ou plusieurs événements séparés. Pour mesurer cette différence de temps, utiliser la procédure suivante :

1. Choisir la position AC ou DC du commutateur AC-GND-DC de chaque voie.

2. Placer la commande MODE sur la position CHOP ou ALT. En général, la position CHOP s'emploie dans le cas d'un signal de basse fréquence. Dans ce chapitre, la partie visualisation verticale donne plus d'informations sur le choix de ce mode.

3. Positionner le commutateur de déclenchement sur la voie 1 ou sur la voie 2 de sorte que la voie choisie permette la meilleure synchronisation pour les deux voies.

4. Appliquer le signal de référence à la prise de l'entrée CH1 et le signal à comparer à la prise de l'entrée CH2. Le départ du signal de référence doit précéder celui du signal à comparer. Utiliser des câbles coaxiaux ou des sondes qui introduisent des retards similaires pour les liaisons.

5. Si les signaux ont des polarités opposées, il faudra en tenir compte dans le calcul final.

6. Régler la commande VOLTS/DIV de manière à obtenir une représentation d'environ quatre divisions d'amplitude.

7. Régler les commandes du déclenchement pour obtenir une représentation stable. Agir sur la commande SECONDS/DIV de manière à ce que les points de mesure soient séparés par une distance de trois divisions ou plus si cela est possible.

8. Placer verticalement les points de mesure sur la ligne centrale horizontale du réticule (commandes POSITION).

9. Agir sur la commande POSITION (horizontale) pour que le signal de la voie 1 (référence) rencontre la ligne centrale horizontale du réticule sur une ligne verticale.

10. Mesurer la distance séparant le signal de la voie 1 et celui de la voie 2 (voir Fig. 2-7).

11. Multiplier la distance mesurée par l'indication de la commande SECONDS/DIV.

Exemple : supposons que la commande SECONDS/DIV soit sur la position 50 μs et que la distance mesurée entre les deux points soit de quatre divisions. En utilisant la formule :

$$\text{Intervalle de temps} = \text{Indication en SECONDS/DIV} \times \text{Distance horizontale (divisions)}$$

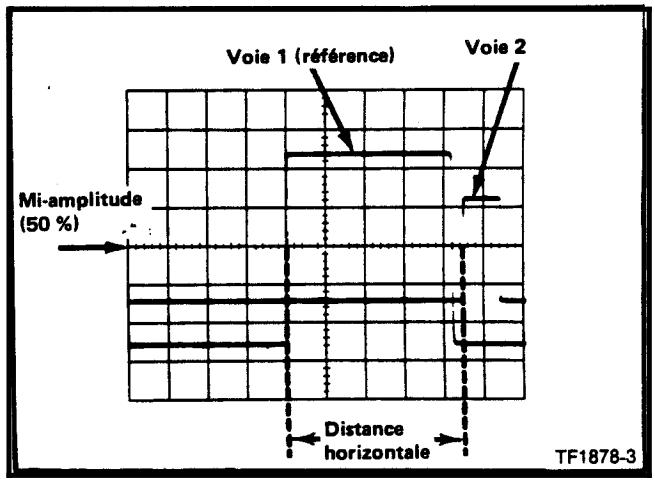


Fig. 2-7. Mesure de temps entre 2 impulsions.

$= (50\ \mu s).(4) = 200\ \mu s$

La différence de temps est de 200 μs.

Mesures de déphasage entre plusieurs traces

La comparaison de la phase entre deux ou plusieurs signaux de même fréquence peut être faite en utilisant les entrées des deux voies verticales. Cette méthode de mesure de déphasage peut être utilisée jusqu'à la fréquence limite du système vertical. Pour effectuer la comparaison, suivre cette procédure.

1. Placer les commandes AC-GND-DC des deux voies sur la même position AC ou DC.

2. Placer la commande MODE sur la position CHOP ou ALT. En général, le mode CHOP est utilisé aux fréquences basses et le mode ALT aux fréquences élevées. Des informations plus complètes sont données dans le paragraphe «Représentations verticales», dans ce chapitre.

3. Positionner le commutateur de déclenchement sur la voie 1 ou sur la voie 2 de sorte que la voie choisie permette un déclenchement stable et correct des deux voies.

4. Appliquer le signal de référence à la prise d'entrée CH1 et le signal à comparer à la prise d'entrée CH2. Les câbles ou les sondes utilisés pour véhiculer les deux signaux doivent présenter des temps de transmission identiques. Le signal de référence doit précéder, en temps, le signal à comparer.

5. Si les signaux ont des polarités opposées dues à un déphasage de 180°, le calcul final doit en tenir compte.

6. Agir sur les commandes CH1 et CH2 VOLTS/DIV et sur les commandes CAL pour que l'amplitude de chaque représentation soit identique et égale à environ 5 divisions.

7. Régler le déclenchement pour obtenir une représentation stable. Choisir une position SECONDS/DIV de manière que la représentation soit d'environ un cycle du signal.

8. Centrer la représentation sur le réticule à l'aide des commandes POSITION CH1 et CH2.

9. Tourner la commande variable CAL SECONDS/DIV jusqu'à ce qu'un cycle du signal de référence (voie 1) occupe exactement 8 divisions sur l'axe horizontal (voir Fig. 2-8). entre la deuxième et la dixième ligne verticale du réticule. Chaque division du réticule représente 45° (360° ÷ 8 divisions = 45°/division. L'échelle horizontale peut donct être établie en degrés comme par exemple 45°/division.

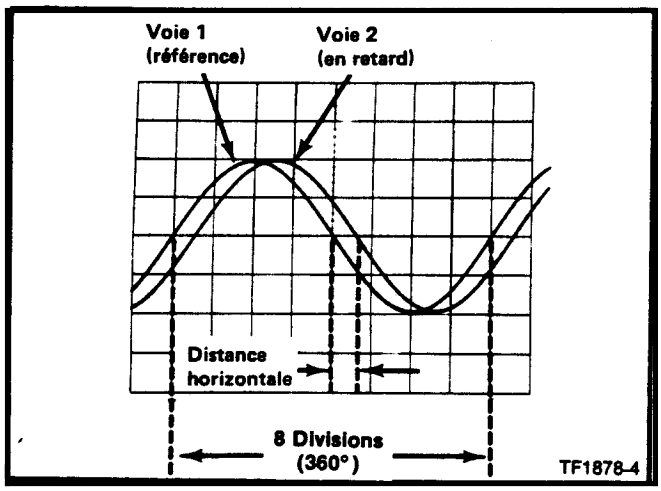


Fig. 2-8. Mesure de déphasage.

10. Mesurer la distance horizontale entre deux points correspondants sur les signaux.

11. Multiplier la distance (en divisions) par 45°/division pour exprimer le déphasage.

Exemple : supposons que la distance horizontale soit de 0,6 division avec une échelle horizontale de 45°/div comme le montre la figure 2-8, en utilisant la formule :

$$\text{Déphasage} = \begin{matrix}\text{Distance} \\ \text{horizontale} \\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{Echelle} \\ \text{horizontale} \\ \text{(degrés/division)}\end{matrix}$$

$$= (0{,}6)\,(45) = 27^\circ$$

Le déphasage est 27°

Mesures de phase de haute résolution

Des mesures de phase plus précises peuvent être effectuées avec deux traces en augmentant la vitesse de balayage (sans changer la position variable de la commande CAL de la base de temps). L'un des moyens les plus simples consiste à utiliser l'expanseur de balayage (X10).

Exemple : si l'échelle horizontale est expansée dix fois, la valeur d'une division est (45°/division) ÷ 10 = 4,5°/div. La figure 2-9 représente le signal de la figure 2-8 expansé 10 fois. Si la différence horizontale est 6 divisions, le déphasage est :

$$\text{Déphasage} = \begin{matrix}\text{Distance} \\ \text{horizontale} \\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{Echelle horizontale} \\ \text{expansée} \\ \text{(degrés/division)}\end{matrix}$$

$$= (6)\,(4{,}5^\circ) = 27^\circ$$

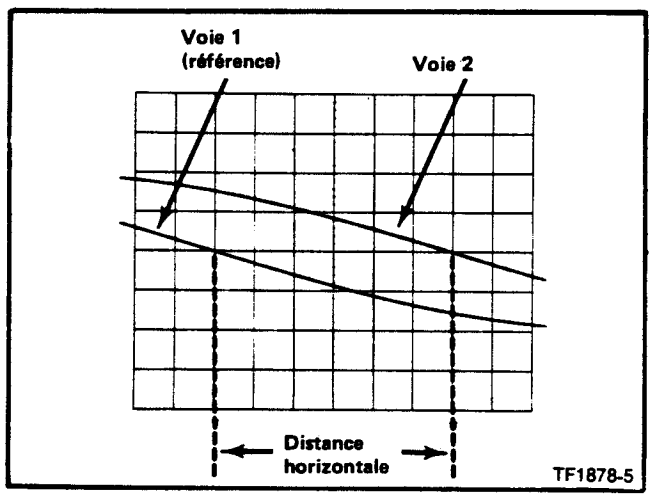


Fig. 2-9. Mesure de déphasage de haute résolution par augmentation de la vitesse de balayage.

INTERFACE ARRIERE

Des broches libres sont disponibles sur le connecteur arrière (liaison SC 502/TM 500) en vue d'une application spécialisée (voir le chapitre 5). Un ou plusieurs compartiments d'un châssis d'alimentation TM 500 peuvent être réunis par câblage. Ce câblage est protégé par des détrompeurs de plastique. La position de chaque détrompeur code l'utilisation des composants. Consulter le manuel du châssis d'alimentation pour plus d'informations.

BEDIENUNGSANLEITUNG

EINFÜHRUNG

Das Zweikanaloszilloskop SC 502 ist ein Vielzweckoszilloskop mit einer Bandbreite von 15 MHz und eignet sich für den Betrieb in zwei Einschubfächern von Stromversorgungsmodulen der Serie TM 500. Für die Verwendung mit dem SC 502 werden die Tastköpfe P6105, P6062B und P6060 empfohlen. Der Tastkopf P6062B ist mit einem wählbaren Teiler von 1X und 10X ausgestattet; der P6105 arbeitet mit dem Teiler 10X.

Installation

Bei Lieferung ist der SC 502 kalibriert und einsatzbereit. Das Oszilloskop wird entsprechend Abb. 2–1 installiert. Stellen Sie den Wahlschalter MODE auf die Position ALT, um das Gerät mit Strom zu versorgen. Überprüfen Sie, ob die Anzeigelampe POWER an der Frontplatte leuchtet.

VORSICHT

Schalten Sie die Stromversorgung der Stromversorgungseinheit aus, bevor Sie den Einschub einschieben. Andernfalls können die Schaltkreise des Einschubs zerstört werden.

GRUNDBESCHREIBUNG DER BEDIENUNG

Im folgenden wird eine kurze Grundbeschreibung der Arbeitsweise der Bedienungselemente und Anschlüsse der Frontplatte gegeben.

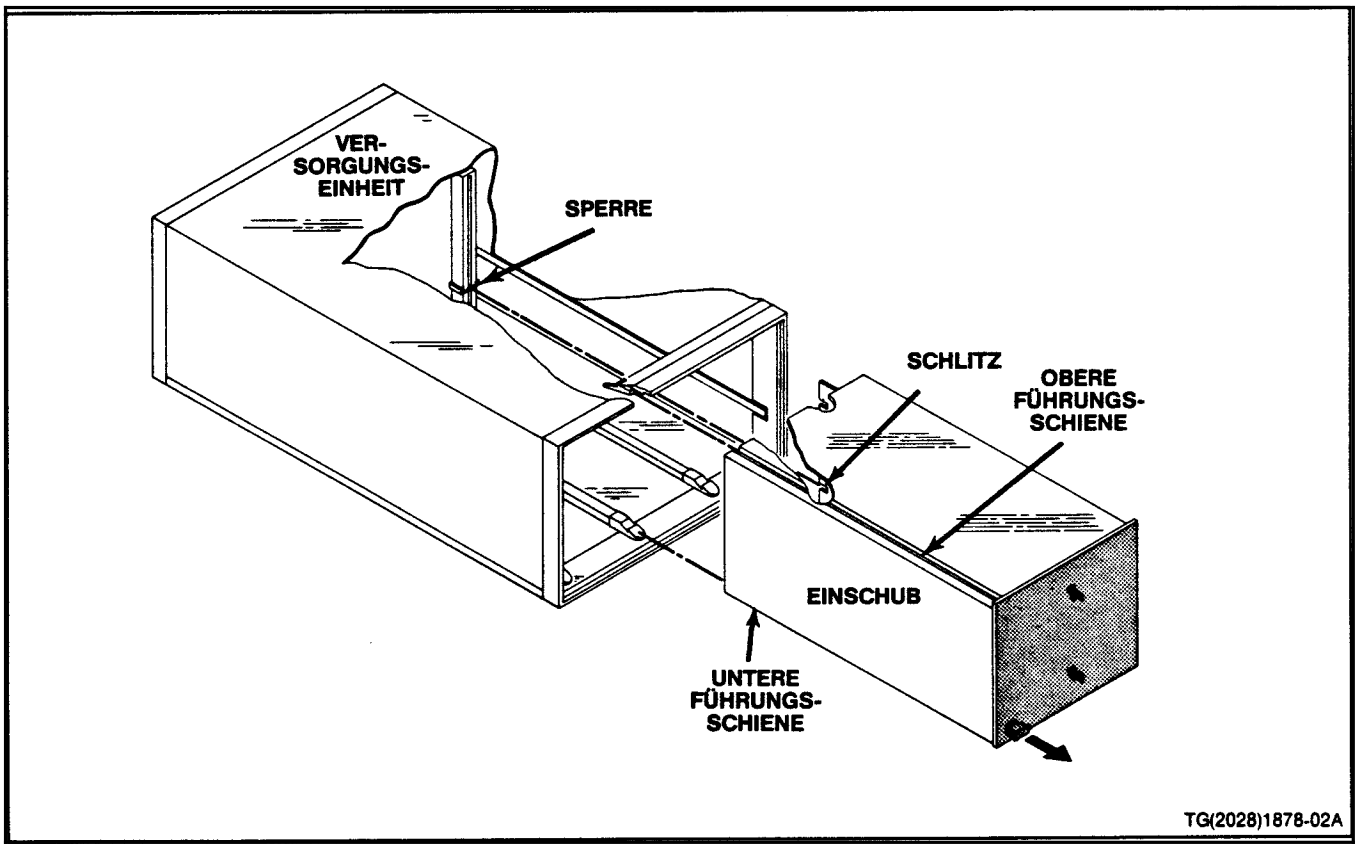


Abb. 2–1. Installation und Auswechseln.

BEACHTE!

Die hellschattierten Bereiche auf der Frontplatte hinter dem Knopfkragen von VOLTS/DIV und SECONDS/DIV kennzeichnen die gewählten Grundeinstellungen für Empfindlichkeit und Zeitablenkung. Die dunkelschattierten Bereiche hinter dem Knopfkragen von VOLTS/DIV kennzeichnen die Empfindlichkeit, wenn ein 10X-Tastknopf verwendet wird. Der farblich schattierte Bereich hinter dem Knopf von SECONDS/DIV kennzeichnet die eingestellte Zeitablenkgeschwindigkeit, wenn die Zeitdehnung SWP MAG eingeschaltet ist. Die Schattierungen und die zusätzlich aufgedruckten Werte dienen lediglich zur besseren Orientierung des Bedieners. Die Knöpfe dürfen nicht hinter ihre mechanischen Anschläge eingestellt werden.

Einstellinformationen

1. Stellen Sie den Schalter MODE des SC 502 auf PWR OFF. Schalten Sie den Stromversorgungsschalter der Versorgungseinheit TM 500 aus und installieren Sie den SC 502 in ein Einschubfach. Vergewissern Sie sich, daß die Stromversorgungsquelle den Spannungs- und Frequenzerfordernissen entspricht. Danach schalten Sie den Stromversorgungsschalter der Versorgungseinheit ein.

2. Stellen Sie die Bedienungselemente des SC 502 wie folgt ein:

INTENSITY	Linksanschlag
FOCUS	Bleibt
MODE	CH 1
POSITION	
CH 1	Mittelbereich
CH 2	Mittelbereich
CH 1 VOLTS/DIV	.2
Variable	Rechtsanschlag
CH 1 AC-GND-DC	DC
CH 2 VOLTS/DIV	.2
Variable	Rechtsanschlag
CH 2 AC-GND-DC	DC
POSITION (Horizontal)	Mittelbereich
SECONDS/DIV	5 m
CAL/SWP/MAG	Rechtsanschlag und gedrückt
SINGL SWP	Aus (Taste gelöst)
TRIGGERING	
SLOPE	+
LEVEL	Mittelbereich
SOURCE	CH 1
COUPL	AUTO

3. Stellen Sie die Helligkeit des Ablenkstrahls mit Hilfe von INTENSITY so ein, daß der Strahl gut sichtbar dargestellt wird.

4. Verbinden Sie die Ausgangsbuchse CAL mit Hilfe eines X1-Tastkopfes oder Leiterklemmen mit der Eingangsbuchse CH 1.

5. Stellen Sie mit Hilfe der vertikalen und horizontalen Lageregler (POSITION) die Darstellung so ein, daß sie vertikal zentriert ist und an der linken Seite des Rasters startet.

6. Stellen Sie mit Hilfe von FOCUS einen scharfen Ablenkstrahl für die gesamte Strahllänge ein.

7. Entfernen Sie das Eingangssignal und stellen Sie den Ablenkstrahl vertikal so ein, daß er sich auf der mittleren Horizontallinie des Rasters befindet.

Überprüfung der Kalibrierung

8. Verschieben Sie den Ablenkstrahl 1,5 Teile unterhalb der Mittellinie des Rasters und schließen Sie wieder das Kalibratorsignal an die Eingangsbuchse CH 1.

9. Die Amplitude der Darstellung sollte 3 Rasterteile betragen und es sollten 5 komplette Signalzyklen horizontal dargestellt werden.

Trigger View

10. Drücken Sie die Taste TRIGGER VIEW, um das Triggersignal betrachten zu können. Der Start des Triggersignals auf der horizontalen Mittellinie ist der Triggerpunkt.

Eingang für externe Helligkeitsmodulation

11. Schließen Sie ein 5 V, 1 kHz-Sinussignal oder Rechtecksignal an Pin 24A (externer Z-Achseneingang) an dem rückwärtigen Interface-Stecker an.

12. Drehen Sie jetzt INTENSITY langsam im Gegenuhrzeigersinn, bis der Ablenkstrahl als eine Reihe von dunklen und hellen Segmenten erscheint. Die hellen Segmente entsprechen den Signaldächern des Sinus- oder Rechtecksignals.

Hiermit endet die Grundbeschreibung für den Betrieb des SC 502. Weitere Einzelheiten zu den Funktionen und der Bedienung finden Sie unter „Allgemeine Bedienungsinformationen".

BEDIENUNGSELEMENTE UND ANSCHLÜSSE

① FOCUS – Bildschärfe. Regler zur Einstellung der Bildschärfe des Schreibstrahls.

② INTENSITY – Bildhelligkeit. Regler zur Einstellung der Helligkeit der Darstellung auf der Elektronenstrahlröhre.

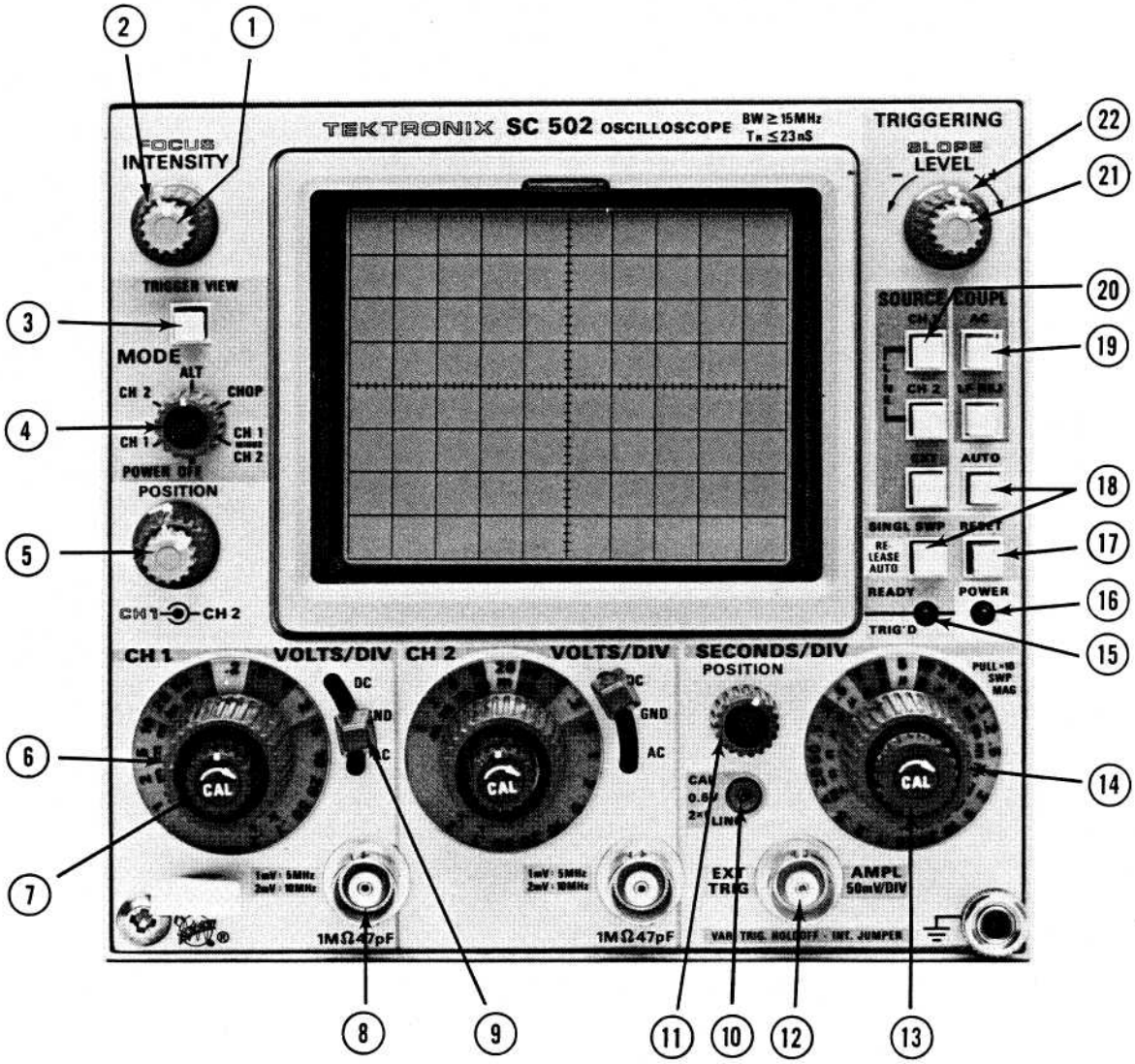


Abb. 2–2. Bedienungselemente und Anschlüsse der Frontplatte.

③ TRIGGER VIEW – Darstellung des Triggersignals. Mit Hilfe dieser Drucktaste wird das Triggersignal auf dem Bildschirm sichtbar gemacht.

④ MODE – Vertikale Betriebsart. Dieser Wahlschalter gestattet die Wahl der Betriebsart des vertikalen Verstärkersystems und dient gleichzeitig dazu, das Instrument ein- und auszuschalten.

PWR OFF – Stromversorgungsschalter. In dieser Position des Wahlschalters ist die interne Stromversorgung ausgeschaltet.

CH 1 – Kanal 1. Es erfolgt nur die Darstellung von Kanal 1.

CH 2 – Kanal 2. Es erfolgt nur die Darstellung von Kanal 2.

ALT – Alternierend. Zweispurdarstellung des Signals beider Kanäle, wobei die Umschaltung von einem Kanal zum anderen am Ende jeder Zeitablenkung erfolgt. Diese Betriebsart wird für Zeitablenkungsgeschwindigkeiten oberhalb 1 ms/cm verwendet.

CHOP – Freilaufende Umschaltung. Zweispurdarstellung der Signale beider Kanäle. Die Darstellung wird zwischen den Kanälen mit einer Folgegeschwindigkeit von etwa 250 kHz umgeschaltet. Diese Betriebsart wird für Zeitablenkgeschwindigkeiten unterhalb 1 ms/cm verwendet.

CH 1 MINUS CH 2. Der Eingang von Kanal 2 wird invertiert und algebraisch zu Kanal 1 addiert.

⑤ CH 1 und CH 2 POSITION – Lageregler Kanal 1 und Kanal 2. Die Regler gestatten die vertikale Einstellung der Lage der Darstellung.

⑥ VOLTS/DIV – Vertikale Ablenkkoeffizienten. Wählt kalibrierte Ablenkkoeffizienten in der Folge 1-2-5. Der variable Einsteller CAL muß auf Rechtsanschlag eingestellt sein, damit die Ablenkkoeffizienten kalibriert sind. Bei Verwendung eines 1X-Tastkopfes werden die Werte des hellschattierten Bereichs abgelesen; bei der Verwendung eines 10X-Tastkopfes die Werte im grauschattierten Bereich.

⑦ CAL – Variables Einstellglied. Gestattet stufenlose Einstellung zwischen den kalibrierten Stufen des Stufenschalters VOLTS/DIV.

⑧ Eingangsanschluß. BNC-Buchse zum Anschluß der vertikalen Eingangssignale.

⑨ AC-GND-DC – Schalter für Eingangskopplung. Wählt die Art, in der das Eingangssignal an den Vertikalverstärker gekoppelt wird. In der Position AC wird das Eingangssignal kapazitiv an den vertikalen Verstärker gekoppelt, wobei die Gleichspannungskomponente unterdrückt wird. In der Position GND wird der Eingangsverstärker geerdet. Außerdem erfolgt die Aufladung des Eingangskoppelkondensators (Precharge-Funktion). In der Position DC wird das Eingangssignal direkt an den vertikalen Verstärker gekoppelt, so daß alle Signalkomponenten zum Eingangsverstärker gelangen.

⑩ Kalibratorausgang. Diese Buchse liefert ein positives Rechtecksignal von 0,6 V mit doppelter Netzfrequenz zur Kalibrierung der Verstärkung und Tastkopfkompensation.

⑪ POSITION – Horizontaler Lageregler. Regler zur horizontalen Einstellung der Lage der Darstellung.

⑫ EXT TRIG/AMPL – Eingangsbuchse. Diese BNC-Buchse dient als Eingang für externe Triggersignale. Darüberhinaus wird im XY-Betrieb das X (horizontal)-Signal an diese Buchse gelegt. Die Eingangskopplung (AC-DC) des externen Verstärkersignals wird über die Triggertaste AC gewählt.

⑬ CAL – Variables Einstellglied/Zeitdehnung. Das Einstellglied CAL gestattet stufenlose Einstellungen zwischen den kalibrierten Stufen des Stufenschalters SECONDS/DIV. Durch Umstecken einer internen Brücke werden mit diesem Einstellglied variable Triggerholdoffzeiten eingestellt.

Durch Ziehen des Knopfes wird die Zeitdehnung eingeschaltet, d. h. die horizontale Darstellung wird um X10 gedehnt.

⑭ SECONDS/DIV – Zeitablenkung. Dieser Stufenschalter wählt geeichte Ablenkzeiten sowie XY-Betrieb in der Position AMPL. Damit die Ablenkzeiten kalibriert sind, muß das variable Einstellglied auf Rechtsanschlag eingestellt sein. Der hellschattierte Bereich unter dem Knopfkragen kennzeichnet die ungedehnte Zeitablenkung; der farbig-schattierte Bereich kennzeichnet gedehnte Zeitablenkung.

⑮ TRIG'D READY – Bereit. Das Leuchten dieser Anzeigelampe zeigt in der Betriebsart der einmaligen Zeitablenkung an, daß die Zeitablenkung bereitgestellt ist und nach Erhalt eines geeigneten Triggersignals eine Darstellung mit einmaliger Zeitablenkung erfolgt. Ansonsten zeigt die Anzeigelampe an, daß die Zeitablenkung getriggert ist.

⑯ POWER – Anzeigelampe. Das Leuchten dieser Anzeigelampe zeigt an, daß der SC 502 mit Strom versorgt ist.

⑰ RESET – Zurücksetzen. Wird diese Taste in der Betriebsart der einmaligen Zeitablenkung gedrückt, erfolgt die Darstellung der einmaligen Zeitablenkung nach korrekter Triggerung. Um weitere Zeitablenkungen darstellen zu können, muß die RESET-Taste erneut gedrückt werden.

⑱ Triggerbetriebsarten

AUTO gedrückt – Automatisch. Die Zeitablenkung wird durch das angelegte Triggersignal ausgelöst. Fehlt ein geeignetes Triggersignal, läuft die Zeitablenkung frei und liefert eine helle Bezugsspur.

AUTO gelöst – Normaler Triggerbetrieb. In dieser Betriebsart wird die Zeitablenkung durch das angelegte Triggersignal ausgelöst. Fehlt ein geeignetes Triggersignal, wird keine helle Bezugsspur geliefert.

SINGL SWP gedrückt – Einmalige Zeitablenkung. Wird diese Taste gedrückt und die Taste AUTO ist gelöst, arbeitet die Zeitablenkung in der Betriebsart der einmaligen Zeitablenkung. Nachdem eine einmalige Zeitablenkung erfolgt ist, können so lange keine weiteren Zeitablenkungen stattfinden, bis die Taste RESET gedrückt wird.

⑲ COUPLING – Triggerkopplung. Diese Tasten wählen die Art, mit der das Triggersignal an die Triggerschaltkreise gekoppelt wird.

AC-Taste gedrückt – Wechselspannungskopplung. Die Triggersignale werden kapazitiv an die Triggerschaltkreise gekoppelt. Gleichspannungen werden unterdrückt und Signale unter etwa 50 Hz werden abgeschwächt.

AC-Taste gelöst (DC) – Gleichspannungskopplung. Die Triggersignale werden direkt an die Triggerschaltkreise gekoppelt.

LF REJ gedrückt (Hochpaß). Die Triggersignale werden kapazitiv an die Triggerschaltkreise gekoppelt. Gleichspannung wird unterdrückt, Signale unter 5 kHz werden abgeschwächt.

⑳ SOURCE – Triggerquelle. Diese Tasten wählen die Triggerquelle.

CH 1 gedrückt – Kanal 1. Ein Teil des Signals, das in Kanal 1 zur Verfügung steht, wird als Triggerquelle verwendet.

CH 2 gedrückt – Kanal 2. Ein Teil des Signals, das in Kanal 2 zur Verfügung steht, wird als Triggerquelle verwendet.

LINE – Netz (Beide Tasten, CH 1 und CH 2, gedrückt). Werden die Tasten CH 1 und CH 2 gleichzeitig gedrückt, ist die Betriebsart LINE eingeschaltet; ein Teil der Netzspannung wird als Triggersignal verwendet.

EXT gedrückt – Extern. Signale, die an den externen Triggereingang (12) angeschlossen sind, werden für die Triggerung verwendet.

㉑ SLOPE – Flankenwahlschalter. Gestattet die Wahl der positiven oder negativen Flanke des Triggersignals, an der die Zeitablenkung ausgelöst wird.

㉒ LEVEL – Pegelregler. Wählt den Amplitudenpunkt auf dem Triggersignal, an dem die Auslösung der Zeitablenkung erfolgt.

ALLGEMEINE BEDIENUNGSINFORMATIONEN

Raster

Der Bildschirm des SC 502 ist mit einem internen Raster ausgestattet, um parallaxefreie, genaue Ablesungen zu ermöglichen. Das Raster ist in acht vertikale und zehn horizontale Rasterteile aufgeteilt. Jedes Rasterteil hat eine Größe von etwa 0,6 cm x 0,6 cm. Jedes Rasterteil ist nochmal in fünf Teile markiert. Die Vertikalverstärkung und Zeitbasis sind so kalibriert, daß genaue Messungen mit Hilfe des Rasters durchgeführt werden können.

Helligkeitsregelung

Die Helligkeit der Darstellung auf der Elektronenstrahlröhre wird mit Hilfe des Bedienungselementes INTENSITY geregelt. Der Regler wird normalerweise so eingestellt, daß der Ablenkstrahl gut sichtbar, mit ausreichender (nicht zu hoher) Helligkeit dargestellt wird. Bei Änderung der Zeitablenkgeschwindigkeit muß der Helligkeitsregler u. U. nachgeregelt werden. Seien Sie bitte vorsichtig, wenn nur ein Punkt auf dem Bildschirm dargestellt wird. Ein Punkt mit hoher Helligkeit kann den Phosphor einbrennen und zu einer dauerhaften Zerstörung der Elektronenstrahlröhre führen, wenn dies länger auftritt.

Bildschärfe

Sollte mit Hilfe des Reglers FOCUS keine genügend scharfe Darstellung eingestellt werden können (insbesondere bei geringer Helligkeit), muß intern der Astigmatismus justiert werden. Dies sollte nur von geschultem Servicepersonal durchgeführt werden.

Zur Überprüfung des Astigmatismus drehen Sie FOCUS langsam durch den Optimumbereich, wobei ein Signal auf dem Bildschirm dargestellt wird. Ist der Astigmatismus korrekt eingestellt, werden die vertikalen und horizontalen Teile des Signals bei ein und derselben FOCUS-Einstellung am schärfsten dargestellt.

Ausrichtung der Strahlspur

Die Strahlspur kann intern parallel zum Raster ausgerichtet werden. Diese Justage sollte nur von qualifiziertem Servicepersonal durchgeführt werden.

Helligkeitsmodulation (nur in Verbindung mit dem Anschluß von Pin 24A des Interface-Steckers)

Mit Hilfe der Helligkeitsmodulation (Z-Achse) kann eine dritte Größe auf die zweidimensionale Darstellung der vertikalen (Y-Achse) und horizontalen (X-Achse) Koordinaten bezogen werden, ohne daß die Form des dargestellten Signals beeinträchtigt wird. Das Modulationssignal für die Z-Achse wird an Pin 24A des rückwärtigen Interface-Steckers angeschlossen und ändert die Helligkeit des dargestellten Signals. Die Amplitude des für die Modulation benutzten Signals hängt von der Helligkeitseinstellung ab. Eine Spannung von + 5 V erzeugt den normalen Helligkeitspegel der Darstellung und ein Signal von – 5 V schaltet die Helligkeit aus. Signale zwischen + 5 V und – 5 V erzeugen Grauwerte. Die max. zulässige Eingangsspannung beträgt ±10 V; der Frequenzbereich für die Z-Achsen-Schaltkreise beträgt 0 bis 2 MHz.

Kalibrator

Der interne Kalibrator des SC 502 dient als Signalquelle für die Überprüfung der Verstärkung und der Zeitbasis. Ebenso wird das Kalibratorsignal zur Kompensation von Tastköpfen verwendet. Die rechteckförmige Ausgangsspannung beträgt 600 mV bei einer Genauigkeit von 1 %. Die Frequenz des Rechtecksignals ist die doppelte Netzfrequenz.

Vertikaldarstellungen

Einkanaldarstellung. Jedes der Eingangssignale kann zur Einkanaldarstellung benutzt werden. Legen Sie das Signal an den gewünschten Eingang und schalten Sie den MODE-Schalter auf den benutzten Kanal. Der Triggerquellenschalter SOURCE kann jeden Vertikalkanal als Triggersignal wählen.

Zweikanaldarstellung (alternierender Betrieb). Die Position ALT des MODE-Schalters erzeugt eine Darstellung mit alternierender Umschaltung zwischen den Kanälen 1 und 2, jeweils nachdem der Strahl über die CRT abgelenkt wurde. Obwohl die ALT-Betriebsart bei allen Ablenkzeiten benutzt werden kann, erzeugt die CHOP-Betriebsart bei Ablenkzeiten von 50 µs/Teil und länger eine zufriedenstellendere Darstellung.

In der Position CH 1 und CH 2 des SOURCE-Schalters werden zwei Signale in richtiger Zeitrelation dargestellt. Liegt zwischen den beiden Signalen kein Zeitbezug vor, wird eines von beiden Signalen instabil dargestellt.

Zweikanalbetrieb (zerhackte Darstellung). Die CHOP-Schalterstellung des MODE-Schalters erzeugt eine Darstellung, die zwischen beiden Signalen elektronisch geschaltet wird. Die CHOP-Betriebsart erzeugt die besten Darstellungen bei Ablenkzeiten von 50 ms/Teil und langsamer oder wenn einmalige Ereignisse zweikanalig dargestellt werden sollen. Bei schnelleren Ablenkzeiten wird die Umschaltung sichtbar und kann die Darstellung beeinflussen.

Mit einem externen Triggersignal, das einen Zeitbezug zu einem der Eingangssignale hat, erzielt man im CHOP-Betrieb gute Triggerergebnisse. Diese Betriebsart hat den gleichen Erfolg wie die interne Triggerung auf Kanal 1 oder Kanal 2.

Zwei zeitbezogene Signale können im CHOP-Betrieb mit den echten Zeitverhältnissen dargestellt werden. Liegt kein Zeitbezug vor, wird ein Signal ständig instabil dargestellt.

Algebraische Addition. Die Stellung CH 1 minus CH 2 des MODE-Schalters kann zur Darstellung der Differenz zwischen zwei Signalen oder zur Gleichtaktunterdrükkung von unerwünschten Signalen benutzt werden oder für DC-Offsets (an den Eingang des einen Kanals wird eine Gleichspannung gelegt, um den Gleichspannungsanteil des anderen Signals zu kompensieren).

Die folgenden Vorsichtsmaßnahmen sollten beachtet werden:

1. Überschreiten Sie nicht die Eingangsnennspannung des SC 502.

2. Legen Sie keine Signale an, die den eingestellten Ablenkkoeffizienten (VOLTS/DIV) um mehr als Faktor 6 überschreiten. Wenn beispielsweise mit dem VOLTS/DIV-Schalter ein Wert von 0,5 eingestellt ist, sollte das Signal dieses Kanals 3 V nicht überschreiten. Höhere Spannungen könnten die Darstellung verzerren.

3. Benutzen Sie die Lageeinsteller von Kanal 1 und Kanal 2 um die Signale, wenn diese einzeln dargestellt werden, in Schirmmitte zu schieben. Diese Maßnahme garantiert den größten Dynamikbereich in der Betriebsart CH 1 MINUS CH 2.

4. Um gleiches Verhalten beider Kanäle zu gewährleisten, stellen Sie den Schalter DC-GND-AC beider Kanäle in die gleiche Stellung.

Ablenkkoeffizienten

Der Betrag der Vertikalablenkung wird durch die Signalamplitude, die Einstellung des Schalters VOLTS/-DIV und durch die Stellung der variablen Einstellung des VOLTS/DIV-Schalters bestimmt. Die kalibrierten Ablenkkoeffizienten, die von dem VOLTS/DIV-Schalter angezeigt werden, sind nur dann gültig, wenn die variable Einstellung in der kalibrierten Stellung steht (Rechtsanschlag).

Die variable Einstellung von VOLTS/DIV bietet die Möglichkeit, den Ablenkkoeffizienten kontinuierlich zwischen den kalibrierten Stufen des VOLTS/DIV-Schalters zu variieren. Die variable Einstellung VOLTS/DIV überschreitet den größten vertikalen Ablenkkoeffizienten bis zu einem Wert von 50 V/Teil.

Zuverlässige Messungen können nur durchgeführt werden, wenn das Oszilloskop und das Meßobjekt an einer gemeinsamen Bezugsleitung (Masse) und an der Signalleitung angeschlossen sind. Der Masseanschluß am Tastkopf bietet die beste Masseverbindung. Um eine gemeinsame Masse zu gewährleisten, muß die Masseleitung auch mit dem Chassis des Meßobjektes verbunden werden.

Eingangskopplung

Der AC-GND-DC-Schalter erlaubt verschiedene Kopplungsmethoden für das angelegte Signal. Die gewählte Kopplungsart hängt von dem angelegten Signal und von der gewünschten Darstellung ab.

Bei der AC-Kopplung wird der Gleichspannungsanteil des Signals durch eine Kapazität im Eingangsschaltkreis abgeblockt. Die untere Frequenzgrenze (– 3 dB-Punkt) liegt bei der AC-Kopplung bei ca. 10 Hz. Dadurch muß bei niedrigen Frequenzen im Bereich der Grenzfrequenz mit Signaldämpfungen gerechnet werden. Rechtecksignale mit Niederfrequenzanteilen werden durch diese Dämpfung in der Signalform beeinflußt. Die AC-Kopplung bietet die besten Darstellungen von Signalen, die einen Gleichspannungsanteil haben, der wesentlich größer ist als der Wechselspannungsanteil.

Die DC-Kopplung kann für die meisten Anwendungen benutzt werden. Diese Kopplungsart ermöglicht Messungen von Signalen mit Gleichspannungsanteilen und mit Frequenzen < 50 Hz, zur Vermeidung von Dämpfungen, die durch die AC-Kopplung hervorgerufen werden.

In der GND-Position wird eine Massereferenz an den Eingang gelegt, ohne daß der Tastkopf über eine externe Masse geerdet wird. Das angelegte Signal wird intern vom Eingangskreis abgetrennt und dieser über einen 1 MΩ-Widerstand auf Massepotential gelegt. Der Eingangsverstärker-Schaltkreis wird auf Massepotential gehalten.

In der GND-Position wird das Eingangssignal über einen 1 MΩ-Widerstand, der in Verbindung mit der Koppelkapazität ein Ladungsnetzwerk (precharge) bildet, auf Masse gelegt. Über dieses Netzwerk wird die Eingangs-Koppelkapazität auf den Signalmittelwert des angelegten Signals aufgeladen. Da dies in der GND-Position des AC-GND-DC-Schalters statfindet, werden versehentlich hervorgerufene transiente Spitzenspannungen nicht an den Verstärker-Eingang gelangen. Das Ladungsnetzwerk bietet außerdem einen Schutz gegen starke Strombelastungen vom Meßobjekt, der während der Aufladung der Eingangskapazität fließen kann. Die folgende Anleitung sollte beachtet werden, wenn die Tastkopfspitze an eine Signalquelle gelegt wird, die im Gleichspannungsanteil unterschiedlich ist gegenüber einem vorher angelegten Signal.

1. Bevor die Signalquelle an die Tastkopfspitze angeschlossen wird, stellen Sie den Schalter AC-GND-DC auf GND.

2. Berühren Sie mit der Tastkopfspitze das Oszilloskopchassis. Warten Sie einige Sekunden, bis die Eingangskoppelkapazität entladen ist.

3. Verbinden Sie die Tastkopfspitze mit der Signalquelle.

4. Warten Sie einige Sekunden, bis die Eingangskoppelkapazität geladen ist.

5. Stellen Sie den AC-GND-DC-Schalter auf DC. Die Darstellung ist zur Messung der Wechselspannungskomponenten auf dem Bildschirm.

Triggerquelle

Interne Triggerung. Bei den meisten Anwendungen kann die Zeitablenkung intern getriggert werden. In den Positionen CH 1 und CH 2 des Triggerquellen-Schalters wird das Triggersignal aus dem Vertikalablenkungssystem abgeleitet. Für Zweikanal-Darstellungen müssen spezielle Betrachtungen gemacht werden, um eine korrekte Darstellung zu erzielen.

Beziehen Sie sich auf die Erklärungen für den Zweikanalbetrieb. In dem Teil über Vertikaldarstellungen der allgemeinen Bedienungsanleitung ist die Zweikanal-Triggerung beschrieben.

Netztriggerung. Die LINE-Position des Triggerquellenschalters wird durch gleichzeitiges drücken der Tasten CH 1 und CH 2 eingeschaltet. In der LINE-Position wird ein Teil der Netzspannung als Eingangssignal für den Triggergenerator benutzt. Die Netztriggerung ist besonders nützlich, wenn das Eingangssignal einen Zeitbezug zur Netzfrequenz hat. Es kann außerdem zur stabilen Darstellung von komplexen netzfrequenten Signalen benutzt werden.

Externe Triggerung. Ein externes Signal, das an die EXT IN-Buchse angeschlossen ist, kann zur Triggerung benutzt werden, wenn der Triggerquellenschalter in der Position EXT steht. Um eine stabile Darstellung zu erzielen, muß das externe Triggersignal einen Zeitbezug zum dargestellten Signal haben.

Ein externes Triggersignal kann dann zur Signaltriggerung benutzt werden, wenn beispielsweise das interne Signal eine zu geringe Amplitude aufweist oder Signalanteile enthält, auf denen nicht getriggert werden soll. Bei Signaltrennungen in Verstärkern, Phasennetzwerken, Signalformstufen usw. ist die externe Triggerung ebenfalls von Vorteil. Von einem Schaltungspunkt des Meßobjekts kann das Signal über ein Kabel oder einen Tastkopf mit dem externen Trigger-Eingang verbunden werden. Die Zeitablenkung wird dann immer durch das gleiche Signal getriggert und erlaubt die Messung an unterschiedlichen Punkten in der Schaltung, wobei das Signal sowohl Amplitudenänderungen, Änderungen in der Zeitrelation oder der Signalform aufweisen kann, ohne daß die Triggereinstellung nachgestellt werden muß.

Triggerkopplung

Mit dem Triggerkopplungsschalter lassen sich zwei verschiedene Kopplungsarten wählen. Jede Kopplungsart ermöglicht die Bevorzugung oder Unterdrückung von bestimmten Frequenzen des Triggersignals, um eine selektive Triggerung zu erzielen.

AC-Kopplung. In der AC-Position werden die Gleichspannungsanteile des Triggersignals abgeblockt. Signale mit niederfrequenten Anteilen unter 50 Hz werden gedämpft. Im allgemeinen kann die AC-Kopplung für die meisten Anwendungen benutzt werden. Enthält das Triggersignal unerwünschte Frequenzkomponenten, kann mit dem Schalter LF REJ COUPLING eine bessere Darstellung erzielt werden.

Niederfrequenzunterdrückung. Die Schalterstellung LF REJ läßt alle hochfrequenten Frequenzanteile über 5 kHz passieren. Gleichspannung wird unterdrückt und Signale unterhalb 5 kHz werden gedämpft. Bei der Triggerung von komplexen Signalformen eignet sich diese Betriebsart für die stabilen Darstellungen von Hochfrequenzanteilen.

Triggerflanke

Der Triggerflanken-Schalter (SLOPE) bestimmt, ob der Triggerkreis auf dem steigenden oder fallenden Signalteil ausgelöst wird. Wenn der SLOPE-Schalter in der + (steigend) Stellung steht, startet die Zeitablenkung mit dem steigenden Signalanteil. Sind in der Darstellung mehrere Wiederholungen, ist die Einstellung des SLOPE-Schalters oft nicht wichtig. Soll allerdings nur ein Schwingungsausschnitt dargestellt werden, ist die richtige Einstellung des SLOPE-Schalters wichtig, damit die Darstellung an der gewünschten Flanke des Eingangssignals beginnt.

Triggerpegel

Die Triggerpegeleinstellung LEVEL bestimmt den Amplitudenpunkt auf dem Signal, bei dem die Zeitablenkung getriggert werden soll. Befindet sich der LEVEL-Regler im positiven Bereich, wird der Triggerkreis reagieren, sobald das Triggersignal steigende Amplituden hat. Ist der Pegelregler im negativen Bereich, wird der Triggerkreis reagieren, sobald sich die Amplitude des Triggersignals in negativer Richtung ändert. Bevor der Triggerpegel eingestellt wird, sollten zuerst die Triggerquelle SOURCE, die Kopplungsart COUPLING und die Triggerflanke SLOPE gewählt werden.
Danach stellen Sie den Pegelregler an Rechtsanschlag und drehen Sie ihn im Gegenuhrzeigersinn, bis die Darstellung an dem gewünschten Punkt beginnt.

Triggerbetriebsart

Automatische Triggerung. Die AUTO-Stellung (AUTO-Taste gedrückt) des Triggerbetriebsartenschalters bietet bei richtig eingestelltem Triggerpegel und ausreichendem Triggersignal eine stabile Triggerung. Die Anzeigelampe READY TRIG'D zeigt an, daß der Ablenkzeitgenerator getriggert ist.

Ist die Wiederholfrequenz des Triggersignals < 20 Hz oder ist kein ausreichendes Triggersignal vorhanden, läuft der Ablenkzeitgenerator frei, um auf dem Bildschirm eine helle Bezugsspur zu erzeugen. Wird ein Triggersignal angeschlossen, wird der freilaufende Zustand beendet und der Ablenkzeitgenerator zur stabilen Signaldarstellung getriggert (mit der richtigen Pegeleinstellung).

Normale Triggerung. Der normale Triggerbetrieb (Drucktaste AUTO gelöst) entspricht, solange ein Triggersignal anliegt, dem automatischen Betrieb; ist allerdings kein Triggersignal vorhanden, arbeitet der Ablenkzeitgenerator nicht und es erfolgt keine Strahlablenkung. Die READY TRIG'D-Anzeigelampe bleibt dunkel.

Benutzen Sie zur Triggerung von Signalen mit Wiederholfrequenzen unter 20 Hz die normale Betriebsart. Diese Betriebsart bietet eine Anzeige des vorhandenen Triggersignals und einer Korrektur der Triggerkontroll-Einstellungen, da bei Fehlen eines Triggersignals keine Darstellung erfolgt. Bei korrekter Triggerung leuchtet die Anzeigelampe TRIG'D.

Trigger-Holdoff. Durch Umschalten des internen Stekkers HO-SWP in die Stellung HO wird die variable Zeitablenkung (CAL) zur variablen Trigger-Holdoff-Einstellung umfunktioniert. In dieser Konfiguration können mit dem variablen Trigger-Holdoff stabile Triggerungen auf aperiodischen oder unregelmäßigen Signalen, wie komplexen Digitalworten, erzielt werden (Der interne Stecker sollte nur von qualifiziertem Personal umgesteckt werden).

Die Benutzung der Holdoff-Einstellung setzt die bestmögliche und stabilste Darstellung voraus, die mit den Triggereinstellelementen auf normale Weise möglich ist. Danach drehen Sie den variablen Einsteller für den Trigger-Holdoff im Gegenuhrzeigersinn, bis alle übriggebliebenen Instabilitäten verschwunden sind.

Einmalige Ablenkung. Wenn das dargestellte Signal nicht repetierend ist oder sich in der Amplitude, Form oder Zeit ändert, erzeugt die normale Darstellung ein instabiles Oszillogramm. In der Betriebsart „einmalige Ablenkung" (single sweep) kann dies vermieden werden. Die einmalige Ablenkung kann auch zur Fotografie eines nichtrepetierenden Signals benutzt werden.

Die Benutzung der einmaligen Ablenkung setzt voraus, daß der Triggerkreis auf das darzustellende Ereignis anspricht. Lösen Sie die Tasten AUTO und SINGL SWP und stellen Sie das Signal so gut als möglich dar (die Trigger-Einstellung für statistische Signale sollte über ein Signal erfolgen, das in der Amplitude und Frequenz dem statistisch erscheinenden Signal entspricht). Danach drücken Sie die SINGL SWP-Taste und drücken und lösen Sie die RESET-Taste. Der nächste Triggerpuls löst die Zeitablenkung aus und ein einmaliger Strahl erscheint auf dem Schirm. Nachdem diese Ablenkung komplett beendet ist, wird der Zeitablenkgenerator bis zu seiner Rückstellung verriegelt. Die Anzeigelampe READY leuchtet, wenn die Verriegelung des Zeitablenkgenerators aufgehoben wird und dieser eine neue Ablenkung erzeugen kann. Nach jeder Ablenkung erlischt die READY-Anzeige. Die Freigabe des Triggerkreises für eine erneute einmalige Ablenkung erfolgt durch Drücken und Lösen der Taste RESET.

Horizontale Ablenkzeiten

Mit dem Schalter SECONDS/DIV werden die kalibrierten Ablenkzeiten des Ablenkzeitgenerators gewählt. Zwischen den kalibrierten Stufen kann mit der variablen Ablenkzeiteinstellung gearbeitet werden. Die Ablenkzeiten sind nur dann kalibriert, wenn sich die variable Einstellung an Rechtsanschlag befindet.

Horizontal-Dehnung

Die Dehnung verkürzt die Ablenkzeit um Faktor 10. Das mittlere Rasterteil der ungedehnten Darstellung ist in der gedehnten Darstellung auf dem Schirm sichtbar. Die äquivalente Länge der gedehnten Darstellung ist mehr als 100 Teile. Jede beliebigen 10 Teile der gedehnten Darstellung können durch Veränderung der Horizontallage in den sichtbaren Bildschirmbereich gebracht werden.

Bei Benutzung der Dehnung empfiehlt es sich, zuerst den gewünschten Teil der Darstellung auf Rastermitte zu stellen. Danach ziehen Sie den Schalter SWP MAG. Benutzen Sie den Horizontallageregler um den gedehnten Signalausschnitt in die gewünschte Position zu bringen.

Wenn der Schalter SWP MAG eingeschaltet ist, wird die Ablenkzeit durch Teilung der Einstellung des SECONDS/DIV-Schalters durch 10 bestimmt. Wenn beispielsweise der SECONDS/DIV-Schalter auf .5 µ steht, ist die gedehnte Ablenkung 0,05 µs/Teil.

XY-Betrieb

Bei einigen Anwendungen ist es wünschenswert, ein Signal gegen ein anderes darzustellen (XY) und nicht gegenüber der internen Zeitbasis. Die AMP-Stellung des SECONDS/DIV-Schalters bietet die Möglichkeit, ein externes Signal an den Horizontalverstärker zu legen und dadurch eine XY-Darstellung zu erhalten.

BEACHTE

Die Position CHOP des MODE-Schalters muß für eine Zweikanaldarstellung benutzt werden. In der Position ALT des MODE-Schalters wird nicht das korrekte Signal erzeugt.

Überschreiten Sie im XY-Betrieb nicht die horizontale Darstellbreite. Diese Betriebsart kann zur Messung von Phasendifferenzen, von Signalen mit Frequenzen bis zu 50 kHz benutzt werden. Oberhalb dieser Frequenz werden Phasenmessungen durch eigene Phasenverschiebungen schwierig.

GRUNDANWENDUNGSBEISPIELE

Im folgenden werden einige Grundmessungen beschrieben, die mit Hilfe des SC 502 durchgeführt werden können. Die Anwendungsbeispiele werden nicht bis ins letzte Detail beschrieben, da jede Anwendung auf individuelle Meßerfordernisse abgestimmt werden muß.

Messung der Spitzenspannung AC

Eine Spitzenspannungsmessung wird wie folgt durchgeführt:

1. Stellen Sie den Schalter AC-GND-DC des benutzten Kanals auf die Position GND ein und schließen Sie das zu messende Signal an die entsprechende Eingangsbuchse an.

2. Stellen Sie den entsprechenden Schalter AC-GND-DC auf die Position AC und wählen Sie mittels VOLTS/DIV einen vertikalen Ablenkkoeffizienten, um das Signal über etwa 5 bis 6 Vertikalteile des Rasters darzustellen. Überprüfen Sie, daß das variable Einstellglied des Schalters VOLTS/DIV auf Rechtsanschlag steht.

3. Stellen Sie die Bedienungselemente der Triggerung so ein, daß das Signal stabil auf dem Bildschirm dargestellt wird und wählen Sie mittels SECONDS/DIV eine Ablenkzeit, die einige Signalzyklen des Signals darstellt.

4. Stellen Sie die Lage der Darstellung mit Hilfe des Reglers POSITION so ein, daß der untere Signalteil parallel zu einer der sich unterhalb der Mittellinie befindlichen Rasterlinie dargestellt wird und der obere Teil des Signals noch im Darstellbereich liegt. Verschieben Sie die Darstellung mit dem horizontalen Lageregler so, daß eine der oberen Spitzen deckungsgleich zur vertikalen Mittellinie dargestellt wird (siehe Abb. 2-3).

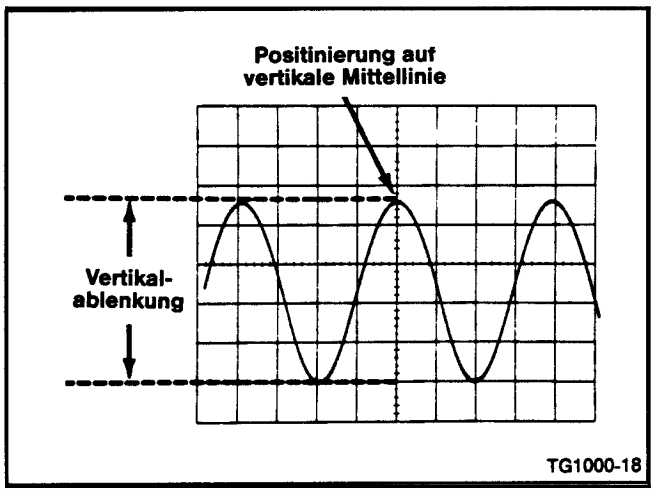


Abb. 2–3. Messung der Spitzenspannung eines Signals.

5. Nun kann die Vertikalablenkung von Spitze zu Spitze in Rasterteilen abgelesen werden.

BEACHTE!

Diese Technik kann ebenso für Messungen zwischen zwei beliebigen Punkten auf dem Signal verwendet werden.

6. Multiplizieren Sie die in Schritt 5 abgelesene Distanz (in Rasterteilen) mit dem am Stufenschalter VOLTS/DIV eingestellten Wert. Falls notwendig, ist der Teilungsfaktor des Tastkopfes zu berücksichtigen.

BEISPIEL: Wenn z.B. die vertikale Ablenkung 4,6 Teile beträgt und VOLTS/DIV auf 5 V eingestellt ist, wird die Spitzenspannung wie folgt ermittelt:

$$U_{SS} = 4{,}6 \text{ Teile} \times 5 \text{ V/Teil} = 23 \text{ V}.$$

BEACHTE!

Falls ein Teilertastkopf benutzt wird, muß das Ergebnis mit dem Teilungsfaktor multipliziert werden.

Gleichspannungswertmessung

Um den Gleichspannungspegel eines Signals an einem bestimmten Punkt des Signals zu messen, gehen Sie wie folgt vor:

1. Stellen Sie den AC-GND-DC-Schalter des gewählten Kanals auf die Position GND ein und positionieren Sie den Ablenkstrahl auf die untere Rasterlinie (oder eine andere Rasterlinie). Ist die zu messende Spannung mit Bezug auf Masse negativ, wird die obere Rasterlinie als Referenzlinie gewählt. Nachdem die Referenzlinie eingestellt ist, darf die vertikale Lage der Darstellung nicht mehr verändert werden.

BEACHTE!

Werden Spannungspegel mit Bezug zu einer anderen Spannung als Masse gemessen, nehmen Sie in Schritt 1 folgende Änderungen vor: Stellen Sie AC-GND-DC auf DC ein und schließen Sie die Referenzspannung an die Eingangsbuchse an. Danach stellen Sie die Referenzlinie ein.

2. Schließen Sie das Signal an die Eingangsbuchse an. Stellen Sie den entsprechenden Schalter AC-GND-DC auf DC ein (die Massereferenz kann jederzeit durch Einstellen von GND überprüft werden).

3. Stellen Sie den Stufenschalter VOLTS/DIV so ein, daß das Signal vertikal über 5 bis 6 Rasterteile dargestellt wird. Überprüfen Sie, daß das variable Einstellglied des benutzten Kanals sich auf Rechtsanschlag befindet. Stellen Sie mit Hilfe der Bedienungselemente der Triggerung eine stabile Darstellung ein.

4. Lesen Sie die Distanz in Rasterteilen zwischen Referenzlinie und dem zu messenden Punkt des dargestellten Signals ab. Im Beispiel Bild 2-4 wurde die Messung zwischen der Referenzlinie und dem Punkt A durchgeführt.

5. Stellen Sie die Polarität fest. Die Spannung ist positiv, wenn das Signal sich oberhalb der Referenzlinie befindet.

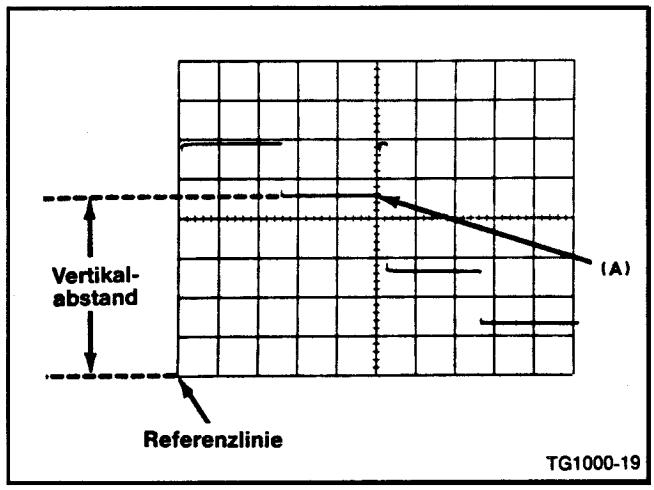


Abb. 2–4. Gleichspannungsmessung mit Bezug auf eine Referenzspannung.

6. Multiplizieren Sie die abgelesene Distanz mit dem am Stufenschalter VOLTS/DIV eingestellten Wert. Gegebenenfalls ist der Teilerfaktor des Tastkopfes mit in die Rechnung einzubeziehen (siehe Beispiel Spitzenspannungsmessung).

BEISPIEL: Angenommen, die vertikale Distanz betrage 4,6 Teile und die Polarität sei positiv und der an VOLTS/DIV eingestellte Wert betrage 2 V. Die Spannung wird unter diesen Voraussetzungen wie folgt bestimmt:

U = 4,6 Teile x 2 V/Teil = + 9,2 V.

Messung der Periodendauer

Eine Messung der Periodendauer zwischen zwei Punkten auf einem Signal wird wie folgt durchgeführt:

1. Schließen Sie das zu messende Signal an die Eingangsbuchse an, wählen Sie entweder AC-Kopplung oder DC-Kopplung und stellen Sie den Stufenschalter VOLTS/DIV so ein, daß das Signal über etwa vier Teile dargestellt wird.

2. Stellen Sie die Bedienungselemente der Triggerung so ein, daß das Signal stabil auf dem Bildschirm dargestellt wird. Wählen Sie eine so schnelle Ablenkzeit, daß ein Signalzyklus über weniger als acht horizontale Rasterteile dargestellt wird. (Im ersten und letzten Rasterteil können Nichtlinearitäten auftreten.) Siehe Abb. 2-5.

3. Verschieben Sie die Darstellung mittels POSITION vertikal so, daß die Punkte, zwischen denen die Messung stattfinden soll, sich auf der horizontalen Mittellinie befinden. Mit Hilfe des horizontalen Lagereglers stellen Sie die Meßpunkte ein.

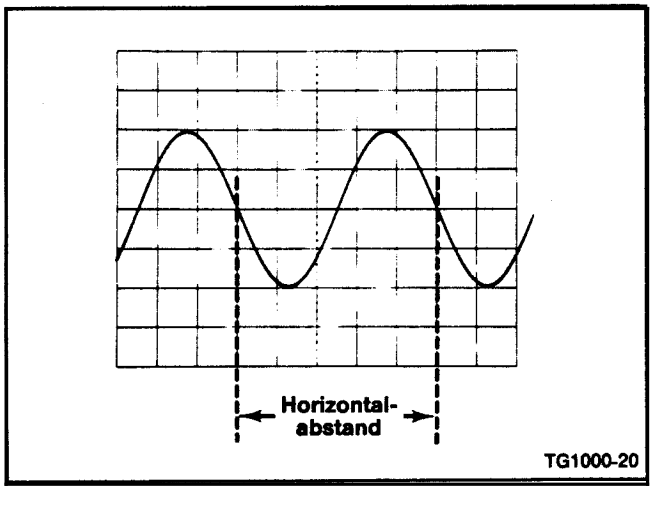


Abb. 2-5. Periodendauermessung zwischen zwei Punkten.

4. Jetzt lesen Sie die Distanz (horizontal) zwischen den beiden Meßpunkten ab. Vergewissern Sie sich, daß das variable Einstellglied des Wahlschalters SECONDS/DIV auf Rechtsanschlag eingestellt ist.

BEISPIEL: Wenn der horizontale Abstand zwischen den Meßpunkten fünf Teile beträgt und SECONDS/DIV auf 0,1 ms eingestellt ist, kann die Periodendauer wie folgt bestimmt werden:

Periodendauer = Horizontalteile x Ablenkkoeffizient = 5 Teile x 0,1 ms/Teil = 0,5 ms.

Die Periodendauer beträgt 0,5 ms

Frequenzmessung

Mit Hilfe der Zeitmessung kann auch die Frequenz von Signalen bestimmt werden. Die Frequenz repetierender Signale ist der Reziprokwert der Periodendauer ($f = \frac{1}{T}$).

1. Messen Sie zunächst mit Hilfe des oben beschriebenen Verfahrens die Dauer eines Signalzyklus.

2. Zur Bestimmung der Frequenz bilden Sie den Reziprokwert der gemessenen Periodendauer.

BEISPIEL: Die Frequenz des in Abb. 2-5 gezeigten Signals, das eine Periodendauer von 0,5 ms hat, beträgt:

$$\text{Frequenz} = \frac{1}{\text{Periodendauer}} = \frac{1}{0{,}5\text{ ms}} = 2\text{ kHz}.$$

Messung der Anstiegszeit

Für die Messung der Anstiegszeit werden im Prinzip dieselben Techniken verwendet wie bei der Messung der Periodendauer. Der Unterschied besteht hauptsächlich in der Wahl der Punkte, zwischen denen die Messung erfolgt. Im folgenden wird das Grundprinzip einer Anstiegszeitmessung zwischen den 10%- und 90%-Punkten eines Signals beschrieben.

1. Schließen Sie das zu messende Signal an die Eingangsbuchse an.

2. Stellen Sie mit Hilfe des Stufenschalters VOLTS/DIV sowie dem variablen Einstellglied des verwendeten Kanals eine Darstellung ein, deren Amplitude exakt 5 Teile beträgt.

3. Stellen Sie die Darstellung mit Hilfe des horizontalen Lagereglers ins Zentrum des Rasters ein.

4. Stellen Sie mit Hilfe der Bedienungselemente der Triggerung eine stabile Darstellung des Signals ein. Stellen Sie mittels SECONDS/DIV die schnellste Ablenkzeit ein, bei der das Signal mit weniger als 8 horizontalen Rasterteilen zwischen dem 10%- und 90%-Punkt dargestellt wird. (Siehe Abb. 2-6.)

5. Verschieben Sie die Darstellung mit Hilfe des horizontalen Lagereglers so, daß der 10%-Punkt deckungsgleich mit der zweiten Vertikallinie des Rasters dargestellt wird.

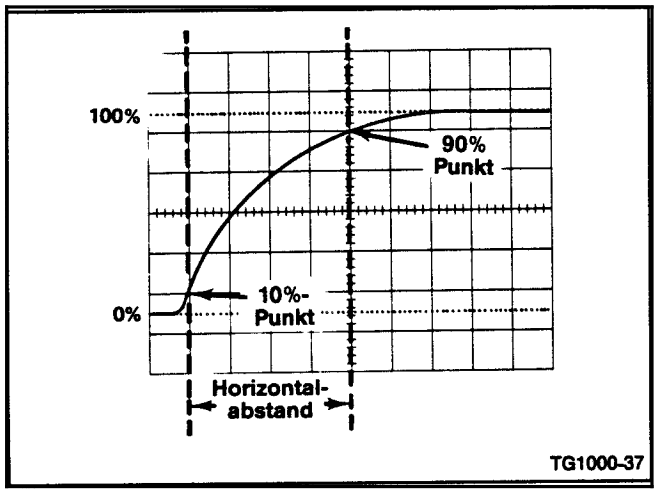


Abb. 2–6. Messung der Anstiegszeit.

6. Lesen Sie die horizontale Distanz zwischen dem 10%-Punkt und dem 90%-Punkt ab. Vergewissern Sie sich, daß das variable Einstellglied des Stufenschalters SECONDS/DIV auf Rechtsanschlag eingestellt ist.

7. Multiplizieren Sie die abgelesene horizontale Distanz mit dem am Stufenschalter SECONDS/DIV eingestellten Wert.

BEISPIEL: Wenn z.B. die horizontale Distanz zwischen dem 10%-Punkt und dem 90%-Punkt vier Teile beträgt und der Stufenschalter SECONDS/DIV auf 1 µs eingestellt ist, wird die Anstiegszeit wie folgt bestimmt:

Anstiegszeit = Horizontaldistanz x Ablenkzeit =
4 Teile x 1 µs/Teil = 4 µs.

Die Anstiegszeit beträgt 4 µs.

Zeitdifferenzmessung

Mit dem SC 502 können Zeitdifferenzen zwischen einem oder mehreren getrennten Ereignissen gemessen werden. Zeitdifferenzmessungen werden wie folgt durchgeführt:

1. Stellen Sie AC-GND-DC beider Kanäle auf entweder AC oder DC ein.

2. Stellen Sie den Wahlschalter für die vertikale Betriebsart MODE entweder auf CHOP oder ALT ein. Grundsätzlich ist die Betriebsart CHOP für die Darstellung von Niederfrequenzsignalen geeignet.

3. Stellen Sie mit Hilfe der Bedienungselemente der Triggerung entweder die Triggerung auf Kanal 1 oder auf Kanal 2 ein, je nachdem, auf welchem der beiden Kanäle die stabliste und korrekteste Triggerung für beide Kanäle erhalten wird.

4. Schließen Sie das Referenzsignal an die Eingangsbuchse von Kanal 2. Das Referenzsignal sollte vor dem Vergleichssignal starten. Verwenden Sie für den Signalanschluß Koaxialkabel oder Tastköpfe mit gleichen Zeitverzögerungscharakteristika.

5. Sollten die Signale eine unterschiedliche Polarität haben, ist dies nachher bei der Berechnung der Zeitdifferenz zu berücksichtigen.

6. Stellen Sie die Stufenschalter VOLTS/DIV so ein, daß die Signale über 5 Rasterteile dargestellt werden.

7. Stellen Sie die Bedienungselemente der Triggerung so ein, daß das Signal stabil auf dem Bildschirm dargestellt wird.

8. Stellen Sie die Lageregler POSITION so ein, daß die Meßpunkte sich auf der horizontalen Mittellinie befinden.

9. Stellen Sie den horizontalen Lageregler so ein, daß das Signal von Kanal 1 (Referenzsignal) die mittlere horizontale Rasterlinie an einer vertikalen Rasterlinie schneidet.

10. Lesen Sie die vertikale Distanz zwischen den beiden Meßpunkten ab. (Siehe Abb. 2-7.)

11. Multiplizieren Sie die gemessene Distanz mit dem am Stufenschalter SECONDS/DIV eingestellten Wert.

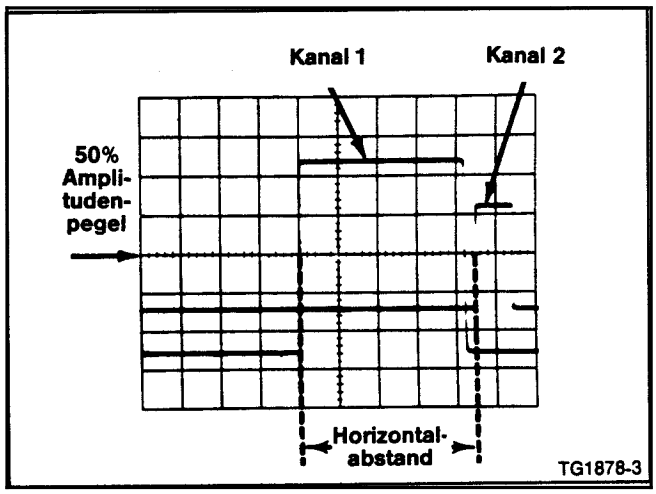


Abb. 2–7. Zeitdifferenzmessung zwischen zwei Impulsen.

BEISPIEL: Wenn der Stufenschalter SECONDS/DIV auf 50µs eingestellt ist und der horizontale Abstand zwischen den Meßpunkten vier Teile beträgt, wird die Zeitdifferenz wie folgt bestimmt:

Zeitdifferenz = Ablenkzeit X horizontaler Abstand
50 µs/Teil x 4 Teile = 200 µs.

Die Zeitdifferenz (Verzögerung) beträgt 200 µs.

Phasendifferenzmessung

Mit Hilfe der beiden Vertikalkanäle besteht die Möglichkeit, einen Phasenvergleich zwischen zwei oder mehreren Signalen derselben Frequenz durchzuführen. Phasendifferenzmessungen können bis zu der Grenze des Vertikalsystems durchgeführt werden. Ein Phasenvergleich wird wie folgt durchgeführt:

1. Stellen Sie die Schalter AC-GND-DC der beiden Eingangskanäle auf entweder AC oder DC ein.

2. Stellen Sie den Wahlschalter für den Vertikalbetrieb MODE auf CHOP oder ALT ein. Grundsätzlich eignet sich die Betriebsart CHOP für Niederfrequenzsignale und die Betriebsart ALT für Hochfrequenzsignale.

3. Stellen Sie mit Hilfe der Bedienungselemente der Triggerung entweder die Triggerung auf Kanal 1 oder auf Kanal 2 ein, je nachdem, auf welchem der beiden Kanäle die stabilste und korrekteste Triggerung für beide Kanäle erhalten wird.

4. Schließen Sie das Referenzsignal an den Eingang von Kanal 1 an und das zu vergleichende Signal an den Eingang von Kanal 2. Das Referenzsignal sollte zeitlich vor dem Vergleichssignal liegen. Verwenden Sie zum Anschluß der Signale Koaxialkabel oder Tastköpfe mit gleichen Zeitverzögerungscharakteristika.

5. Weisen die Signale entgegengesetzte Polarität auf (180° Phasendifferenz), muß diese am Ende berücksichtigt werden.

6. Stellen Sie mit Hilfe des Stufenschalters VOLT/DIV und der variablen Einstellglieder eine Darstellung von genau fünf vertikalen Rasterteilen ein.

7. Stellen Sie die Bedienungselemente der Triggerung so ein, daß die Signale stabil dargestellt werden. Stellen Sie den Stufenschalter SECONDS/DIV so ein, daß etwa ein Signalzyklus dargestellt wird.

8. Bringen Sie die Darstellung mit Hilfe der Lageregler ins Zentrum des Rasters.

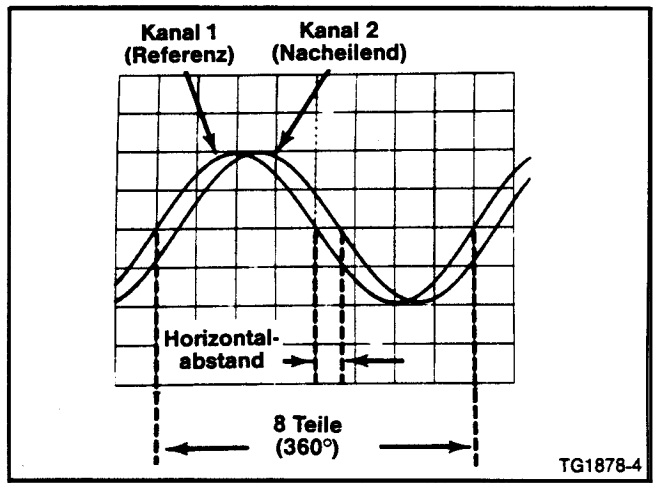


Abb. 2–8. Messung der Phasendifferenz.

9. Stellen Sie das variable Einstellglied von SECONDS/DIV so ein, daß ein Zyklus des Referenzsignals (Kanal 1) genau 8 Teile zwischen der zweiten und zehnten Vertikallinie einnimmt. (Siehe Abb. 2-8.) Jedes Rasterteil entspricht 45° des Zyklus (360° : 8 Teile = 45°/Teil). Die Ablenkzeit stellt praktisch Grad als 45°/Teil dar.

10. Lesen Sie die horizontale Distanz zwischen den entsprechenden Punkten der Signale ab.

11. Multiplizieren Sie die Distanz (in Teilen) mit 45°/Teil (Ablenkzeit), um den exakten Betrag der Phasendifferenz zu erhalten.

BEISPIEL: Wenn die horizontale Distand 0,6 Teil beträgt und die Ablenkzeit 45° pro Teil beträgt, wie in Abb. 2-8 zu sehen, wird die Phasendifferenz wie folgt bestimmt:

Phasendifferenz = Horizontalteile x Grad/Teil
= 0,6 Teile x 45°/Teil = 27°

Die Phasendifferenz beträgt 27°.

Phasenmessung mit hoher Auflösung

Durch Erhöhung der Zeitablenkgeschwindigkeit (ohne variable Einstellung) können zweikanalige Phasenmessungen mit hoher Auflösung durchgeführt werden. Auf einfachste Weise wird die Ablenkgeschwindigkeit mit der Zeitdehnung X10 erhöht.

BEISPIEL: Wird die Zeitablenkung 10fach gedehnt, beträgt die gedehnte Zeitablenkgeschwindigkeit 45°/Teil : 10 = 4,5°/Teil. Abb. 2-9 zeigt dasselbe Signal wie Abb. 2-8 mit dem Unterschied, daß die Zeitdehnung eingeschaltet ist. Bei einem Horizontalabstand von sechs Teilen beträgt die Phasendifferenz:

Phasendifferenz = Horizontalabstand (Teile) x
gedehnte Ablenkzeit (Grad/Teil)
= 6 Teile x 4,5°/Teil = 27°

Die Phasendifferenz beträgt 27°.

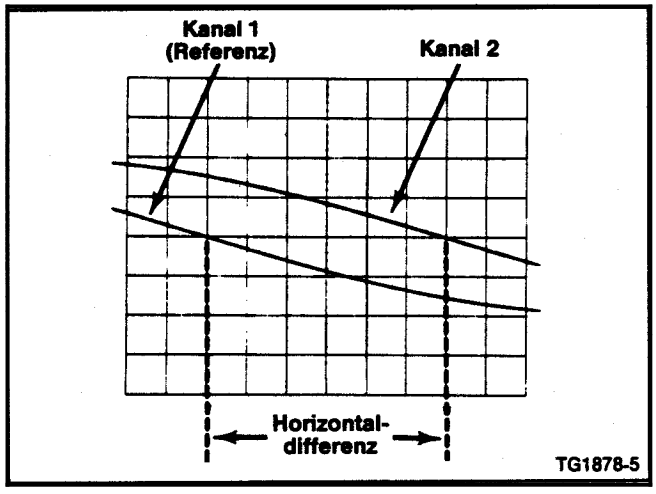


Abb. 2–9. Phasendifferenzmessung mit hoher Auflösung bei erhöhter Ablenkgeschwindigkeit.

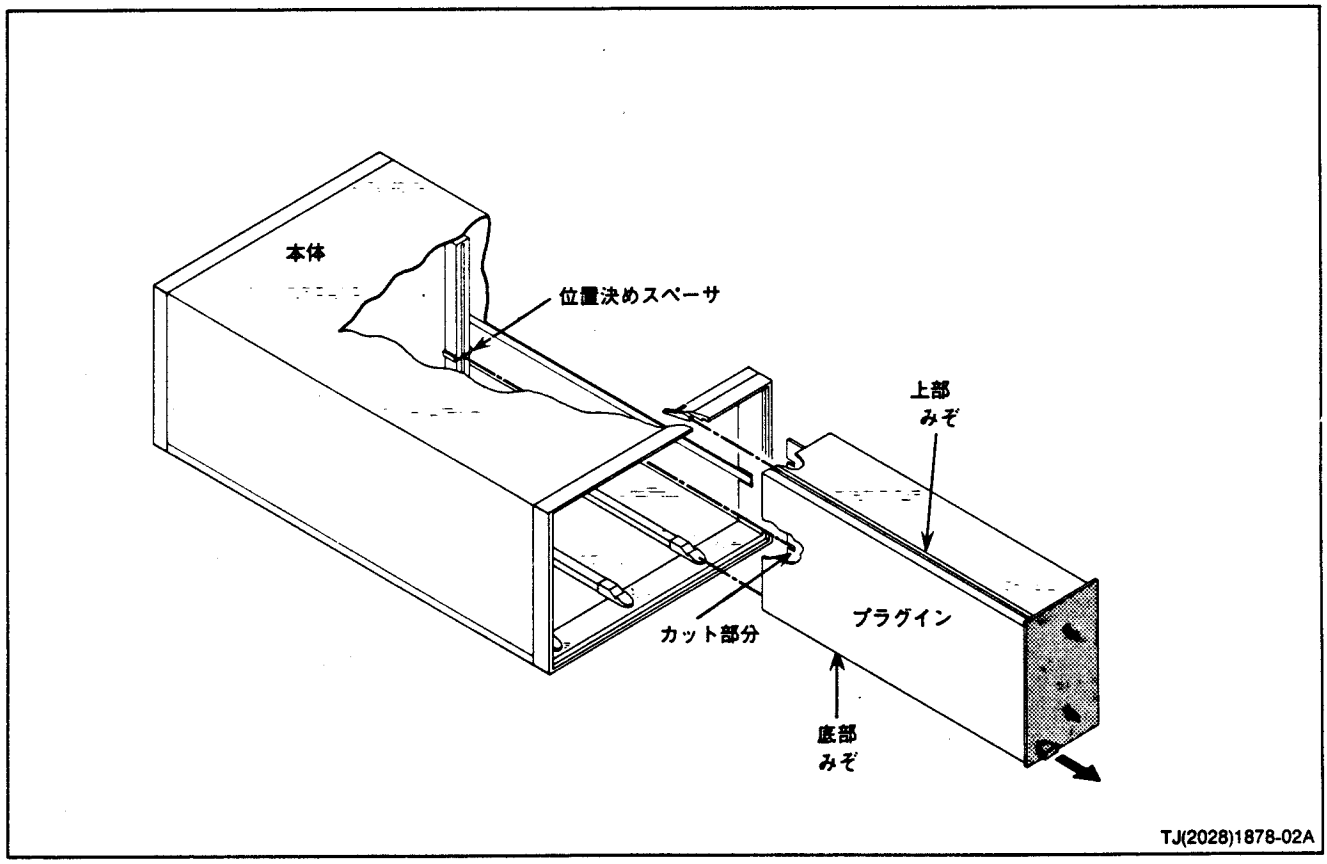
Interfacestecker der Rückwand

Am rückwärtigen Interface-Stecker stehen nichtverbundene freie Pins für den Signalanschluß für Spezialanwendungen zur Verfügung. (Siehe Kapitel 5). Ein oder mehrere Einschubfächer einer Stromversorungseinheit können mit Brücken verdrahtet werden, um spezielle Funktionen zwischen den Einschubfächern zu errichten. Weitere Informationen hierzu finden Sie in den Bedienungsanleitungen der Stromversorungseinheiten.

取 扱 説 明

SC502型オシロスコープは、**TM500**シリーズ電源本体に適合するダブル幅プラグインです。周波数帯域15MHz、2現象で汎用性に富んでいます。**SC502型**に適合するプローブは**P6062B型**、**P6060型**および**P6105型**です。**P6062B型**は減衰比を1：1と10：1に選択が可能ですが、**P6105型**は10：1のみです。

SC502型は工場出荷時に校正されていますので、そのまま使用できます。**2−1図**を参考にして**SC502型**を電源本体に取付け、電源を入れるため**MODE**コントロールを**ALT**に設定して下さい。前面パネルの**POWER**ランプが点燈しているのをご確認下さい。



2−1図　取付および取はずし方法

注

プラグインを抜き差しする場合には本体の電源を切ってから行って下さい。切らずに抜き差ししますと内部回路に悪影響を与えます。

基本操作

前面パネルのコントロールとコネクタの簡単な機能説明が以下に書かれています。

注

VOLTS/DIVとSECONDS/DIVスイッチのアクリル円板後方の前面パネル上に、垂直方向に白くなった部分があり、設定された垂直感度と掃引率を表わしています。VOLTS/DIVスイッチで2時の位置の灰色になった部分は、10Xのプローブを使用した時の感度を表わし、またSECONDS/DIVスイッチで10時位置の色のついた部分はSWP MAGが動作した時の掃引率を表わしています。これらの部分は操作する人にとって設定レンジがすぐに解るため便利です。ストップ位置に注意して必要以上の力をスイッチに加えないで下さい。

各コントロールの設定

1．**SC502型**のMODEスイッチをPOWER OFF位置にします。**TM500**シリーズ本体の電源スイッチをオフにした後、**SC502型**を本体に組込みます。ラインの電源電圧と周波数が本体の電源仕様に合っていることを確認して、本体の電源をオンにします。

2．**SC502型**のコントロールを次の様に設定します。

INTENSITY	左回し一杯
FOCUS	適切に
MODE	CH 1
POSITION(垂直)	
CH 1	中央位置
CH 2	中央位置
CH 1 VOLTS/DIV	0.2
Variable	右回し一杯
CH 1 AC-GND-DC	DC
CH 2 VOLTS/DIV	0.2
Variable	右回し一杯
CH 2 AC-GND-DC	DC
POSITION(水平)	中央位置
SECONDS/DIV	5m
CAL/SWP MAG	右回し一杯で押し込んだ状態
SINGL SWP	オフ(外に出ている状態)
SLOPE	+
LEVEL	中央位置
SOURCE	CH 1
COUPL	AUTO

3．トレースが適度な明るさになるまでINTENSITYコントロールを回します。トレースが目盛の中心に表われます。

4．1：1プローブまたはテスト・リードでCALコネクタの信号をCH1コネクタに接続します。

5．垂直と水平POSITIONコントロールでトレースが管面の左端からスタートし垂直方向の中央にくるように調整します。

6．FOCUSコントロールにより、最もシャープなトレースが得られるよう調整します。

7．入力信号をはずしトレースが中央の水平目盛に一致する様に垂直位置を調整します。

校正信号のチェック

8．トレースを中央水平目盛から1.5div下に移動させCAL信号をCH1入力コネクタに接続します。

9．3divの振幅で完全な5周期(60Hzラインでは6サイクル)のCAL信号が表示されます。

トリガ・ビュー

10. TRIGGER VIEWボタンを押しトリガ信号を表示させます。水平目盛の中央での波形のスタートがトリガ・ポイントです。

外部輝度変調入力

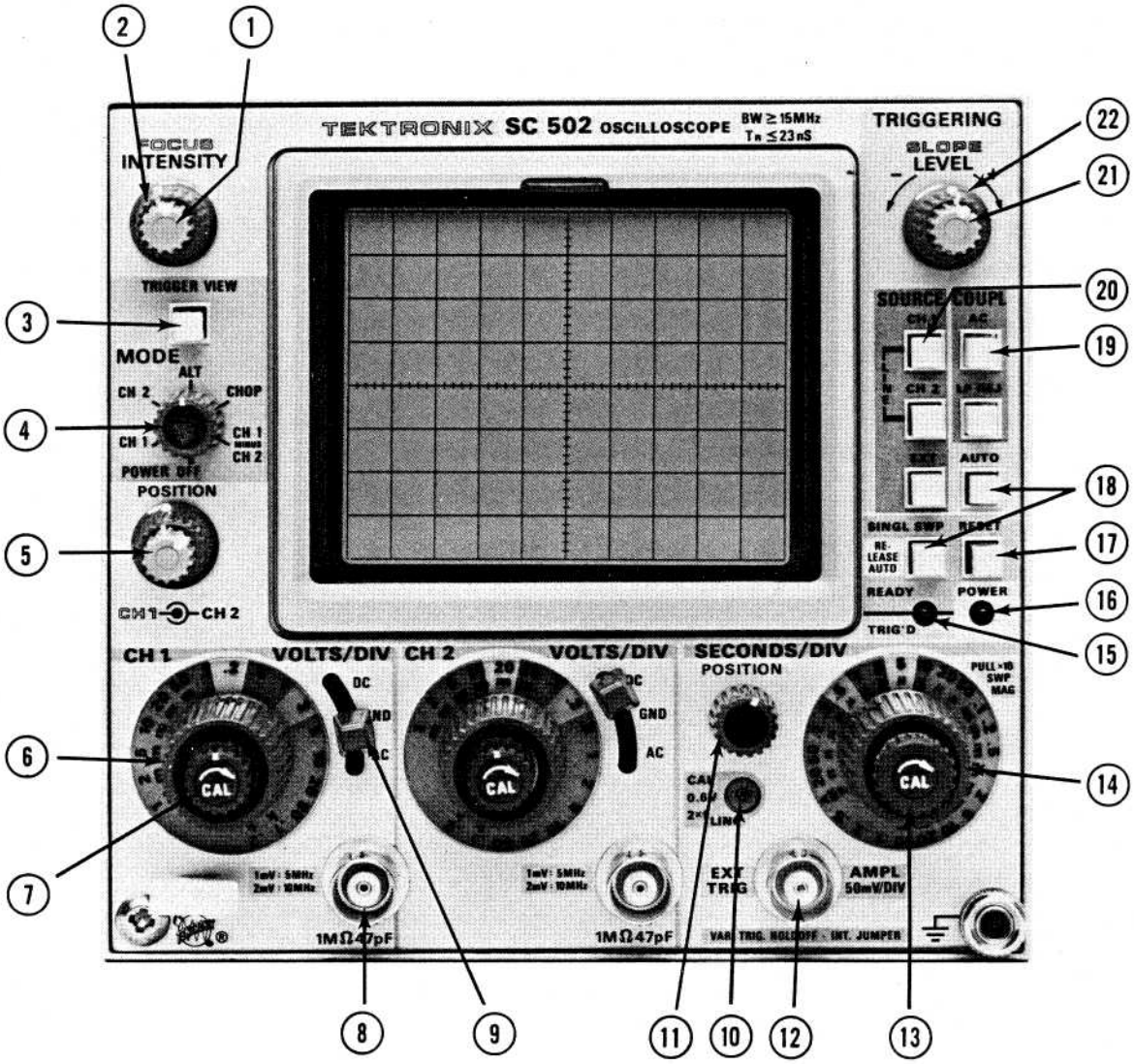
11. 後部インターフェイス・コネクタのピン番号24A(外部Z軸入力)に5Vで1kHzの正弦波または方形波を接続します。

12. トレースが明るい部分と暗い部分になるまでINTENSITYコントロールを左方向にゆっくりと回します。明るい部分は正弦波または方形波の頂上の部分に相当します。

これで**SC502型**の基本操作手順の説明は終りです。ここに書かれていない操作方法については操作の特徴の項で説明してあります。

コントロールとコネクタ

①. FOCUSコントロール：表示のフォーカスを調整します。
②. INTENSITYコントロール：表示の輝度を変化させます。



2−2図　コントロールとコネクタ

③. TRIG VIEW：このスイッチを押し込むとトリガ信号がCRTに表示されます。

④. MODEスイッチ：垂直動作モードと電源のオンまたはオフを選択します。
POWER OFF：SC502型内部電源をオフします。
CH 1：チャンネル1が表示されます。
CH 2：チャンネル2が表示されます。
ALT：両チャンネルの2現象表示で、各掃引の終りで表示されるチャンネルが切り換わります。通常1ms/cmより速い掃引率の時に有効です。
CHOP：両チャンネルの2現象表示で、約250kHz でチャンネル間を切り換えます。通常1ms/cmより遅い掃引率の時に有効です。
CH 1 MINUS CH2：極性反転されたチャンネル2とチャンネル1との代数和を表示します。

⑤. CH1及びCH2 POSITIONコントロール：表示の垂直位置を決定します。

⑥. VOLTS/DIVスイッチ：垂直軸感度を設定するためのスイッチで1－2－5ステップで切換えることができます。校正された垂直軸感度を得るためには、CALつまみを右回しいっぱいの校正位置にします。1：1プローブをご使用になる場合、またはプローブをお使いにならない場合は白色部分の感度を読み取って下さい。10：1プローブをご使用になる場合は灰色部分の感度を読み取って下さい。

⑦. CAL可変コントロール：VOLTS/DIV スイッチの校正位置間の、連続可変(非校正)の感度が得られます。

⑧. 入力コネクタ：垂直入力信号用のBNCコネクタです。

⑨. DC-GND-ACスイッチ：垂直軸の増幅器に信号を接続する方法を選択します。
DC：入力信号の全周波数成分が垂直軸増幅器に入力されます。
GND：垂直軸増幅器の入力は入力コネクタから切離され接地されます。入力結合キャパシタをプリチャージします。
AC：信号はキャパシタを通して結合され、入力信号のDC成分は除去されます。

⑩. CAL 0.6V：この出力ジャックより、繰り返し率が電源周波数の2倍、0.6Vの方形波信号が得られます。機器の電圧校正とプローブの補正に便利です。

⑪. POSITIONコントロール：表示の水平位置を決定します。

⑫. EXT TRIG/AMPL：外部トリガ信号又は水平増幅器の外部入力用のBNCコネクタです。水平増幅器入力のAC-DC結合の切替えはトリガAC押しボタンで行います。

⑬. CAL(可変)コントロール／PULL×10 SWP MAGスイッチ：SECONDS／DIVスイッチで設定される校正掃引率間を連続的に変化させます。又、内部ジャンパの設定によりトリガ・ホールドオフ時間を変化させる事もできます。
CALスイッチが引出されている時には、掃引率は設定値の10倍となります。

⑭. SECONDS/DIVスイッチ：このスイッチで掃引率または水平増幅器外部入力のAMPLモードを設定します。校正掃引率を得るにはCALコントロールを右回しいっぱいの位置にして下さい。アクリル円板の白色部分は拡大されない通常の掃引率を示し10時位置の色のついた部分は10倍の拡大掃引率を表わします。

⑮. TRIG'D READYランプ：単掃引がリセットされている場合、あるいはトリガがかかっている場合にランプが点燈します。

⑯. POWERランプ：SC502型に電源が投入されている場合にランプが点燈します。

⑰. RESET押しボタン：単掃引作動の時に掃引をリセットします。

⑱. トリガ・モード押しボタン
AUTO 押しボタン：このボタンが押し込まれた状態では適切なトリガ信号がない時にも掃引はフリーランし、基準トレースが与えられます。
ボタンが外に出ている状態では、トリガ信号が入力されて初めて掃引が開始します。適切なトリガ信号がない時は何も表示されません。
SINGLE SWP押しボタン：このボタンが押し込まれた状態で、AUTO押しボタンが外に出ている時は単掃引モードになります。1度掃引が行われると、再びRESET押しボタンが押されるまでは次の掃引はスタートしません。AUTO押しボタンが外に出た状態で、単掃引作動のトリガ LEVEL 調整を行います。

⑲. COUPLING押ボタン：トリガ回路に入力するトリガ信号の結合を選択します。
AC押ボタン：このボタンが押し込まれた状態では、トリガ信号はキャパシタを通してトリガ回路に結合されます。トリガ信号のDC成分は除去され、50kHz以下の信号は減衰します。
このボタンが外に出ている状態では、トリガ信号の全周波数成分がトリガ回路に結合されます。
LF REJ押ボタン：このボタンが押し込まれた状態では、トリガ信号はキャパシタを通してトリガ回路に結合されます。トリガ信号のDC成分は除去され、5kHz以下の信号は減衰します。

⑳. SOURCE押しボタン：トリガ回路に結合すべき、トリガ信号を選択します。
CH1押しボタン：CH1に入力されている信号がトリガ源となります。
CH2押しボタン：CH2に入力されている信号がトリガ源となります。
LINE(CH1とCH2押しボタンが同時に押された時)：電源ラインからの信号がトリガ源となります。
EXT押しボタン：外部トリガ入力コネクタに接続された信号がトリガ信号源として用いられます。

㉑. SLOPEスイッチ：掃引をスタートさせるトリガ信号の極性を選択します。

㉒. LEVELコントロール：トリガ信号上で掃引をトリガする振幅点を選択します。

操作の特徴

目　　盛

目盛は、管面の内側から刻まれ、精確な無視差測定ができます。目盛は11本の縦線と9本の横線とからなっていて垂直8div、水平10divで各divは0.25インチとなっています。中央の縦線と横線では、それぞれの大きな区画が5つの小目盛に分けられています。垂直ゲインと水平タイミングは目盛に対して校正されているため、直接管面表示から精確な測定が得られます。

精度コントロール

INTENコントロールでは表示が見やすくなるように、適切な輝度に調節します。別の信号を表示したり掃引率をかえる時には再調整が必要です。輝点が明る過ぎる場合は輝度を下げて下さい。輝度が高いとCRTの蛍光体が焼けて、損傷を受けることがあります。

表示の焦点調整

FOCUSコントロールは機器内部のアスティグ・コントロールとともにシャープなトレース、またははっきりした輝点を得るために用います。

アスティグ・コントロールの設定が適当であるかどうかをチェックするには、管面上の表示がほぼ最適になるようにFOCUSコントロールをゆっくり回します。表示の垂直部分と水平部分の両方が同じFOCUS位置で最善のフォーカスを得ることができれば、アスティグ調整は正確です。

トレースのアライメント調整

機器内部調整が必要です。フィールド・エンジニアにお尋ね下さい。

輝度変調(インターフェイス・コネクタの24Aピンにのみ信号を接続します)

管面上に表示された信号の形に影響を与えることなく、X軸およびY軸に対応して第3軸として輝度(Z軸)変調が使用されます。後部インターフェイス・コネクタの24Aピンに加えられたZ軸変調信号により、表示波形の輝度が変化します。観測可能な輝度変調入力電圧はINTENSITYコントロールの設定によって変わります。約5Vの電圧で、オフレベルから通常の明るさに輝度を増加し、－5Vで通常の明るさをオフレベルにします。"グレイ・スケール"輝度変調はこの電圧レベル間で得られます。最大安全入力電圧は±10Vで、Z軸回路の使用可能な周波数範囲はDC～2MHzです。

キャリブレータ

SC502型の内蔵キャリブレータは基本的な垂直ゲインと時間軸タイミングをチェックするための便利な信号源となります。出力方形波の電圧は600mV±1%です。この信号はプローブのインストラクション・マニュアルで説明しているようなプローブ補正の調整にも便利です。方形波の周波数は2倍の電源周波数です。

垂直操作モード

単現象表示 入力チャンネルのどちらかを使って、単現象の表示が得られます。信号をどちらかの入力コネクタに接続し、MODEスイッチを使用チャンネルにセットします。トリガSOURCEスイッチによりどちらかの垂直チャンネルをトリガ信号源として選択できます。

2現象操作(オルタネート・モード) MODEスイッチを、ALT位置にすると、チャンネル1とチャンネル2とが交互に掃引する表示が得られます。ALTモードはすべての掃引率で使用できますが、CHOPモードでは満足すべき表示が得られるのは50μs/div より遅い掃引率に限られます。このような遅い掃引率では、オルタネート・モードのスイッチングが眼でみえるようになります。

トリガSOURCEスイッチをCH1またはCH2位置にセットすると、真の時間関係を示しながら、両チャンネルの信号が表示されます。信号が時間的に無関係な場合には、表示される信号の一方が不安定になります。

2現象操作(チョップ・モード) MODEスイッチをCHOP位置にすると、チャンネル間を電子回路で切換える表示が得られます。一般的に、掃引率が約50μs/divより遅い場合、または2現象で単発現象を表示する場合には、CHOPモードが最良の表示を与えます。より速い掃引率では、チョップ・スイッチングがみえて、表示の妨げとなります。

どちらかの信号に時間関係をもった信号による外部トリガリングは、チャンネル1またはチャンネル2からの内部トリガリングと同じ結果を与えます。

時間関係のある2つの信号は、真の時間関係を示すように、チョップ・モードで表示できます。しかし、信号間に時間関係がない場合は、表示される信号の一方は不安定になります。

代数和

MODEスイッチをCH1 MINUS CH2位置に設定すると2つの信号の差を表示して、同相除去により不要なDC成分(片チャンネルにDC電圧を入力し、もう一方のチャンネルの信号にDC成分をオフセットさせます) を除去することができます。

代数和モードを使用する時は、次の点に注意して下さい。

1. SC502型の定格入力電圧をこえないようにして下さい。
2. VOLTS/DIVスイッチ設定値の約8倍相当を超える信号は入力しないで下さい。たとえば、VOLTS/DIVスイッチが0.5にセットされた場合、同チャンネルに加えられる電圧は約4Vをこえてはいけません。電圧が高すぎると表示がひずみます。
3. CH1とCH2のPOSITIONコントロールはMODEスイッチをCH1かCH2にセットした時に、各チャンネルの信号が画面中央にもっとも近く位置するような設定値を使用します。これにより代数和モードの操作に対して、最大のダイナミック・レンジが得られます。
4. 各チャンネルから同様なレスポンスを得るには、CH1とCH2のDC-GND-ACスイッチを同じ位置にセットして下さい。

感　　度

信号によって生ずる垂直偏向は、信号振幅、VOLTS/DIVスイッチの設定値、およびVOLTS/DIVのCALコントロールの設定によって決定されます。CALコントロールが校正位置(時計方向一ぱいに回した時の刻み位置) にセットされた時にのみ、VOLTS/DIVスイッチで指示される校正感度が適用されます。

CALコントロール、VOLTS/DIVスイッチの校正設定値での非校正の連続可変垂直感度がえられます。CALコントロールで、最大垂直感度は少なくとも50V/divまで拡大します。

接地のとり方

オシロスコープと被測定物の両方が、信号リードまたはプローブの他に、共通の基準(アース)リードで結合されない限り、信頼できる測定結果は得られません。プローブのアース線で最良の接地がえられます。またSC502型のシャーシ・アース用端子にアース・リードを接続すると、信号源との共通アースを作ることができます。

入力結合

DC-GND-ACスイッチで、入力信号の結合方法を選択します。使用する結合方法は、必要な表示の種類と入力信号の種類とによって決定されます。

AC位置では、信号のDC成分は入力回路内のキャパシタにより除去されます。AC位置での低周波－3dB点は約10Hzです。したがってこの周波数限界の近辺では、ある程度減衰が予想されます。低周波成分をもった方形波では、波形の傾斜という形で減衰が現れます。AC位置では、AC成分よりはるかに大きなDC成分をもった信号の最良の表示が得られます。

DC位置はほとんどの用途に使用できます。この位置では信号のDC成分の測定を可能にし、AC結合を用いた場合の約50Hz以下の信号の減衰を避けることができます。

GND位置では、プローブを外部で接地しなくとも、入力でグラウンド基準がえられます。プローブに入力された信号は内部で入力回路から離され、1MΩの抵抗を通してアースに接続されます。増幅器の入力回路はグラウンド電位に保持されます。

GND位置では、入力信号が1MΩの抵抗を通して接地されて、プリチャージング回路を作ります。この回路により入力結合キャパシタは、プローブに入力された信号の平均DC電圧レベルまで充電されます。この動作がDC-GND-ACスイッチのGND位置で行われますからGND位置からAC位置に切換えた時などに発生する大きな電圧トランジェントは、増幅器に入力されませんのでトレースのポジションが大きく移動してしまうことがありません。プリチャージ回路はまた、キャパシタの充電中に外部回路からとり出される電流レベルを減少させることにより、外部回路に対する保護手段を与えます。プローブを今までとは異なるDCレベルをもった信号に接続する場合には、必らず次の順序に従って下さい。

1. プローブ・チップを信号源に接続する前に、DC-GND-ACスイッチをGNDにセットします。
2. プローブ・チップをオシロスコープのシャーシ・アースに触れさせます。入力結合キャパシタが放電するまで数秒待ちます。
3. プローブ・チップを信号源に接続します。
4. 入力結合キャパシタが充電されるまで数秒待ちます。
5. DC-GND-ACスイッチをACにセットします。表示は管面上に留まっていますから、信号のAC成分が通常の方法で測定できます。

トリガ・ソース

内部トリガリング　大部分の用途では掃引は内部でトリガできます。トリガSOURCEスイッチをCH1およびCH2にセットした時、トリガ信号は垂直偏向システムから得られます。しかし2現象表示の場合には、正しい表示を得るのに特別な考慮を払う必要があります。詳しくは基本操作の項の垂直操作モードをご参照下さい。

ライン・トリガリング　LINE位置では、電源ライン電圧のサンプルが、トリガ・ゼネレータの入力に接続されます。入力信号が電源周波数と時間関係がある（整数倍または整数分の1）場合には、ライン・トリガリングが便利です。複雑な波形中の電源周波数成分を安定表示するのにも役立ちます。

外部トリガリング　EXT IN入力コネクタに接続された外部信号は、SOURCEスイッチをEXT位置に設定した場合に、掃引をトリガするのに利用できます。安定な表示を得るには、外部信号は表示される信号に対して時間関係をもたねばなりません。内部信号の振幅が低すぎて正しいトリガが得られない時や、トリガされるのが好ましくない信号成分を含んでいる場合には、外部トリガ信号を用いて表示が得られます。これはまた増幅器、位相シフト回路、波形整形回路などで、信号を追跡する際にも便利です。テスト中の回路内の1点からの信号は、ケーブルまたはプローブを通して、EXT IN入力コネクタに接続できます。掃引はいつでも同じ信号でトリガされ、トリガ・コントロールを調整し直さなくても、回路の各点における信号の振幅、時間関係または波形変化を観測できます。

トリガ結合

トリガ信号をトリガ回路に結合するには、トリガCOUPLスイッチによって2種の方法を選択できます。それぞれの位置では、トリガ信号の特定の周波数成分を選択または除去したトリガ信号を得ることができます。

AC結合　AC位置ではトリガ信号のDC成分が除去されます。約50Hz以下の低周波成分をもった信号は減衰されます。一般にAC結合は大ていの用途に使用できます。しかしトリガ信号が不必要な周波数成分を含んでいる時は、LF REJを使用します。

低周波除去　LF REJ位置は約5kHz以上のすべての高周波信号を通します。DC成分は除去され、約5kHz以下の信号は減衰されます。複雑な波形からトリガする場合には、この位置は高周波成分の安定な表示を得るのに有効です。

トリガ・スロープ

トリガSLOPEスイッチは、トリガ回路が信号の正方向部分でトリガするか負方向部分でトリガするかを決定します。SLOPEスイッチが＋位置にある時は、表示は波形の増加部分でスタートします。－位置では、表示は波形の減少部分でスタートします。表示に数周期分の信号が現れる場合には、SLOPEスイッチの設定は余り重要でないことがよくあります。しかし特定部分だけを表示するときは、入力信号の希望スロープでスタートする表示を得るために、SLOPEスイッチを正しく設定することが重要です。

トリガ・レベル

トリガLEVELコントロールは、トリガ信号上で、掃引がスタートする電圧レベルを決定します。LEVELコントロールを正領域に設定するとトリガ回路はトリガ波形の正電圧レベルで反応し、負領域に設定すると負電圧レベルで反応します。LEVELコントロールをセットする際には、先ずトリガSOURCE、COUPLおよびSLOPEを設定します。次にLEVELコントロールを反時計方向一ぱいに回し、表示が所要の点でスタートするように時計方向にもどします。

トリガ・モード

オートマチック・トリガリング　AUTOボタンを押し込んだ時、LEVELコントロールが正しくセットされ、十分なトリガ信号が存在する場合に、安定した表示が得られます。掃引ゼネレータがトリガされるとTRIG'Dランプが点燈します。

トリガ繰返し率が約20Hz以下、または十分なトリガ信号がない場合には、掃引ゼネレータはフリーランとなり、基準トレースを生じます。十分なトリガ信号を再び加えると、フリーランは止まり掃引ゼネレータがトリガされて、安定した表示を生じます(LEVELコントロールの設定は正しいとします。)

ノーマル・トリガリング　AUTOボタンが出ている状態がノーマル・モードでトリガ信号を入力した時のAUTO位置と同じです。しかしトリガ信号がない場合には、掃引ゼネレータはオフのままで、表示は出ません。掃引ゼネレータがトリガされると、TRIG'Dランプが点燈します。

繰返し率が約20Hz以下の信号を表示するにはNORMモードをご使用下さい。トリガが適正でないと表示が出ませんから、このモードでの掃引開始はトリガ信号の大きさ、ならびにトリガ・コントロールの設定が正しいことを意味します。掃引が正しくトリガされない時は、TRIG'Dランプは点燈しません。

単掃引　表示すべき信号が繰返されない時、または振幅、波形や時間が変動する場合には、通常の掃引による表示は不安定になることがあります。これを避けるには、単掃引機能をご利用下さい。単掃引モードは非繰返し性の信号を撮影するのにも利用できます。

単掃引モードを用いるには、先ずトリガ回路が、表示しようとする信号に応答することを確かめます。AUTOボタンとSINGLE SWPボタンが出ている状態にし、通常の方法でできるだけ安定した表示にします。(ランダム信号の場合には、ランダム信号とほぼ同じ振幅と周波数の信号でトリガされるようにトリガ回路をセットします。)次に、SINGLE SWPボタンを押しRESETボタンを一旦押します。次のトリガ・パルスで掃引を開始します。管面上にシングル・・パルスで掃引を開始します。管面上にシングル・トレースが表示され掃引が完了すると、掃引ゼネレータはリセットされるまではロックアウトされます。READYランプは掃引ゼネレータがリセットされている間と掃引中は点燈していますが、掃引が終了すると消えます。新たな掃引に備えて回路をリセットするにはRESETボタンを再び押して下さい。

トリガ・ホールドオフ　内部のHO-SWPジャンパをHO位置に設定することにより、可変掃引コントロール(CAL)でホールドオフを可変することができます。これによって、非周期性または不規則な信号（複雑なデジタル・ワードのような）でトリガする場合に、安定なトリガ表示を得ることを可能にします。このコントロールを用いるには、先ず他のトリガ・コントロールを通常の方法で調整して、できるだけ安定した表示を作ります。次に可変ホールド・オフコントロールを時計方向に回して、残りの不安定さをなくします。

水平掃引率

SECONDS/DIVスイッチは、校正された掃引率を選択します。可変コントロールはSECONDS/DIVスイッチの設定間の掃引率を連続的に変化します。可変コントロールが右回しいっぱいの位置にある時は、掃引率は校正されています。

掃引拡大

掃引拡大は掃引を10倍に拡大します。拡大されない表示の中央1divが、拡大された場合に管面一杯でみることができます。拡大された掃引の等価長さは100div以上です。水平POSITIONコントロールを調整すると、希望の部分を観測範囲に移して、拡大された掃引の10div部分をみることができます。

拡大掃引を用いるには、先ず拡大すべき表示部分を目盛の中央に移します。次にSWP MAGスイッチを引き出します。水平POSITIONコントロールで拡大部分を所要位置に動かします。

SWP MAGスイッチが動作している時の掃引率はSECONDS/DIVスイッチ設定値を10で割った値となります。例えばSECONDS/DIVスイッチが0.5μの時は拡大掃引率は0.05 μs/divとなります。

X-Y操作

一部の用途では、一つの信号を時間(内部掃引)に対してではなく、別の信号に対して表示すること(X−Y)が必要な場合があります。SECONDS/DIVスイッチのAMP位置(反時計方向一ぱい)では、この種の表示のために、外部信号を水平増幅器に入力する手段が得られます。

注

MODEスイッチのCHOP位置では2現象X-Y表示が得られますが、ALT位置では得られません。

X−Y操作では表示が水平動作領域を超えないようにして下さい。このモードでは50kHzまでの信号間の位相差を測定できます。50kHz以上ではシステム固有の位相差により測定が困難になります。

基本的測定

基本的な測定を行う場合の順序や方法を以下に説明します。それぞれの取扱い方法は、個々の測定について必要に応じて変えなければなりません。この説明書に述べられた他にも、多くの用途に使用することができます。特殊な測定を行う場合には、当社のフィールド・エンジニアへお問い合わせ下さい。

ピーク電圧測定−AC

ピーク・ツー・ピーク電圧測定を行う手順を次に示します。

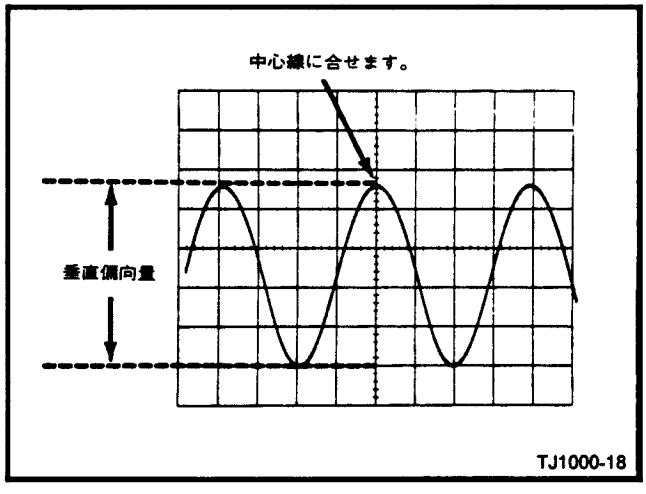
1．使用するチャンネルのDC-GND-ACスイッチをGNDにして信号を入力コネクタに接続します。

2．使用するチャンネルのDC-GND-ACスイッチをACにしてVOLTS/DIVスイッチで約5または6divの波形が表示されるようにします。可変VOLTS/DIVコントロールが右回し一杯の校正位置にあることを確認します。

3．トリガ・コントロールを調整して、安定した表示が得られるようにします。数サイクルの波形が表示されるように、SECONDS/DIVスイッチを設定します。

4．垂直POSITIONコントロールを回し、波形の下端が、中心水平線の下の目盛線の1つと一致し、かつ波形の上部が観測域の中に入るようにします。水平POSITIONコントロールを回して、上側のピークの1つが中心垂直線の近くに来るように表示を動かします（**2−3図**参照）

5．ピークからピークまでの垂直偏向の目盛を測ります。



2−3図　波形のピーク電圧測定

注

この方法はピークからピークまでの他に、波形上の2点間の測定を行なうのにも利用できます。

6．ステップ5で測った距離に、VOLTS/DIVスイッチの設定値を乗じます。プローブを使用する場合には、プローブの減点比もかけます。

例. ピーク間の垂直偏向が4.6目盛(**2－3図**)、VOLTS/DIVスイッチの設定値が5Vとします。

計算には次の式を用います。

ピーク電圧＝垂直偏向量(div)×VOLTS/DIV

与えられた値を入れると

ピーク電圧＝4.6×5V

すなわち求めるピーク電圧は23Vです。

注

減衰プローブを使用した時は上式の答に減衰率を乗じます。

瞬時電圧測定－DC

波形のある1点のDC電圧を測定する手順を次に示します。

1．使用するチャンネルのDC-GND-ACスイッチをGNDにして、1番下の(または任意の)水平目盛線に一致させます。測定しようとする電圧がグランドのレベルに対してマイナスの時は1番上の水平目盛線に一致させます。一度基準に合わせたら、垂直POSITIONは動かさないで下さい。

注

グラウンド・レベル以外の電圧に対する電圧レベルを測定する場合には、ステップ1を次のように変えて下さい。DC-GND-ACスイッチをDCにセットし、入力コネクタに基準電圧を入力します。次いでトレースを基準線に合わせます。

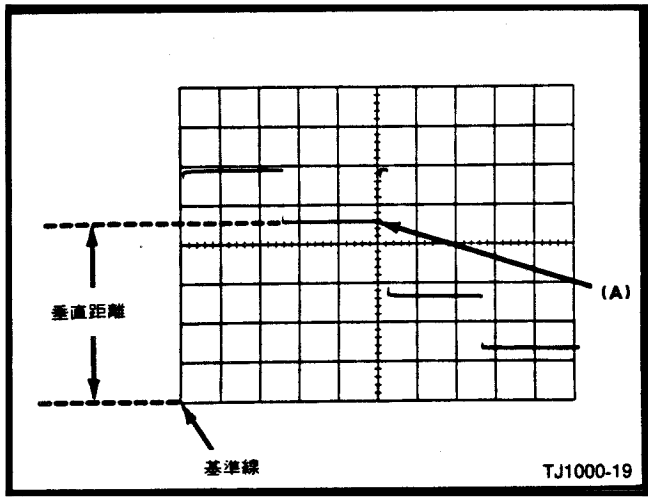
2．信号を入力コネクタに接続しそのチャンネルのDC-GND-ACスイッチをDCにセットします。グラウンド基準線はいつでもGND位置に切換えてチェックできます。

3．安定な表示を得るようにトリガ・コントロールをセットします。信号を数サイクルにわたって表示するように、SECONDS/DIVスイッチを設定します。

4．DCレベルを測定すべき波形上の1点と、基準線との間の距離をdivで測ります。たとえば**2－4図**では、基準線と点Aとの間で測定を行ないます。

5．信号の極性を確かめます。波形が基準線の上にあれば、電圧は正、基準線の下なら負です。

6．ステップ4で測定した距離にVOLTS/DIVスイッチの設定値を乗じます。プローブを用いる場合は、プローブの減衰比を乗じます。



2－4図　基準電圧に対する瞬時DC電圧値の測定

例. 測定された垂直距離が4.6div(**2-4図**)、波形は基準線の上にあり、VOLTS/DIVスイッチが2Vに設定されているとします。計算には次の式を用います。

瞬時電圧＝垂直距離(div)×極性×VOLTS/DIV設定値

与えられた値を代入すると、

瞬時電圧＝4.6×(＋1)×2V

したがって瞬時電圧は＋9.2Vです。

時間間隔測定

波形の2点間の時間間隔(周期)を測定する手順を次に示します。

1．信号を垂直入力コネクタに接続し、ACまたはDC結合を選びVOLTS/DIVスイッチで約4divの波形が表示されるように設定します。

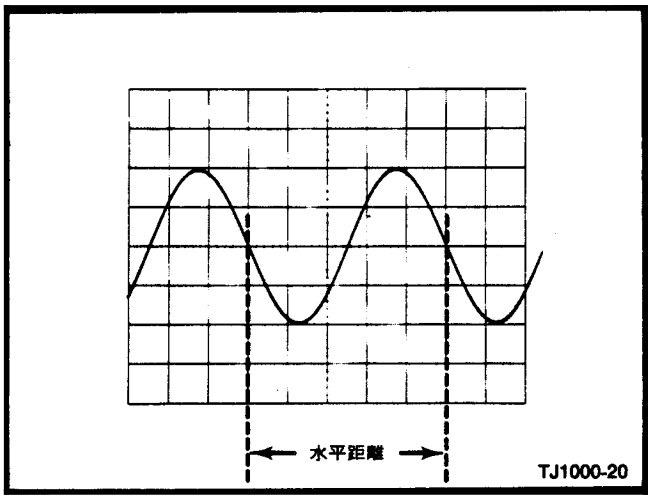
2．安定した表示が得られるようにトリガ・コントロールを設定します。

3．時間測定点の間に8div以下が入る、もっとも速い掃引率にSECONDS/DIVスイッチを設定します。(最初と最後の1divでは非直線性が生じることがあります。**2－5図**参照)

4．垂直POSITIONコントロールを回して、時間測定を行なうべき点を、中央の水平線にのせます。

5．水平POSITIONコントロールを回して、時間測定点を目盛の中央8div以内におきます。

6．時間測定点の水平距離を測ります。可変SECONDS/DIVコントロールが校正位置にあることを確かめます。



2−5図　時間間隔測定

7．ステップ4で得られた距離にSECONDS/DIVスイッチの設定値を乗じます。掃引拡大が使用された場合は、この結果を10で割ります。

例. 時間測定間の距離が5div (**2−5図**)、TIME/DIV スイッチが0.1msに設定され、拡大はOFFになっているものとします。
次の式を用います。

$$\text{時間間隔}=\frac{\text{水平距離(div)}\times\text{SECONDS/DIV設定値}}{\text{拡　大　率}}$$

与えられた値を代入すると、

$$\text{時間間隔}=\frac{5\times 0.1\text{ms}}{1}$$

すなわち時間間隔は0.5msとなります。

周波数測定

時間測定法は、信号の周波数を求めるのにも使用できます。周期的にくり返される信号の周波数は、1サイクルの時間間隔（周期）の逆数です。

次のように操作して下さい。

1．前に説明したように波形の1サイクルの周期を測ります。

2．周期の逆数をとって周波数を定めます。

例. 2−5図に示した、周期0.5msの信号の周波数は

$$\text{周波数}=\frac{1}{\text{周期}}=\frac{1}{0.5\text{ms}}=2\text{kHz}$$

立上り時間測定

立上り時間の測定は、基本的には時間間隔測定と同じ方法を使用します。主な相違は測定しようとする2点の違いにあります。次にあげる方法は、波形の10%と90%との間で、立上り時間を測定する基本的方法です。立下り時間は、波形の立下りについて同様な方法で測定できます。

1．信号をどちらかの入力コネクタに接続します。

2．表示の振幅がちょうど5divになるように、使用されるチャンネルのVOLTS/DIVスイッチと可変VOLTS/DIVコントロールを設定します。

3．垂直POSITIONコントロールを回して、表示が中央水平目盛線の所に来るようにします。

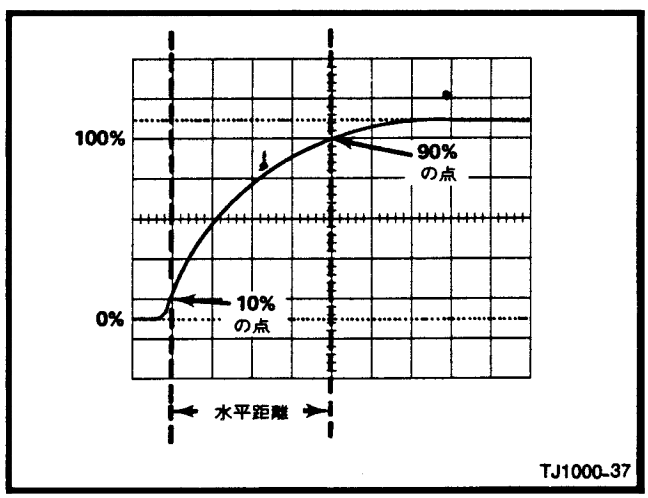
4．安定した表示を得るように、トリガ・コントロールを調整します。

波形上の10%と90%との間が、水平8div以下に表示されるように、もっとも速い掃引率にSECONDS/DIVスイッチを設定します。(**2−6図**参照)

5．水平POSITIONコントロールを回して、波形の10%点を、目盛の2番目の垂直線に合せます。

6．10%点と90%点との間の水平距離を測ります。可変SECONDS/DIVコントロールが校正位置に設定されていることを確かめます。

7．ステップ6で測定した距離に、SECONDS/DIVスイッチの設定値を乗じます。



2−6図　立上り時間測定

例. 10%点と90%点との間の水平距離が4div、SECONDS/DIVスイッチが1μsに設定されているとします。

時間間隔の式を用いて立上り時間を求めます。

$$\text{時間間隔（立上り時間）} = \text{水平距離(div)} \times \text{SECONDS/DIV 設定値}$$

与えられた値を代入すると

$$\text{立上り時間} = 4 \times 1\ \mu s$$

すなわち立上り時間は4μsです。

時間差の測定

校正された掃引率と2現象性能とにより、2つの異なる現象の間の時間差を測ることができます。時間差測定の手順を次に示します。

1．両チャンネルのDC-GND-ACスイッチをACまたはDC位置に設定します。

2．MODEスイッチをCHOP又はALTにします。大体において、低周波信号にはCHOP、高周波信号にはALT位置が適しています。詳しくは垂直操作モードの項をご参照下さい。

3．トリガ・スイッチをより安定したトリガ信号が得られるCH1またはCH2に設定します。

4．基準信号をCH1コネクタに、比較信号をCH2コネクタに接続します。基準信号は時間的に比較信号に先行しなければなりません。信号を入力コネクタに接続するには、同じ遅延時間をもった同軸ケーブルまたはプローブを使用します。

5．信号が逆極性の場合には、最後の計算の時に考慮して下さい。

6．約4divの表示が得られるようにVOLTS/DIVスイッチを設定します。

7．安定した表示を得るように、トリガ・コントロールを設定します。

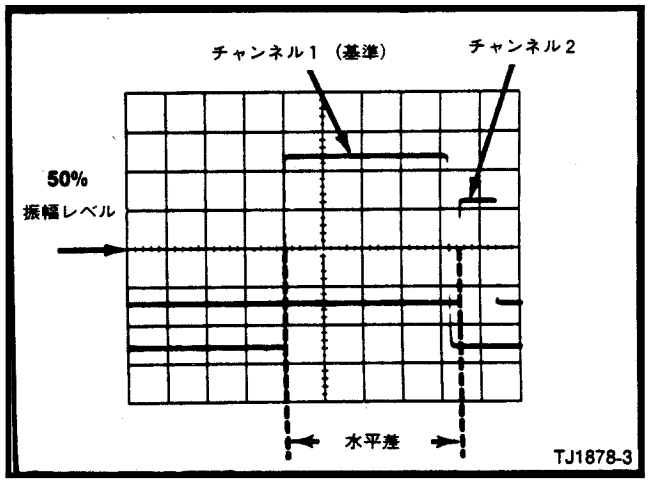
できれば2つの波形の間の差が3div以上になるような掃引率に、SECONDS/DIVスイッチを設定して下さい。

8．垂直POSITIONコントロールを回して、各波形（または測定を行なうべき表示上の点）を中央の水平線に寄せます。

9．水平POSITIONコントロールを回して、チャンネル1(基準)の波形が垂直目盛線の所で、中央水平線を横切るようにします。

10．チャンネル1の波形と、チャンネル2の波形との間の水平差距離を測ります。(**2−7図**参照)

11．測定した差の値に、SECONDS/DIVスイッチの設定値を乗じます。



2−7図　2つのパルス間の時間差測定

例. SECONDS/DIVスイッチが50μsに設定され、波形間の水平距離が、4divあるとします。

次の式を用います。

$$\text{遅延時間} = \text{SECONDS/DIV 設定値} \times \text{水平差(div)}$$

与えられた値を代入すると

$$\text{遅延時間} = 50\ \mu s \times 4$$

すなわち時間差は200μsです。

2現象位相差測定

同じ周波数の2信号間の位相比較は、2チャンネル入力を用いて行います。この方法による位相差測定は、垂直偏向システムの周波数限界まで利用することができます。位相比較測定の手順を次に示します。

1．各入力チャンネルのDC-GND-ACスイッチをACまたはDC位置に設定します。

2．VERT MODEスイッチをCHOPまたはALTに設定します。ふつうCHOPは低周波の信号に、ALTは高周波信号に適しています。詳しくは垂直操作モードの項をご参照下さい。

3．トリガ・スイッチをより安定したトリガ信号が得られるCH1またはCH2に設定します。

4．基準信号をCH1入力コネクタに、比較信号をCH2入力コネクタに接続します。基準信号は時間的に比較信号に先行しなければなりません。信号を入力コネクタに接続するには、遅延時間の等しい同軸ケーブルまたはプローブをご使用下さい。

5．信号の極性が逆であれば、その時は最後の計算で考慮に入れます。

6．CH1とCH2のVOLTS/DIVスイッチと、CH1とCH2のVARコントロールを設定して、表示が等しく振幅が約5divになるようにします。

7．安定した表示を得るようにトリガ・コントロールを調整します。

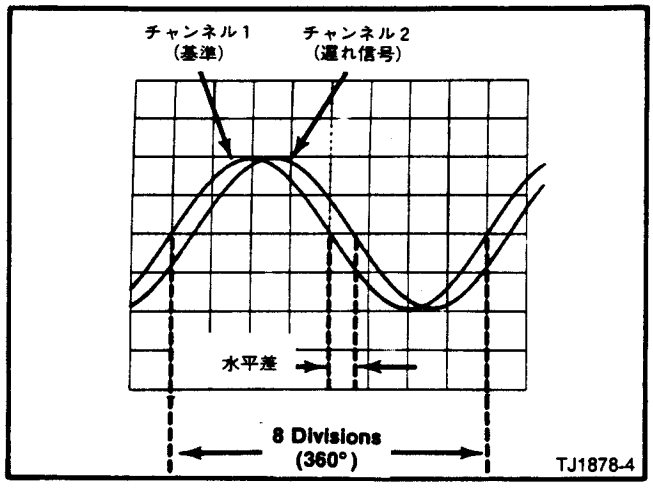
およそ1サイクルの波形を表示する掃引率に、SECONDS/DIVスイッチを設定します。

8．CH1とCH2のPOSITIONコントロールを使って、波形を目盛の中央にずらします。

9．可変SECONDS/DIVコントロールを回して、基準信号（チャンネル1）の1サイクルが、第1と第9の目盛線の間、ちょうど8divを占めるようにします(**2－8図**)。目盛の1divは、1サイクルの45°を表わします。(360°÷8div＝45°/div) 掃引率は45°/divのように角度単位で表現することもできます。

10．波形上の対応点の間の水平差を測ります。

11．測定した距離(div)に45°/div (掃引率)を乗じて、正確な位相差を得ます。



2－8図　位相差測定

例. 水平差が0.6div、掃引率が45°/divであるとします(**2－8図**参照)

次の式を用います。

位相差＝水平差(div)×掃引率(度/div)

与えられた値を代入すると、

位相差＝0.6×45°

位相差は27°です。

高分解能位相差測定

掃引率を速くすれば(可変SECONDS/DIVコントロールの設定は変えません)、より精確な2現象位相差測定が得られます。掃引率を増すもっとも簡単な方法は、X10 SWP MAGスイッチを利用することです。

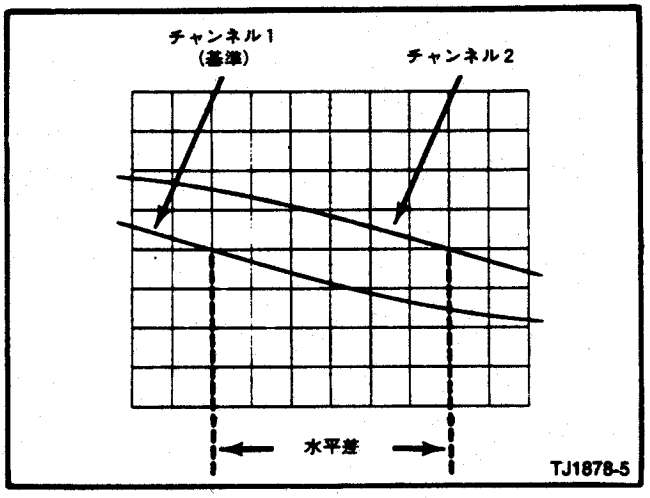
例. 拡大を使って掃引率が10倍になったとすると拡大された掃引率は45°÷10＝4.5°/divとなります。**2－9図**は**2－8図**と同じ信号ですが、X10 SWP MAGスイッチをX10に設定した場合を示します。水平差が6divとすれば、位相差は次式で計算されます。

位相差＝水平差(div)×拡大された掃引率(度/div)

与えられた値を代入すると、

位相差＝6×4.5°

位相差は27°です。



2-9図　掃引率を増加した高分解能位相差測定

後部インターフェイス

特殊な応用として、後部コネクタの使用されていないピンを使ってSC502型に信号を送ったり、受け取ったりすることができます（5章の後部インターフェイス・コネクタのピン割当てをご参照下さい）。多数のプラグイン・ホールを持つTM500シリーズ本体では、各プラグイン間で特殊な機能を持たせるよう配線し、位置決めスペーサによって他のプラグインが挿入できなくすることもできます。詳細はTM500シリーズ本体の取扱い説明書をご覧下さい。

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

THEORY OF OPERATION

DIAGRAM ① & ② CIRCUIT DESCRIPTION

Vertical Amplifier

The vertical amplifier provides attenuation and amplification for the vertical signal before it is applied to the vertical deflection plates of the crt. The vertical amplifier circuitry includes the delay line and trigger view circuit, which allows the oscilloscope to display its triggering signal.

NOTE

Where both channels 1 and 2 are similar, only channel 1 will be described.

Input Coupling

Signals applied to the front-panel input connectors may be capacitively coupled (AC), directly coupled (DC), or internally disconnected (GND). Input coupling is selected by S100 at the input for channel 1.

Assuming that a signal is applied to the input, when S100 is set to DC, the applied signal is passed directly to the attenuators. When S100 is set to AC, C100 is placed in the circuit to couple signals of about 10 Hz (−3 dB point) and higher to the attenuator. This capacitor blocks any dc component of the signal. When S100 is set to GND, a ground reference is provided to the input of the amplifier without the need to remove the applied signal from the input connector.

NOTE

When dc levels (above 10 V) are to be blocked by ac coupling, the AC-GND-DC switch should be set to GND while input connections are made or broken, or when voltage levels are changed. This will allow the coupling capacitor to charge without overdriving the amplifier.

Input Attenuator

The input attenuator is a frequency-compensated voltage divider and provides 100X attenuation in positions 0.5 to 20 of the VOLTS/DIV switch. At dc and for low frequency signals, the divider is essentially resistive (attenuation ratio determined by the resistance ratio).

In addition to providing constant 100X attenuation at all frequencies within the bandwidth capabilities of the instrument, the input attenuator maintains a constant input rc characteristic (1 MΩ paralleled by about 47 pF).

Preamplifier Stage

The preamplifier consists of two identical operational amplifiers, connected in a differential configuration. Fig. 3-1 shows a simplified block diagram of the preamplifer.

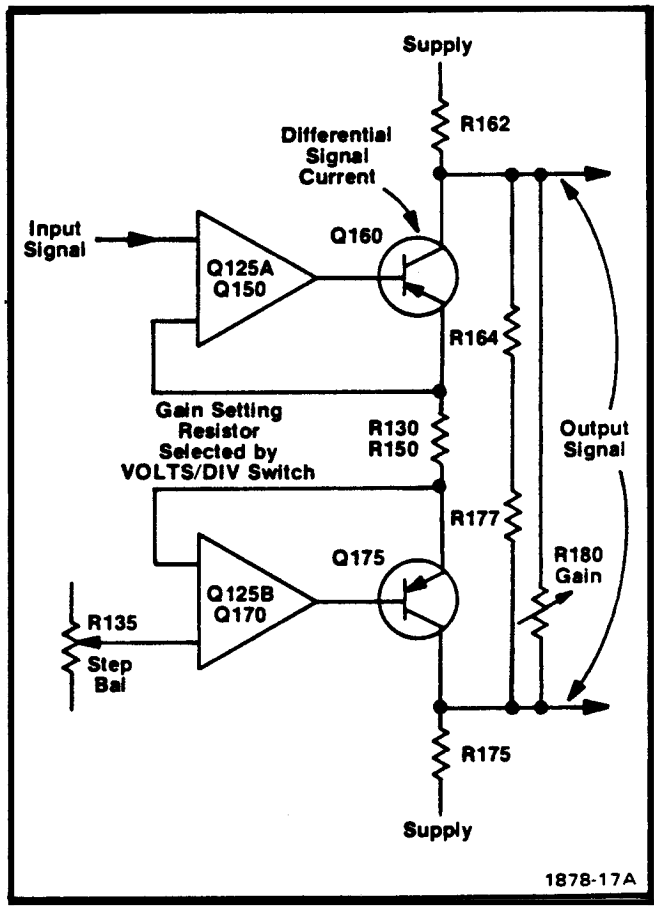


Fig. 3-1. Input preamplifier detailed block diagram showing signal current paths.

The operational amplifiers are composed of Q125A, Q150 and Q160 on one side, and Q125B, Q170 and Q175 on the other side. Q125A and Q125B provide a voltage follower input to output transistors Q160 and Q175. Total gain of the stage is determined by the resistance between the two sides of the amplifier, and R162 and R175, paralleled by R164, R177, and R180 (the signal current path in Fig. 3-1).

Correct adjustment of the Step Bal control, R135 will quiescently balance the two sides of the amplifier so that there is no current through the gain-setting resistor(s). When a signal is applied to the gate of Q125A the signal current is developed through the gain-setting resistor R130-R150. Conduction of Q160 and Q175 is changed by the amount of this current, developing the output voltage across R162 and R175. The output is a push-pull signal. The value of R130-R150 is selected by the VOLTS/DIV switch, S150, to determine the gain.

To minimize trace shift as different vertical deflection factors are selected, the Q125A and Q125B sources are dc balanced at equal potentials so that the voltage across the gain-setting resistors is near zero at all settings of the VOLTS/DIV switch. This dc balancing is achieved by adjusting Step Bal control R135 for no trace movement while rotating the VOLTS/DIV switch from 0.2 V to 1 mV.

DIAGRAM ③ CIRCUIT DESCRIPTION

Vertical Amplifier

Gain Stage

The differential signal developed at the collectors of Q160 and Q175 is passed through emitter followers Q320 and Q325 to the output amplifier channel switch. Q320 and Q325 are also the lower half of a push-pull cascode amplifier. Q320 and Q325 provide current gain to drive the channel switch loads and trigger signal amplifier Q340 and Q345.

Channel Switch

The outputs of the channel 1 and channel 2 gain stages go to the channel switch where the signal that goes to the output amplifier is determined.

The MODE switch S300 controls the channel switch by forward biasing selected transistors. Table 3-1 shows in positive logic which transistor will be turned on by the lows (0). Since the different positions of the MODE switch operate in a similar manner, only the CH 1 position will be described in detail.

Channel 1 MODE switch operation. Setting the MODE switch to CH 1 places a low at pin 3 of U355 disabling the chop multivibrator and a low at pins 2, 3, 4 and 5 of J-K flip-flop U360. The low at the CLR input of U360 results in a low at pin 8 of U360, turning on Q330, Q335, Q415 and Q410. The remaining channel switch transistors are biased off. The signal from channel 1 is passed through Q330 and Q335 to the delay line. The channel 2 signal is passed through Q415 and Q410, the currents are summed then split equally by R427-R425 (Diagram 4) and applied to each side of the delay line. Summing the current of the unused channel and applying them equally to each side of the delay line supplies the output amplifier with a constant input current, independent of either the MODE or TRIGGER VIEW switch positions.

Table 3-1

CHANNEL SWITCH LOGIC TABLE

	Output Level			
MODE Switch	U360 Pin 8	U360 Pin 6	U355 Pin 12	U355 Pin 13
CH 1	Low (0)	High (1)	High (1)	Low (0)
CH 2	High (1)	Low (0)	High (1)	High (1)
CH 1 minus CH 2	Low (0)	High (1)	Low (0)	High (1)

Chop multivibration operation. The chop multivibrator output is controlled by the MODE switch. In the CHOP position of the MODE switch pins 3 and 9 of U355 are disconnected from ground and the multivibrator (U355A-U355B) produces a 250 kHz square-wave signal. This signal is supplied via NAND gate U355C to the clock (pin 12) input of U360 and also to the blanking circuit. The chop output to the clock input of U360 is used to switch the channel switch output between channels 1 and 2. The chop output to the blanking circuit is used to blank the chop-switching transients.

Alternate mode operation. In the ALT position of the MODE switch, a pulse at the end of each sweep is supplied to the clock (pin 12) input of U360. The pulse to the clock input of U360 causes the channel switch to change the

input channel that is connected to the output amplifier at the end of each sweep.

Trigger Amplifier

Trigger amplifier Q340 and Q345 amplifies the output signal from the vertical preamplifier and supplies it to the appropriate connections of the trigger pickoff circuit to be used as a triggering signal source for that vertical channel. The channel 1 trigger amplifier also supplies the signal to an auxiliary trigger amplifier.

DIAGRAM ④ CIRCUIT DESCRIPTION

Vertical Amplifier & Trigger View

Delay Line

Delay Line DL400 provides approximately 140 ns delay for the vertical signal, which allows the sweep generator circuits time to initiate a sweep before the vertical signal reaches the vertical deflection plates of the crt. This lets the instrument display the leading edge of the signal that originated the trigger pulse when using internal triggering.

Output Amplifier

Q455 and Q450 are connected as a common-base amplifier to provide a low input impedance to properly terminate the delay line. It also provides isolation between the delay line and the following stages.

Q465 and Q460 compose an emitter-coupled push-pull amplifier that drives the output power amplifiers Q475 and Q470. R461, R460 and R470 set the gain of the stage by controlling the signal degeneration between the emitters of Q465 and Q460. Variable capacitor C474 and the series rc networks provide high-frequency compensation to optimize amplifier frequency response. L470 and L475 are high-frequency peaking coils to provide additional amplifier speed.

Trigger View

Trigger view amplifier Q440 and Q435 amplify the output signal from the trigger comparator and supply it to the TRIGGER VIEW switch. When the TRIGGER VIEW switch is depressed, the vertical signal from each vertical channel is summed and split equally by R427-R425 and applied to each side of the delay line. At the same time the triggering signal is applied differentially to each side of the delay line. The trigger signal is now amplified and displayed as the vertical signal.

DIAGRAM ⑤ CIRCUIT DESCRIPTION

Trigger Pickoff and Generator

The trigger pickoff selects the internal trigger signal. It also selects and amplifies the external trigger signal to the level necessary to match the current level of the internal trigger signals. Input signal for the trigger pickoff is either a sample of the signal applied to Channel 1, or Channel 2, a sample of the power line voltage or an external signal.

The trigger generator produces trigger pulses to start the sweep generator. These trigger pulses are derived either from the internal trigger signal from the vertical deflection system, an external signal connected to the EXT TRIG input connector, or a sample of the power line voltage applied to the instrument. Controls are provided in this circuit to select trigger level, slope, and coupling.

Trigger Pickoff

The EXT TRIG signal from the front-panel connector is applied to the gate of field effect transistor source follower Q520A which provides a high input impedance for the signal and a low impedance to the base of Q525. Q520B provides isolation between the Ext Horiz Bal control, R535 and the base of Q525 as well as acting as a constant current source for Q520A. Q520B also provides temperature compensation for Q520A. Q525 forms a voltage-to-current converter whose output current will match that of the other triggering sources. The output from common base amplifier Q530 is supplied to the horizontal amplifier. R518 supplies current for Q525 when the front-panel EXT SOURCE pushbutton is not pushed in.

Trigger Generator

The output of the trigger pickoff, which is selected by the SOURCE pushbutton switches, is applied to the emitter of common base amplifier Q500 to provide a low input impedance. The output of Q500 passes through the COUPLING pushbutton switches to emitter follower Q510. The output of Q510 goes to the trigger level circuit (Q555, Q565, Q550 and Q560) and also to the trigger comparator (Q580 and Q575). The other input to the trigger comparator is from the triggering LEVEL control, R560. If the voltage at the trigger comparator base of Q575 is higher, current flows through Q575 and the collector of Q580 is high. The opposite is true if the base voltage of Q575 is lower (the collector of Q580 is low). Both outputs of the trigger comparator are supplied to gate generator U595 and to the trigger view amplifier Q440 and Q435.

Trigger Level Control. The triggering level, with the AUTO trigger mode pushbutton pushed in, is controlled by the triggering signal, applied simultaneously to the bases of Q555 and Q565.

Assume a + input signal. This signal, coupled through emitter follower Q555, causes the emitter voltage to rise and charge C552 to the peak positive level of the input signal. C567 is charged in a similar manner to the peak negative level of the input signal. The peak-sensing capacitors, C552-C567, set the voltage levels applied to the triggering LEVEL control (R560) via emitter followers Q550 and Q560. This allows the triggering LEVEL control to be adjusted between the two voltage levels representing the most negative and most positive peaks of the trigger signal.

With the AUTO pushbutton out, the triggering LEVEL control limits are set by R556-R558 and R568-R569.

Gate generator, integrated circuit (IC), U595 converts the output signals from the trigger comparator to a gate waveform which is used for sweep generator control. With pin 1 connected to ground (+ SLOPE), a positive going waveform (3 to 4 V) on the IC input (pin 13) causes pin 3 (output) to rise to about 4.1 V and pin 4 ($\overline{\text{output}}$) to drop to about 3.2 V. Pin 14 is negative going under the above conditions. The output gate occurs when pins 13 and 14 are within about 20 mV of each other. Floating pin 1 (− SLOPE) causes a gate output at pins 3 and 4 when pin 13 is negative going and pin 14 positive going. The holdoff signal from the sweep generator is supplied to U595 so that after completion of the sweep, pins 6 and 10 are high (about +4.2 V) during the holdoff time. This inhibits the gate generator until these pins drop to about 3.2 V after the holdoff time. The triggered gate and holdoff are available at the rear interface connector through line drivers U600B and U600C.

If it is desired to over-ride the gate output of U595, pin 24B of the rear interface connector is grounded. This enables line receiver U600A to supply the substitute Ext Gate and $\overline{\text{Ext Gate}}$ input signals from the rear interface connector. Q625 and Q630 control the diode switch used to select an internal or external gate as the input to the sweep generator.

Auxiliary Trigger Amplifier

A sample of the channel 1 preamplifier output signal is supplied to common base amplifier Q540 to provide a low input impedance and isolation. The output of Q540 is connected to pin 28B on the rear interface connector.

DIAGRAM ⑥ CIRCUIT DESCRIPTION

Sweep Control and Generator

Sweep Control

U650, with additional external circuity, controls the sweep generator. In the automatic triggering mode, pin 19 of U650 is grounded. If pin 1 of U650 receives no trigger gates from the trigger generator for a period of time determined by R664 and C662, circuitry in U650 outputs a negative-going square-wave. This negative-going square-wave from pin 3 drives the base of Q660 negative. When the sweep operates in the triggered mode a positive pulse from the trigger generator drives the base of Q670 positive. Either a positive signal at the base of Q670 or a negative signal at the base of Q660 will cause the entire collector current of the constant current source Q665 to flow through Q660, thus turning off Q670. Q660 turning on supplies current to unblank the crt, while turning Q670 off allows the sweep generator to run.

In the single sweep mode, pin 12 of U650 is connected to +5 V and pin 19 must be ungrounded by releasing the AUTO trigger mode pushbutton. When the sweep is armed, pins 7 and 11 of U650 are low, causing TRIG'D READY indicator to light. This action at pins 7 and 11 also occurs when the sweep is in the triggered mode. R643 limits the LED current.

When pin 18 is about +4 V, the sweep is disabled. When the voltage is about 0 V, the sweep is enabled. This occurs through action at the anode of CR649 from the horizontal amplifier SECOND/DIV switch or, through CR648 and the RESET button. The sweep is disabled when the RESET button is held in (closed) to prevent transients from falsely triggering the sweep in the single sweep mode.

A holdoff waveform is available at pin 17 which connects to the trigger generator preventing the generation of sweep gating waveforms during holdoff times after a single sweep has occurred. Holdoff time begins at the peak of the sweep ramp. It is necessary to allow the sweep circuits to return completely to quiescent conditions before the next sweep starts. The capacitors and resistors connected to pin 8 of U650 determine the holdoff time. They are determined by the sweep rate setting of the SECONDS/DIV switch. Holdoff time starts when pin 16 of U650 reaches about 2.4 V.

Q655 acts as an emitter follower and a regulator for a −5 V supply.

Sweep Generator

The sweep ramp is generated during the time Q670 is off. When Q670 is off, transistors Q685 and Q675 will be off. The current from the timing resistor now flows into the timing capacitor due to the action of the operational amplifier (Q690A, Q690B, and Q695) creating the sweep ramp. The positive going ramp now runs up at a rate determined by the timing resistor and capacitor combination, until it reaches approximately +6.9 V.

At the end of the sweep, Q670 is turned on forcing current through Q675 and Q685. When the Q685 current exceeds the timing resistor current, the sweep ramp is forced to retrace. As the sweep ramp drops below 0 V, Q680 and CR675 turn on. This causes the Q685 current to equal the timing resistor current, thus clamping the integrator output to 0 V until the start of the next sweep. The Swp Offset control, R681 adjusts the drain current of Q690B so the gate of Q690A is at 0 V.

The output of the sweep generator goes to: the input of the horizontal preamplifier, pin 18A of the rear interface connector through emitter followers Q310 and Q300 (Schematic 3), sweep control integrated circuit U650 pin 16 through comparator Q310 and Q315 to signal the start of the holdoff, and the channel switch alternate mode circuit through comparator Q310 and Q315 to cause the channel switch to change the input channel at the end of each sweep.

HORIZONTAL AMPLIFIER

Preamplifier

When the SECONDS/DIV switch is in a sweep rate position, the sweep ramp from the sweep generator is amplified by common base amplifier Q700, which provides low input impedance and isolation. It is then supplied to the input of the horizontal output amplifier. The gain of Q700 is determined by the position of the SWP MAG switch which controls the size of the collector resistor. The SECONDS/DIV switch in the sweep rate positions also forward biases Q715 and reverse biases Q720 to prevent the external horizontal signal from reaching the output amplifier.

In the AMP position of the SECONDS/DIV switch, the output of the external horizontal signal from the trigger

pickoff is amplified by common base amplifier Q720. Q720 provides a low input impedance and isolation for the input signal. The gain of Q720 is determined by the size of the collector resistor, which includes the Ext Horiz Gain control R723 and R725. The SECONDS/DIV switch in the AMP position also causes Q710 to be forward biased and Q700 to be reverse biased to prevent the sweep ramp from reaching the output amplifier.

The POSITION control is connected to the base of current source transistor Q730, whose output adjusts the current being fed to the input of the output amplifier.

DIAGRAM ⟨7⟩ CIRCUIT DESCRIPTION

Horizontal Amplifier

Output Amplifier. The output of the horizontal preamplifier is applied to the base of Q745. Q745 and Q765 comprise an emitter coupled paraphase amplifier. Q755 is the current source for the paraphase amplifier. The Centering control, R760 provides a means of correcting for differential unbalance in the amplifier or crt, while the Sweep Gain control, R770 sets the overall gain of the horizontal amplifier. R750 and R764 provide thermal compensation for the paraphase amplifier stage.

Transistors Q775-Q780-Q785 and Q770-Q795-Q790 are connected as two separate current-driven feedback amplifiers. Input transistor Q775 (in the left output amplifier) is an NPN transistor for better response to positive-going signals, while input transistor Q770 (in the right output amplifier) is a PNP transistor for better negative-going signal response.

Negative feedback is provided from the collectors of output transistors Q780-Q785-Q795-Q790 to the base of input transistors Q775 and Q770 through feedback networks C773-R773 and C785-R789. Capacitors C775, C776, and C791 are speed-up capacitors to improve the amplifier response to fast changes.

DIAGRAM ⟨8⟩ CIRCUIT DESCRIPTION

Z-Axis Amplifier and Crt Circuit

The crt circuit produces the high voltage potentials and provides the control circuits necessary for operation of the cathode-ray tube (crt). The Z-Axis amplifier and Blanking amplifier circuits are included with the crt circuit discussion, since they set the intensity of the crt display.

Z-Axis Amplifier

The Z-Axis amplifier is a current driven, shunt-feedback operational amplifier with a voltage output. The amplifier consists of Q835, Q845, and Q840. The feedback path is from the Q845-Q840 collectors through C834-R834 to the summing point at the base of Q835. Q845 and Q840 are connected as a collector-coupled complementary amplifier that provides a fast linear output signal while consuming minimum quiescent power, Q845 acts as the pull-up transistor and Q840 acts as the pull-down transistor for the amplifier. The output voltage from the amplifier provides the drive signal to control the crt intensity level through the control-grid supply.

The output voltage level of the Z-Axis amplifier is determined by the voltage drop across R834 in reference to the voltage level at the summing point for the amplifier (base of Q835). The current through R834 is determined by the input current from a combination of two sources, INTENSITY control and sweep blanking. CR841 and current limiting resistor R841 act as a protection circuit for the Z-Axis amplifier in case of a high-voltage short. Q825 and Q830 form a comparator with the sweep blanking signal setting the reference level. To unblank the crt, the voltage level at Q830 base must be more positive than the level at the base of Q825.

Blanking Amplifier

A combination of four different input signals control the output current of the blanking amplifier. These signals are: sweep unblanking, horizontal amplifier mode, chop blanking and intensify from pin 19B of the rear interface. Q800 and Q805 form a comparator circuit with the base of Q805

set at about +3.7 V. The input intensify signal must go more negative than +3.7 V before it controls the blanking amplifier output.

All the controlling input signals pass through common base amplifier Q815, which provides a low input impedance and isolation from the impedance-matching and bias-setting transistor Q820. A current flow of approximately 5 mA through Q820 turns the crt beam off, while the front-panel set intensity causes a current of about 1 mA through the transistor. If the current through Q820 is about 0.3 mA, the crt beam will be intensified.

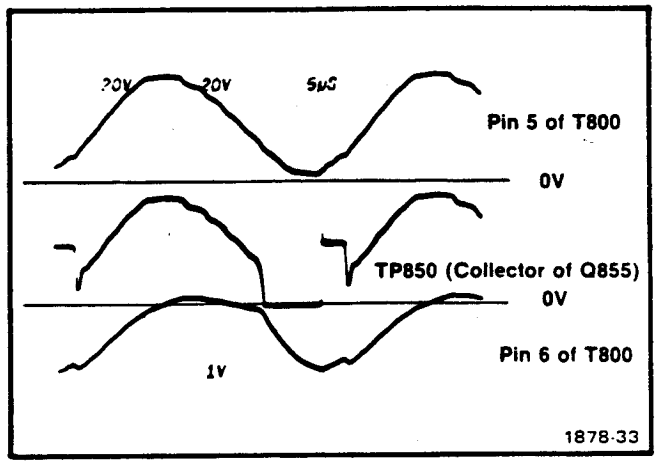


Fig. 3-2. Time relationship of waveforms at three points in the high-voltage regulator.

High-Voltage Regulator

High-Voltage Regulator. Q860, Q855, Q850 and U860 with their associated components provide the regulation and the drive to energize a resonant transformer T800. T850 allows T800 primary winding (pins 4 and 5) to move sinusoidally while allowing Q855 and Q850 to function as saturating switches.

High-Voltage Regulation. Refer to Fig. 3-2 during the following discussion. Regulation is accomplished by sampling the −2 kV across voltage divider R893C-R893D and comparing it to a +20.0 V reference supply. The junction of R893C-R893D as well as pin 3 of U860, is nominally 0 V. If the −2 kV supply should become less negative, the junction of R893C-R893D and hence pin 3 of U860 becomes more positive, causing the output (pin 6) of U860 to go positive. The output of U860 going positive results in increased charging current for C857, which will cause Q855 to conduct longer during each cycle, thereby increasing the average current to T800 and T850. As Q855 begins to conduct, T850 allows it to saturate while providing positive feedback from its one-turn winding to ensure that saturation will continue until pin 5 of T800 is at its most negative voltage. During the conduction of Q855, C854 is charging, then at the time pin 5 of T800 is at its most negative voltage, C854 starts discharging, cutting off CR855 and turning on CR853 to provide base current to Q860. Q860's conduction reduces the base current of Q855, thus causing its collector to go more positive. The turning off of Q855 is speeded up by the action of T850 with its one-turn winding. The current through T850 and the energy stored within the coil now flows through T800 via Q850 and CR850. Q850 remains turned on until T850 has been completely discharged. With 0 V across Q850 base-emitter, the primary of T800 may now swing more positive than the input supply voltage.

The high Q of T800 causes its voltages to vary sinusoidally, thus setting conditions for conduction again. During the time that Q855 was not conducting, U860 was charging C857 to a voltage level which when combined with voltage of the one-turn feedback winding of T850 will again cause Q855 to conduct. Initially at instrument turn on, the reference supply voltage is allowed to move positive slowly, depending upon the charging rate of C870 (which is controlled by R860). Once the voltage at pin F11 becomes more positive than +20 V, CR862 conducts and the reference supply is held as a constant +20.6 V. If a short should occur to the T800 secondary, the voltage at pin F11 will move toward zero, thereby reducing the reference voltage and consequently the transformer drive. If a T800 secondary winding short remains for a time, F800 will blow to protect Q855. If the R893C-R893D voltage divider or the regulator circuit should fail R855 and R857 will turn CR856 on to remove the base drive from Q855 via Q860.

High-Voltage Outputs

The secondary winding of T800 provides the negative and positive accelerating potential for the crt, the bias voltage for the control grid and heater voltage for the crt.

Positive accelerating voltage for the crt screen is supplied by voltage tripler U850. The applied voltage to the input of U850 from the T800 secondary winding is about 3.3 kV peak. The voltage for the crt directly heated cathode is also obtained from the T800 secondary winding. CR881 half-wave rectifies the transformer output and supplies the −2 kV to the crt cathode.

Diodes CR885 and CR884 provide the rectified negative control voltage for the crt control grid. The output level of this supply is set by the Beam adjustment R873. Diodes CR879 and CR882 clip the crt grid bias voltage from the T800 secondary, to determine the operating level at the control grid. CR879 limits the negative excursion of the bias voltage, depending upon the output voltage of the Z-Axis amplifier. The positive clipping level at the cathode of CR882 is set by the Beam adjustment. CR885 acts as a dc restorer and CR884 as a rectifier. This results in a dc level across R888 equal to the peak-to-peak excursion at the anode of CR882.

CRT Control Circuits

In addition to the INTENSITY control discussed previously, front-panel FOCUS and internal astigmatism controls have been incorporated for arriving at an optimum crt display. FOCUS control R894 provides the correct voltage for the second anode in the crt. Proper voltage for the third anode is obtained by adjusting Astig control R899. In order to obtain optimum spot size and shape, both the FOCUS and Astic controls are adjusted to provide the proper electrostatic lens configuration in the crt.

Geom adjustment R897 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display. The trace rotation control, R895, permits adjustment of the dc current through beam-rotation coil L895 to align the display with the horizontal graticule lines.

DIAGRAM 9 CIRCUIT DESCRIPTION

Low Voltage Power Supplies and Calibrator

−20 V Supply

Power for the −20 V regulator is supplied from the TM 500 Series Power Module −33.5 V unregulated supply. The regulator for the −20 V supply consists of operational amplifier U950, and the series pass stage consisting of Q960 and the NPN transistor that is located in the power module. The gain of the amplifier is set by R949, R947 and R945. R949 is the input resistor, while R947 and R945 are the feedback resistors for the operational amplifier. The gain of the amplifier is set to about 2.9 times by R947 (−20 V Adjust). The supply voltage is established by comparing the voltage at the negative input (pin 2) of U950 with the voltage reference at the positive input (pin 3). Any differences between the negative and positive inputs to U950 cause a change in the conduction of Q960 and power module series pass transistor to correct for the output error. Q960 and the power module NPN series pass transistor are connected as an operational amplifier whose output is connected back to its negative input. Q955 protects the supply in the event of a current overload. The overload (increase in current through R943) will cause Q955 to turn on, which biases Q960 off, shutting the −20 V supply off.

+20 V Supply

The −20 V and +20 V supplies are similar in operation.

Power Off Circuit for −20 V and +20 V Supplies

Placing the MODE switch (S300) in the PWR OFF position applies +11.5 V to the negative input of U930 and to the base of Q930. The +11.5 V applied to U930 reduces the output of the +20 V regulator, while the +11.5 V turns Q930 on, pulling the supply output down to ground.

At the same time +11.5 V is applied to Q930 and U930, +11.5 V is applied to the emitter of common base amplifier Q950 which in turn applies a slightly positive voltage to the positive input of U950. This reduces the output of the −20 V regulator to near 0 V.

+5 V Supply

Power for the +5 V regulator is supplied from the TM 500 Series Power Module +11.5 V unregulated supply. The regulator for the +5 V supply consists of operational amplifier U960 and series pass transistor Q970. The amplifier is connected for unity gain. R969 is the feedback resistor for the operational amplifier. The supply voltage is established by comparing the voltage at the negative input of U960 with the voltage reference at the positive input. Any differences between the negative and positive inputs of U960 causes a change in the conduction of Darlington transistor Q970 to correct for the output error. Q965 protects the supply in the event of a current overload. The overload (increase in current through R982) will cause Q965 to turn on, which biases Q970 off, shutting the +5 V supply off.

NOTE

If an over-voltage condition causes fuse F970 to open, an excessive amount of voltage will be applied to Zener diode VR969 which may damage the diode.

Line Trigger

A line-frequency signal is obtained from the secondary of TM 500 Series Power Module transformer and attenuated by R905, R907, and R909 to provide a line-trigger source for the time-base.

Calibrator

The Calibrator circuit composed of Q910, Q900, and their associated passive components produces a square-wave output with accurate amplitude and at a rate of twice the power-line frequency. This output is available at the calibrator jack on the front panel as a 0.6 V (ground to peak) square-wave voltage.

The resistive-capacitive network at the base of Q900 receives a pulsating dc voltage from full-wave rectifier CR900-CR902 and produces a nearly symmetrical switching signal for Q910 and Q900. As Q910 is alternately switched on and off at twice the line frequency, current through R915 is alternately switched through the transistor or through CR915 and R917, producing the calibrator test signal.

CALIBRATION PROCEDURE

PERFORMANCE CHECK

Introduction

This procedure checks the electrical characteristics of the SC 502 that appear in the Specification portion of this section. If the instrument fails to meet the requirements given in this performance check, the adjustment procedure should be performed. This procedure can also be used by an incoming inspection facility to determine acceptability of performance.

The electrical characteristics in this section are valid only if the SC 502 is adjusted at an ambient temperature of +20°C to +30°C and operated at an ambient temperature of 0°C to +50°C.

Tolerances that are specified in this performance check procedure apply to the instrument under test and do not include test equipment error.

Test Equipment Required

Below is a list of equipment required to verify operation as specified. Other equipment may be substituted when suitable.

Table 4-1

LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Applications	Example
TM 500 power module		All steps.	TEKTRONIX TM 503, TM 504, TM 506.
Function generator	5 Hz to 5 kHz.	Frequency response.	TEKTRONIX FG 503 Function Generator*.
Time-mark generator	0.2 s to 5 ns in 1, 2, 5 sequence.	Sweep rate accuracy.	TEKTRONIX TG 501 Time Mark Generator*.
Calibration generator	Amplitude calibration, 5 mV to 100 V; accuracy, ±0.25% into 1 MΩ; output, squarewave at approximately 1 kHz.	Vertical deflection accuracy.	TEKTRONIX PG 506 Calibration Generator*.
Leveled sine wave generator	50 kHz to 15 MHz.	Bandwidth, trigger sensitivity & range, & X-Y phasing.	TEKTRONIX SG 503 Leveled Sine-Wave Generator*.
Input normalizer	47 pF and 1 MΩ.	Vertical amplifier input.	Tektronix part no. 067-0541-00.
Termination	Impedance, 50 Ω; accuracy, within 2%; connectors, bnc.	Output termination for signal generator.	Tektronix part no. 011-0049-01.
Coaxial cable	Impedance, 50 Ω; length, 42 inch; connectors, bnc.	Provides signal interconnection.	Tektronix part no. 012-0482-00.
Dual input cable	Bnc female to 2 bnc male connectors.	X-Y phasing.	Tektronix part no. 067-0525-01.
Adapter	Bnc-to-pin jack.	Calibrator.	Tektronix part no. 013-0084-01.

Table 4-1 (cont)

Description	Performance Requirements	Applications	Example
Termination	Impedance, 600 Ω; accuracy, within 2%; connectors, bnc.	Low frequency response.	Tektronix part no. 011-0092-00.
DC voltmeter	0-200 V, accuracy, 0.1%.	Power supply checks.	TEKTRONIX DM 501A.
Plug-in extension		All steps.	Tektronix part no. 067-0645-02.
10X attenuator	50 Ω.	Vertical frequency response.	Tektronix part no. 011-0059-02.

*Requires TM 500-series power module.

Preliminary Control Settings

CH 1	
VOLTS/DIV	1
CAL	cw (detent)
DC-GND-AC	GND
CH 2	
VOLTS/DIV	1
CAL	cw (detent)
DC-GND-AC	GND
SECONDS/DIV	.2 m
PULL X10 HORIZ MAG-CAL	pushed in-cw (detent)
TRIGGERING	
AUTO	in
COUPL	DC (all buttons out)
SOURCE	CH 1
SLOPE	+
LEVEL	≈ midrange
MODE	CH 1
INTEN	normal brightness
FOCUS	sharp trace
POSITION (vertical)	
CH 1	≈ midrange
CH 2	≈ midrange
POSITION (horizontal)	≈ midrange
SINGLE SWP	out

1. Check the Vertical Deflection Accuracy (+15°C To +35°C)

DC-GND-AC	DC
VOLTS/DIV (CH 1 and CH 2)	20

a. Connect the calibration generator to the CH 1 input connector through a 50 Ω coaxial cable.

b. Adjust the generator variable control until exactly five graticule divisions are displayed on the crt.

c. Check—that the readout error is less than 2.0%.

d. Check—readout error for the following settings listed in Table 4-2.

NOTE

When checking the deflection accuracy at an ambient temperature range of 0° C to +50° C, derate the accuracy by an additional 1.0%.

Table 4-2

VERTICAL DEFLECTION ACCURACY AND TOLERANCE

VOLTS/DIV	Generator Setting	Display	Tolerance
10	50 V	5	2.0%
5	20 V	4	2.0%
2	10 V	5	2.0%
1	5 V	5	2.0%
.5	2 V	4	2.0%
.2	1 V	5	2.0%
.1	.5 V	5	2.0%
50 m	.2 V	4	2.0%
20 m	.1 V	5	2.0%
10 m	50 mV	5	2.0%
5 m	20 mV	4	2.0%
2 m	10 mV	5	5.0%
1 m	5 mV	5	5.0%

e. Repeat parts a through d for CH 2.

f. Disconnect all cables and return the front-panel controls to the preliminary settings.

2. Check the Vertical Deflection Variable Range

DC-GND-AC	DC
VOLTS/DIV (CH 1 and CH 2)	10 m
SECONDS/DIV	1 μ
SOURCE	EXT

a. Connect a 50 Ω coaxial cable from the calibration generator output connector to the SC 502 CH 1 input connector.

b. Adjust the generator output for five graticule divisions of display.

c. Rotate the CH 1 POSITION controls to center the displayed signal on the screen.

d. Turn the CH 1 CAL control to the fully counter-clockwise position.

e. Check—that the display is less than two graticule divisions in amplitude.

f. Connect the 50 Ω coaxial cable to the CH 2 input connector and repeat parts b through e of this procedure.

g. Disconnect all cables and return the front-panel controls to the preliminary settings.

3. Check the Vertical Bandwidth (5 mV/div to 20 V/div)

VOLTS/DIV (CH 1 and CH 2)	5 m
DC-GND-AC	DC
SECONDS/DIV	1 m

a. Connect a 50 kHz sine-wave signal from the output connector of the leveled sine-wave generator through a coaxial cable, X10 attenuator, and a 50 Ω termination to the SC 502 CH 1 input connector.

b. Adjust the generator for a crt display of exactly six graticule divisions.

c. Set the generator frequency to 15 MHz and adjust the frequency variable until the displayed signal is at least 4.2 major divisions in amplitude.

d. Check—that the frequency readout from the generator is equal to or greater than 15 MHz.

e. Change the MODE switch to CH 2.

f. Connect the sine-wave generator output to CH 2 input connector and return the generator frequency to 50 kHz and set the amplitude for six graticule divisions.

g. Repeat parts c and d to check the CH 2 bandwidth.

h. Leave all controls and connections for the next step.

4. Check the Vertical Bandwidth (2 mV/div)

VOLTS/DIV (CH 1 and CH 2)	2 m

a. Return the generator to 50 kHz and adjust the leveled sine-wave generator for a crt display of exactly six graticule divisions.

b. Set the generator frequency to 10 MHz and adjust the frequency variable until the displayed signal is at least 4.2 divisions in amplitude.

c. Check—that the frequency readout from the generator is equal to or greater than 10 MHz.

d. Change the MODE switch to CH 1.

e. Connect the generator output to CH 1 input connector and return the generator frequency to 50 kHz and set the amplitude for six divisions.

f. Repeat parts b and c to check the CH 2 bandwidth.

g. Leave all controls and connections for the next step.

5. Check the Vertical Bandwidth (1 mV/div)

VOLTS/DIV (CH 1 and CH 2)	1 m

a. Return the generator to 50 kHz and adjust the leveled sine-wave generator for a crt display of exactly six divisions.

b. Set the generator frequency to 5 MHz and adjust the frequency variable until the displayed signal is at least 4.2 major divisions in amplitude.

c. Check—that the frequency readout from the generator is equal to or greater than 5.0 MHz.

d. Change the MODE switch to CH 2.

e. Connect the generator output to CH 2 input connector and return the generator frequency to 50 kHz and set the amplitude for six divisions.

f. Repeat parts b and c to check the CH 2 bandwidth.

g. Disconnect all cables and return front panel controls to the preliminary settings.

6. Check the AC LF Response

MODE	CH 1
VOLTS/DIV (CH 1 and CH 2)	.5
DC-GND-AC	DC
SECONDS/DIV	AMPL

a. Adjust the INTEN and FOCUS controls for a well-defined line on the crt display.

b. Connect a 10 Hz sine-wave signal from the function generator through a 50 Ω coaxial cable, with a 50 Ω termination, to the CH 1 input connector.

c. Adjust the function generator output amplitude for six graticule divisions of display (one vertical line displayed).

d. Set the DC-GND-AC switch to AC.

e. Check—that the displayed amplitude is greater than 4.2 divisions.

f. Set the MODE switch to CH 2, reconnect the generator to the CH 2 input connector and repeat parts b through e.

g. Disconnect all cables and return the front-panel controls to the preliminary settings.

7. Check the Displayed Noise

VOLTS/DIV (CH 1 and CH 2)	1 m
MODE	CH 2
DC-GND-AC	DC
SOURCE	EXT
SECONDS/DIV	5.0 μs

a. Connect a 0.2 mV standard amplitude signal from the calibration generator through a 50 Ω coaxial cable to the CH 2 input connector.

b. Adjust the INTEN and FOCUS controls for a well-defined display.

c. Check—to distinguish space between the two lines on the crt display.

d. Change the DISPLAY switch to CH 1 and reconnect the generator to the CH 1 input connector and repeat parts a through c.

e. Disconnect all cables and return the front-panel controls to the preliminary settings.

8. Check the Position Range

SECONDS/DIV	.5 m
VOLTS/DIV (CH 1 and CH 2)	10 m
DC-GND-AC	AC

a. Connect a 0.12 V standard amplitude signal from the calibration generator through a 50 Ω coaxial cable to the CH 1 input connector.

b. Rotate the vertical POSITION control fully clockwise and counterclockwise and note the position of the peaks of the displayed waveform.

c. Check—that the positive and negative peaks of the waveform can be positioned to the center graticule line.

d. Rotate the vertical POSITION control to midrange.

e. Set the MODE switch to CH 2 and the source to CH 2. Reconnect the generator to the CH 2 input connector and repeat parts b through d.

f. Disconnect cable and return the front-panel controls to the preliminary settings.

9. Check CH 1 and CH 2 Operation

SECONDS/DIV	1 m

a. Adjust the TRIGGERING LEVEL control for a visible trace.

b. Check—for one trace affected by CH 1 front-panel controls.

c. Set the MODE switch to CH 2.

d. Check—for one trace affected by CH 2 front-panel controls.

e. Return the front-panel controls to the preliminary settings.

10. Check Alternate Operation

SECONDS/DIV	5 m
MODE	ALT

a. Check—for two traces on the screen.

b. Adjust CH 1 and CH 2 vertical POSITION controls for approximately one major division separation between traces.

c. Check—that the sweep alternates between CH 1 and CH 2 traces for each SECONDS/DIV setting from 5 m through .5.

d. Return the front-panel controls to the preliminary settings.

11. Check Chopped Operation

SECONDS/DIV	5 m
MODE	CHOP

a. Check—that two traces move across the screen simultaneously for each SECONDS/DIV setting from 5 m through .5.

b. Return the front-panel controls to the preliminary settings.

12. Check 1—2 Operation

DISPLAY	1—2

a. Check—that one trace is visible on the screen and that the CH 1 and CH 2 vertical POSITION controls move the trace equally in opposite directions.

b. Return the front-panel controls to the preliminary settings.

13. Check the Calibrated Sweep Range (+15° C to +35° C)

VOLTS/DIV (CH 1 and CH 2)	.5
DC-GND-AC	DC
SECONDS/DIV	.1 m

a. Connect .1 m time marks from the time-mark generator through a 50 Ω coaxial cable, with a 50 Ω termination, to the CH 1 input connector.

b. Rotate the TRIGGERING LEVEL control for a stable display. Vertically position the display to the center of the crt viewing area.

c. Check—that one time marker per graticule division is displayed on the crt within the accuracy tolerance listed in Table 4-3.

d. Disconnect all cables.

NOTE

When checking the sweep accuracy at an ambient temperature range of 0° C to +50° C, derate the accuracy by an additional 1%.

Table 4-3

HORIZONTAL DEFLECTION ACCURACY

SECONDS/DIV	Unmagnified	Magnified
0.5 s/div to 0.1 s/div	±3%	±4%
50 ms/div to 1 μs/div	±2%	±3%
0.5 μs/div to 0.2 μs/div	±3%	±2%

14. Check the Sweep Variable Range

SECONDS/DIV 0.5 m

a. Connect 5 ms time marks from the time-mark generator through a 50 Ω coaxial cable, with a 50 Ω termination, to the CH 1 input connector.

b. Rotate the TRIGGERING LEVEL control for a stable display. Vertically position the display to the center of the crt viewing area.

c. Turn the SECONDS/DIV CAL control to the fully counterclockwise position.

d. Check—that the third marker is to the left of the ninth graticule line.

e. Disconnect the cable.

15. Check the Mag Register

PULL X10 HORIZ MAG out

a. Horizontally position the sweep start (left end of sweep) on the graticule center line.

b. Depress the PULL X10 HORIZ MAG switch.

c. Check—that the beginning of the trace is within 0.5 division of the graticule center line.

d. Return the front-panel controls to the preliminary settings.

16. Check the External Horizontal Deflection Factor

SECONDS/DIV AMP

a. Connect the calibration generator to the EXT TRIG input connector through a 50 Ω coaxial cable and set its output amplitude for 0.2 V.

b. Adjust the generator variable control until exactly four graticule divisions are displayed on the crt.

c. Check—that the readout error is less than 5%.

d. Disconnect all cables.

17. Check the External Horizontal Bandwidth

a. Connect a 50 kHz sine-wave signal from the leveled sine-wave generator thorugh a 50 Ω coaxial cable, to a 50 Ω termination, to the EXT TRIG input.

b. Adjust the generator for a crt display of exactly five graticule divisions.

c. Set the generator frequency to 2 MHz.

d. Check—that the display is greater than 3.5 divisions measured horizontally.

e. Disconnect the cable.

18. Check the XY Phasing

VOLTS/DIV (CH 1 and CH 2) 50 m
DC-GND-AC GND
SECONDS/DIV AMP

a. Connect a 50 kHz sine-wave signal from the leveled sine-wave generator through a 50 Ω coaxial cable, to the 50 Ω termination, to the dual input cable, to the CH 1 and EXT TRIG input connectors.

b. Adjust the generator for a horizontal deflection of eight graticule divisions on the crt display.

c. Set CH 1 DC-GND-AC to DC.

d. Center the display on the crt screen with the POSITION controls.

e. Check—that the horizontal opening, at screen center, is less than 0.4 graticule division.

f. Disconnect all cables and return the front-panel controls to the preliminary settings.

19. Check the Trigger Sensitivity (below 5 MHz)

SECONDS/DIV	.5 μ
VOLTS/DIV (CH 1 and CH 2)	.5
DC-GND-AC	DC

a. Connect a 5 MHz signal from the leveled sine-wave generator through a 50 Ω coaxial cable, to a 50 Ω termination, to the CH 1 input connector.

b. Adjust the generator output amplitude for 0.4 graticule division on the crt screen.

c. Check—that a triggered positive-going display can be obtained at some setting of the TRIGGERING LEVEL control.

d. Set the SLOPE switch to − position.

e. Check—that a triggered negative-going display can be obtained at some setting of the TRIGGERING LEVEL control.

f. Release the AUTO button (Normal Mode).

g. Check—repeat parts c through e.

h. Depress the COUPL ac LF REJ switch.

i. Check—repeat parts c through e.

j. Release the ac LF REJ switch (out position) and press in the COUPL AC pushbutton.

k. Check—repeat parts c through e.

l. Release the AC pushbutton and press the AUTO button.

m. Connect a 5 MHz signal from the leveled sine-wave generator through a 50 Ω coaxial cable, to a 50 Ω termination, to the CH 2 input connector.

n. Set the front-panel controls as follows:

MODE	CH 2
SOURCE	CH 2
SLOPE	+

o. Repeat parts b through l of the above procedure to check the trigger sensitivity for CH 2.

20. Trigger Sensitivity (5 MHz to 15 MHz)

a. Change the generator frequency to 15 MHz and adjust the output frequency for 15 MHz.

b. Adjust the generator amplitude for one graticule division of display on the crt screen.

c. Set the SLOPE switch to + position.

d. Check—that a triggered positive-going display can be obtained at some setting of the TRIGGERING LEVEL control.

e. Reset the SLOPE switch to − position.

f. Check—that a triggered negative-going display can be obtained at some setting of the TRIGGERING LEVEL control.

g. Release the AUTO button (Normal Mode).

h. Check—repeat parts c through f.

i. Press the LF REJ button.

j. Check—repeat parts c through f.

k. Release the AC and LF REJ pushbuttons to the out position and press the COUPL AC switch.

l. Check—repeat parts c through f.

m. Release the AC pushbutton and press the AUTO button.

n. Reconnect the generator to the CH 1 input connector.

o. Set the front-panel controls as follows:

MODE	CH 1
SOURCE	CH 1
SLOPE	+

p. Repeats parts b through l in the above procedure to check the trigger sensitivity for CH 1.

q. Disconnect the cable and return the front-panel controls to the preliminary settings.

21. Check Auto, Normal, and Single Sweep Modes

SECONDS/DIV	0.5 m
CH 1 DC-GND-AC	DC
CH 1 VOLTS/DIV	1

a. Connect the function generator to the CH 1 input connector through a 50 Ω coaxial cable and a 50 Ω termination.

b. Set the generator for a 1 kHz sine wave and adjust the amplitude for a display of six divisions. Adjust the TRIGGERING LEVEL control for a stable display.

c. Set the SOURCE switch to EXT.

d. Check—that the sweep free runs.

e. Set the SOURCE switch to CH 1.

f. Release the AUTO button (Normal Mode).

g. Check—for a visible trace.

h. Press the SOURCE EXT button.

i. Check—that the trace disappears.

j. Set the SOURCE switch to CH 1.

k. Press the SINGLE SWP button in.

l. Press and release the SGL SWP button.

m. Check—that the trace appears once each time the SINGLE SWP RESET button is pressed and released.

n. Disconnect the cable and return the front-panel controls to the preliminary settings.

22. Check the Calibrator

CH 1 VOLTS/DIV	.1
CH 1 DC-GND-AC	DC
SECONDS/DIV	1 m

a. Connect the output of the calibrator to the CH 1 input connector using the pin-jack-to-bnc adapter.

b. Check—that the display amplitude is six divisions within .06 divisions.

c. Disconnect the cable and return the front-panel controls to the preliminary settings.

23. Check the External Trigger Level Range

SECONDS/DIV	10 μs
AUTO	OUT
SOURCE	EXT
COUPL	AC

a. Connect the leveled sine-wave generator through a 50 Ω coaxial cable and a 50 Ω termination to EXT TRIG.

b. Press and hold the TRIG VIEW pushbutton during the following steps.

c. Set the generator frequency range to 50 kHz and adjust the sine-wave generator amplitude for a display of six divisions.

d. Set the TRIGGERING LEVEL control to midrange.

e. Check—that the READY TRIG'D light is on.

f. Adjust the TRIGGERING LEVEL control fully clockwise.

g. Check—that the READY TRIG'D light is off and the trace stops running.

h. Set the TRIGGERING LEVEL control fully counterclockwise.

i. Check—that the READY TRIG'D light is off and the trace stops running.

j. Release the TRIG VIEW pushbutton.

k. Disconnect the cable and return the front-panel controls to the preliminary settings.

24. Check the Internal Trigger Level Range

SECONDS/DIV	10 μs
CH 1 DC-GND-AC	DC
AUTO	OUT
CH 1 VOLTS/DIV	.2
COUPL	AC

a. Connect the leveled sine-wave generator output through a 50 Ω coaxial cable and a 50 Ω termination to the CH 1 input connector.

b. Set the generator frequncy to 50 kHz and adjust the amplitude for a display of eight divisions.

c. Adjust the TRIGGERING LEVEL control to midrange.

d. Check—that the READY TRIG'D light is on.

e. Set the CH 1 VOLTS/DIV to 0.1.

f. Set the TRIGGERING LEVEL control fully clockwise.

g. Check—that the READY TRIG'D light is off and the sweep stops.

h. Set the TIRGGERING LEVEL control fully counterclockwise.

i. Check—that the READY TRIG'D light turns off and the sweep stops.

j. Change TRIGGERING SLOPE to − and repeat parts c through i.

k. Disconnect all cables and return the front-panel controls to the preliminary settings. This completes the Performance Check Procedure.

ADJUSTMENT PROCEDURE

Adjustment is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy.

To ensure instrument accuracy, check the calibration every 2000 hours of operation, or every six months if used infrequently.

Before complete calibration, thoroughly clean and inspect this instrument as outlined in the service section of the Power Module manual. The Power Module manual also contains information for general maintenance of this instrument, including preventive maintenance, component identification and replacement, etc.

NOTE

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

WARNING

Dangerous potentials exist at several points throughtout this instrument. When the instrument is operated with the covers removed, do not touch exposed connections or components. Disconnect power by removing the SC 502 from the TM 500-Series Power Module before cleaning the instrument or replacing parts. The SC 502 MODE switch PWR OFF position does not remove all power from the oscilloscope.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0° C to +50° C range. Make any adjustment at a temperature of +25° C, ±5° C.

1. Check that the power is OFF in both the SC 502 and TM 500 Series Power Module.

2. Connect the nominal line selector block of the Power Module to the correct line selector pins (120 V ac or 220 V ac). Also check that the regulating range selected includes the input line voltage. See Installation Section of Power Module Manual.

a. Connect Power Module to the line voltage source.

3. Remove the SC 502 Oscilloscope side and top covers and connect the oscilloscope to the Power Module, using the plug-in extension.

a. Set the following controls:

FOCUS	As is
INTENSITY	Fully counterclockwise
TRIGGER VIEW	As is
MODE	PWR OFF
POSITION (Vertical)	
CH 1	midrange
CH 2	midrange
CH 1	
VOLTS/DIV	0.1
AC-GND-DC	AC
CH 2	
VOLTS/DIV	.02
AC-GND-DC	GND
POSITION (Horizontal)	Midrange
SECONDS/DIV	0.5 ms
CAL/SWP MAG	Fully clockwise and pushed in
Trigger Mode	
SINGLE SWP	Out position
AUTO	Pushed in
COUPLING	
AC	Pushed in
LF REJ	Out position
SOURCE	
CH 1	Pushed in
CH 2	Out position
EXT	Out position
SLOPE (Triggering)	+
LEVEL (Triggering)	As is

4. Turn the Power Module on by pulling the Power switch out.

a. Turn the SC 502 MODE switch to CH 1 to apply power.

CAUTION

If any work has been performed on the SC 502 power supplies, then the +20 V, −20 V and +5 V power supplies must be checked to be within 0.2 V of the correct voltage immediately after turn-on and before the warm-up period. See step 1 for power supply adjustments.

5. Allow 15 minutes for the SC 502 to warm-up and stabilize.

Adjustment Procedure

NOTE

The tabbed foldout page labeled "Adjustment Locations" contains illustrations showing the location of each adjustment in this procedure.

1. Adjust +20 V and −20 V Power Supplies R925 and R947 (Trigger Circuit Board)

NOTE

Adjusting the +20 V and −20 V power supplies with the 0.1% dc voltmeter is adequate for oscilloscope operation; however, if the supplies are adjusted this way the output CAL peak-to-peak square-wave voltage cannot be guaranteed to be within 1%. If a 1% or less calibrator output amplitude is required, then the +20 V and −20 V power supplies must be adjusted with a dc voltmeter having at least a 0.01% accuracy.

Connect the dc voltmeter between the +20 V test point and the ground test point. Adjust +20 V, R925 for a voltmeter reading of +20 V ±0.06 V.

Disconnect the voltmeter from the +20 V test point and connect it between the −20 V test point and the ground test point. Adjust −20 V, R947 for a voltmeter reading of −20 V ±0.1 V.

Disconnect the voltmeter.

2. Check +5 V Power Supply

Connect the dc voltmeter between the +5 V test point and the ground test point. Check for a voltmeter reading of +5.07 V ±0.08 V.

3. Adjust Beam Current R873 (F & I Circuit Board)

CAUTION

To avoid possible damage to the crt phosphor, do not allow a bright spot to remain stationary for an extended period of time within the viewing area.

Connect the positive lead of the dc voltmeter to the beam current test point (located on main circuit board) and the voltmeter negative lead to a chassis ground. Set the voltmeter to measure about 2 V full scale.

Set the SC 502 SECONDS/DIV switch to AMP, the horizontal POSITION control to position the spot off the crt viewing area, and the INTENSITY control fully clockwise.

Adjust Beam, R873 for a voltmeter reading of 0.40 V ±0.01 V. Disconnect the voltmeter and turn the INTENSITY control to its midrange position.

4. Adjust Astigmatism R899 (F & I Circuit Board)

Connect a test lead from CH 1 to the CAL connector. Trigger the oscilloscope and adjust FOCUS control R899 (Astigmatism) and the INTENSITY control for a clearly focused waveform. Remove the test lead.

5. Adjust Trace Rotation R895 (F & I Circuit Board)

Set the SC 502 SECONDS/DIV switch to .5 m. Position the SC 502 trace to the center horizontal graticule line.

Adjust Trace, R895 until the crt trace is parallel to the center horizontal graticule line.

6. Adjust Geometry R897, F & I Circuit Board (Below SN B039280)

NOTE

Geometry adjustment will cause some change in sweep timing.

Connect 0.5 ms time-markers form the properly terminated time mark generator to the CH 1 input connector. Trigger the display and adjust CH 1 POSITION fully ccw.

Adjust Geom R897 for minimum bow or tilt of the vertical lines, using the vertical graticule lines as the reference. The adjustment of R897 may have to be a compromise to bring all points within the 0.1 major division or less tolerance.

Disconnect the time-mark generator.

7. Adjust Channel 1 & 2 Preamplifier Attenuator Balance R135 and R235 (Main Circuit Board)

Set the CH 1 AC-GND-DC switch to GND and the VOLTS/DIV switch to 0.2. Position the crt trace to the center horizontal graticule line using the CH 1 vertical POSITION control.

Rotate the CH 1 VOLTS/DIV switch to 1 m. Adjust CH 1 Step Bal R135 (CH 2 Step Bal R235) to bring the crt trace back to the center horizontal graticule line. Return the CH 1 VOLTS/DIV switch to 0.2 and return the crt trace to the center horizontal graticule line using the vertical position control, then repeat this step until all interaction is removed.

Change the SC 502 MODE switch to CH 2 and repeat the above step for channel 2.

8. Adjust Channel 1 & 2 Preamplifier Input Capacitance C105, C115, C119, C205, C215 and C219 (Main Circuit Board)

Set the CH 2 AC-GND-DC switch to DC, the VOLTS/DIV switch to 10 m and the triggering SOURCE to CH 2. Connect a 47 pF input normalizer to the CH 2 input connector. Connect a properly terminated high amplitude signal from the pulse generator through a 10X attenautor to the CH 2 input connector via the 47 pF input normalizer. Adjust the pulse generator for a 1 ms period and an output amplitude of approximately 50 mV (10 mV X 5 div). Adjust the triggering LEVEL control for a stable display.

Adjust C205 (C105) for a flat top. Remove the 10X attenuator from the cable. Change the VOLTS/DIV switch to .5 and increase the output amplitude of the pulse generator to obtain again a 5 major division signal. Adjust C215 (C115) for a flat top and C219, (C119) for a square front corner having 2% peak or 3% peak-to-peak or less of aberrations on the displayed waveform. (C333 is selected to balance Channel 1 aberrations with Channel 2.)

Change the SC 502 MODE switch to CH 1, along with the applicable CH 1 controls, and repeat the above step for Channel 1. Disconnect the pulse generator and the 47 pF normalizer.

9. Adjust Channel 1 & 2 Preamplifier Gain R180 and R280 (Main Circuit Board)

Set the CH 1 VOLTS/DIV switch to 10 m and rotate the triggering LEVEL fully clockwise. Connect a 50 mV standardized amplitude signal from the pulse generator to the CH 1 input connector. Adjust CH 1 (CH 2) POSITION control to center display.

Adjust CH 1 Gain R180 (CH 2 Gain R280) for a waveform amplitude of exactly 5 major graticule divisions. Check that the remaining VOLTS/DIV switch positions are within the tolerance listed in Table 4-4.

Table 4-4

VOLTS/DIV ATTENUATOR CHECK

VOLTS/DIV Setting	Standardized Amplitude Applied to Input	Display Amplitude In Major Divisions	Tolerance
1 mV	5 mV	5	5%
2 mV	10 mV	5	5%
5 mV	20 mV	4	2%
10 mV	50 mV	5	Adjusted
20 mV	.1 mV	5	2%
50 mV	.2 V	4	2%
.1 V	.5 V	5	2%
.2 V	1V	5	2%
.5 V	2 V	4	2%
1 V	5V	5	2%
2 V	10 V	5	2%
5 V	20 V	4	2%
10 V	50 V	5	2%
20 V	100 V	5	2%

Change the SC 502 MODE switch to CH 2, along with the applicable CH 2 controls, and repeat the above step for channel 2. Disconnect the pulse generator.

10. Adjust Channel 1 & 2 Preamplifier Position Centering R335 and R394 (F & I Circuit Board)

Set the CH 2 AC-GND-DC to AC, the VOLTS/DIV switch to 10 m and the triggering SOURCE to CH 2. Connect a 200 mV pulse with a 1 ms period from the pulse generator to the CH 2 input connector. Adjust the triggering LEVEL control for a stable display. Rotate the CH 2 vertical POSITION control to each of its extremes and check that the bottom of the pulse display can be positioned at least one major division above (when positioning upward), and that the top of the pulse can be positioned at least one major division below, (when positioning downward) the graticule horizontal center line.

Adjust Vert Pos CH 2 R394 (CH 1 R335) so that the top and bottom of the pulse waveform are brought within an equal distance of the graticule center line at the two extremes of the vertical POSITION control.

Change the SC 502 MODE switch to CH 1, along with the applicable CH 1 controls, and repeat the above step for channel 2. Disconnect the pulse generator.

11. Adjust Vertical Output Amplifier R465, R473, C473, and C474 (F & I Circuit Board)

Set the SC 502 SECONDS/DIV switch to 2 μ and the triggering SOURCE switch to CH 1. Connect a properly terminated, 60 mV positive-going, fast-rise, 10 μs period pulse from the pulse generator to the CH 1 input connector. Adjust the triggering LEVEL control for a stable display.

Adjust R465 for flat top without roll-off or overshoot on the crt displayed waveform.

Set the SC 502 SECONDS/DIV switch to .2 μ and the pulse generator for a 1 μs pulse period.

Adjust R473, C473 and C474 (using a low-capacitance alignment tool) for the squarest front corner without roll-off or overshoot.

Change the SC 502 MODE switch to CH 2, along with the applicable CH 2 controls, and check the results of the above adjustments using Channel 2. Adjust C387 for best match of aberrations to CH 1. If necessary, compromise the above adjustment so that the amplifier response is equal for both vertical channels. Disconnect the pulse generator.

12. Check Vertical Bandwidth

Set the SC 502 MODE switch to CH 2, the SECONDS/DIV switch to 5 m, the triggering SOURCE switch to CH 2, and the triggering LEVEL control fully clockwise. Connect a properly terminated leveled sine-wave generator to the CH 2 input connector. Set the output frequency of the sine-wave generator to 50 kHz and adjust its output amplitude to obtain 6 major divisions of SC 502 crt display.

Without disturbing the output amplitude control on the sine-wave generator, increase the generator frequency to 15 MHz. Check that the display amplitude is at least 4.2 major divisions; if it is not, repeat step 11 adjustments.

Change the SC 502 MODE switch to CH 1 along with the applicable CH 1 controls and check the bandwidth of channel 1. Disconnect the sine-wave generator.

13. Adjust Sweep Offset R681 (Main Circuit Board)

Set the SC 502 MODE switch to CH 1, the SECONDS/DIV switch to .2 m and the triggering SOURCE switch to CH 1. Connect the dc voltmeter positive lead to TP677 and the negative lead to a convenient ground. Set the voltmeter to read about 2 V full scale.

Adjust Offset R681 for a voltmeter reading of 0 V. Disconnect the dc voltmeter.

14. Adjust Horizontal Amplifier Centering R760 (Hor Defl Circuit Board)

Connect TP745 (TP test point) temporarily to ground with a jumper. Adjust Center R760 to position the crt spot to the vertical graticule center line. Remove the shorting jumper.

15. Adjust Sweep Gain R770 (Hor Defl Circuit Board)

Set the CH 1 VOLTS/DIV switch to .5, set SECONDS/DIV to .2 m. Connect 0.2 ms time-markers from a properly terminated time mark generator to the CH 1 input connector. Rotate the LEVEL control to obtain a stable display. Vertically position the display to the center of the viewing area of the crt.

Adjust Sweep Gain R770 until an SC 502 display of 1-time marker per major graticule division is obtained. The second and tenth time markers must line up exactly with their respective graticule lines.

16. Adjust X10 Magnifier Gain R708 (Main Circuit Board)

Change the time mark generator output so it will now supply 20 μs markers to the CH 1 input connector. Pull the SECONDS/DIV CAL/SWP MAG control out.

Adjust Mag Gain R708 until a display of 1-time marker per major graticule division is obtained. The second and tenth time markers must line up exactly with their respective graticule lines.

17. Adjust Fast Timing C1005 (Main Circuit Board)

Set the SC 502 SECONDS/DIV switch to 1 μ and push the CAL/SWP MAG control in. Change the time-mark generator output so it will now supply 1 μs markers to the CH 1 input connector.

Adjust Time C1005 until a display of one-time marker per major graticule division is obtained. The second and tenth markers must line up exactly with their respective graticule lines.

Change the SECONDS/DIV switch and the marker output of the time-mark generator to 0.2 μs. Check the SC 502 display for one-time marker per major graticule division (within 3%) in the center 8 graticule divisions. Check all sweep rates between 0.2 μs and 5 μs, using appropriate time markers, and check display again for one marker per major graticule division (within 3% for 0.5 μs and 0.2 μs and within 2% from 1 μs to 5 μs).

The final adjustment of C1005 may need to be a compromise so that the time markers in the center 8 graticule divisions for the above sweep rates are all within tolerance. Disconnect the time mark generator.

18. Adjust External Balance R535 (Trigger Circuit Board)

CAUTION

To avoid possible damage to the crt phosphor, do not allow a bright spot to remain stationary for an extended period of time within the viewing area.

Set the SC 502 SECONDS/DIV switch to 5 m and rotate the horizontal position control to align the start of the crt trace with the far left graticule line. Change the SECONDS/DIV switch to AMP. Set the INTENSITY level such that the crt phosphor will not be damaged.

Adjust EXT Bal R535 to position the crt spot to the vertical graticule center line.

19. Adjust External Horizontal Attenuator Compensation and Gain C516 (Trigger Circuit Board) and R723 (Main Circuit Board)

Set the SC 502 SECONDS/DIV switch to .2 m and the triggering SOURCE switch to EXT. Set the AUTO trigger mode pushbutton to its out position. Connect a properly terminated fast-rise signal of 1 ms period from the pulse generator to the EXT TRIG input connector. Push the TRIG VIEW pushbutton in and hold during the following adjustment. Adjust the TRIGGERING LEVEL as necessary to position the waveform at the center of the crt. Adjust pulse generator for a 5 div display.

Adjust ATT C, C516 for a flat top on the waveform without any overshoot or rolloff.

Release the TRIG VIEW pushbutton and set the SECONDS/DIV switch to AMP and the triggering SOURCE switch to CH 1. Disconnect the fast-rise pulse generator signal from the EXT TRIG input connector and connect a 0.5 V standardized amplitude signal from the pulse generator to the connector.

Adjust horizontal POSITION to center two dots on screen.

Adjust Ext Gain R723 for exactly 10 major graticule divisions between the two crt spots. Disconnect the pulse generator.

20. Adjust Trigger View Centering R433 (F & I Circuit Board)

Set the SC 502 SECONDS/DIV SWITCH to 5 μ and push the AUTO trigger mode pushbutton in. Connect a properly terminated sine-wave generator to the CH 1 input connector.

Set the output frequency of the sine-wave generator to 50 kHz and adjust its output amplitude to obtain 6 major divisions of SC 502 crt display. Adjust the triggering LEVEL to trigger the sine-wave signal at its 50% point; i.e., midway between peaks. Depress the TRIG VIEW pushbutton and hold it in during the following adjustment.

Adjust Trig View (TV) Center R433 so the start of the waveform trace on the SC 502 crt display is at the horizontal graticule center line. Change the triggering SLOPE switch to minus and recheck the starting position of the display (TRIG VIEW pushbutton still depressed). The final adjustment of R433 should be a compromise between the display starts for both the + and − SLOPE switch positions.

Release the TRIG VIEW pushbutton and change the position of the triggering LEVEL to select another triggering point on the waveform. Depress the TRIG VIEW pushbutton and check that the display corresponds to the previous setting. Repeat at various triggering LEVEL points. Disconnect the sine-wave generator.

This completes the adjustment procedure for the SC 502.

MAINTENANCE

General system maintenance procedures are provided in the Power Module instruction manual, i.e., preventive maintenance, troubleshooting aids, parts removal and replacement procedures, parts ordering information, etc.

CRT Replacement

The following procedure outlines the removal and replacement of the cathode-ray tube. Refer to Fig. 5-1.

WARNING

Use care when handling a crt. Protective clothing and safety glasses should be worn. Avoid striking crt on any object which might cause it to crack or implode. When storing a crt, place it in a protective carton or set it face down in a protected location on a smooth surface with a soft mat under the faceplate to protect it from scratches.

A. REMOVAL

1. Remove the instrument vented electrical shields (side covers), the top cover, and remove crt filter (16) with spring (15) from front of crt.

2. Disconnect the FOCUS extension shaft (1) from the focus potentiometer.

3. Loosen black thumb screw (2). Remove the "T" bracket (3) which is held with three screws (4).

4. Remove the two screws (5) holding the hor defl circuit board. (It's not necessary to remove board, just 8-pin ribbon connector and two horizontal deflection pin wires.) Lift the board slightly away from the SC 502 and disconnect the 8-pin ribbon wire connector and the two horizontal crt deflection pin leads.

5. Disconnect the coaxial cable 10-pin connector from the back of the F & I circuit board along with the trace rotation coil 2-pin connector. Also, disconnect the coaxial cable 4-pin connector and coaxial cable 2-pin connector from the back of the Trigger Circuit board. Don't remove (6) from (7). (6) would then be in the way of crt shield. Momentarily touch the crt end of the anode connector to chassis ground to discharge any voltage.

6. Remove the high-voltage shield (8), which is held by the two screws (9). Remove the 3-pin ribbon wire connector from Q970, which is mounted on the rear panel. Remove the eight screws (10) and remove the rear panel (11) being careful to not lose two board insulators. (See Fig. 5-1.)

7. Disconnect the crt socket (12) and the two crt vertical deflection pin leads, then lift out the crt shield with the crt inside.

B. REPLACEMENT

1. Install the (spacer) front crt support (13) into the bezel opening of the front subpanel (14).

2. Install the crt into the crt shield, then install the assembly into the appropriate area of the oscilloscope. Be careful not to bend any of the protruding connector pins. Place the crt shield (14) up against the (spacer) front crt support (13) and the crt into the front crt support (13), see Fig. 5-2. Install the crt socket (12), then hold the assembly in position and install the rear panel (11) with enough screws to hold the crt assembly in place.

3. Finish the installation procedure by reversing the removal procedure.

4. Install the (crt filter) spring (15) in the groove between the bottom front bezel portion of the front subpanel with the spring ends down. Install the implosion shield/filter (16) into the front bezel portion of the front subpanel by compressing the spring (15) and pushing in.

5. Replacing the crt will require partial instrument readustment. Refer to the Adjustment section of this manual (section 4).

Circuit Board Removal

The following procedure outlines the removal and installation of the circuit boards.

A. REMOVAL

1. Remove the crt using the crt removal procedure.

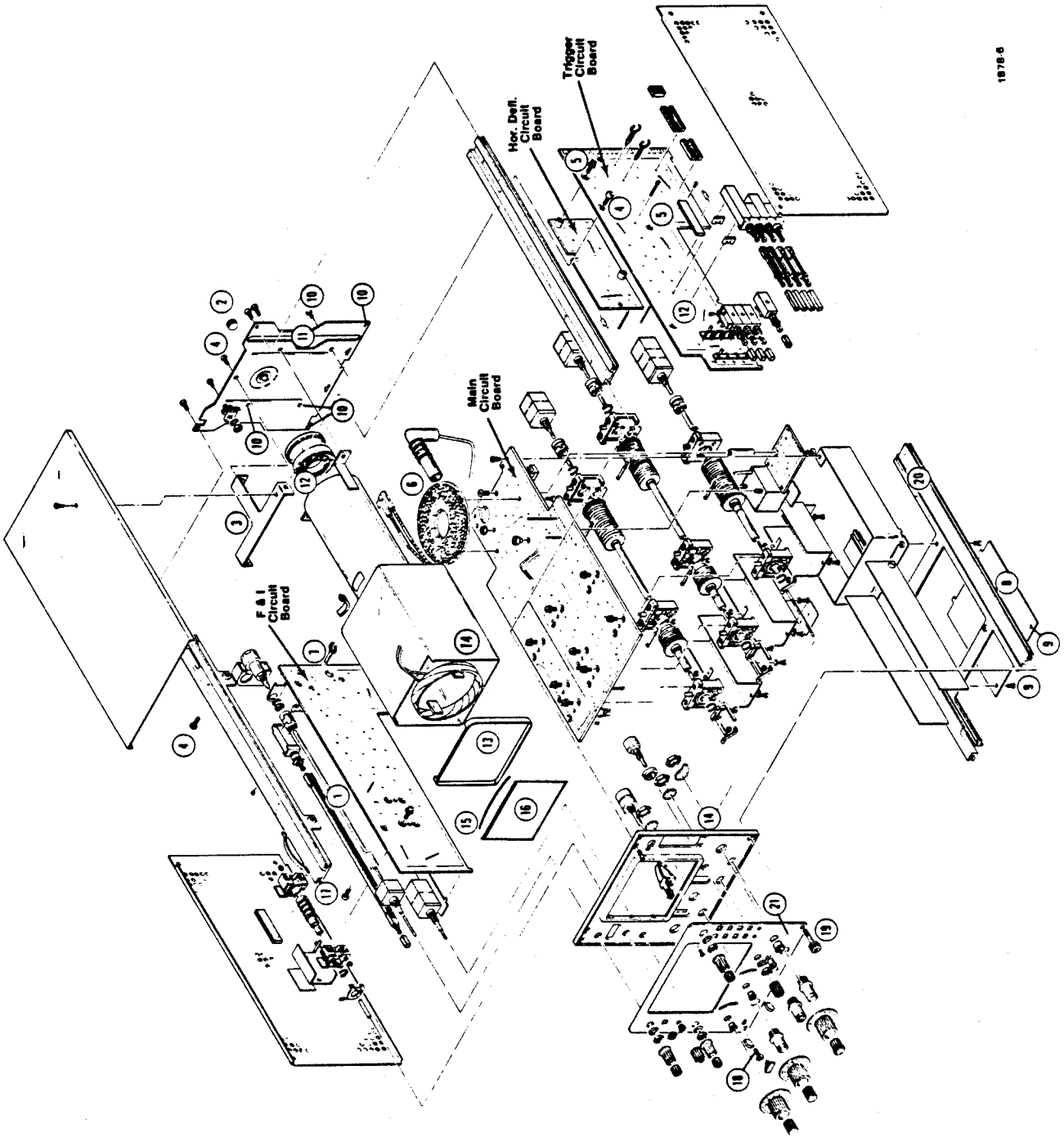


Fig. 5-1. Replacing the cathode-ray tube, and circuit board removal.

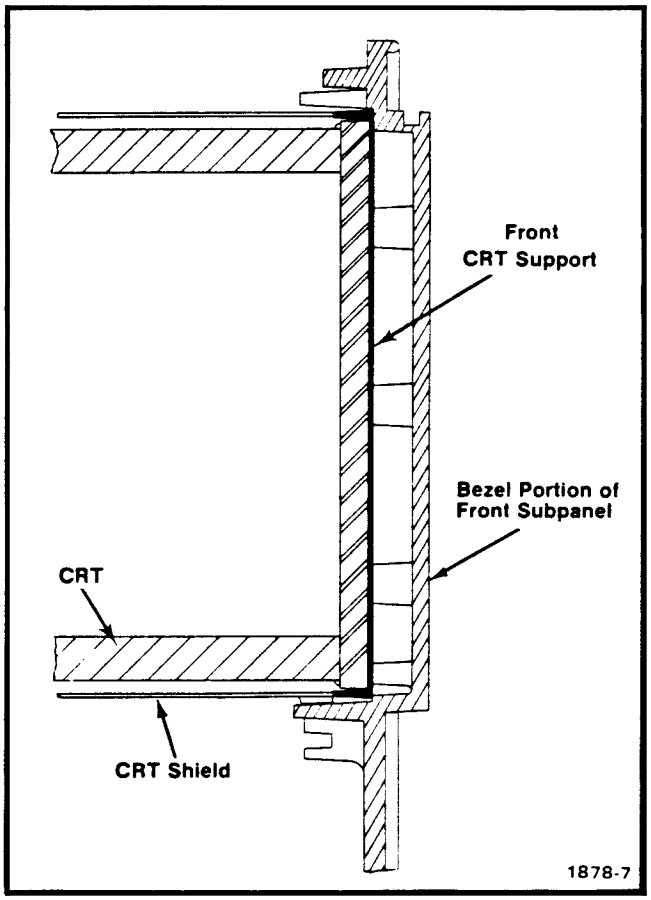


Fig. 5-2. Cross sectional view showing placement position of front crt support, crt shield and crt.

2. Remove all the knobs except the SLOPE, LEVEL and horizontal POSITION.

3. Remove the two screws (17) which hold the circuit board assembly to the top rails. Remove screw (18) and stud post with knurled nut (19) and remove bottom section frame (20).

4. Remove any nuts and washers holding the controls (from which the knobs have been removed) to the front subpanel (14) and front panel (21). Disconnect from the circuit boards those connectors whose leads go to the front-panel connectors or controls which still have knobs.

5. Slide the circuit board assembly away from the front subpanel until it is clear.

6. Disconnect the plugged-together circuit board assembly as required.

B. INSTALLATION

1. Reverse the Circuit Board Removal procedure, then follow the CRT Replacement procedure.

Variable Trigger Holdoff/Variable Sweep Time

The knob in the center of the Time-Div switch is normally used for varying the time per division settings of the sweep generator. Figure 5-3 shows the jumper change necessary for changing the function of this knob to a variable trigger hold-off adjustment. This is useful when triggering on irregular waveforms.

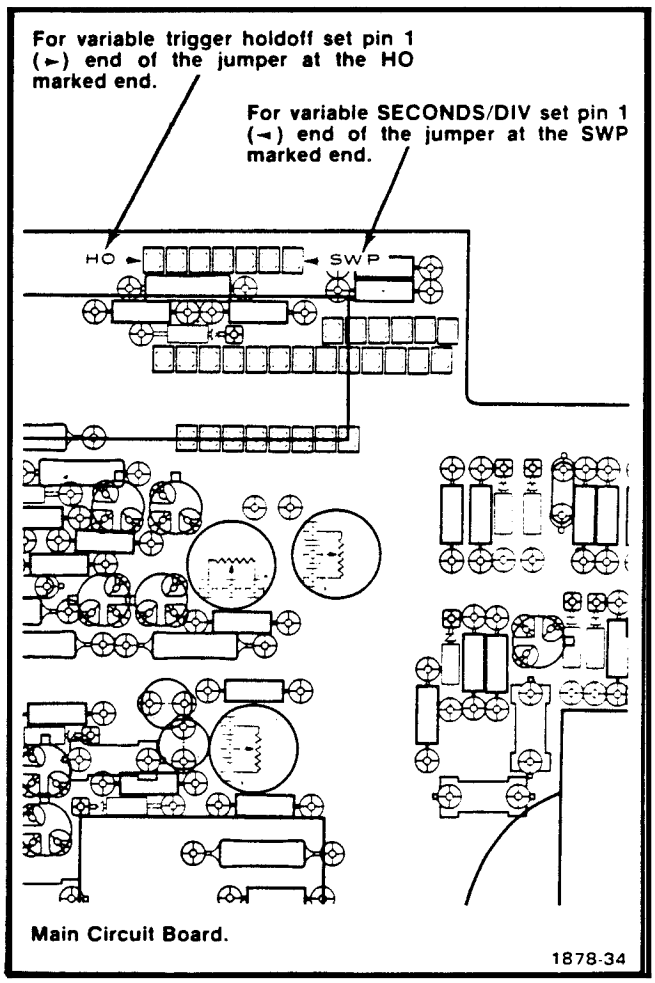


Fig. 5-3. Variable Trigger Hold Off—Variable Sweep Time jumper placement.

External Z-Axis In

An external Z-axis input signal can be used to turn the crt beam on or off. To do this, connect a coaxial cable from the auxiliary Z-axis amplifier solder pads (see Fig. 5-4) to contacts 24A (center conductor) and 23A (ground) of the rear interface. A +5 V signal turns the crt beam on from an off condition and −5 V turns the beam off from an on condition. The input resistance is about 1 kΩ.

(Above serial No. B021190 the Z-axis input connection is factory installed.)

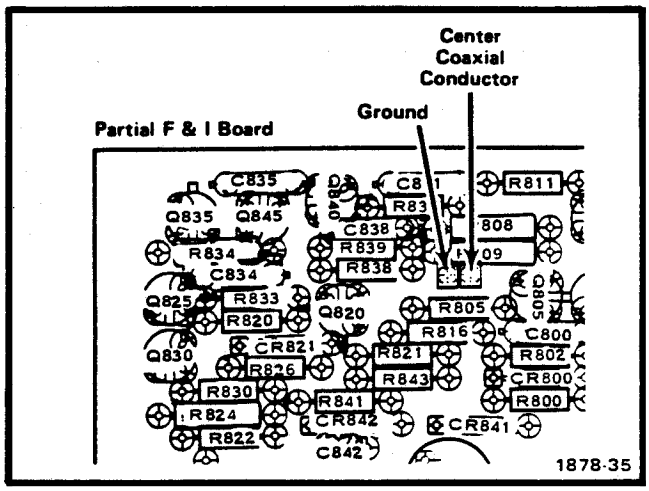


Fig. 5-4. Location of auxiliary Z-axis input solder pads.

Remarks	Maximum Recommended Loads	Active Level	Output or Input	Pin B		Pin A	Output or Input	Active Level	Maximum Recommended Loads	Remarks
Linear Output	>10 kΩ	0 V dc 50 mV/div ≈100 Ω Output	Channel 1 Out	*28		*28				
			Channel 1 Out Ground	*27	Delaying System Barrier Slot	27				
Logic Output	See note[1]		Triggered Gate Out	*26		26				
Logic Output	See note[1]		Triggered Gate Out	*25		25				
Logic Input	Open Circuit or ground through ≤kΩ		Gate Select In	*24		*24	External Z-Axis In[2]			Linear Input
Logic Input	See note[3]		External Gate In	*23		*23	External Z-Axis In Ground[2]			
Logic Input	See note[3]		External Gate In	*22		22				
Logic Output	See note[1]		Holdoff Out	*21		21				
Logic Output	See note[1]		Holdoff Out	*20		20				
Logic Input	Input resistance ≈10 kΩ	ECL runs between +5 V and ground	Intensify In	*19		19				
				18		*18	Ramp Out	0 to +6.4 V	>100 kΩ	Linear Output
				17		*17	Channel 2 Vertical In Ground[2]			
				16		*16	Channel 2 Vertical In[2]			Linear Input
Linear Input			External Horizontal or Trigger In[2]	*15		*15	Channel 1 Vertical In Ground[2]			
			External Horizontal or Trigger In Ground[2]	*14		*14	Channel 1 Vertical In[2]			Linear Input
			25 VAC winding	*13		*13	25 VAC winding			Connected to ground
			+33.5 V filtered DC	*12		*12	+33.5 V filtered DC			
			Collector Lead of PNP Series-Pass	*11		*11	Base Lead of PNP Series-Pass			
Grounded			Transformer shield lead	*10		*10	Emitter Lead of PNP Series Pass			
			±33.5 V common return	*9		*9	±33.5 V common return			
			−33.5 V filtered DC	*8		*8	−33.5 V filtered DC			
			Collector Lead of NPN Series-Pass	*7	TM 500 Barrier Slot	*7	Emitter Lead of NPN Series-Pass			
			No connection	6		*6	Base lead of NPN Series-Pass			
			17.5 VAC winding	5		5	17.5 VAC winding			
			+11.5 V common return	*4		*4	+11.5 V common return			
			+11.5 V common return	*3		*3	+11.5 V common return			
			+11.5 V filtered DC	*2		*2	+11.5 V filtered DC			
Connected to ground			25 VAC winding	*1	Rear View of Plug-In	*1	25 VAC winding			
				B		A				

Assignments listed for pins 1A-13A and 1B-13B are available in all power modules; however, only those pins marked with an asterisk (*) are used by the SC 502.

[1]Designed to drive 100 Ω side-to-side terminated line with ECL line receiver. ECL integrated circuits are run between +5 V and ground and have their outputs protected by 47 Ω resistors.

[2]Customer optionally connected inputs.

[3]100 Ω side-to-side terminated line with ECL line receiver. ECL integrated circuits are run between +5 V and ground.

1878-36

Fig. 5-5. Input-Output Assignments for Plug-In Rear Interface Connector.

OPTIONS

There are no options available at this time.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

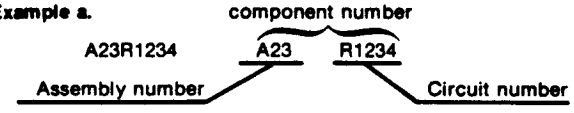
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

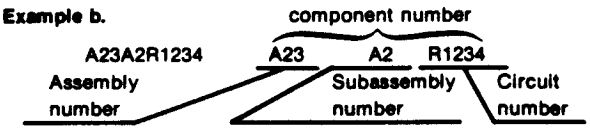
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00853	SANGAMO WESTON INC SANGAMO CAPACITOR DIV	SANGAMO RD P O BOX 128	PICKENS SC 29671
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
02114	AMPEREX ELECTRONIC CORP FERROXCUBE DIV	5083 KINGS HWY	SAUGERTIES NY 12477
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
05828	GENERAL INSTRUMENT CORP GOVERNMENT SYSTEMS DIV	600 W JOHN ST	HICKSVILLE NY 11802
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
12697	CLAROSTAT MFG CO INC	LOWER WASHINGTON ST	DOVER NH 03820
12969	UNITRODE CORP	580 PLEASANT ST	WATERTOWN MA 02172
13511	AMPHENOL CADRE DIV BUNKER RAMO CORP		LOS GATOS CA
14193	CAL-R INC	1601 OLYMPIC BLVD	SANTA MONICA CA 90404
14433	ITT SEMICONDUCTORS DIV		WEST PALM BEACH FL
14552	MICRO/SEMICONDUCTOR CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704
15238	ITT SEMICONDUCTORS A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORP	500 BROADWAY P O BOX 168	LAWRENCE MA 01841
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
25088	SIEMENS CORP	186 WOOD AVE S	ISELIN NJ 08830
30487	HUNTINGTON ELECTRIC INC	550 CONDIT ST P O BOX 366	HUNTINGTON IN 46750
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE MN 55343
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
51406	MURATA ERIE NORTH AMERICA INC GEORGIA OPERATIONS	1148 FRANKLIN RD SE	MARIETTA GA 30067
52763	STETTNER ELECTRONICS INC	6135 AIRWAYS BLVD PO BOX 21947	CHATTANOOGA TN 37421
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040
53944	GLOW LITE CORP	BOX 698	PAULS VALLEY OK 73075
54583	TDK ELECTRONICS CORP	755 EASTGATE BLVD	GARDEN CITY NY 11530
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
56289	SPRAGUE ELECTRIC CO	87 MARSHALL ST	NORTH ADAMS MA 01247
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
58361	GENERAL INSTRUMENT CORP OPTOELECTRONICS DIV	3400 HILLVIEW AVE	PALO ALTO CA 94304
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO TX 79915
60211	VOLTAGE MULTIPLIERS INC	8711 WEST ROOSEVELT	VISALIA CA 93291
71400	BUSSMANN MFG CO MCGRAW EDISION CO	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
71590	GLOBE-UNION INC CENTRALAB ELECTRONICS DIV	HWY 20 W P O BOX 858	FORT DODGE IA 50501
75042	TRW INC TRW ELECTRONIC COMPONENTS IRC FIXED RESISTORS PHILADELPHIA DIV	401 N BROAD ST	PHILADELPHIA PA 19108
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES IL 60016
76493	BELL INDUSTRIES INC MILLER J W DIV	19070 REYES AVE P O BOX 5825	COMPTON CA 90224

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
80031	MEPCO/ELECTRA INC	22 COLUMBIA RD	MORRISTOWN NJ 07960
83003	VARO INC	2203 WALNUT ST P O BOX 401426	GARLAND TX 75040
91637	DALE ELECTRONICS INC	P O BOX 609	COLUMBUS NE 68601
TK1727	PHILIPS NEDERLAND BV AFD ELONCO	POSTBUS 90050	5600 PB EINDHOVEN THE NETHERLANDS

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	670-3758-00	B010100	B023819	CIRCUIT BD ASSY:MAIN	80009	670-3758-00
A1	670-3758-01	B023820		CIRCUIT BD ASSY:MAIN	80009	670-3758-01
A2	670-3760-04	B010100	B041555	CIRCUIT BD ASSY:FOCUS & INTENSITY	80009	670-3760-04
A2	670-3760-06	B041556		CIRCUIT BD ASSY:FOCUS & INTENSITY	80009	670-3760-06
A3	670-3759-00	B010100	B022579	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-00
A3	670-3759-01	B022580	B039279	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-01
A3	670-3759-02	B039280	B039879	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-02
A3	670-3759-03	B039880		CIRCUIT BD ASSY:TRIGGER	80009	670-3759-03
A4	670-3761-00			CIRCUIT BD ASSY:HORIZONTAL DEFLECTION	80009	670-3761-00
A5	670-3821-00	B010100	B039879	CIRCUIT BD ASSY:AUXILIARY HIGH VOLTAGE	80009	670-3821-00
A5	670-3821-01	B039880		CIRCUIT BD ASSY:HIGH VOLTAGE	80009	670-3821-01
A1	670-3758-00	B010100	B023819	CIRCUIT BD ASSY:MAIN	80009	670-3758-00
A1	670-3758-01	B023820		CIRCUIT BD ASSY:MAIN	80009	670-3758-01
A1C100	285-0816-01	B010100	B022509	CAP,FXD,PLASTIC:0.019UF,10%,600V	80009	285-0816-01
A1C100	285-0816-04	B022510		CAP,FXD,PLASTIC:0.019UF,10%,600V	80009	285-0816-04
A1C103	281-0504-00			CAP,FXD,CER DI:10PF,+/-1PF,500V	54583	TCC20CH2H100FYA
A1C105	281-0182-00			CAP,VAR,PLASTIC:1.8-10PF,500V	TK1727	2222-809-05002
A1C110	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C111	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C115	281-0182-00			CAP,VAR,PLASTIC:1.8-10PF,500V	TK1727	2222-809-05002
A1C117	283-0669-00			CAP,FXD,MICA DI:360PF,1%,500V	00853	D155F361F0
A1C119	281-0178-00			CAP,VAR,PLASTIC:1-3.5PF,500V	80031	2805D013R5BH02F0
A1C122	283-0001-00			CAP,FXD,CER DI:0.005UF,+100-0%,500V	59821	2DDH61L502P
A1C126	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C143	281-0511-00	B020200		CAP,FXD,CER DI:22PF,+/-2.2PF,500V	52763	2RDPLZ007 22P0KC
A1C145	281-0511-00	B020200		CAP,FXD,CER DI:22PF,+/-2.2PF,500V	52763	2RDPLZ007 22P0KC
A1C150	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A1C156	290-0517-00			CAP,FXD,ELCTLT:6.8UF,20%,35V	05397	T368B685M035AZ
A1C164	283-0643-00			CAP,FXD,MICA DI:22PF,0.5%,500V	00853	D105E220D0
A1C170	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A1C200	285-0816-01	B010100	B022509	CAP,FXD,PLASTIC:0.019UF,10%,600V	80009	285-0816-01
A1C200	285-0816-04	B022510		CAP,FXD,PLASTIC:0.019UF,10%,600V	80009	285-0816-04
A1C203	281-0504-00			CAP,FXD,CER DI:10PF,+/-1PF,500V	54583	TCC20CH2H100FYA
A1C205	281-0182-00			CAP,VAR,PLASTIC:1.8-10PF,500V	TK1727	2222-809-05002
A1C210	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C211	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C215	281-0182-00			CAP,VAR,PLASTIC:1.8-10PF,500V	TK1727	2222-809-05002
A1C217	283-0669-00			CAP,FXD,MICA DI:360PF,1%,500V	00853	D155F361F0
A1C219	281-0178-00			CAP,VAR,PLASTIC:1-3.5PF,500V	80031	2805D013R5BH02F0
A1C222	283-0001-00			CAP,FXD,CER DI:0.005UF,+100-0%,500V	59821	2DDH61L502P
A1C226	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C243	281-0511-00	B020200		CAP,FXD,CER DI:22PF,+/-2.2PF,500V	52763	2RDPLZ007 22P0KC
A1C245	281-0511-00	B020200		CAP,FXD,CER DI:22PF,+/-2.2PF,500V	52763	2RDPLZ007 22P0KC
A1C250	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A1C256	290-0517-00			CAP,FXD,ELCTLT:6.8UF,20%,35V	05397	T368B685M035AZ
A1C264	283-0643-00			CAP,FXD,MICA DI:22PF,0.5%,500V	00853	D105E220D0
A1C270	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A1C670	283-0239-00			CAP,FXD,CER DI:0.022UF,10%,50V	04222	3439-050C-223K
A1C672	290-0523-00			CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
A1C693	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C694	290-0517-00			CAP,FXD,ELCTLT:6.8UF,20%,35V	05397	T368B685M035AZ
A1C697	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A1C698	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A1C699	281-0508-00			CAP,FXD,CER DI:12PF,+/-0.6PF,500V	52763	2RDPLZ007 12P0JC
A1C725	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A1C729	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A1C733	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1C850	290-0272-00	B010100	B040399	CAP,FXD,ELCTLT:47UF,20%,50V	56289	109D476X0050F2
A1C850	290-0986-00	B040400		CAP,FXD,ELCTLT:47UF,20%,50V	55680	TLB1H470M
A1C851	290-0272-00	B010100	B040399	CAP,FXD,ELCTLT:47UF,20%,50V	56289	109D476X0050F2
A1C851	290-0986-00	B040400		CAP,FXD,ELCTLT:47UF,20%,50V	55680	TLB1H470M
A1C852	281-0525-00			CAP,FXD,CER DI:470PF,+/-94PF,500V	52763	2RDPLZ007 470PMO
A1C854	281-0549-00			CAP,FXD,CER DI:68PF,10%,500V	52763	2RDPLZ007 68P0KU
A1C857	283-0167-00	B010100	B023819	CAP,FXD,CER DI:0.1UF,10%,100V	04222	3430-100C-104K
A1C857	283-0341-00	B023820		CAP,FXD,CER DI:0.047UF,10%,100V	04222	SR301C473KAA
A1C858	283-0341-00	B029000		CAP,FXD,CER DI:0.047UF,10%,100V	04222	SR301C473KAA
A1C862	283-0220-00			CAP,FXD,CER DI:0.01UF,20%,50V	04222	3429 050C 103M
A1C863	283-0111-00			CAP,FXD,CER DI:0.1UF,20%,50V	05397	C330C104M5U1CA
A1C868	283-0167-00			CAP,FXD,CER DI:0.1UF,10%,100V	04222	3430-100C-104K
A1C869	290-0517-00			CAP,FXD,ELCTLT:6.8UF,20%,35V	05397	T368B685M035AZ
A1C870	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
A1C872	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
A1C873	281-0543-00			CAP,FXD,CER DI:270PF,10%,500V	52763	2RDPLZ007 27P0MO
A1C879	281-0523-00			CAP,FXD,CER DI:100PF,20%,350V	52763	2RDPLZ007 100PMU
A1C911	283-0095-00			CAP,FXD,CER DI:56PF,10%,200V	59660	855-536-C0G0560K
A1C913	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A1C1005	281-0207-00			CAP,VAR,PLASTIC:2-18PF,100V	52769	GXA 18000
A1C1010	283-0674-00			CAP,FXD,MICA DI:85PF,1%,500V	00853	D155F850F0
A1C1015	295-0138-00			CAP SET,MATCHED:1UF,0.01UF,MATCHED 1% QA	80009	295-0138-00
A1C1020	----- -----			(PART OF C1015)		
A1CR126	152-0323-00			SEMICOND DVC,DI:SW,SI,35V,0.1A,DO-7	14433	WG1518
A1CR145	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR150	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR153	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR170	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR226	152-0323-00			SEMICOND DVC,DI:SW,SI,35V,0.1A,DO-7	14433	WG1518
A1CR245	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR250	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR253	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR270	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR670	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR675	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR697	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR850	152-0398-00			SEMICOND DVC,DI:RECT,SI,200V,1A	04713	SR3609RL
A1CR851	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR853	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR855	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR856	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR862	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR864	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
A1CR865	152-0333-00			SEMICOND DVC,DI:SW,SI,55V,200MA,DO-35	07263	FDH-6012
A1CR869	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A1CR870	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A1CR879	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A1CR882	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A1CR911	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1CR915	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A1L140	276-0507-00			SHLD BEAD,ELEK:FERRITE	02114	56-590-65B/3B
A1L240	276-0507-00			SHLD BEAD,ELEK:FERRITE	02114	56-590-65B/3B
A1L850	108-0422-00			COIL,RF:FIXED,80UH	80009	108-0422-00
A1LR698	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A1LR733	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A1Q125	151-1031-00			TRANSISTOR:FET,N-CHAN,SI	80009	151-1031-00
A1Q150	151-0325-00	B010100	B042044	TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q150	151-0220-00	B042045		TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00

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A1Q160	151-0325-00			TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q170	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1Q175	151-0325-00			TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q225	151-1031-00			TRANSISTOR:FET,N-CHAN,SI	80009	151-1031-00
A1Q250	151-0325-00	B010100	B042044	TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q250	151-0220-00	B042045		TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1Q260	151-0325-00			TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q270	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A1Q275	151-0325-00			TRANSISTOR:PNP,SI,TO-92,SEL	80009	151-0325-00
A1Q675	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A1Q680	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A1Q685	151-0259-00			TRANSISTOR:NPN,SI,TO-106	07263	S39288
A1Q690	151-1054-00			TRANSISTOR:FET,N-CHAN,SI,TO-71	80009	151-1054-00
A1Q695	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A1Q700	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A1Q710	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A1Q720	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A1Q730	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A1Q850	151-0364-00			TRANSISTOR:PNP,SI,X-51C	03508	X43CR181
A1Q855	151-0426-00			TRANSISTOR:NPN,SI,TO-220	03508	X44HR242
A1Q860	151-0437-00			TRANSISTOR:SELECTED	80009	151-0437-00
A1Q900	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A1Q910	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A1R100	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
A1R104	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J
A1R110	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R111	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R115	322-0624-03			RES,FXD,FILM:990K OHM,0.25%,0.25W,TC=T2	91637	MFF1421D99002C
A1R117	315-0200-00			RES,FXD,FILM:20 OHM,5%,0.25W	19701	5043CX20R00J
A1R119	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC10001C
A1R122	315-0474-00			RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
A1R125	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A1R126	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R129	321-0226-02			RES,FXD,FILM:2.21K OHM,0.5%,0.125W,TC=T2	91637	MFF1816D22100D
A1R130	321-0193-03			RES,FXD,FILM:1K OHM,0.25%,0.125W,TC=T2	07716	CEAC10000C
A1R135	311-1556-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3352T-DY7-503
A1R136	321-0364-00			RES,FXD,FILM:60.4K OHM,1%,0.125W,TC=T0	19701	5043ED60K40F
A1R138	321-0125-00			RES,FXD,FILM:196 OHM,1%,0.125W, TC=T0	07716	CEAD196R0F
A1R140	321-0226-02			RES,FXD,FILM:2.21K OHM,0.5%,0.125W,TC=T2	91637	MFF1816D22100D
A1R141	321-0193-03			RES,FXD,FILM:1K OHM,0.25%,0.125W,TC=T2	07716	CEAC10000C
A1R143	321-0097-03			RES,FXD,FILM:100 OHM,0.25%,0.125W,TC=T0	91637	CMF55116D100R0C
A1R145	321-0097-03			RES,FXD,FILM:100 OHM,0.25%,0.125W,TC=T0	91637	CMF55116D100R0C
A1R148	321-0030-03			RES,FXD,FILM:20.0 OHM,0.25%,0.125W,TC=T2	57668	CRB14 CYE 20 OHM
A1R150	321-0030-03			RES,FXD,FILM:20.0 OHM,0.25%,0.125W,TC=T2	57668	CRB14 CYE 20 OHM
A1R153	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A1R155	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R159	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
A1R160	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
A1R162	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
A1R164	321-0154-00			RES,FXD,FILM:392 OHM,1%,0.125W,TC=T0	07716	CEAD392R0F
A1R170	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A1R172	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
A1R175	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
A1R177	311-1599-00	B010100	B041865	RES,VAR,NONWW:PNL,2.5K OHM,1W,W/SW	01121	25M909
A1R177	311-1599-01	B041866		RES,VAR,NONWW:PNL,2.5K OHM,20%,0.5W	01121	25M909
A1R180	311-1239-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386X-T07-252
A1R200	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
A1R204	315-0105-00			RES,FXD,FILM:1M OHM,5%,0.25W	19701	5043CX1M000J

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A1R210	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R211	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R215	322-0624-03			RES,FXD,FILM:990K OHM,0.25%,0.25W,TC=T2	91637	MFF1421D99002C
A1R217	315-0200-00			RES,FXD,FILM:20 OHM,5%,0.25W	19701	5043CX20R00J
A1R219	321-0289-03			RES,FXD,FILM:10.0K OHM,0.25%,0.125W,TC=T2	07716	CEAC10001C
A1R222	315-0474-00			RES,FXD,FILM:470K OHM,5%,0.25W	19701	5043CX470K0J92U
A1R225	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A1R226	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R229	321-0226-02			RES,FXD,FILM:2.21K OHM,0.5%,0.125W,TC=T2	91637	MFF1816D22100D
A1R230	321-0193-03			RES,FXD,FILM:1K OHM,0.25%,0.125W,TC=T2	07716	CEAC10000C
A1R235	311-1556-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3352T-DY7-503
A1R236	321-0364-00			RES,FXD,FILM:60.4K OHM,1%,0.125W,TC=T0	19701	5043ED60K40F
A1R238	321-0125-00			RES,FXD,FILM:196 OHM,1%,0.125W, TC=T0	07716	CEAD196R0F
A1R240	321-0226-02			RES,FXD,FILM:2.21K OHM,0.5%,0.125W,TC=T2	91637	MFF1816D22100D
A1R241	321-0193-03			RES,FXD,FILM:1K OHM,0.25%,0.125W,TC=T2	07716	CEAC10000C
A1R243	321-0097-03			RES,FXD,FILM:100 OHM,0.25%,0.125W,TC=T0	91637	CMF55116D100R0C
A1R245	321-0097-03			RES,FXD,FILM:100 OHM,0.25%,0.125W,TC=T0	91637	CMF55116D100R0C
A1R248	321-0030-03			RES,FXD,FILM:20.0 OHM,0.25%,0.125W,TC=T2	57668	CRB14 CYE 20 OHM
A1R250	321-0030-03			RES,FXD,FILM:20.0 OHM,0.25%,0.125W,TC=T2	57668	CRB14 CYE 20 OHM
A1R253	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A1R255	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A1R259	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
A1R260	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
A1R262	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
A1R264	321-0154-00			RES,FXD,FILM:392 OHM,1%,0.125W,TC=T0	07716	CEAD392R0F
A1R270	315-0330-00			RES,FXD,FILM:33 OHM,5%,0.25W	19701	5043CX33R00J
A1R272	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
A1R275	321-0233-00			RES,FXD,FILM:2.61K OHM,1%,0.125W,TC=T0	07716	CEAD26100F
A1R277	311-1599-00	B010100	B041865	RES,VAR,NONWW:PNL,2.5K OHM,1W,W/SW	01121	25M909
A1R277	311-1599-01	B041866		RES,VAR,NONWW:PNL,2.5K OHM,20%,0.5W	01121	25M909
A1R280	311-1239-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3386X-T07-252
A1R670	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
A1R672	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
A1R675	321-0162-00			RES,FXD,FILM:475 OHM,1%,0.125W,TC=T0	19701	5033ED475R0F
A1R677	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R679	315-0303-00			RES,FXD,FILM:30K OHM,5%,0.25W	19701	5043CX30K00J
A1R681	311-1560-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3352T-1-502
A1R683	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A1R685	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A1R686	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A1R688	301-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.5W	19701	5053CX3K300J
A1R693	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A1R694	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A1R697	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A1R698	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R699	321-0220-00			RES,FXD,FILM:1.91K OHM,1%,0.125W,TC=T0	19701	5033ED1K91F
A1R700	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R702	321-0243-00			RES,FXD,FILM:3.32K OHM,1%,0.125W,TC=T0	19701	5033ED3K32F
A1R704	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A1R705	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
A1R706	321-0192-00			RES,FXD,FILM:976 OHM,1%,0.125W,TC=T0	19701	5033ED976R0F
A1R708	311-1567-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3352T-1-101
A1R709	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A1R712	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A1R713	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A1R719	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A1R721	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A1R723	311-1568-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3352T-1-500

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A1R725	321-0125-00			RES,FXD,FILM:196 OHM,1%,0.125W, TC=T0	07716	CEAD196R0F
A1R727	321-0344-00			RES,FXD,FILM:37.4K OHM,1%,0.125W,TC=T0	19701	5033ED 37K40F
A1R729	321-0315-00			RES,FXD,FILM:18.7K OHM,1%,0.125W,TC=T0	19701	5043ED18K70F
A1R730	321-0353-00			RES,FXD,FILM:46.4K OHM,1%,0.125W,TC=T0	07716	CEAD46401F
A1R733	321-0232-00			RES,FXD,FILM:2.55K OHM,1%,0.125W,TC=T0	19701	5043ED2K550F
A1R850	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A1R852	315-0200-00			RES,FXD,FILM:20 OHM,5%,0.25W	19701	5043CX20R00J
A1R854	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
A1R855	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A1R857	315-0363-00			RES,FXD,FILM:36K OHM,5%,0.25W	57668	NTR25J-E36K0
A1R859	315-0104-00			RES,FXD,FILM:100K OHM,5%,0.25W	57668	NTR25J-E100K
A1R860	315-0394-00			RES,FXD,FILM:390K OHM,5%,0.25W	57668	NTR25J-E390K
A1R862	315-0202-00	B010100	B023819	RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
A1R862	315-0911-00	B023820		RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
A1R864	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
A1R866	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A1R868	315-0123-00			RES,FXD,FILM:12K OHM,5%,0.25W	57668	NTR25J-E12K0
A1R869	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R879	315-0394-00			RES,FXD,FILM:390K OHM,5%,0.25W	57668	NTR25J-E390K
A1R880	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R883	315-0221-00			RES,FXD,FILM:220 OHM,5%,0.25W	57668	NTR25J-E220E
A1R893	307-0490-00			RES NTWK,FXD,FI:HIGH VOLTAGE DIVIDER	80009	307-0490-00
A1R911	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A1R913	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A1R915	321-0602-00			RES,FXD,FILM:3.908K OHM,0.25%,0.125W,TC=T2	91637	MFF1816D39080C
A1R917	321-0927-07			RES,FXD,FILM:125 OHM,0.1%,0.125W,TC=T9	19701	5033RE125R0B
A1R987	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
A1R1000	315-0124-00			RES,FXD,FILM:120K OHM,5%,0.25W	19701	5043CX120K0J
A1R1003	321-0234-00			RES,FXD,FILM:2.67K OHM,1%,0.125W,TC=T0	19701	5033ED2K67F
A1R1008	321-0917-03			RES,FXD,FILM:2792K OHM,0.25%,0.125W,TC=T2	19701	5033RD27K20C
A1R1010	321-0268-03			RES,FXD,FILM:6.04K OHM,0.25%,0.125W,T=T2	07716	CEAC60400C
A1R1015	321-0856-03			RES,FXD,FILM:330K OHM,0.25%,0.125W,TC=T2	19701	5033C330K0C
A1R1018	321-0827-03			RES,FXD,FILM:3.61K OHM,0.25%,0.125W,TC=T2	19701	5033RC3K610C
A1R1020	321-0830-03			RES,FXD,FILM:2.41K OHM,0.25%,0.125W,TC=T2	07716	CEAC24100C
A1R1024	321-0200-00			RES,FXD,FILM:1.18K OHM,1%,0.125W,TC=T0	19701	5033ED11K80F
A1R1028	321-0481-03			RES,FXD,FILM:1M OHM,0.25%,0.125W,TC=T2	19701	5033RC1M000C
A1R1030	321-0510-07			RES,FXD,FILM:2.00 MEG OHM,0.1%,0.125W,TC=T0	19701	5033RE2M00B
A1T800	120-1016-00			XFMR,PWR,SDN&SU:HIGH VOLTAGE	80009	120-1016-00
A1T850	108-0828-00			COIL,RF:FXD,56.4UH	80009	108-0828-00
A1TP677	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A1TP850	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A1TP860	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A1U850	152-0634-00			SEMICOND DVC,DI:HV MULTR,SI,6.7KV IN,10KV	60211	VM169
A1U860	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A1VR156	152-0149-00			SEMICOND DVC,DI:ZEN,SI,10V,5%,0.4W,DO-7	15238	Z5406
A1VR256	152-0149-00			SEMICOND DVC,DI:ZEN,SI,10V,5%,0.4W,DO-7	15238	Z5406
A1VR690	152-0227-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ13903
A1VR855	152-0243-00			SEMICOND DVC,DI:ZEN,SI,15V,5%,0.4W,DO-7	04713	SZ13203 (1N965B)
A2	670-3760-04	B010100	B041555	CIRCUIT BD ASSY:FOCUS & INTENSITY	80009	670-3760-04
A2	670-3760-06	B041556		CIRCUIT BD ASSY:FOCUS & INTENSITY	80009	670-3760-06
A2C331	283-0636-00			CAP,FXD,MICA DI:36PF,1.4%,100V	00853	D155E360G0
A2C333	283-0634-00			CAP,FXD,MICA DI:65PF,1%,100V	00853	D155E650F0
A2C338	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A2C353	281-0623-00			CAP,FXD,CER DI:650PF,5%,500V	52763	2RDPLZ007 650PM0
A2C355	281-0546-00			CAP,FXD,CER DI:330PF,10%,500V	52763	2RDPLZ007 330PM0
A2C360	290-0536-00			CAP,FXD,ELCTLT:10UF,20%,25V TANTALUM	05397	T368B106M025AS
A2C387	281-0184-00	B022580		CAP,VAR,PLASTIC:2-18PF,500VDC	TK1727	2222-809-05003
A2C388	283-0636-00			CAP,FXD,MICA DI:36PF,1.4%,100V	00853	D155E360G0

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A2C389	283-0677-00	B010100	B022579	CAP,FXD,MICA DI:82PF,1%,500V	00853	D155E820F0
A2C389	283-0647-00	B022580		CAP,FXD,MICA DI:70PF,1%,100V	00853	D155E700F0
A2C397	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A2C425	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A2C435	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A2C456	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A2C465	281-0543-00			CAP,FXD,CER DI:270PF,10%,500V	52763	2RDPLZ007 27P0M0
A2C467	281-0662-00			CAP,FXD,CER DI:10PF,+/-0.5PF,500V	52763	2RDPLZ007 10P0DE
A2C473	281-0205-00	B010100	B021841	CAP,VAR,PLASTIC:5.5-65 PF,100V	TK1727	2222-808-32659
A2C473	281-0208-00	B021842		CAP,VAR,PLASTIC:5.5-50PF,100V	52769	109-4931-060
A2C474	281-0205-00	B010100	B021841	CAP,VAR,PLASTIC:5.5-65 PF,100V	TK1727	2222-808-32659
A2C474	281-0208-00	B021842		CAP,VAR,PLASTIC:5.5-50PF,100V	52769	109-4931-060
A2C476	283-0677-00			CAP,FXD,MICA DI:82PF,1%,500V	00853	D155E820F0
A2C479	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V	59660	831-610-Y5U0102P
A2C480	283-0167-00			CAP,FXD,CER DI:0.1UF,10%,100V	04222	3430-100C-104K
A2C800	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A2C830	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A2C834	281-0661-00			CAP,FXD,CER DI:0.8PF,+/-0.1PF,500V	52763	2RDPLZ007 0P80BC
A2C835	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A2C838	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A2C841	283-0167-00			CAP,FXD,CER DI:0.1UF,10%,100V	04222	3430-100C-104K
A2C842	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A2C844	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A2C846	283-0167-00			CAP,FXD,CER DI:0.1UF,10%,100V	04222	3430-100C-104K
A2C875	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
A2C876	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
A2C877	290-0164-00			CAP,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA2R2
A2C890	283-0003-00	B010100	B039279	CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A2C895	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A2CR800	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A2CR802	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A2CR821	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A2CR841	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A2CR842	152-0061-00			SEMICOND DVC,DI:SW,SI,175V,0.1A,DO-35	07263	FDH2161
A2L470	108-0054-00			COIL,RF:FIXED,6.9UF	80009	108-0054-00
A2L475	108-0054-00			COIL,RF:FIXED,6.9UF	80009	108-0054-00
A2L870	108-0240-00			COIL,RF:FIXED,820UH	76493	B5147
A2L875	108-0240-00			COIL,RF:FIXED,820UH	76493	B5147
A2LR360	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A2LR840	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A2Q320	151-0437-00			TRANSISTOR:SELECTED	80009	151-0437-00
A2Q325	151-0437-00			TRANSISTOR:SELECTED	80009	151-0437-00
A2Q330	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q335	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q340	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A2Q345	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A2Q350	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A2Q355	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q365	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q375	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q380	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q385	151-0437-00			TRANSISTOR:SELECTED	80009	151-0437-00
A2Q390	151-0437-00			TRANSISTOR:SELECTED	80009	151-0437-00
A2Q400	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A2Q405	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A2Q410	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q415	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q417	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00

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A2Q419	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A2Q425	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q430	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q450	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A2Q455	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A2Q460	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A2Q465	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
A2Q470	151-0103-00			TRANSISTOR:NPN,SI,TO-5	04713	SM1307
A2Q475	151-0103-00			TRANSISTOR:NPN,SI,TO-5	04713	SM1307
A2Q800	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q805	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q815	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q820	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A2Q825	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q830	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A2Q835	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A2Q840	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
A2Q845	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A2R320	321-0131-00			RES,FXD,FILM:226 OHM,1%,0.125W,TC=T0	19701	5043ED226R0F
A2R322	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
A2R324	311-1802-00			RES,VAR,NONWW:PNL,2 X 500 OHM,10%,0.5W	32997	81C2DK29BA0023
A2R325	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
A2R327	321-0131-00			RES,FXD,FILM:226 OHM,1%,0.125W,TC=T0	19701	5043ED226R0F
A2R329	321-0113-00			RES,FXD,FILM:147 OHM,1%,0.125W,TC=T0	07716	CEAD147R0F
A2R331	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A2R333	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
A2R335	311-1594-00			RES,VAR,NONWW:TRMR,10 OHM,0.5W	32997	3352T-1-100
A2R336	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
A2R338	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
A2R340	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A2R341	321-0229-00			RES,FXD,FILM:2.37K OHM,1%,0.125W,TC=T0	19701	5043ED2K37F
A2R343	321-0229-00			RES,FXD,FILM:2.37K OHM,1%,0.125W,TC=T0	19701	5043ED2K37F
A2R345	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A2R346	321-0116-00			RES,FXD,FILM:158 OHM,1%,0.125W,TC=T0	07716	CEAD158R0F
A2R350	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A2R352	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A2R353	315-0182-00			RES,FXD,FILM:1.8K OHM,5%,0.25W	57668	NTR25J-E1K8
A2R355	315-0682-00			RES,FXD,FILM:6.8K OHM,5%,0.25W	57668	NTR25J-E06K8
A2R356	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A2R358	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A2R359	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A2R360	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A2R362	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A2R364	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A2R365	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A2R367	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A2R368	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A2R370	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A2R372	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A2R373	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A2R375	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A2R381	321-0131-00			RES,FXD,FILM:226 OHM,1%,0.125W,TC=T0	19701	5043ED226R0F
A2R383	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
A2R386	321-0113-00			RES,FXD,FILM:147 OHM,1%,0.125W,TC=T0	07716	CEAD147R0F
A2R388	322-0170-00			RES,FXD,FILM:576 OHM,1%,0.25W,TC=T0	75042	CEBT0-5760F
A2R389	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A2R390	321-0131-00			RES,FXD,FILM:226 OHM,1%,0.125W,TC=T0	19701	5043ED226R0F
A2R392	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F

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A2R394	311-1594-00			RES,VAR,NONWW:TRMR,10 OHM,0.5W	32997	3352T-1-100
A2R396	321-0097-00			RES,FXD,FILM:100 OHM,1%,0.125W,TC=T0	91637	CMF55116G100R0F
A2R397	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
A2R399	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A2R400	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A2R401	321-0229-00			RES,FXD,FILM:2.37K OHM,1%,0.125W,TC=T0	19701	5043ED2K37F
A2R404	321-0229-00			RES,FXD,FILM:2.37K OHM,1%,0.125W,TC=T0	19701	5043ED2K37F
A2R405	321-0116-00			RES,FXD,FILM:158 OHM,1%,0.125W,TC=T0	07716	CEAD158R0F
A2R409	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A2R411	315-0152-00			RES,FXD,FILM:1.5K OHM,5%,0.25W	57668	NTR25J-E01K5
A2R413	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A2R425	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
A2R427	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
A2R429	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
A2R431	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
A2R433	311-1563-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3352T-DY7-102
A2R435	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
A2R445	321-0083-00			RES,FXD,FILM:71.5 OHM,1%,0.125W,TC=T0	07716	CEAD71R50F
A2R447	322-0178-00			RES,FXD,FILM:698 OHM,1%,0.25W,TC=T0	75042	CEBT0-6980F
A2R449	321-0253-00			RES,FXD,FILM:4.22K OHM,1%,0.125W,TC=T0	19701	5033ED 4K 220F
A2R450	321-0270-00			RES,FXD,FILM:6.34K OHM,1%,0.125W,TC=T0	19701	5043ED6K340F
A2R453	321-0083-00			RES,FXD,FILM:71.5 OHM,1%,0.125W,TC=T0	07716	CEAD71R50F
A2R454	322-0178-00			RES,FXD,FILM:698 OHM,1%,0.25W,TC=T0	75042	CEBT0-6980F
A2R456	321-0151-00			RES,FXD,FILM:365 OHM,1%,0.125W,TC=T0	07716	CEAD365R0F
A2R458	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
A2R460	322-0180-00			RES,FXD,FILM:732 OHM,1%,0.25W,TC=T0	75042	CEBT0-7320F
A2R461	322-0180-00			RES,FXD,FILM:732 OHM,1%,0.25W,TC=T0	75042	CEBT0-7320F
A2R465	311-1559-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3352T-1-103
A2R467	321-0151-00			RES,FXD,FILM:365 OHM,1%,0.125W,TC=T0	07716	CEAD365R0F
A2R469	321-0085-00			RES,FXD,FILM:75 OHM,1%,0.125W,TC=T0	57668	CRB14FXE 75 OHM
A2R470	321-0103-00			RES,FXD,FILM:115 OHM,1%,0.125W,TC=T0	01121	RNK1150F
A2R473	311-1563-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3352T-DY7-102
A2R475	308-0783-00			RES,FXD,WW:1K OHM,1%,3W,TC=30PPM	91637	NS2BA 10000F
A2R476	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
A2R478	321-0286-00			RES,FXD,FILM:9.31K OHM,1%,0.125W,TC=T0	19701	5043ED9K310F
A2R479	321-0221-00			RES,FXD,FILM:1.96K OHM,1%,0.125W,TC=T0	19701	5043ED1K960F
A2R480	315-0680-00			RES,FXD,FILM:68 OHM,5%,0.25W	57668	NTR25J-E68E0
A2R481	308-0783-00			RES,FXD,WW:1K OHM,1%,3W,TC=30PPM	91637	NS2BA 10000F
A2R800	315-0471-00	B010100	B021189	RES,FXD,FILM:470 OHM,5%,0.25W	57668	NTR25J-E470E
A2R800	315-0301-00	B021190		RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
A2R802	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A2R805	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A2R808	321-0204-00			RES,FXD,FILM:1.30K OHM,1%,0.125W,TC=T0	19701	5033ED1K300F
A2R809	321-0248-00			RES,FXD,FILM:3.74K OHM,1%,0.125W,TC=T0	19701	5043ED3K740F
A2R811	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A2R813	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A2R815	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A2R816	315-0161-00	B010100	B021189	RES,FXD,FILM:160 OHM,5%,0.25W	57668	NTR25J-E 160E
A2R816	315-0331-00	B021190		RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
A2R817	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A2R820	315-0510-00			RES,FXD,FILM:51 OHM,5%,0.25W	19701	5043CX51R00J
A2R821	315-0122-00			RES,FXD,FILM:1.2K OHM,5%,0.25W	57668	NTR25J-E01K2
A2R822	315-0564-00			RES,FXD,FILM:560K OHM,5%,0.25W	19701	5043CX560K0J
A2R824	321-0278-00			RES,FXD,FILM:7.68K OHM,1%,0.125W,TC=T0	07716	CEAD76800F
A2R826	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
A2R830	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A2R831	311-1801-00			RES,VAR,NONWW:PNL,1K OHM,20%,1W	01121	13M499
A2R833	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E

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A2R834	321-0335-00			RES,FXD,FILM:30.1K OHM,1%,0.125W,TC=T0	57668	RB14FXE30K1
A2R836	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A2R838	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A2R839	315-0753-00			RES,FXD,FILM:75K OHM,5%,0.25W	57668	NTR25J-E75K0
A2R841	315-0201-00			RES,FXD,FILM:200 OHM,5%,0.25W	57668	NTR25J-E200E
A2R843	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A2R844	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A2R846	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A2R873	311-1556-00			RES,VAR,NONWW:TRMR,50K OHM,0.5W	32997	3352T-DY7-503
A2R875	315-0203-00			RES,FXD,FILM:20K OHM,5%,0.25W	57668	NTR25J-E 20K
A2R894	311-0349-00	B010100	B041555	RES,VAR,NONWW:PNL,2MEG OHM,0.5W	12697	CM30940
A2R894	311-2282-00	B041556		RES,VAR,NONWW:PNL,2.5 MEGA OHM,1.0W	12697	CM43482
A2R895	311-1559-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3352T-1-103
A2R897	311-1555-00	B010100	B039279	RES,VAR,NONWW:TRMR,100K OHM,0.5W	32997	3352T-1-104
A2R899	311-1555-00			RES,VAR,NONWW:TRMR,100K OHM,0.5W	32997	3352T-1-104
A2S400	260-1310-01			SWITCH,PUSH:4PDT MOMENTARY,NON-SHORTING	31918	ORDER BY DESCR
A2U355	156-0057-02			MICROCKT,DGTL:QUAD 2-INP NAND GATE,SCRN	01295	SN7401NP3
A2U360	156-0038-02			MICROCKT,DGTL:J-K MASTER SLAVE FF,SCRN	01295	SN7472NP3
A2W890	131-0566-00	B039280		BUS,CONDUCTOR:DUMMY RES,0.094 X 0.225	24546	OMA 07
A3	670-3759-00	B010100	B022579	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-00
A3	670-3759-01	B022580	B039279	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-01
A3	670-3759-02	B039280	B039879	CIRCUIT BD ASSY:TRIGGER	80009	670-3759-02
A3	670-3759-03	B039880		CIRCUIT BD ASSY:TRIGGER	80009	670-3759-03
A3C316	281-0605-00			CAP,FXD,CER DI:200PF,10%,500V	59660	301000Y5D201K
A3C500	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C501	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C507	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A3C508	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C510	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C514	281-0519-00			CAP,FXD,CER DI:47PF,+/-4.7PF,500V	52763	2RDPLZ007 47POKC
A3C515	283-0002-00			CAP,FXD,CER DI:0.01UF,+80-20%,500V	59821	D103Z40Z5ULADEG
A3C516	281-0207-00			CAP,VAR,PLASTIC:2-18PF,100V	52769	GXA 18000
A3C518	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C520	281-0512-00			CAP,FXD,CER DI:27PF,+/-2.7PF,500V	52763	2RDPLZ007 27POKC
A3C521	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A3C530	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C535	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A3C539	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C545	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C548	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C550	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C552	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C561	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C567	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C575	283-0003-00	B039280		CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A3C577	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C590	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C592	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C595	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C600	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C603	281-0516-00			CAP,FXD,CER DI:39PF,+/-3.9PF,500V	52763	2RDPLZ007 39POKU
A3C622	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C635	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C643	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C648	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A3C649	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C652	281-0605-00			CAP,FXD,CER DI:200PF,10%,500V	59660	301000Y5D201K
A3C655	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ

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A3C660	281-0543-00			CAP,FXD,CER DI:270PF,10%,500V	52763	2RDPLZ007 27POMO
A3C662	290-0523-00			CAP,FXD,ELCTLT:2.2UF,20%,20V	05397	T368A225M020AS
A3C667	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C900	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C902	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C905	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
A3C930	281-0525-00			CAP,FXD,CER DI:470PF,+/-94PF,500V	52763	2RDPLZ007 470PMO
A3C932	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A3C935	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C940	290-0525-00			CAP,FXD,ELCTLT:4.7UF,20%,50V	05397	T368B475M050AS
A3C943	290-0525-00			CAP,FXD,ELCTLT:4.7UF,20%,50V	05397	T368B475M050AS
A3C947	281-0536-00			CAP,FXD,CER DI:1000PF,10%,500V	52763	2RDPLZ007 1NOOMO
A3C950	290-0522-00			CAP,FXD,ELCTLT:1UF,20%,50V	05397	T368A105M050AZ
A3C967	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A3C980	290-0512-00			CAP,FXD,ELCTLT:22UF,20%,15V	05397	T368B226M015AS
A3CR310	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR500	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR515	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR516	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR518	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR519	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR617	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR620	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR622	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR625	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR627	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR648	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR649	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR657	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR662	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR900	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
A3CR902	152-0107-00			SEMICOND DVC,DI:RECT,SI,400 V,400MA,A1	12969	"G727"
A3CR927	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR929	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR930	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR932	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR940	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A3CR943	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A3CR945	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR950	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A3CR980	152-0066-00			SEMICOND DVC,DI:RECT,SI,400V,1A,DO-41	05828	GP10G-020
A3F800	159-0029-00			FUSE,CARTRIDGE:3AG,0.3A,250V,20SEC	71400	MDL 3/10
A3F970	159-0042-00			FUSE,CARTRIDGE:3AG,0.75A,250V,0.15SEC	75915	312.750
A3LR500	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR530	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR535	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR548	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR592	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR600	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR635	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3LR667	108-0245-00			CHOKE,RF:FIXED,3.9UH	76493	B6310-1
A3Q300	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q310	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q315	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q435	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q440	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q500	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q510	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919

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A3Q520	151-1042-00			SEMICOND DVC SE:FET,SI,TO-92	04713	SPF627M2
A3Q525	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A3Q530	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A3Q540	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q550	151-0216-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS8803
A3Q555	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A3Q560	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
A3Q565	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A3Q575	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q580	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q625	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q630	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q655	151-0188-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0188-00
A3Q660	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q665	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q670	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q715	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q930	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q933	151-1005-00	B039880		TRANSISTOR:FET,N-CHAN,SI,TO-106	04713	SPF685
A3Q935	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3Q940	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
A3Q950	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q955	151-0342-00			TRANSISTOR:PNP,SI,TO-92	07263	S035928
A3Q958	151-1005-00	B039880		TRANSISTOR:FET,N-CHAN,SI,TO-106	04713	SPF685
A3Q960	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A3Q965	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A3R300	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A3R302	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R304	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R310	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R312	321-0302-00			RES,FXD,FILM:13.7K OHM,1%,0.125W,TC=T0	07716	CEAD 13701F
A3R315	321-0307-00			RES,FXD,FILM:15.4K OHM,1%,0.125W,TC=T0	19701	5043ED15K40F
A3R316	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R318	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A3R437	321-0240-00			RES,FXD,FILM:3.09K OHM,1%,0.125W,TC=T0	07716	CEAD30900F
A3R438	321-0126-00	B010100	B039279	RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
A3R438	315-0301-00	B039280		RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
A3R440	321-0240-00			RES,FXD,FILM:3.09K OHM,1%,0.125W,TC=T0	07716	CEAD30900F
A3R500	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
A3R501	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A3R503	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R505	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
A3R507	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A3R509	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A3R510	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R512	321-0452-00			RES,FXD,FILM:499K OHM,1%,0.125W,TC=T0	19701	5043ED499K0F
A3R514	315-0271-00			RES,FXD,FILM:270 OHM,5%,0.25W	57668	NTR25J-E270E
A3R516	321-0452-00			RES,FXD,FILM:499K OHM,1%,0.125W,TC=T0	19701	5043ED499K0F
A3R518	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R520	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J
A3R521	315-0240-00			RES,FXD,FILM:24 OHM,5%,0.25W	57668	NTR25J-E24E0
A3R523	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R525	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R527	321-0112-00			RES,FXD,FILM:143 OHM,1%,0.125W,TC=T0	07716	CEAD143R0F
A3R529	321-0249-00			RES,FXD,FILM:3.83K OHM,1%,0.125W,TC=T0	19701	5033ED3K83F
A3R530	321-0249-00			RES,FXD,FILM:3.83K OHM,1%,0.125W,TC=T0	19701	5033ED3K83F
A3R535	311-1568-00			RES,VAR,NONWW:TRMR,50 OHM,0.5W	32997	3352T-1-500
A3R537	315-0431-00			RES,FXD,FILM:430 OHM,5%,0.25W	19701	5043CX430R0J

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A3R540	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
A3R543	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R545	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R546	315-0101-00	B010100	B021020	RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A3R546	315-0111-00	B021021		RES,FXD,FILM:110 OHM,5%,0.25W	57668	NTR25J-E110E
A3R548	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A3R550	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R552	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A3R555	315-0155-00			RES,FXD,FILM:1.5M OHM,5%,0.25W	19701	5043CX1M500J
A3R556	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
A3R557	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R558	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A3R562	315-0155-00			RES,FXD,FILM:1.5M OHM,5%,0.25W	19701	5043CX1M500J
A3R564	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R567	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A3R568	315-0562-00			RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
A3R569	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A3R575	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R577	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R578	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
A3R579	315-0301-00			RES,FXD,FILM:300 OHM,5%,0.25W	57668	NTR25J-E300E
A3R580	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R581	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
A3R583	315-0911-00	B010100	B039279	RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
A3R583	315-0621-00	B039280		RES,FXD,FILM:620 OHM,5%,0.25W	57668	NTR25J-E620E
A3R585	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
A3R587	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R588	315-0133-00			RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
A3R590	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R595	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R596	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R598	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R600	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R602	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R603	315-0113-00			RES,FXD,FILM:11K OHM,5%,0.25W	19701	5043CX11K00J
A3R605	315-0222-00			RES,FXD,FILM:2.2K OHM,5%,0.25W	57668	NTR25J-E02K2
A3R607	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
A3R608	315-0113-00			RES,FXD,FILM:11K OHM,5%,0.25W	19701	5043CX11K00J
A3R610	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A3R611	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A3R613	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R614	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R615	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R617	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A3R619	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R620	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R622	315-0183-00			RES,FXD,FILM:18K OHM,5%,0.25W	19701	5043CX18K00J
A3R625	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A3R630	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R631	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A3R633	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
A3R635	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R637	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A3R640	321-0220-00			RES,FXD,FILM:1.91K OHM,1%,0.125W,TC=T0	19701	5033ED1K91F
A3R641	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
A3R643	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
A3R645	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
A3R648	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0

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A3R649	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A3R651	315-0124-00			RES,FXD,FILM:120K OHM,5%,0.25W	19701	5043CX120K0J
A3R653	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A3R655	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R657	301-0471-00			RES,FXD,FILM:470 OHM,5%,0.5W	19701	5053CX 470R0J
A3R659	321-0227-00			RES,FXD,FILM:2.26K OHM,1%,0.125W,TC=T0	01121	RNK2261F
A3R660	321-0269-00			RES,FXD,FILM:6.19K OHM,1%,0.125W,TC=T0	07716	CEAD61900F
A3R662	315-0824-00			RES,FXD,FILM:820K OHM,5%,0.25W	19701	5043CX820K0J
A3R664	315-0434-00			RES,FXD,FILM:430K OHM,5%,0.25W	57668	NTR25J-E430K
A3R665	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R667	315-0332-00			RES,FXD,FILM:3.3K OHM,5%,0.25W	57668	NTR25J-E03K3
A3R715	321-0216-00			RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0	07716	CEAD17400F
A3R716	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
A3R900	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A3R902	315-0562-00			RES,FXD,FILM:5.6K OHM,5%,0.25W	57668	NTR25J-E05K6
A3R905	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R907	315-0472-00			RES,FXD,FILM:4.7K OHM,5%,0.25W	57668	NTR25J-E04K7
A3R909	315-0132-00			RES,FXD,FILM:1.3K OHM,5%,0.25W	57668	NTR25J-E01K3
A3R922	321-0236-00			RES,FXD,FILM:2.80K OHM,1%,0.125W,TC=T0	07716	CEAD28000F
A3R925	311-1571-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3352W-1-501
A3R927	321-0263-00			RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0	07716	CEAD53600F
A3R929	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
A3R930	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A3R932	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R934	315-0133-00			RES,FXD,FILM:13K OHM,5%,0.25W	19701	5043CX13K00J
A3R935	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R937	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R939	315-0131-00	B010100	B039879	RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R940	308-0685-00			RES,FXD,WW:1.5 OHM,5%,1W	75042	BW-20-1R500J
A3R943	308-0767-00			RES,FXD,WW:1.1 OHM,5%,1W	75042	BW-20-1R100J
A3R945	321-0263-00			RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0	07716	CEAD53600F
A3R947	311-1571-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3352W-1-501
A3R949	321-0236-00			RES,FXD,FILM:2.80K OHM,1%,0.125W,TC=T0	07716	CEAD28000F
A3R951	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A3R953	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A3R955	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
A3R956	315-0113-00			RES,FXD,FILM:11K OHM,5%,0.25W	19701	5043CX11K00J
A3R957	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R959	315-0333-00			RES,FXD,FILM:33K OHM,5%,0.25W	57668	NTR25J-E33K0
A3R960	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A3R961	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R963	315-0131-00	B010100	B039879	RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A3R965	321-0306-01			RES,FXD,FILM:15.0K OHM,0.5%,0.125W,TC=T0	07716	CEAD15001D
A3R967	321-0764-01			RES,FXD,FILM:5.09K OHM,0.5%,0.125W,TC=T0	19701	5033RD5K090D
A3R969	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A3R973	315-0361-00			RES,FXD,FILM:360 OHM,5%,0.25W	19701	5043CX360R0J
A3R975	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A3R979	315-0181-00			RES,FXD,FILM:180 OHM,5%,0.25W	57668	NTR25J-E180E
A3R982	308-0441-00			RES,FXD,WW:3 OHM,5%,3W	14193	SA31-3R00J
A3S500	263-0013-04			SWITCH PB ASSY:3 LATCHING,10 MM,7 CONTACT	80009	263-0013-04
A3S550	260-1778-00			SWITCH,PUSH:4 BUTTON,2/4 POLE,COUPLING	31918	ORDER BY DESCR
A3S600	263-0011-04			SWITCH PB ASSY:1 PUSH,10MM	80009	263-0011-04
A3TP940	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A3TP941	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A3TP942	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A3TP980	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A3U595	155-0109-00	B010100	B021539	MICROCKT,LINEAR:TRIGGER	80009	155-0109-00
A3U595	155-0109-01	B021540		MICROCKT,LINEAR:MONOLITHIC TRIG	80009	155-0109-01

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A3U600	156-0369-00			MICROCKT,DGTL:ECL,TRIPLE LINE RECEIVER	04713	MC10216 P OR L
A3U650	155-0049-01	B010100	B022749	MICROCKT,DGTL:W/LOCKOUT DSBL FCTN	80009	155-0049-01
A3U650	155-0049-02	B022750		MICROCKT,DGTL:SWEEP CNTRL,W/LOCKOUT DISABLE	80009	155-0049-02
A3U930	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A3U950	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A3U960	156-0067-00			MICROCKT,LINEAR:OPNL AMPL,SEL	04713	MC1741CP1
A3VR930	152-0227-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ13903
A3VR950	152-0227-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ13903
A3VR969	152-0175-00			SEMICOND DVC,DI:ZEN,SI,5.6V,5%,0.4W,DO-7	14552	TD3810976
A4	670-3761-00			CIRCUIT BD ASSY:HORIZONTAL DEFLECTION	80009	670-3761-00
A4C740	283-0178-00			CAP,FXD,CER DI:0.1UF,20%,100V	05397	C330C104Z1U1CA
A4C742	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A4C744	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A4C746	290-0534-00			CAP,FXD,ELCTLT:1UF,20%,35V	05397	T368A105M035AZ
A4C748	283-0178-00			CAP,FXD,CER DI:0.1UF,20%,100V	05397	C330C104Z1U1CA
A4C766	281-0605-00			CAP,FXD,CER DI:200PF,10%,500V	59660	301000Y5D201K
A4C771	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C773	281-0619-00			CAP,FXD,CER DI:1.2PF,+/-0.1PF,500V	52763	2RDPLZ007 1P20BC
A4C775	283-0023-00			CAP,FXD,CER DI:0.1UF,+80-20%,12V	71590	2DDU66B104Z
A4C776	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C781	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C783	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C785	281-0619-00			CAP,FXD,CER DI:1.2PF,+/-0.1PF,500V	52763	2RDPLZ007 1P20BC
A4C790	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C791	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C793	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4C797	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V	59821	D103Z40Z5UJDCEX
A4CR768	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A4CR770	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A4CR772	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A4CR785	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A4CR786	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
A4Q745	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A4Q755	151-0341-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS6919
A4Q765	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
A4Q770	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A4Q775	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
A4Q780	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A4Q785	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
A4Q790	151-0350-00			TRANSISTOR:PNP,SI,TO-92	04713	SPS6700
A4Q795	151-0347-00			TRANSISTOR:NPN,SI,TO-92	04713	SPS7951
A4R740	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A4R742	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R744	315-0150-00			RES,FXD,FILM:15 OHM,5%,0.25W	19701	5043CX15R00J
A4R746	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R748	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A4R749	321-0293-00			RES,FXD,FILM:11.0K OHM,1%,0.125W,TC=T0	07716	CEAD11001F
A4R750	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A4R753	321-0231-00			RES,FXD,FILM:2.49K OHM,1%,0.125W,TC=T0	19701	5033ED2K49F
A4R755	321-0288-00			RES,FXD,FILM:9.76K OHM,1%,0.125W,TC=T0	19701	5033ED9K760F
A4R757	321-0261-00			RES,FXD,FILM:5.11K OHM,1%,0.125W,TC=T0	19701	5033ED5K110F
A4R759	321-0136-00			RES,FXD,FILM:255 OHM,1%,0.125W,TC=T0	07716	CEAD255R0F
A4R760	311-1567-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W	32997	3352T-1-101
A4R762	321-0136-00			RES,FXD,FILM:255 OHM,1%,0.125W,TC=T0	07716	CEAD255R0F
A4R764	315-0131-00			RES,FXD,FILM:130 OHM,5%,0.25W	19701	5043CX130R0J
A4R765	321-0292-00			RES,FXD,FILM:10.7K OHM,1%,0.125W,TC=T0	07716	CEAD10701F
A4R766	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
A4R768	321-0125-00			RES,FXD,FILM:196 OHM,1%,0.125W, TC=T0	07716	CEAD196R0F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A4R770	311-1565-00			RES,VAR,NONWW:TRMR,250 OHM,0.5W	32997	3352T-1-251
A4R771	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
A4R773	321-0339-00			RES,FXD,FILM:33.2K OHM,1%,0.125W,TC=T0	07716	CEAD33201F
A4R775	315-0511-00			RES,FXD,FILM:510 OHM,5%,0.25W	19701	5043CX510R0J
A4R777	315-0821-00			RES,FXD,FILM:820 OHM,5%,0.25W	19701	5043CX820R0J
A4R779	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
A4R781	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R783	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A4R785	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R786	315-0433-00			RES,FXD,FILM:43K OHM,5%,0.25W	19701	5043CX43K00J
A4R788	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
A4R789	321-0339-00			RES,FXD,FILM:33.2K OHM,1%,0.125W,TC=T0	07716	CEAD33201F
A4R790	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
A4R792	315-0242-00			RES,FXD,FILM:2.4K OHM,5%,0.25W	57668	NTR25J-E02K4
A4R793	315-0272-00			RES,FXD,FILM:2.7K OHM,5%,0.25W	57668	NTR25J-E02K7
A4R795	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R797	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
A4R798	315-0620-00			RES,FXD,FILM:62 OHM,5%,0.25W	19701	5043CX63R00J
A4R799	315-0243-00			RES,FXD,FILM:24K OHM,5%,0.25W	57668	NTR25J-E24K0
A4TP745	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A4VR781	152-0227-00			SEMICOND DVC,DI:ZEN,SI,6.2V,5%,0.4W,DO-7	04713	SZ13903
A4VR795	152-0590-00			SEMICOND DVC,DI:ZEN,SI,18V,5%,0.4W,DO-7	04713	SZG35014K2
A5	670-3821-00	B010100	B039879	CIRCUIT BD ASSY:AUXILIARY HIGH VOLTAGE	80009	670-3821-00
A5	670-3821-01	B039880		CIRCUIT BD ASSY:HIGH VOLTAGE	80009	670-3821-01
A5C881	283-0044-00			CAP,FXD,CER DI:1000PF,20%,3000V	51406	DHA12Y5S102M3KV
A5C882	283-0044-00			CAP,FXD,CER DI:1000PF,20%,3000V	51406	DHA12Y5S102M3KV
A5C883	283-0043-00			CAP,FXD,CER DI:6800PF,100-0%,3000V	51406	DHA23Z5U682P3KV
A5C885	283-0263-00			CAP,FXD,CER DI:2200PF,20%,3000V	59660	828556Y5R0222M
A5C887	283-0044-00			CAP,FXD,CER DI:1000PF,20%,3000V	51406	DHA12Y5S102M3KV
A5CR881	152-0429-00			SEMICOND DVC,DI:RECT,SI,5000V,10MA,A298J	83003	VG5X-1
A5CR884	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A5CR885	152-0242-00			SEMICOND DVC,DI:SIG,SI,225V,0.2A,DO-7	07263	FDH5004
A5DS880	119-0181-00	B039880		ARSR,ELEC SURGE:230,GAS FILLED	25088	B1-A230
A5R882	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
A5R885	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
A5R886	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A5R888	315-0226-00			RES,FXD,FILM:22M OHM,5%,0.25W	80009	315-0226-00
A5R889	308-0710-00	B010100	B021109	RES,FXD,WW:0.27 OHM,10%,1W	75042	BW-20-R2700J
A5R889	308-0760-00	B021110		RES,FXD,WW:0.2 OHM,10%,2W	30487	ALSR-2-0.2-10%
A5R891	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
A5VR880	150-0111-00	B010100	B039879	LAMP,GLOW:125V MAX,1.5MA,2AC-AT,WIRE	53944	A1B-9
A5VR890	150-0111-00	B010100	B039879	LAMP,GLOW:125V MAX,1.5MA,2AC-AT,WIRE	53944	A1B-9
	----- -----			CHASSIS PARTS		
DL400	119-0690-00	B010100	B022529	DELAY LINE,ELEC:140NS	80009	119-0690-00
DL400	119-0690-01	B022530		DELAY LINE,ELEC:140NS	80009	119-0690-01
DS640	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	58361	Q6480/MV5274C
DS980	150-1029-00			LT EMITTING DIO:GREEN,565NM,35MA	58361	Q6480/MV5274C
J100	131-1315-01	B010100	B025519	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
J100	131-1315-01	B025520		CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
J200	131-1315-01	B010100	B025519	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
J200	131-1315-01	B025520		CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
J500	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
L895	108-0829-00			COIL,TUBE DEFL:FIXED,TRACE ROTATOR	80009	108-0829-00
Q970	151-0405-00			TRANSISTOR:SELECTED	04713	SJE943
R560	311-1192-00			RES,VAR,NONWW:PNL,10K OHM,1W,W/SW (PART OF S560)	12697	381-CM39695

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R674	311-1803-00			RES,VAR,NONWW:PNL,20K OHM,10%,1W,RTRY DPST (PART OF S700)	01121	25M910
R714	311-0642-00			RES,VAR,NONWW:PNL,20K OHM,0.5W	01121	W-7707
S100	263-1128-00			SW CAM ACTR AS:VOLTS/DIV/AC-GND-DC	80009	263-1128-00
S150	----- -----			(PART OF S100)		
S200	263-1128-00			SW CAM ACTR AS:VOLTS/DIV/AC-GND-DC	80009	263-1128-00
S250	----- -----			(PART OF S200)		
S300	263-1129-00			SW CAM ACTR AS:DISPLAY MODE	80009	263-1129-00
S560	----- -----			(PART OF R560)		
S700	----- -----			(PART OF R674)		
S1000	263-1130-00			SW CAM ACTR AS:SECONDS/DIV	80009	263-1130-00
V800	154-0730-05	B010100	B039279	ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0730-05
V800	154-0859-00	B039280	B040669	ELECTRON TUBE:CRT,P31,INTERNAL SCALE	80009	154-0859-00
V800	154-0859-01	B040670		ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0859-01

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

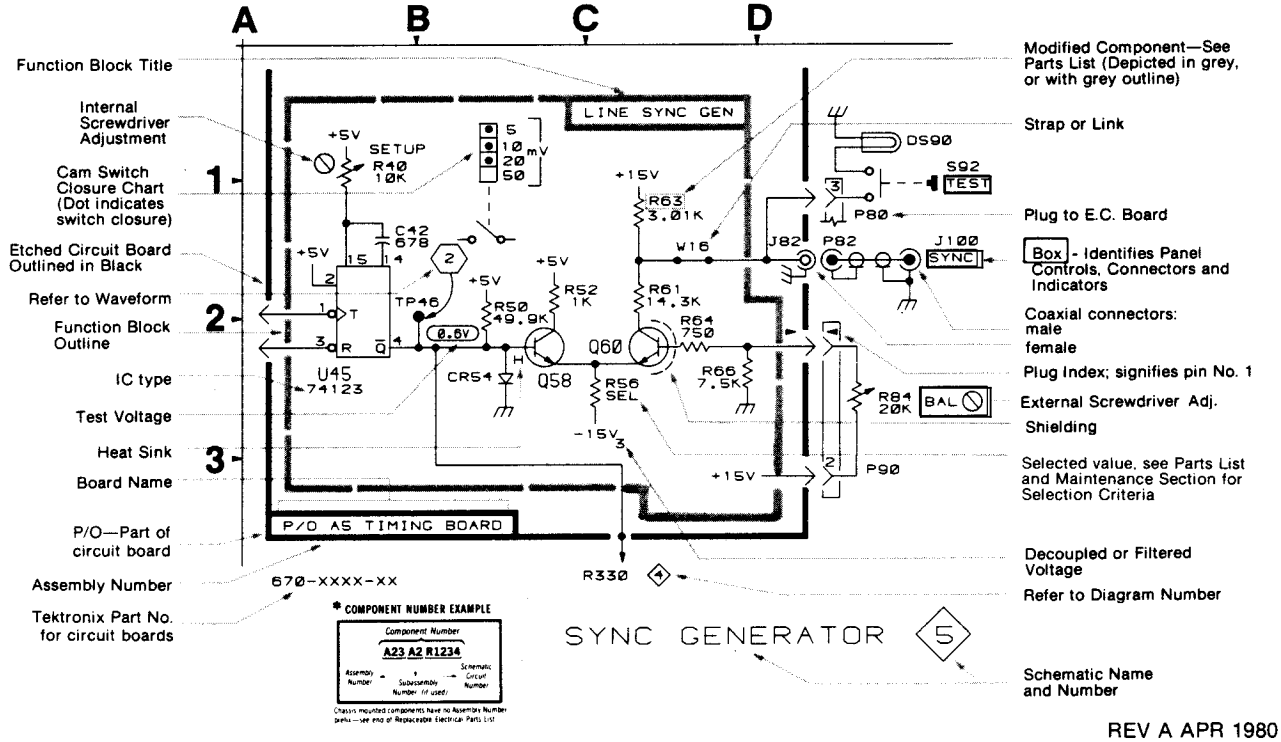
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



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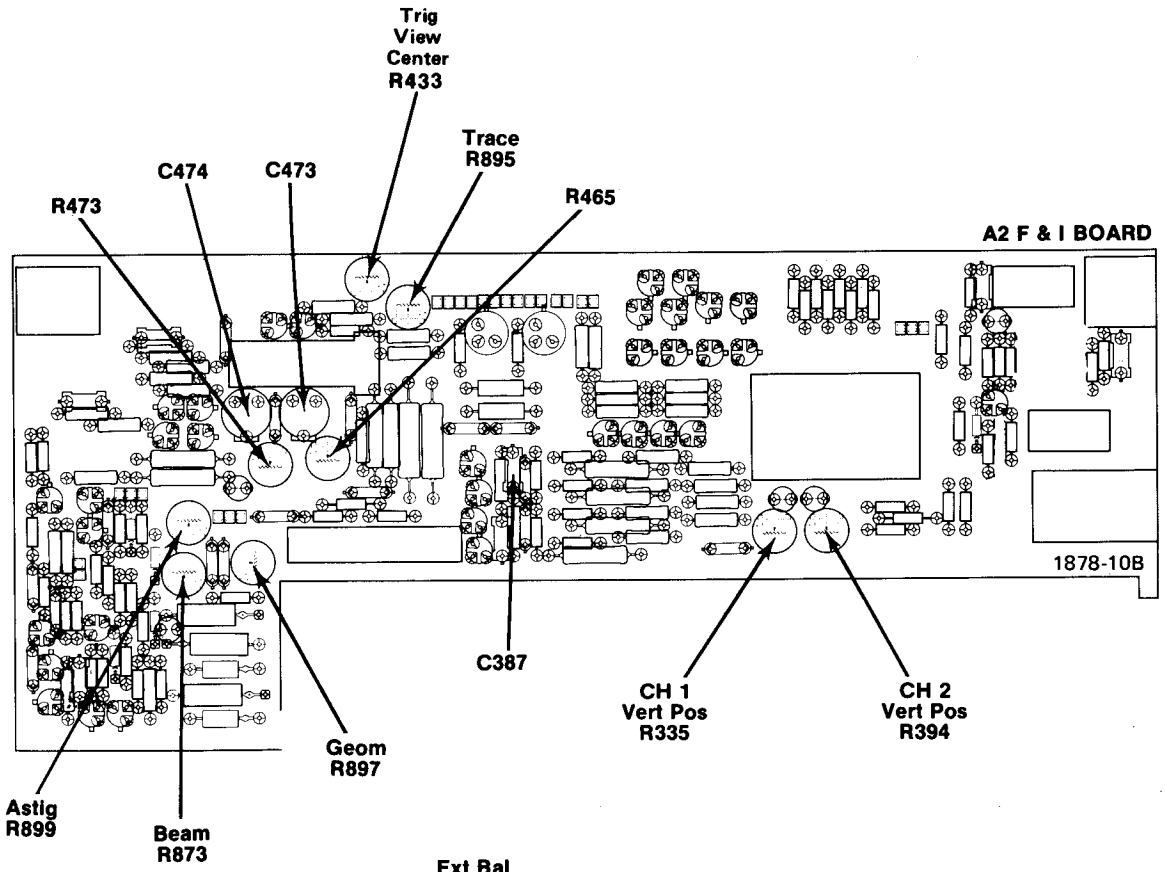
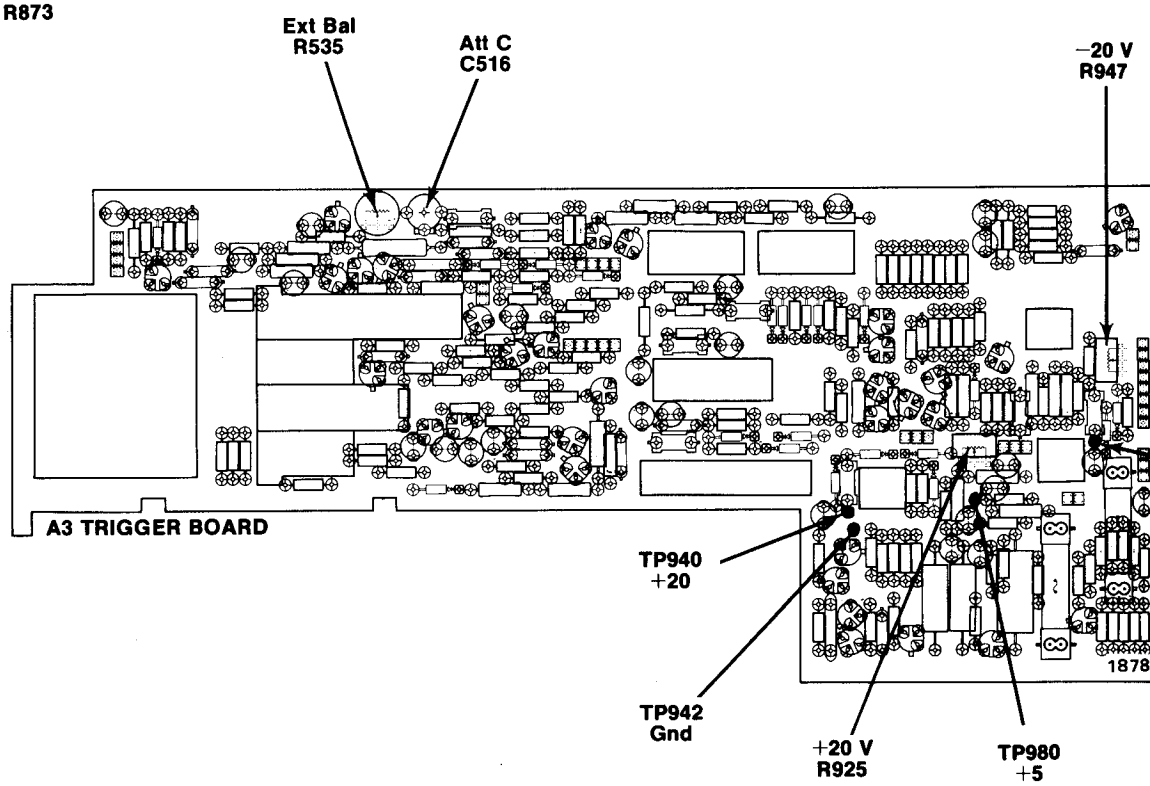
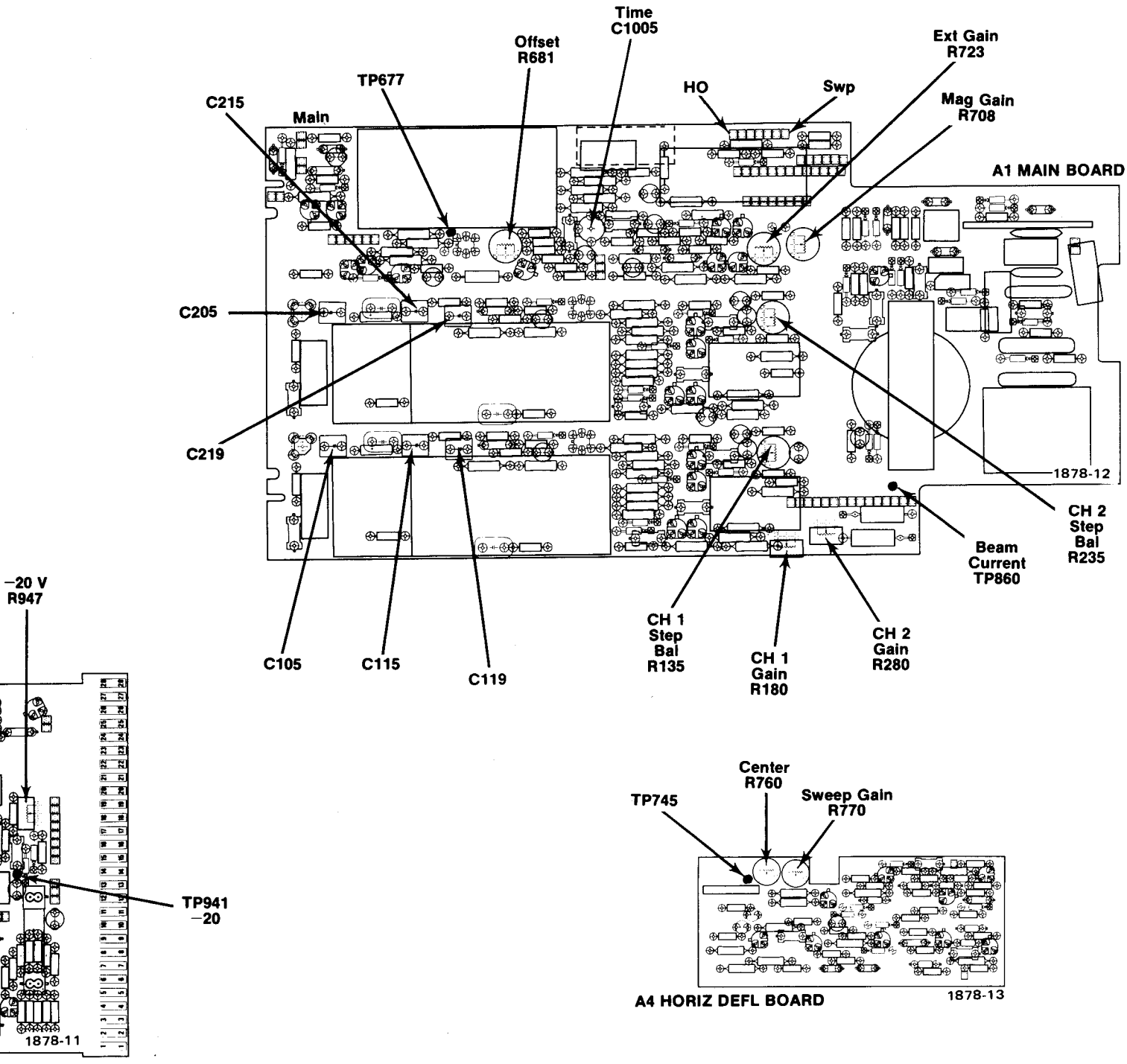
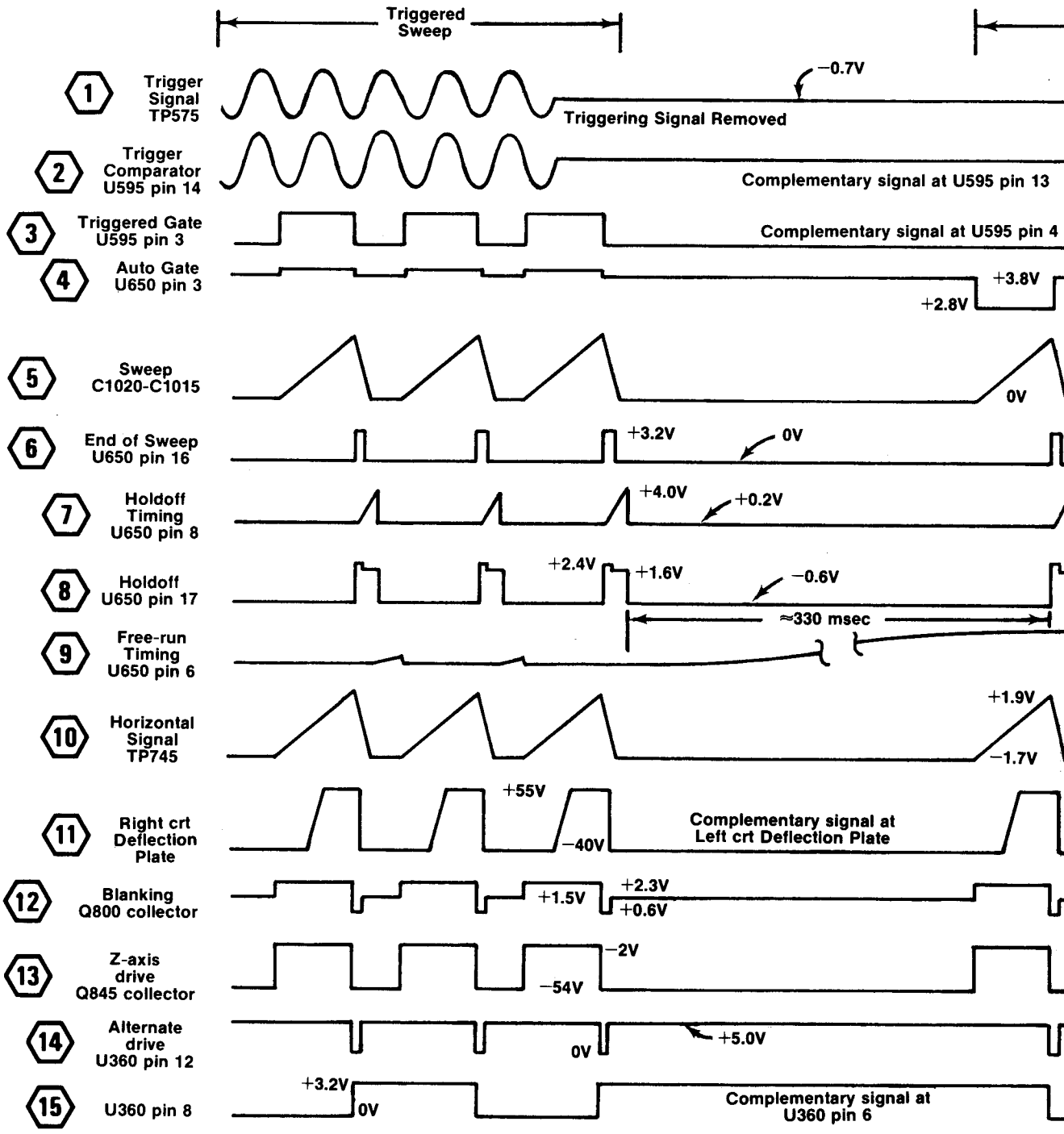

Trig
View
Center
R433
Trace
R895
C474
C473
R473
R465
A2 F & I BOARD
1878-10B
C387
CH 1
Vert Pos
R335
CH 2
Vert Pos
R394
Geom
R897
Astig
R899
Beam
R873


Ext Bal
R535
Att C
C516
−20 V
R947
A3 TRIGGER BOARD
TP940
+20
TP942
Gnd
+20 V
R925
TP980
+5

STMENT LOCATIONS



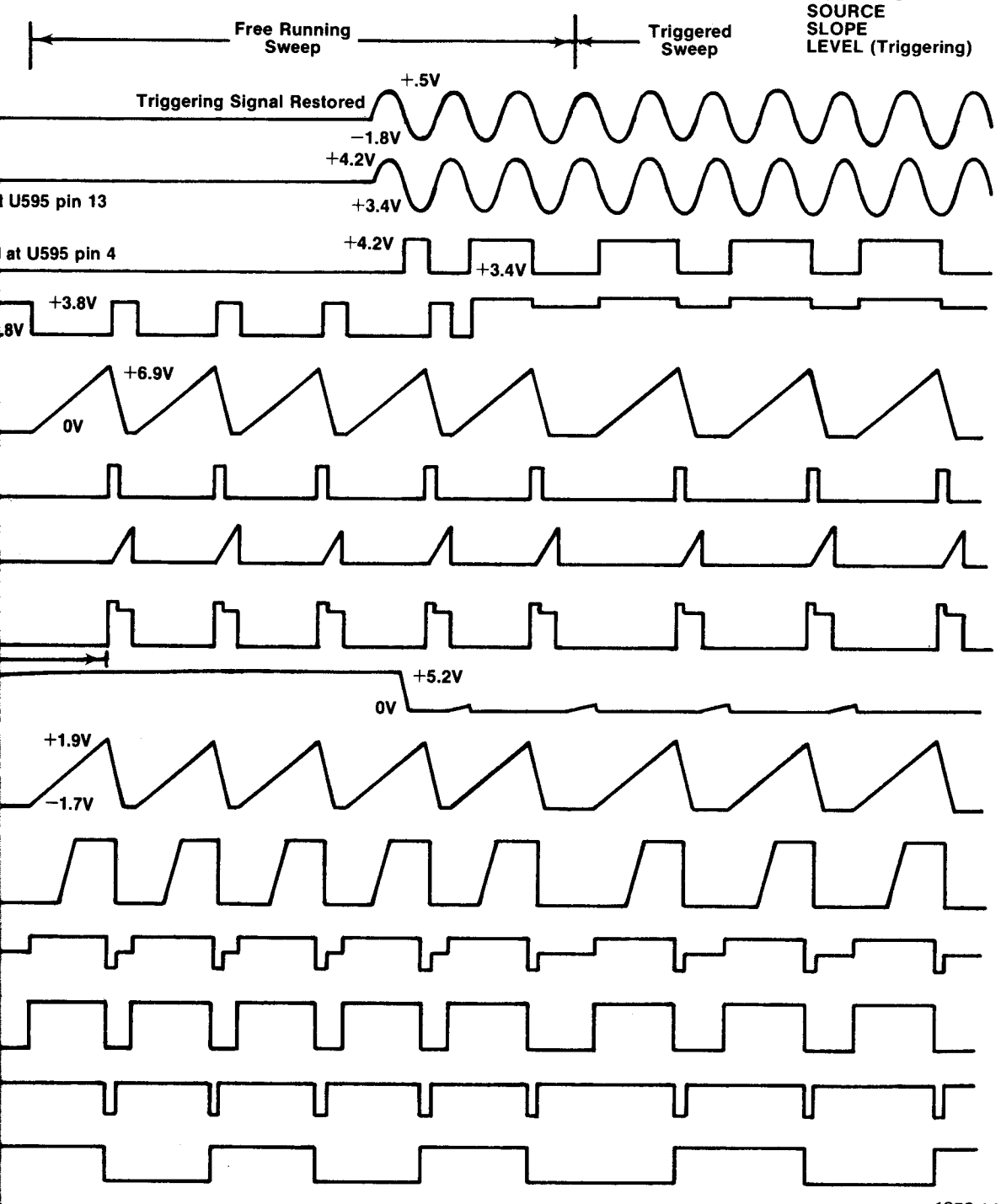
WAVE


Triggered Sweep
1 Trigger Signal TP575
−0.7V
Triggering Signal Removed
2 Trigger Comparator U595 pin 14
Complementary signal at U595 pin 13
3 Triggered Gate U595 pin 3
Complementary signal at U595 pin 4
4 Auto Gate U650 pin 3
+3.8V
+2.8V
5 Sweep C1020-C1015
0V
6 End of Sweep U650 pin 16
+3.2V
0V
7 Holdoff Timing U650 pin 8
+4.0V
+0.2V
8 Holdoff U650 pin 17
+2.4V
+1.6V
−0.6V
≈330 msec
9 Free-run Timing U650 pin 6
10 Horizontal Signal TP745
+1.9V
−1.7V
11 Right crt Deflection Plate
+55V
−40V
Complementary signal at Left crt Deflection Plate
12 Blanking Q800 collector
+1.5V
+2.3V
+0.6V
13 Z-axis drive Q845 collector
−2V
−54V
14 Alternate drive U360 pin 12
0V
+5.0V
15 U360 pin 8
+3.2V
0V
Complementary signal at U360 pin 6

WAVEFORMS

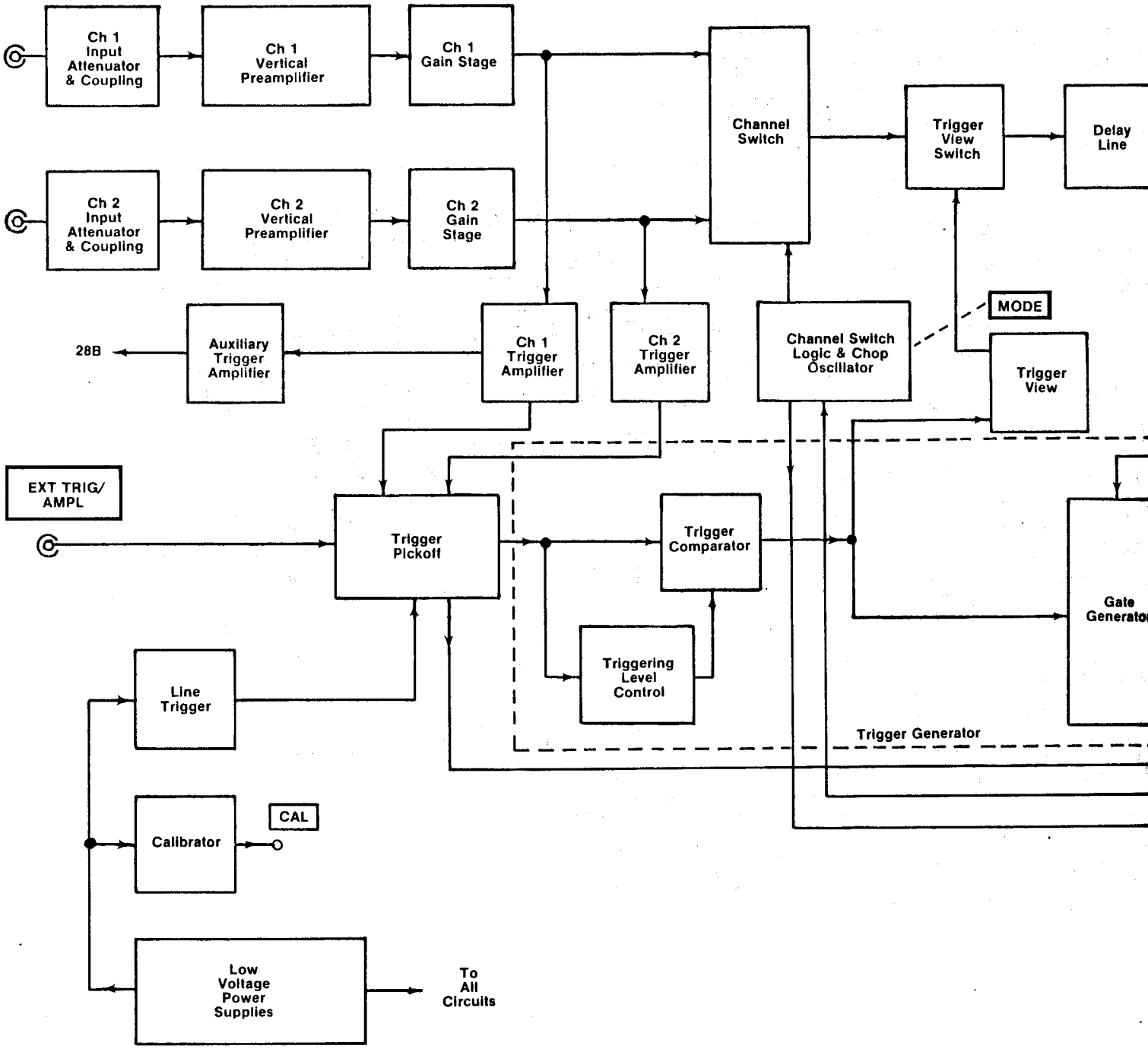
WAVEFORM CONDITIONS

INTENSITY	Midrange
MODE	ALT
POSITION (Horizontal)	Midrange
SECONDS/DIV	2 m
CAL/SWP MAG	Fully clockwise and pulled ou
Trigger Mode	AUTO
COUPLING	AC
SOURCE	LINE
SLOPE	+
LEVEL (Triggering)	Midrange

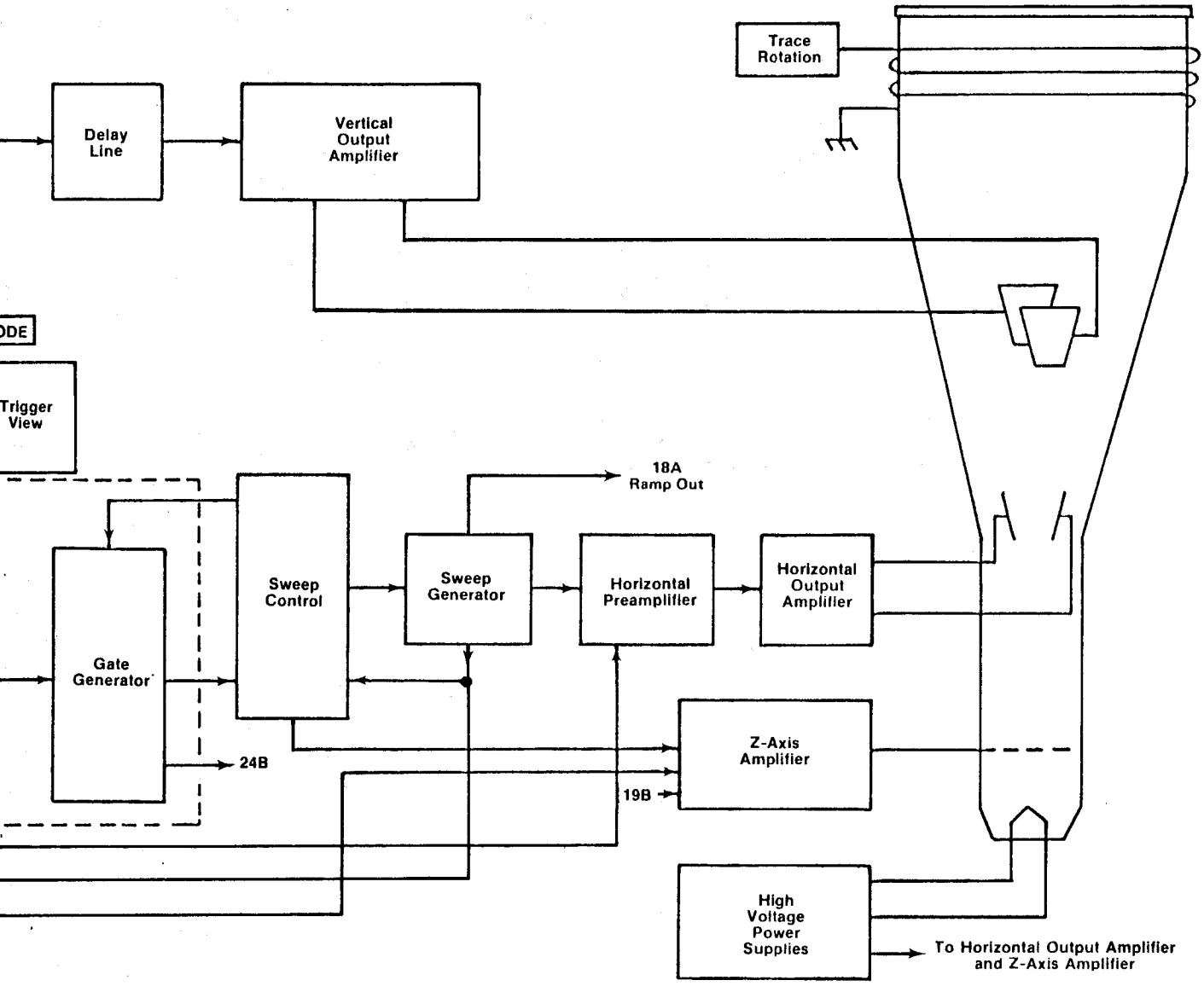


1878-14

BLOCK DIAGRA

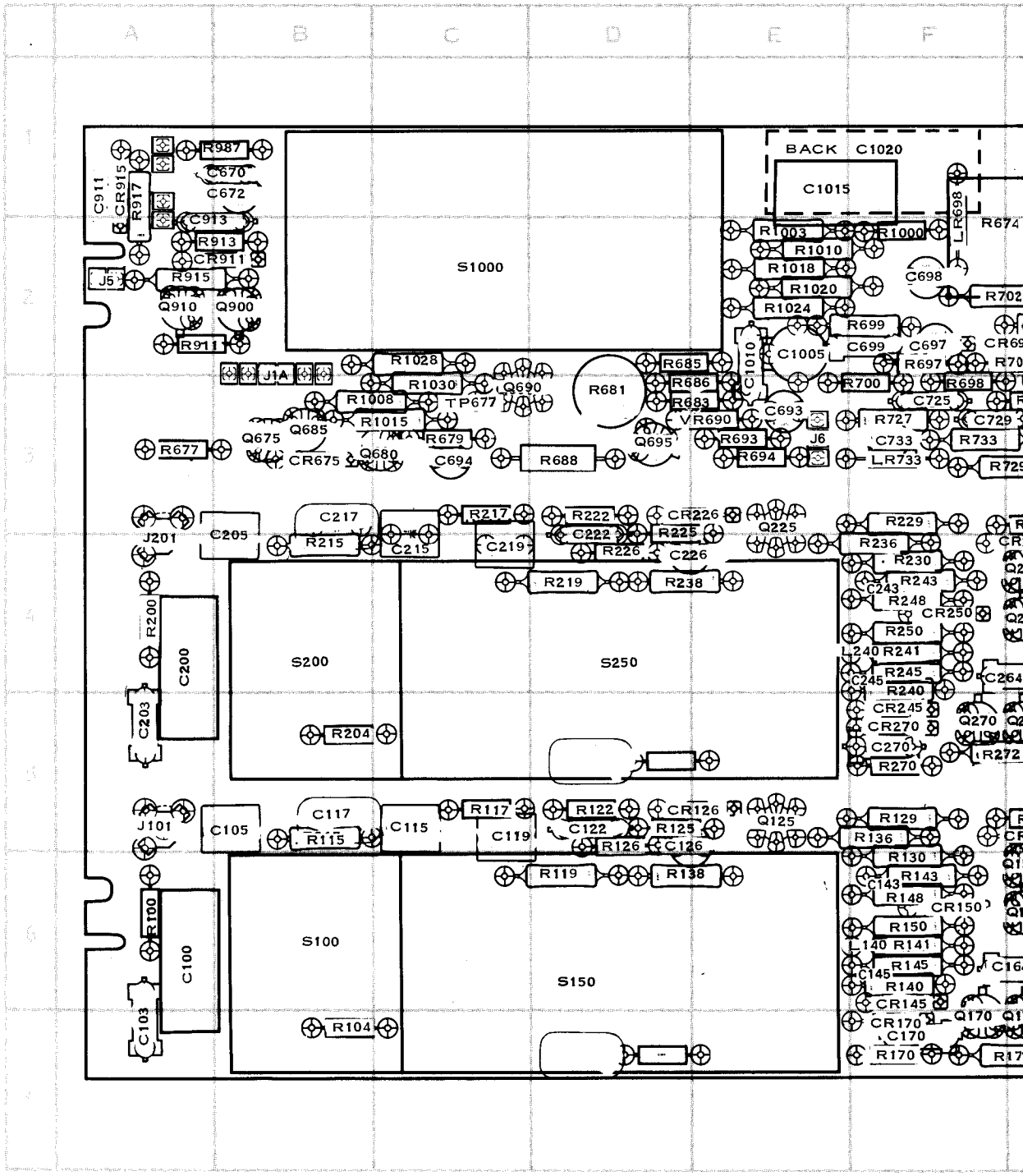


IAGRAM



1878-15

A1 MAIN BOARD PARTS LOCATION



OCATION GRID

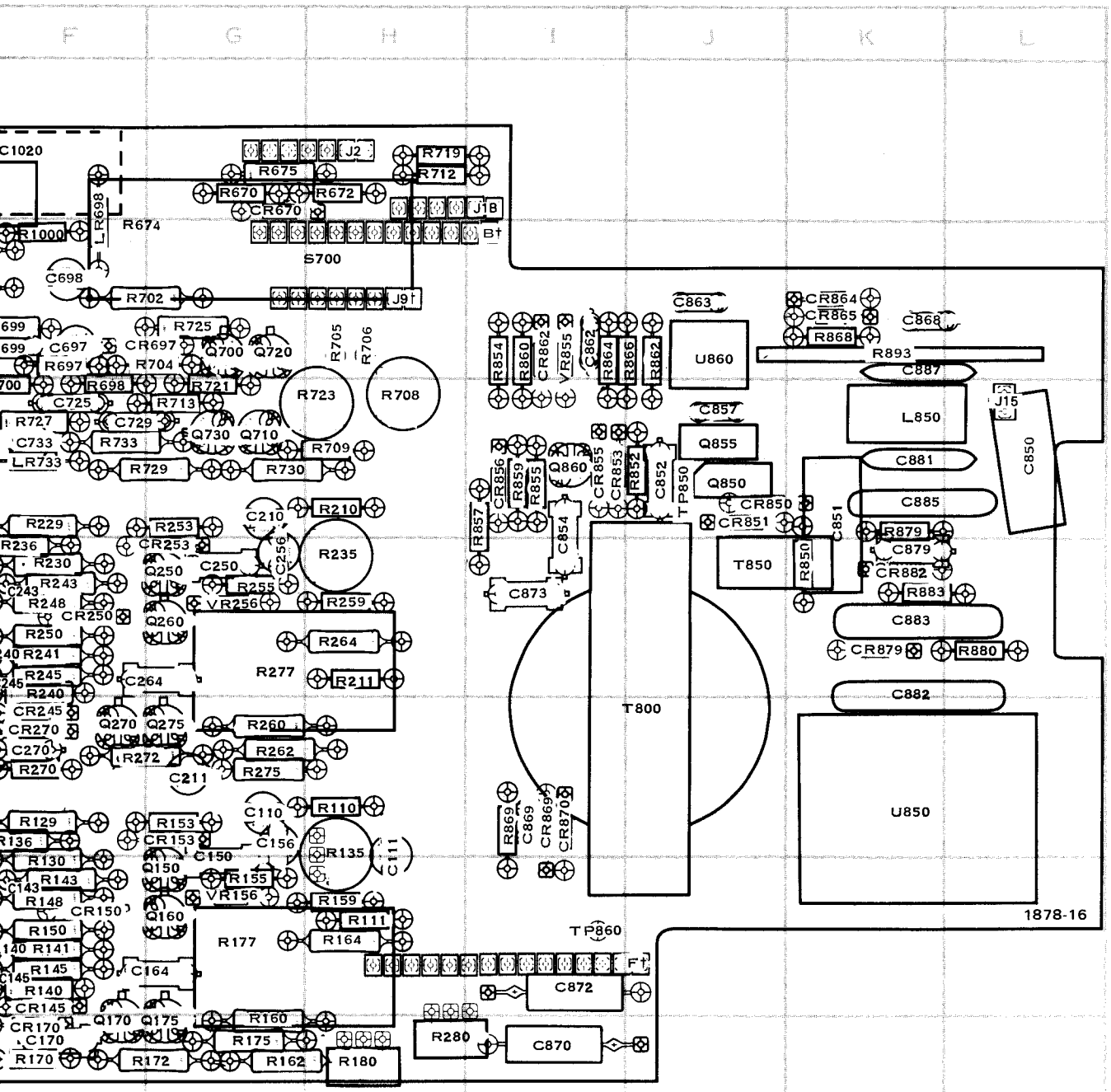


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Table 8-1

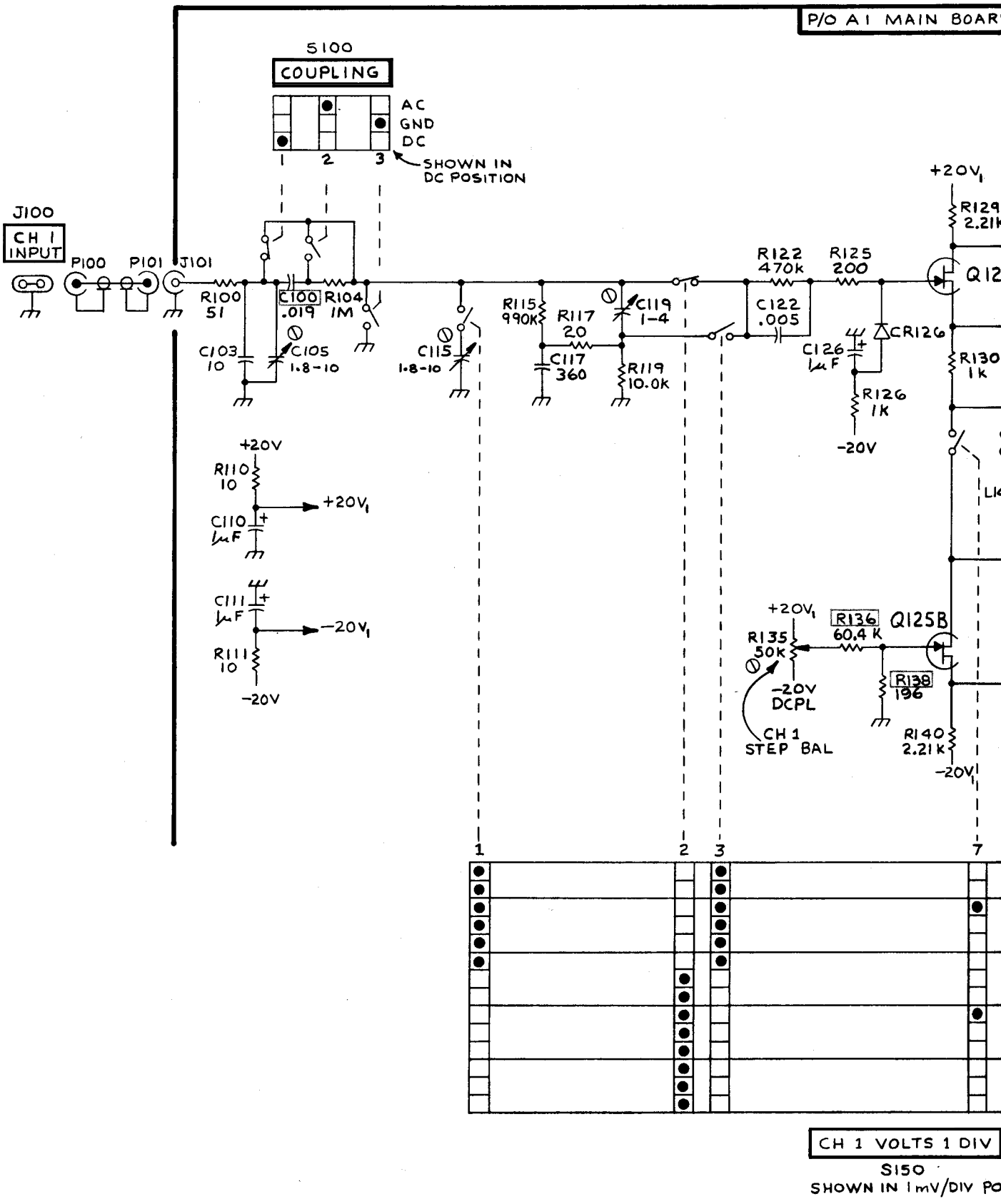
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
B†	H2	CR126	D5	Q720	G2	R259	H4	R917	A1
		CR145	F6	Q730	G3	R260	G5	R987	B1
C100	A6	CR150	F6	Q850	J3	R262	G5	R1000	F2
C103	A7	CR153	G5	Q855	J3	R264	H4	R1003	E2
C105	B5	CR170	F7	Q860	I3	R270	F5	R1008	B2
C110	G5	CR226	D3	Q900	B2	R272	F5	R1010	E2
C111	H5	CR245	F5	Q910	A2	R275	G5	R1015	C3
C115	C5	CR250	F4			R277*	G4	R1018	E2
C117	B5	CR253	G4			R280	H7	R1020	E2
C119	C5	CR270	F5	R100	A6	R670	G1	R1024	E2
C122	D5	CR670	G1	R104	B7	R672	H1	R1028	C2
C126	D5	CR675	B3	R110	H5	R674	F2	R1030	C3
C143	F6	CR697	G2	R111	H6	R675	G1		
C145	F6	CR850	J3	R115	B5	R677	A3		
C150	G6	CR851	J3	R117	C5	R679	C3	S100	B6
C156	G5	CR853	I3	R119	D6	R681	D3	S150	D6
C164	G6	CR855	I3	R122	D5	R683	D3	S200	B4
C170	F7	CR856	I3	R125	D5	R685	D2	S250	D4
C200	A4	CR862	I2	R126	D5	R686	D3	S700	H2
C203	A5	CR864	K2	R129	F5	R688	D3	S1000	C2
C205	B4	CR865	K2	R130	F6	R693	E3		
C210	G3	CR869	I5	R135	H5	R694	E3	T800	J5
C211	G5	CR870	I5	R136	F5	R697	F2	T850	J4
C215	C4	CR879	K4	R138	D6	R698	F3		
C217	B3	CR882	K4	R140	F6	R699	F2	TP677	C3
C219	C4	CR911	B2	R141	F6	R700	F3	TP850	J3
C222	D4	CR915	A1	R143	F6	R702	F2	TP860	I6
C226	D4			R145	F6	R704	G2		
C243	F4	F†	I6	R148	F6	R705	H2	U850	K5
C245	F4			R150	F6	R706	H2	U860	J2
C250	G4	J101	A5	R153	G5	R708	H3		
C256	G4	J201	A4	R155	G6	R709	H3	VR156	G6
C264	G4			R159	H6	R712	H1	VR256	G4
C270	F5	L140	F6	R160	G7	R713	G3	VR690	E3
C670	B1	L240	F4	R162	G7	R719	H1	VR855	I2
C672	B1	L850	K3	R164	H6	R721	G3		
C693	E3			R170	F7	R723	H3	J1A(W)**	B2
C694	C3	LR698	F1	R172	F7	R725	G2	J1B(W)**	H1
C697	F2	LR733	F3	R175	G7	R727	F3	J2(W)**	G1
C698	F2			R177*	G6	R729	F3		
C699	F2	J5	A2	R180	H7	R730	G3		
C725	F3	J6(N)**	E3	R200	A4	R733	F3		
C729	F3	J9(D)†**	H2	R204	B5	R850	K4		
C733	F3	J15	L3	R210	H3	R852	J3		
C850	L3	Q125A	E5	R211	H4	R854	I2		
C851	K3	Q125B	E5	R215	B4	R855	I3		
C852	J3	Q150*	G6	R217	C3	R857	I2		
C854	I3	Q160	G6	R219	D4	R859	I3		
C857	J3	Q170	F7	R222	D3	R860	I2		
C862	I2	Q175	G7	R225	D3	R862	J2		
C863	J2	Q225A	E3	R226	D4	R864	I2		
C868	K2	Q225B	E3	R229	F3	R866	I2		
C869	I5	Q250*	G4	R230	F4	R868	K2		
C870	I7	Q260	G4	R235	H4	R869	I5		
C872	I6	Q270	F5	R236	F4	R879	K3		
C873	I4	Q275	G5	R238	D4	R880	L4		
C879	K4	Q675	B3	R240	F4	R883	K4		
C881§	K3	Q680	C3	R241	F4	R893A	K2		
C882§	K4	Q685	B3	R243	F4	R893B	K2		
C883§	K4	Q690	C3	R245	F4	R893C	K2		
C885§	K3	Q695	D3	R248	F4	R893D	K2		
C887§	K2	Q700	G2	R250	F4	R911	A2		
C911	A1	Q710	G3	R253	G3	R913	B2		
C913	A2			R255	G4	R915	A2		
C1005	E2								
C1010	E2								
C1015	E1								
C1020	F1								

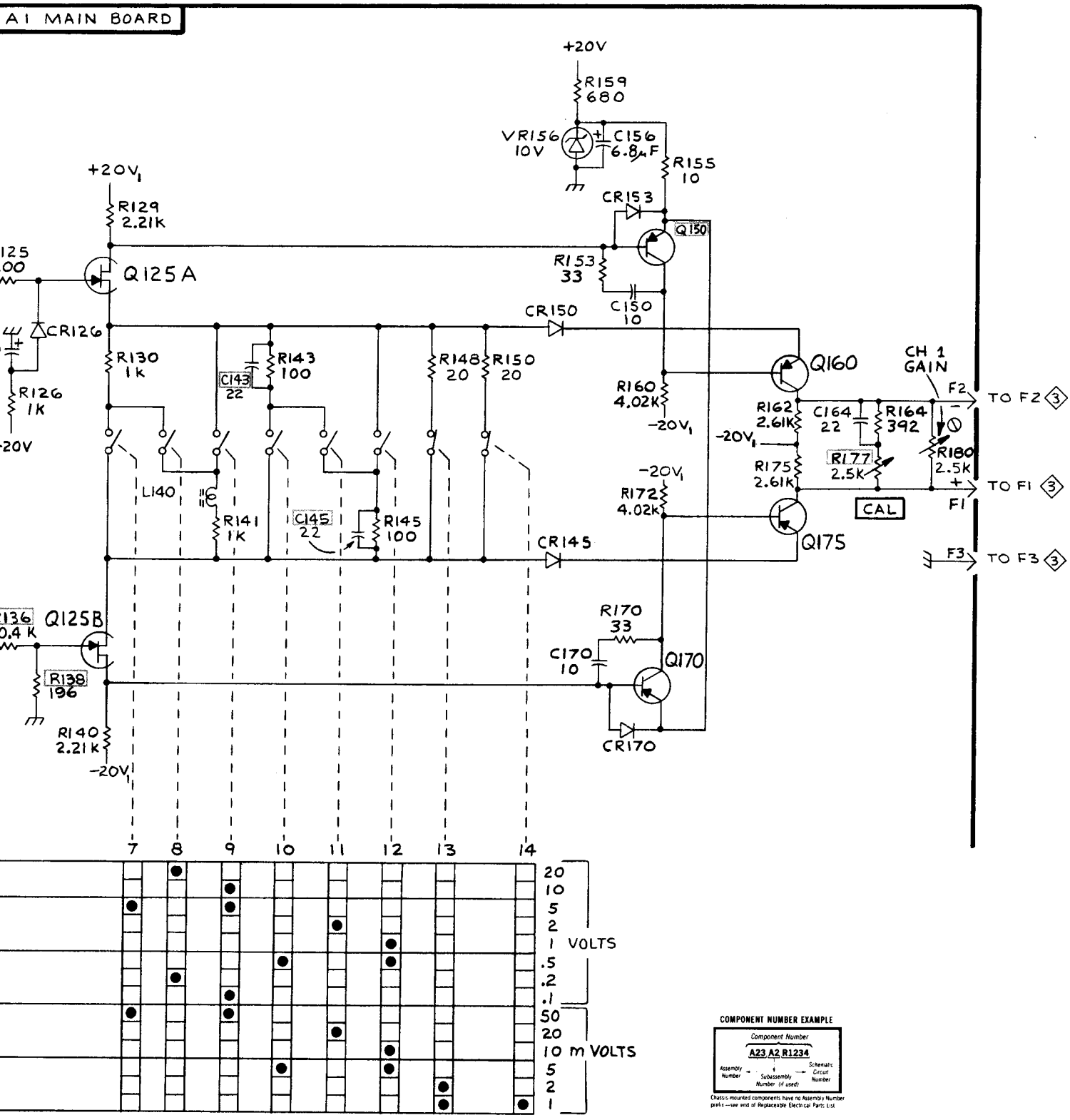
† Located on back of board.

§ Connected between Aux board and Main board.

**Numbers or letters inside parenthesis indicate board designation.

*See Parts List for serial number ranges.


P/O A1 MAIN BOAR
S100
COUPLING
AC
GND
DC
1 2 3
SHOWN IN DC POSITION
J100
CH 1 INPUT
P100
P101
J101
R100 51
C100 .019
R104 1M
C103 10
C105 1.8-10
C115 1.8-10
R115 990K
R117 2.0
C117 360
C119 1-4
R119 10.0K
C122 .005
R122 470k
R125 200
C126 1μF
CR126
R126 1K
-20V
+20V
R110 10
C110 1μF
+20V1
C111 1μF
-20V1
R111 10
-20V
+20V1
R129 2.21K
Q12
R130 1k
R135 50K
-20V DCPL
CH 1 STEP BAL
R136 60.4 K
Q125B
R138 196
R140 2.21k
-20V1
1 2 3 7
CH 1 VOLTS 1 DIV
S150
SHOWN IN 1mV/DIV PO



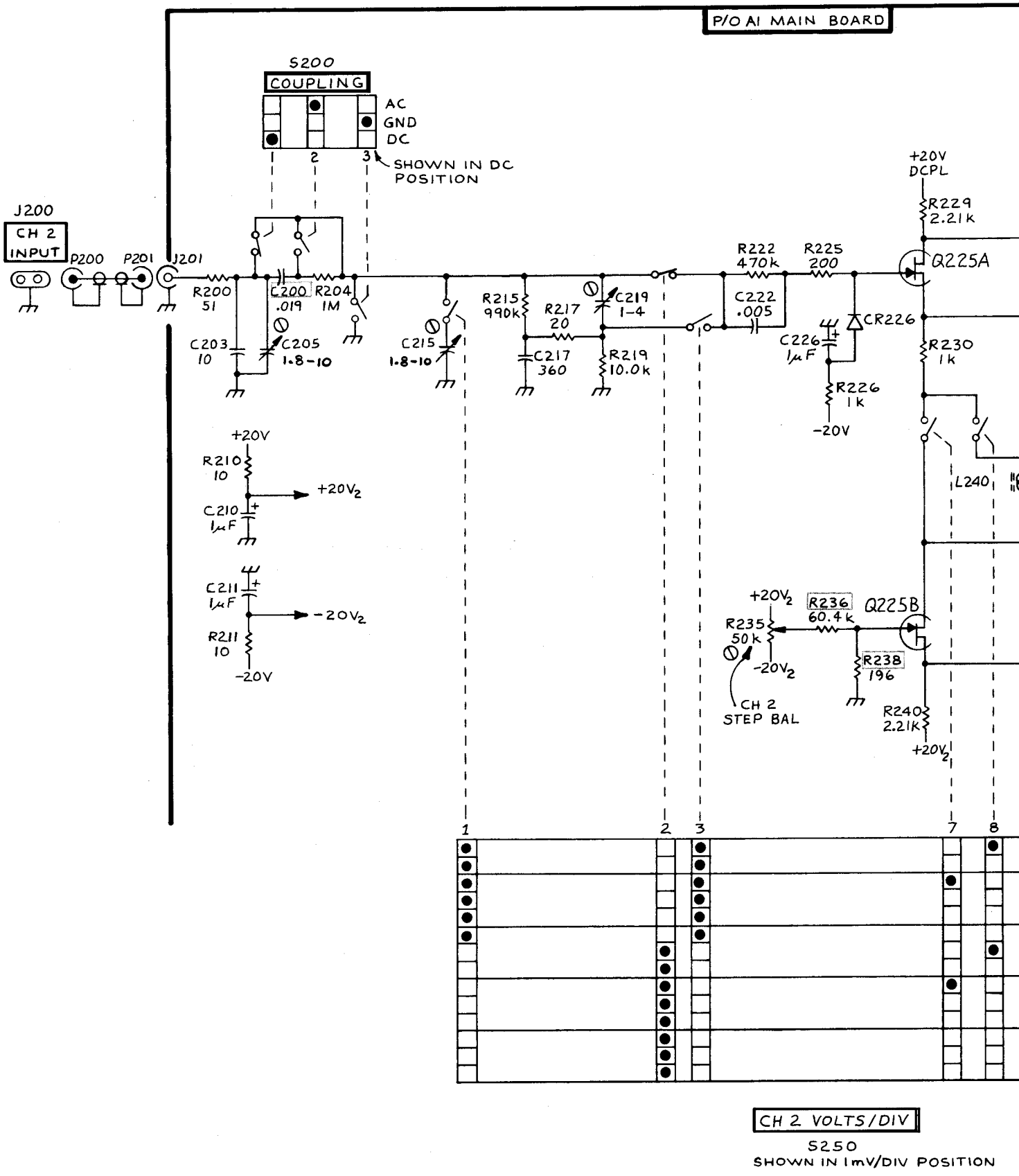
COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
Assembly Number → Subassembly Number (if used) → Schematic Circuit Number

Chassis mounted components have no Assembly Number prefix —see end of Replaceable Electrical Parts List

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

CHANNEL 1 INPUT COUPLING & PREAMP ① DAJ 0575



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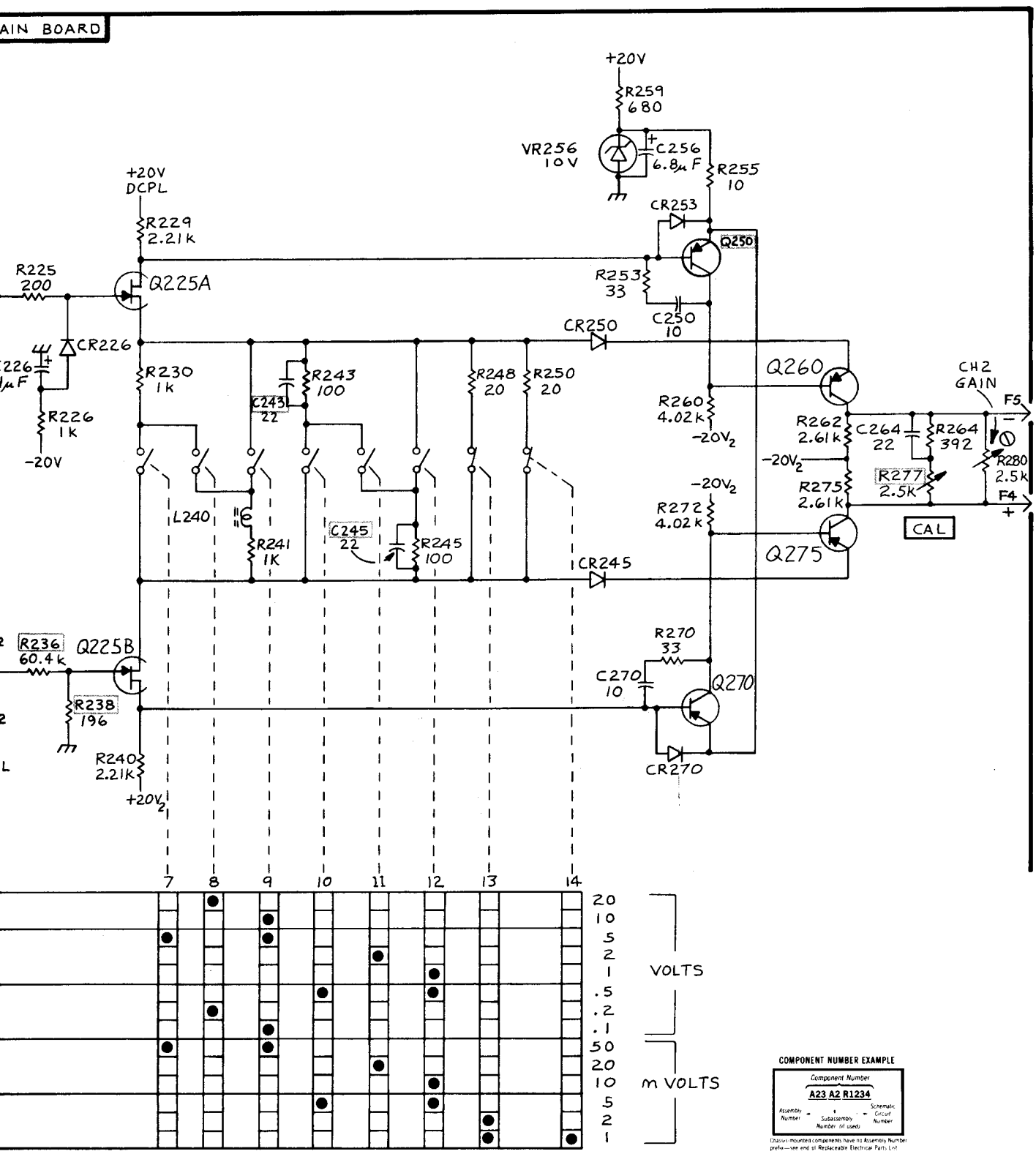
1878-23



2 VOLTS/DIV

S250
WN IN 1mV/DIV POSITION

COMPONENT NUMBER EXAMPLE

Component Number
A23 A2 R1234
Assembly Number – Subassembly Number (if used) – Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

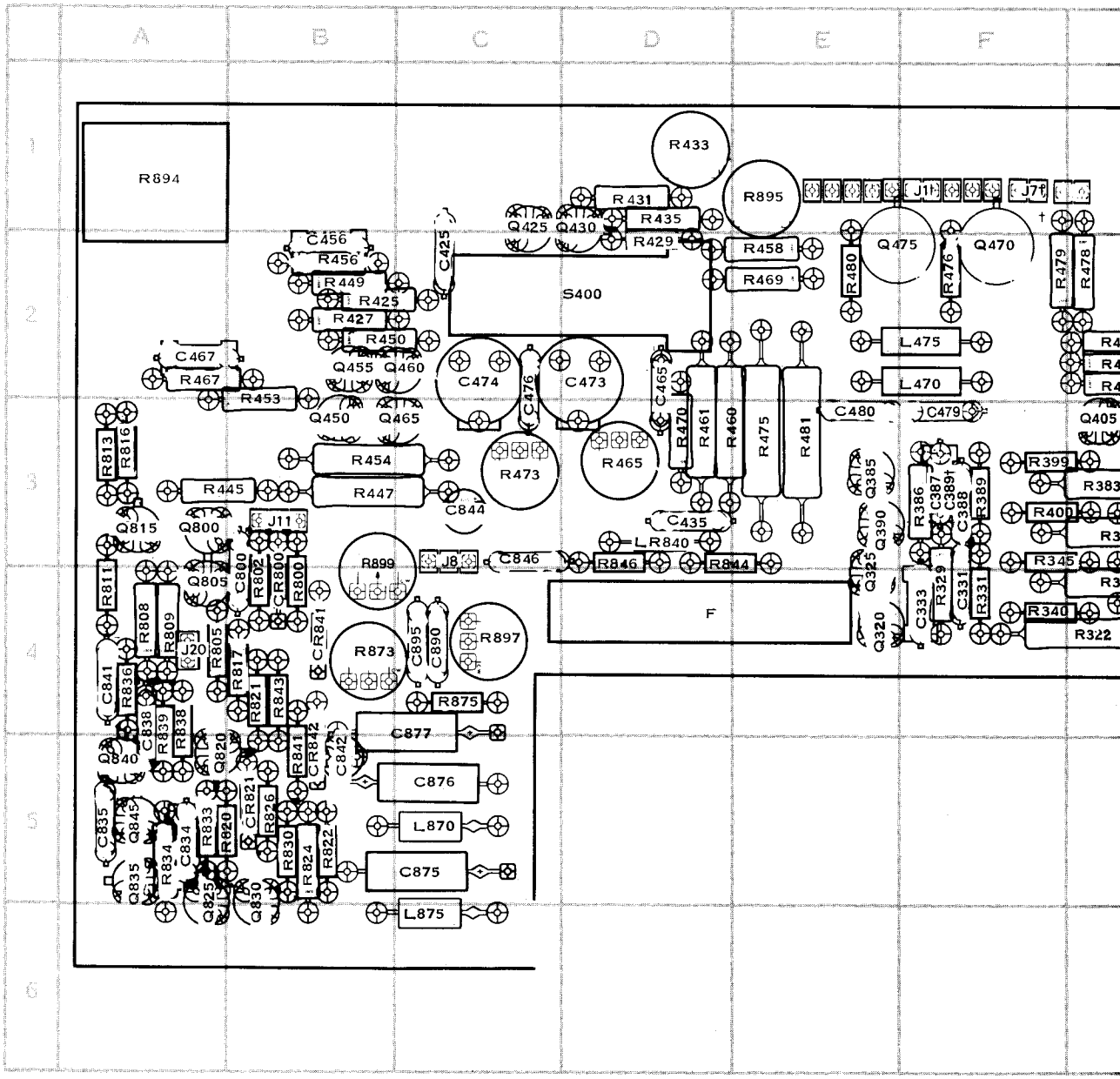
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

REV APR 1986
1878-23

CHANNEL 2 INPUT COUPLING & PREAMP ◇2◇

DAJ
0575

A2 F & I BOARD PARTS LOCATI



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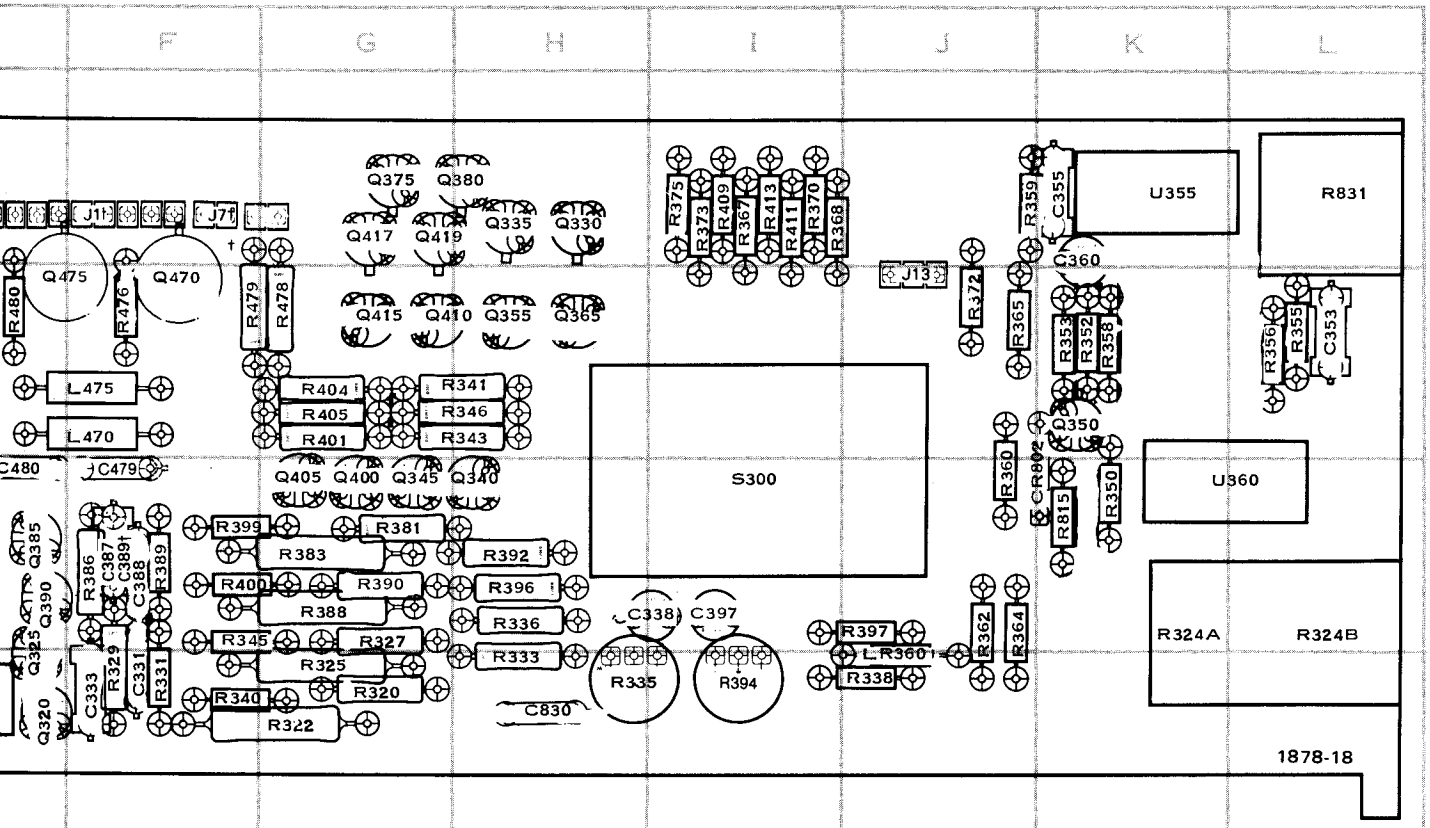
C331	F4	C476	C2	C895	C4	L470	F2	Q320	E4	Q415	G2	Q830	B5	R336	H3		
C333	F4	C479	F3			L475	F2	Q325	E4	Q417	G1	Q835	A5	R338	J4		
C338	I3	C480	E3	CR800	B4	L870	C5	Q330	H1	Q419	G1	Q840	A5	R340	F4		
C353	L2	C800	B4	CR802	K3	L875	C6	Q335	H1	Q425	C1	Q845	A5	R341	H2		
C355	K1	C830	H4	CR821	B5			Q340	H3	Q430	D1			R343	H2		
C360	K1	C834	A5	CR841	B4	LR360	J3	Q345	G3	Q450	B3			R345	F3		
C387*	F3	C835	A5	CR842	B5	LR840	D3	Q350	K2	Q455	B2	R320	G4	R346	H2		
C388	F3	C838	A4					Q355	H2	Q460	C2	R322	G4	R350	K3		
C389†	F3	C841	A4	F	D4			Q365	H2	Q465	C3	R324A	K3	R352	K2		
C397	I3	C842	B5					Q375	G1	Q470	F2	R324B	L3	R353	K2		
C425	C2	C844	C3	J1(G)†**	E1			Q380	H1	Q475	E2	R325	G4	R355	L2		
C435	D3	C846	C3	J7(L)†**	F1			Q385	E3	Q800	A3	R327	G3	R356	L2		
C456	B2	C875	C5	J8	C3			Q390	E3	Q805	A4	R329	F4	R358	K2		
C465	D2	C876	C5	J11(C)**	B3			Q400	G3	Q815	A3	R331	F4	R359	J1		
C467	A2	C877	C4	J13(E)**	J2			Q405	G3	Q820	A5	R333	H4	R360	J3		
C473*	D2	C890	C4					Q410	G2	Q825	A5	R335	H4	R362	J3		
C474*	C2																

ARTS LOCATION GRID

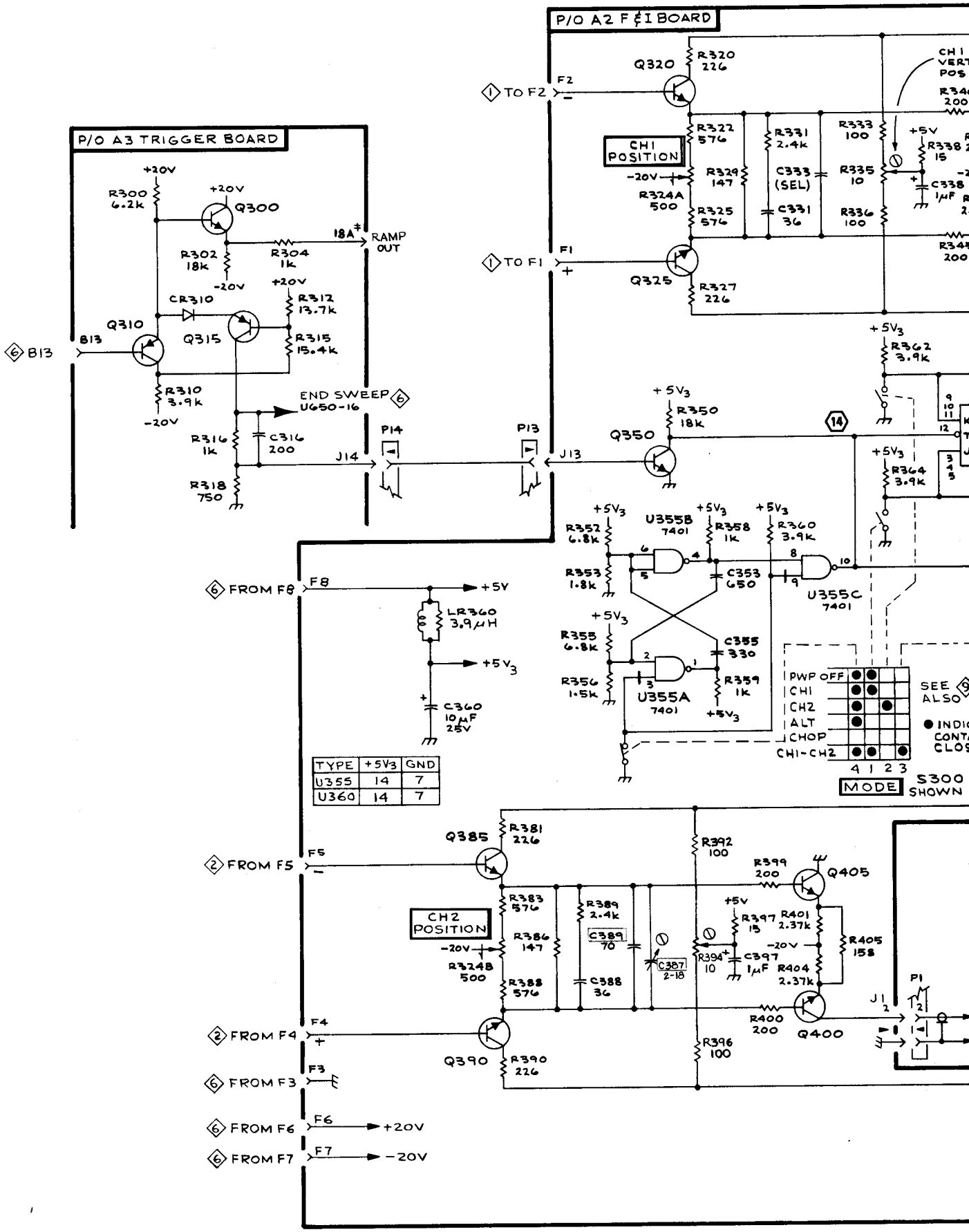


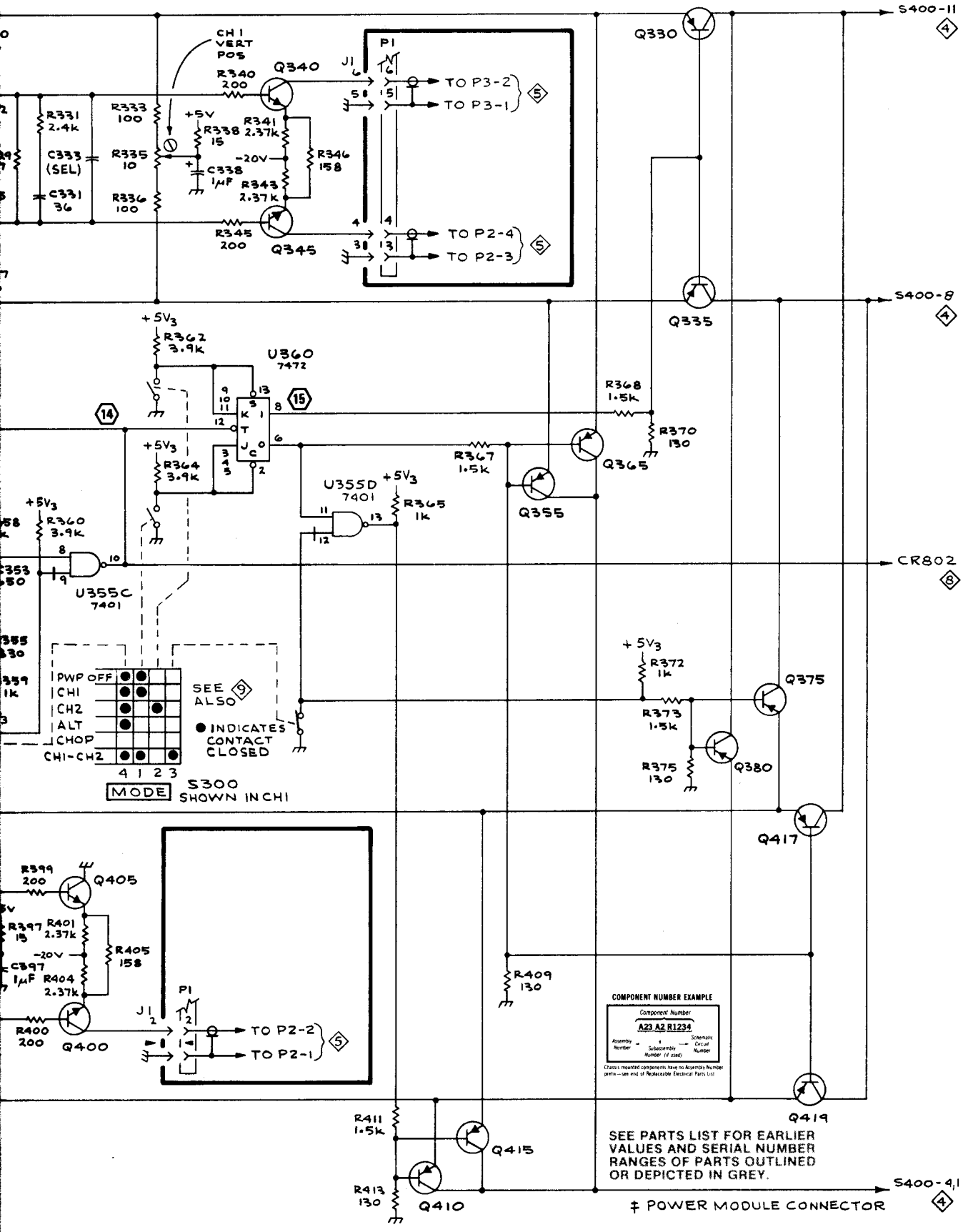
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
Q830	B5	R336	H3	R364	J3	R396	H3	R447	B3	R478	G2	R822	B5	R894 *	A1
Q835	A5	R338	J4	R365	J2	R397	J3	R449	B2	R479	F2	R824	B5	R895	E1
Q840	A5	R340	F4	R367	I1	R399	F3	R450	B2	R480	E2	R826	B5	R897	C4
Q845	A5	R341	H2	R368	I1	R400	F3	R453	B2	R481	E3	R830	B5	R899	B3
		R343	H2	R370	I1	R401	G2	R454	B3	R800	B4	R831	L1		
		R345	F3	R372	J2	R404	G2	R456	B2	R802	B4	R833	A5		
R320	G4	R346	H2	R373	I1	R405	G2	R458	E2	R805	A4	R834	A5		
R322	G4	R350	K3	R375	I1	R409	I1	R460	D3	R808	A4	R836	A4		
R324A	K3	R352	K2	R381	G3	R411	I1	R461	D3	R809	A4	R838	A4	S300	I3
R324B	L3	R353	K2	R383	G3	R413	I1	R465	D3	R811	A4	R839	A4	S400	D2
R325	G4	R355	L2	R386	F3	R425	B2	R467	A2	R813	A3	R841	B5		
R327	G3	R356	L2	R388	G3	R427	B2	R469	E2	R815	K3	R843	B4	U355A	K1
R329	F4	R358	K2	R389	F3	R429	D2	R470	D3	R816	A3	R844	D3	U355B	K1
R331	F4	R359	J1	R390	G3	R431	D1	R473	C3	R817	B4	R846	D3	U355C	K1
R333	H4	R360	J3	R392	H3	R433	D1	R475	E3	R820	A5	R873	B4	U355D	K1
R335	H4	R362	J3	R394	I4	R435	D1	R476	F2	R821	B4	R875	C4	U360	L3
						R445	A3								

*See Parts List for serial number ranges.

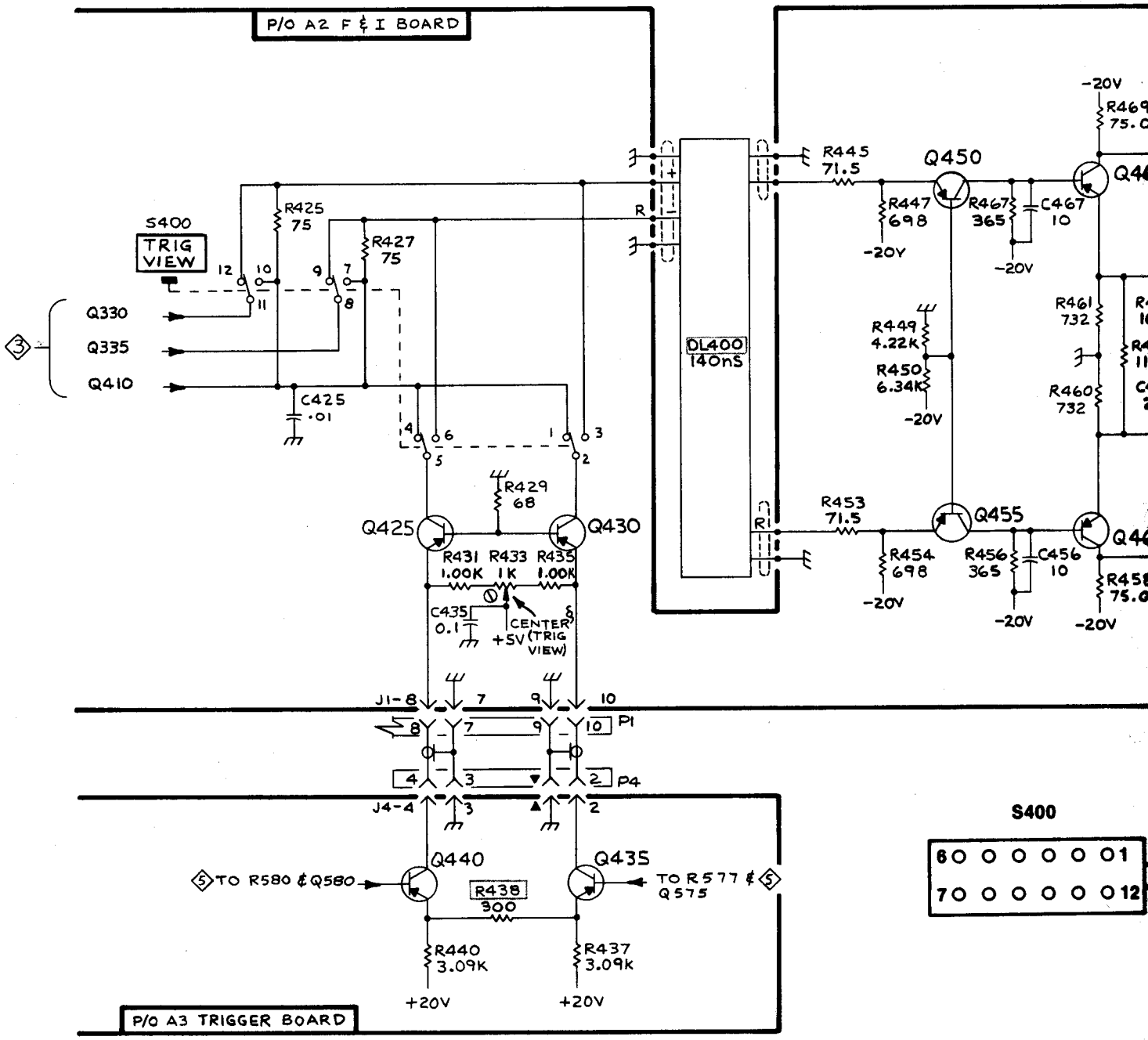
** Numbers or letters inside parenthesis indicate board d

† Located on back of boar


P/O A3 TRIGGER BOARD
P/O A2 F & I BOARD
+20V
R300 6.2k
Q300
18A
RAMP OUT
R302 18k
R304 1k
-20V
CR310
R312 13.7k
Q310
Q315
B13
R315 15.4k
R310 3.9k
END SWEEP
U650-16
R316 1k
C316 200
R318 750
P14
J14
P13
J13
TO F2
F2
TO F1
F1
Q320
R320 226
R322 576
R329 147
-20V
R324A 500
R325 576
Q325
R327 226
R331 2.4k
C333 (SEL)
C331 36
R333 100
R335 10
R336 100
CH1 POSITION
+5V
R338 15
C338 1μF
R345 200
+5V3
R362 3.9k
R364 3.9k
Q350
R350 18k
14
U355B 7401
U355C 7401
U355A 7401
R352 6.8k
R353 1.8k
R355 6.8k
R356 1.5k
R358 1k
R359 1k
R360 3.9k
C353 650
C355 330
PWR OFF
CH1
CH2
ALT
CHOP
CH1-CH2
4 1 2 3
MODE
S300 SHOWN
SEE ALSO
FROM F8
F8
LR360 3.9μH
C360 10μF 25V
TYPE | +5V3 | GND
U355 | 14 | 7
U360 | 14 | 7
FROM F5
F5
Q385
R381 226
CH2 POSITION
-20V
R324B 500
R383 576
R386 147
R388 576
R389 2.4k
C389 70
C388 36
C387 2-18
R392 100
R394 10
R396 100
R397 15
R399 200
Q405
R401 2.37k
C397 1μF
R404 2.37k
R405 158
R400 200
Q400
P1
J1
FROM F4
F4
Q390
R390 226
FROM F3
F3
FROM F6
F6
+20V
FROM F7
F7
-20V

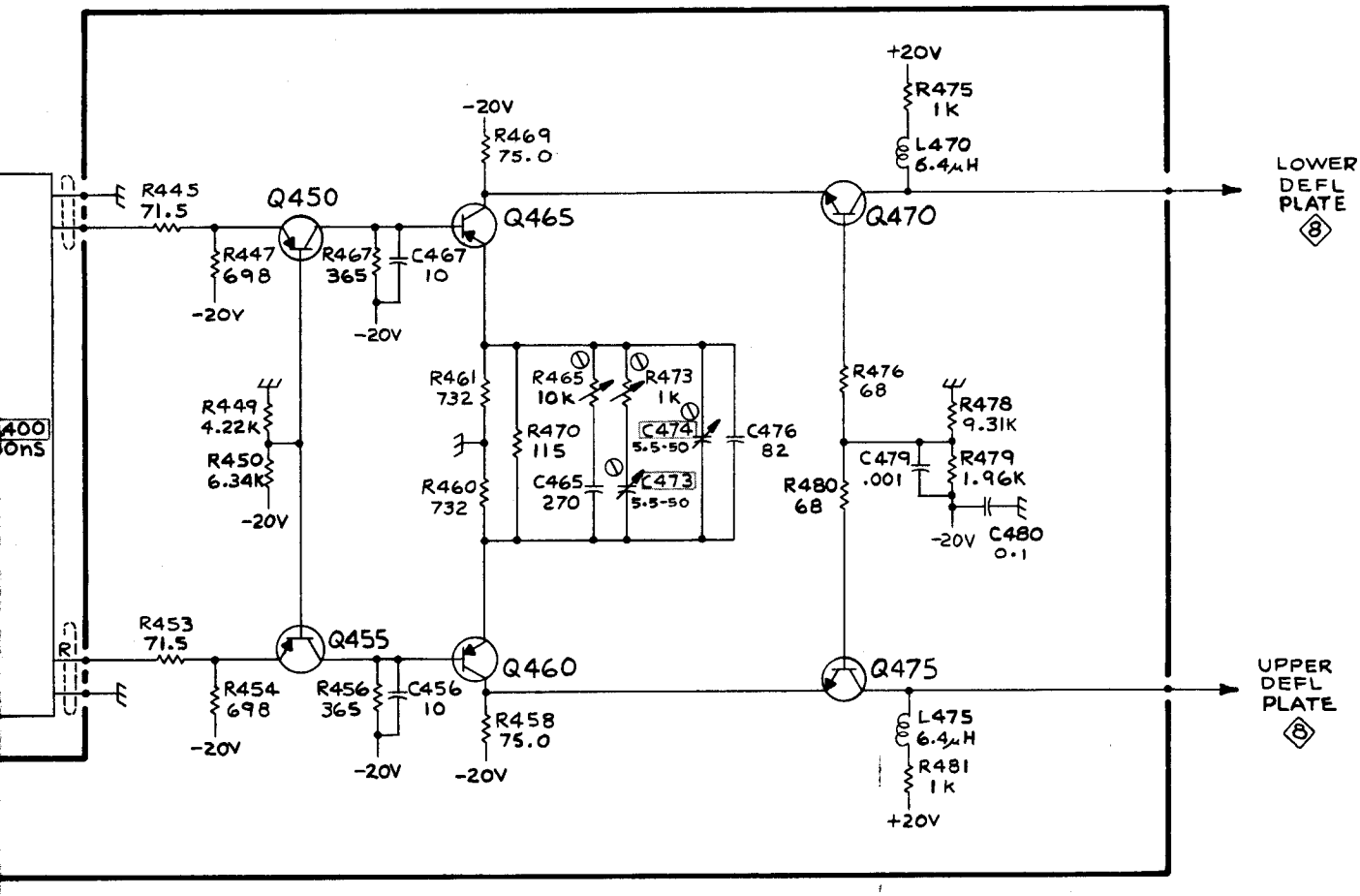


POSITION CONTROL / CHANNEL SWITCHING / TRIGGER PICKOFF ◇3 DEH 0475

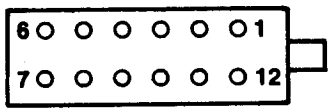


SC 502

REV MAY 1982
1878-25



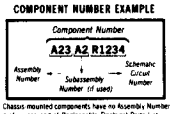
S400



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

§ TRIG VIEW MARKED AS TV ON CIRCUIT BOARD.

COMPONENT NUMBER EXAMPLE

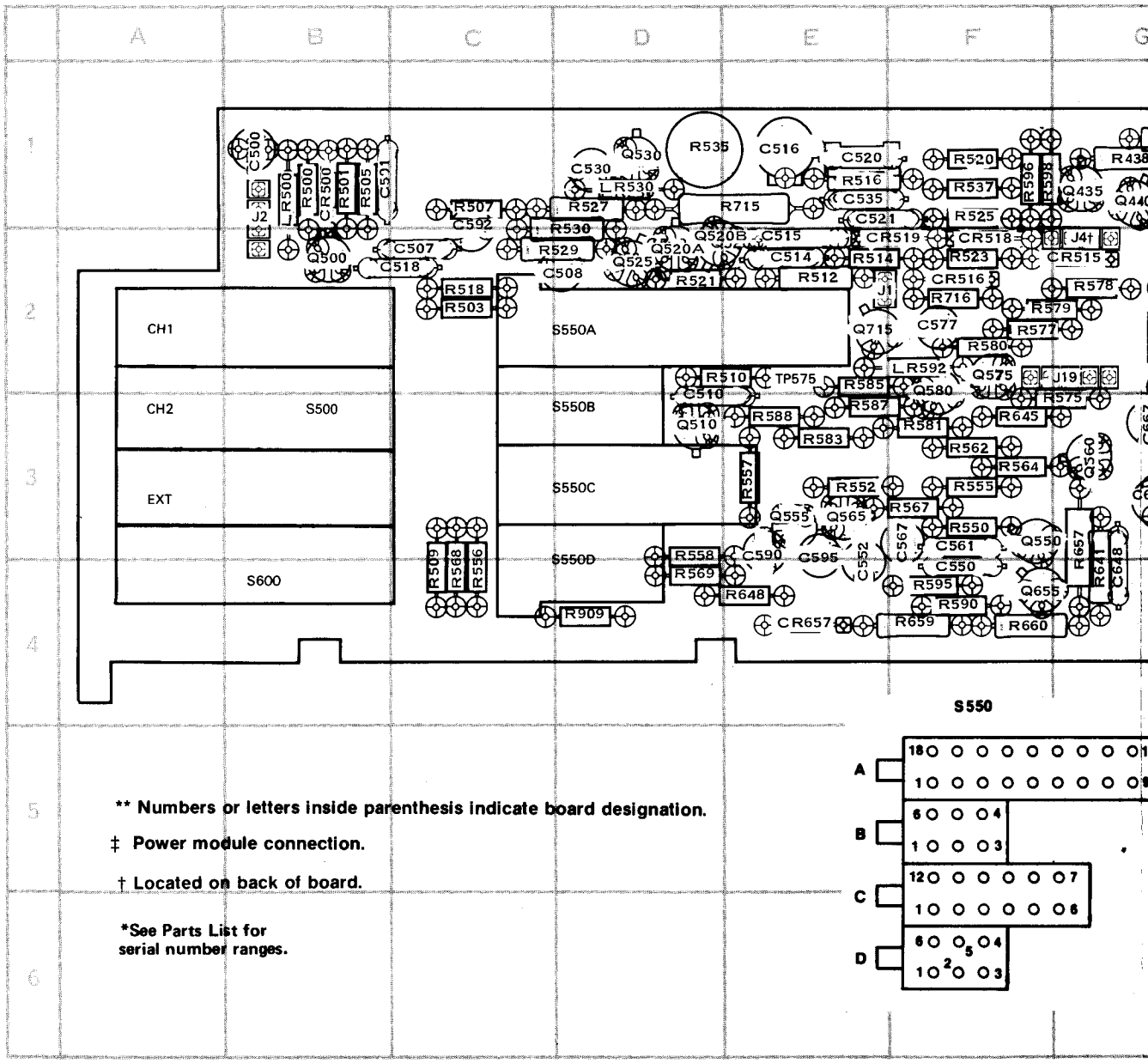


TRIGGER VIEW & VERTICAL OUTPUT AMP ④

DAJ
0575

SC 502

A3 TRIGGER BOARD PARTS LOC



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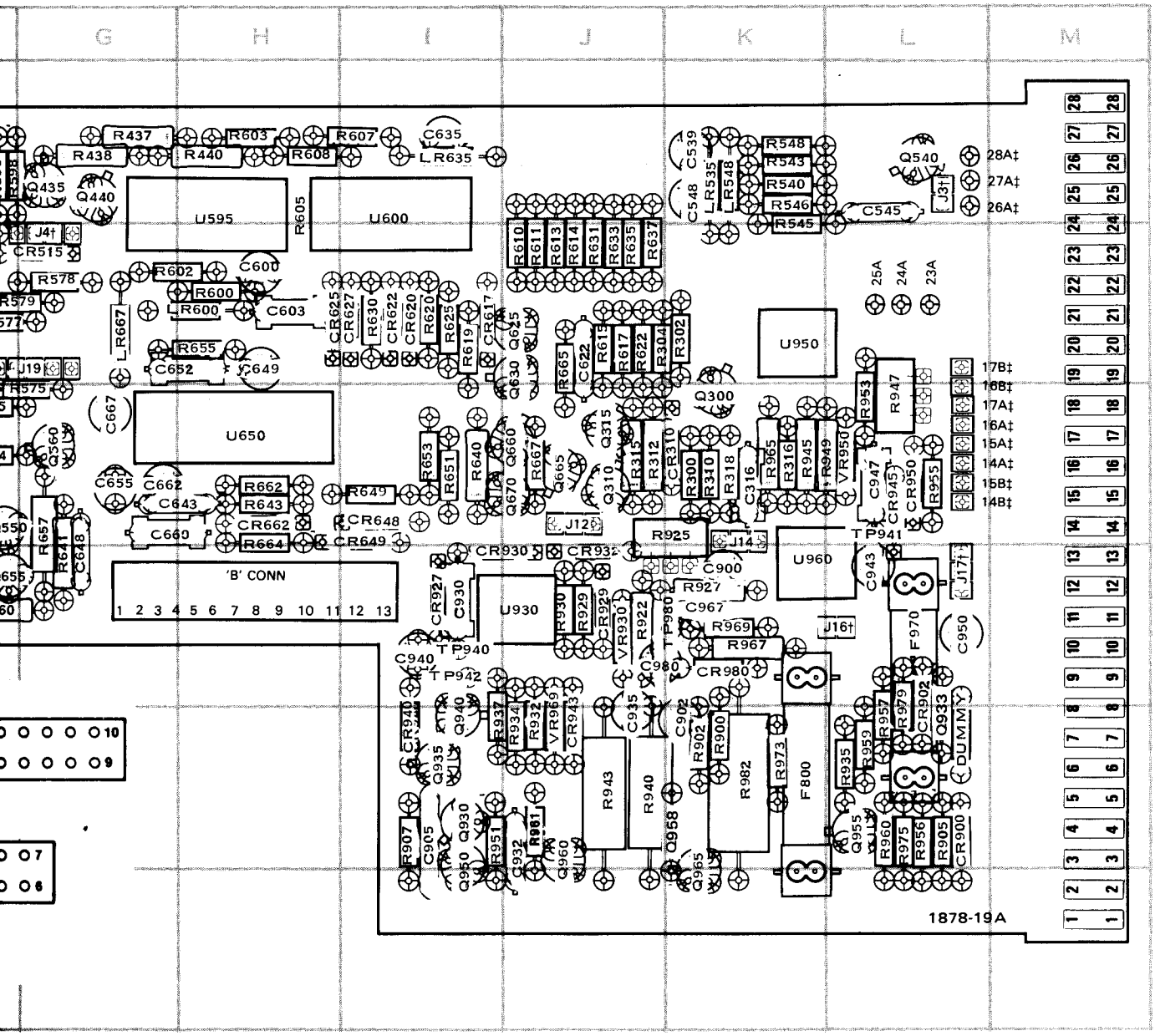
B	H4	C539	K1	C648	G4	C950	L4	CR649	I3	F800	K5	LR530	D1	Q525	D2	Q930
		C545	L1	C649	H2	C967	K4	CR657	E4	F970	L4	LR535	K1	Q530	D1	Q933
C316	K3	C548	K1	C652	H2	C980	J4	CR662	H3			LR548	K1	Q540	L1	Q935
C500	B1	C550	F4	C655	G3			CR900	L5			LR592	F2	Q550	F3	Q940
C501	B1	C552	E3	C660	G3	CR310	K3	CR902	L5	J1(H)**	E2	LR600	H2	Q555	E3	Q950
C507	C2	C561	F3	C662	G3	CR500	B1	CR927	I4	J2(G1)**	B1	LR635	I1	Q560	G3	Q955
C508	D2	C567	F3	C667	G3	CR515	G2	CR929	J4	J3(G5)**†	L1	LR667	G2	Q565	E3	Q958
C510	D3	C577	F2	C900	K4	CR516	F2	CR930	J4	J4(G7)**	G2	Q300	K3	Q575	F2	Q960
C514	E2	C590	E3	C902	K5	CR518	F2	CR932	J4	J12(C)**	J3	Q310	J3	Q580	F2	Q965
C515	E2	C592	C1	C905	I5	CR519	F2	CR940	I5	J14(E)**	K3	Q315	J3	Q625	J2	
C516	E1	C595	E3	C930	I4	CR617	I2	CR943	J5	J16(A)†**	L4	Q435	G1	Q630	J2	R300
C518	C2	C600	H2	C932	J5	CR620	I2	CR945	L3	J17(U)†**	L4	Q440	G1	Q655	F4	R302
C520	E1	C603	H2	C935	J5	CR622	I2	CR950	L3	J19(T)**	G2	Q500	B2	Q660	J3	R304
C521	E1	C622	J2	C940	I4	CR625	H2	CR980	K4	LR500	B1	Q510	D3	Q665	J3	R310
C530	D1	C635	I1	C943	L4	CR627	I2					Q520A	D2	Q670	J3	R312
C535	E1	C643	H3	C947	L3	CR648	I3					Q520B	D2	Q715	E2	R315

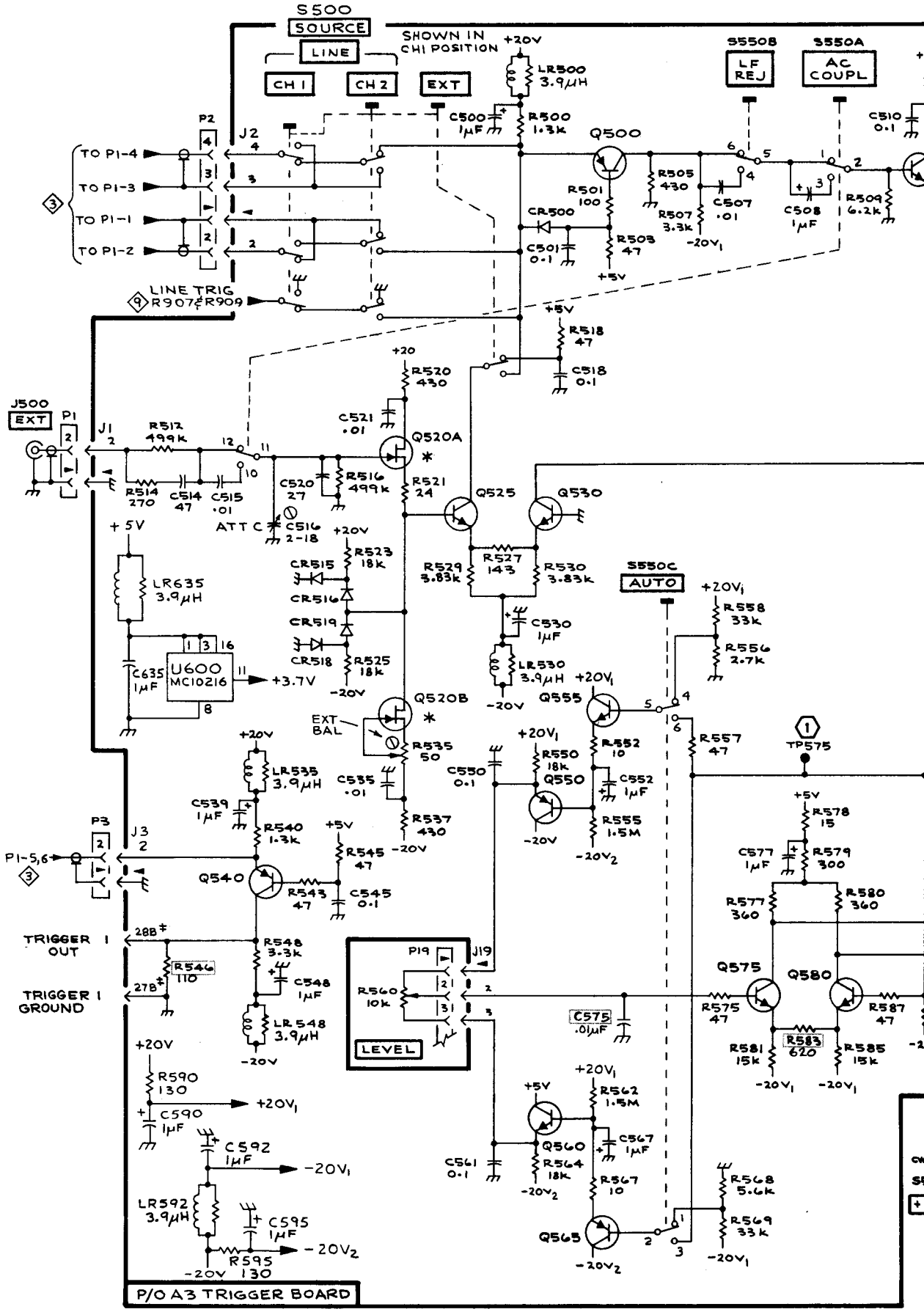
S LOCATION GRID



CKT NO	GRID LOC
R947	L3
R949	L3
R951	I5
R953	L3
R955	L3
R956	L5
R957	L5
R959	L5
R960	L5
R961	J5
R963*	K5
R965	K3
R967	K4
R969	K4
R973	K5
R975	L5
R979	L5
R982	K5
S500A	B3
S500B	B3
TP940	I4
TP941	L3
TP942	I4
TP980	K4
U595	H1
U600A	I1
U600B	I1
U600C	I1
U650	H3
U930	J4
U950	K2
U960	K4
VR930	J4
VR950	L3
VR969	J5

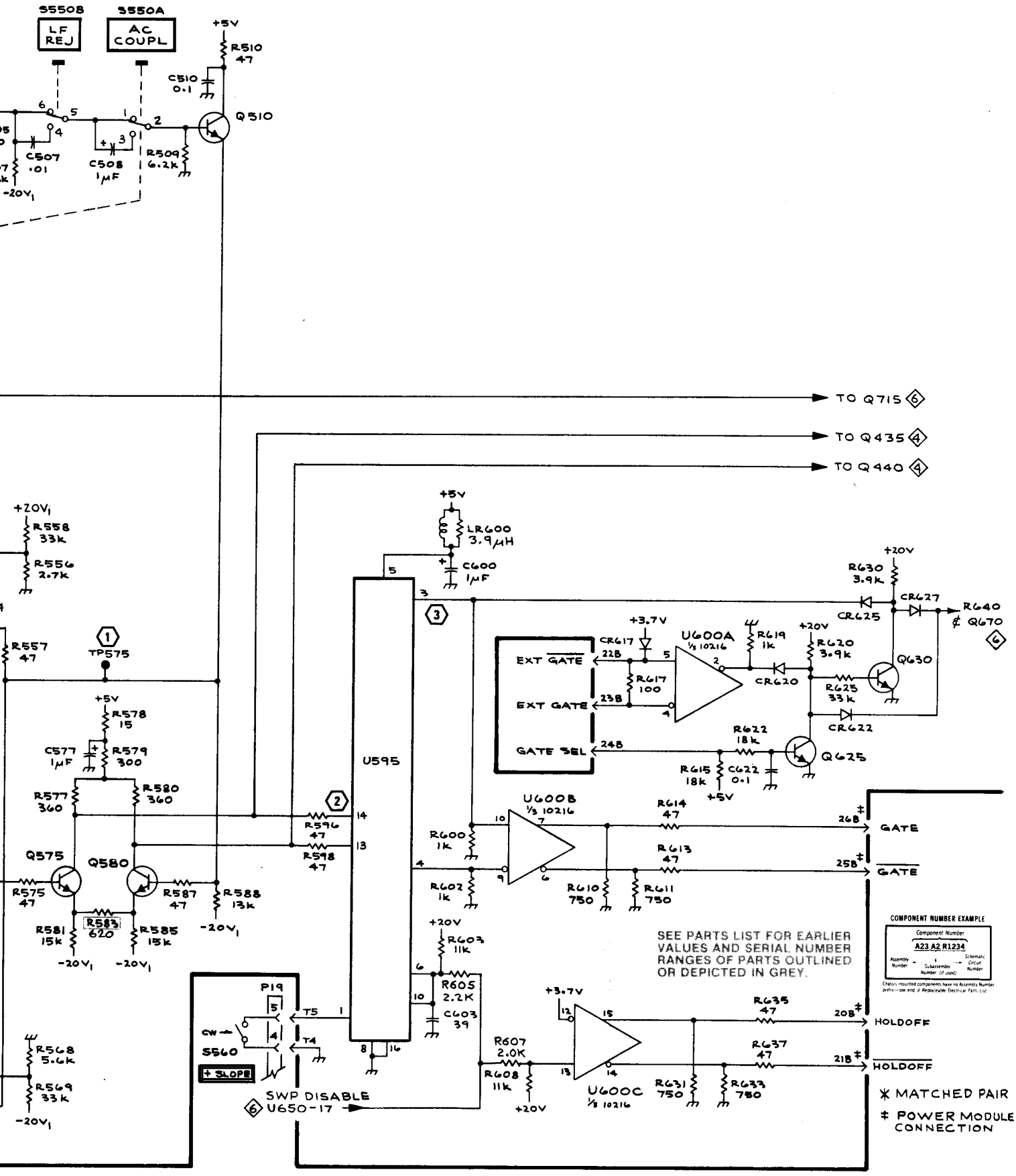
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
D2	Q930	I5	R316	K3	R520	F1	R555	F3	R585	E2	R614	J2	R648	E4	R905	L5
D1	Q933*	L5	R318	K3	R521	D2	R556	C4	R587	E3	R615	J2	R649	I3	R907	I5
L1	Q935	I5	R437	G1	R523	F2	R557	E3	R588	E3	R617	J2	R651	I3	R909	D4
F3	Q940	I5	R438	G1	R525	F1	R558	D3	R590	F4	R619	I2	R653	I3	R922	J4
E3	Q950	I5	R440	H1	R527	D1	R562	F3	R595	F4	R620	I2	R655	H2	R925	J3
G3	Q955	L5	R500	B1	R529	D2	R564	F3	R596	F1	R622	J2	R657	G3	R927	K4
E3	Q958*	K5	R501	B1	R530	D2	R567	F3	R598	F1	R625	I2	R659	F4	R929	J4
F2	Q960	J5	R503	C2	R535	D1	R568	C4	R600	H2	R630	I2	R660	F4	R930	J4
F2	Q965	K5	R505	B1	R537	F1	R569	D4	R602	G2	R631	J2	R662	H3	R932	J5
J2			R507	C1	R540	K1	R575	G3	R603	H1	R633	J2	R664	H3	R934	J5
J2	R300	K3	R509	C4	R543	K1	R577	F2	R605	H1	R635	J2	R665	J2	R935	L5
F4	R302	K2	R510	E2	R545	K1	R578	G2	R607	I1	R637	J2	R667	J3	R937	I5
J3	R304	J2	R512	E2	R546	K1	R579	F2	R608	H1	R640	I3	R715	E1	R939*	L5
J3	R310	K3	R514	E2	R548	K1	R580	F2	R610	J2	R641	G4	R716	F2	R940	J5
J3	R312	J3	R516	E1	R550	F3	R581	F3	R611	J2	R643	H3	R900	K5	R943	J5
E2	R315	J3	R518	C2	R552	E3	R583	E3	R613	J2	R645	F3	R902	K5	R945	K3

REV APR 1984



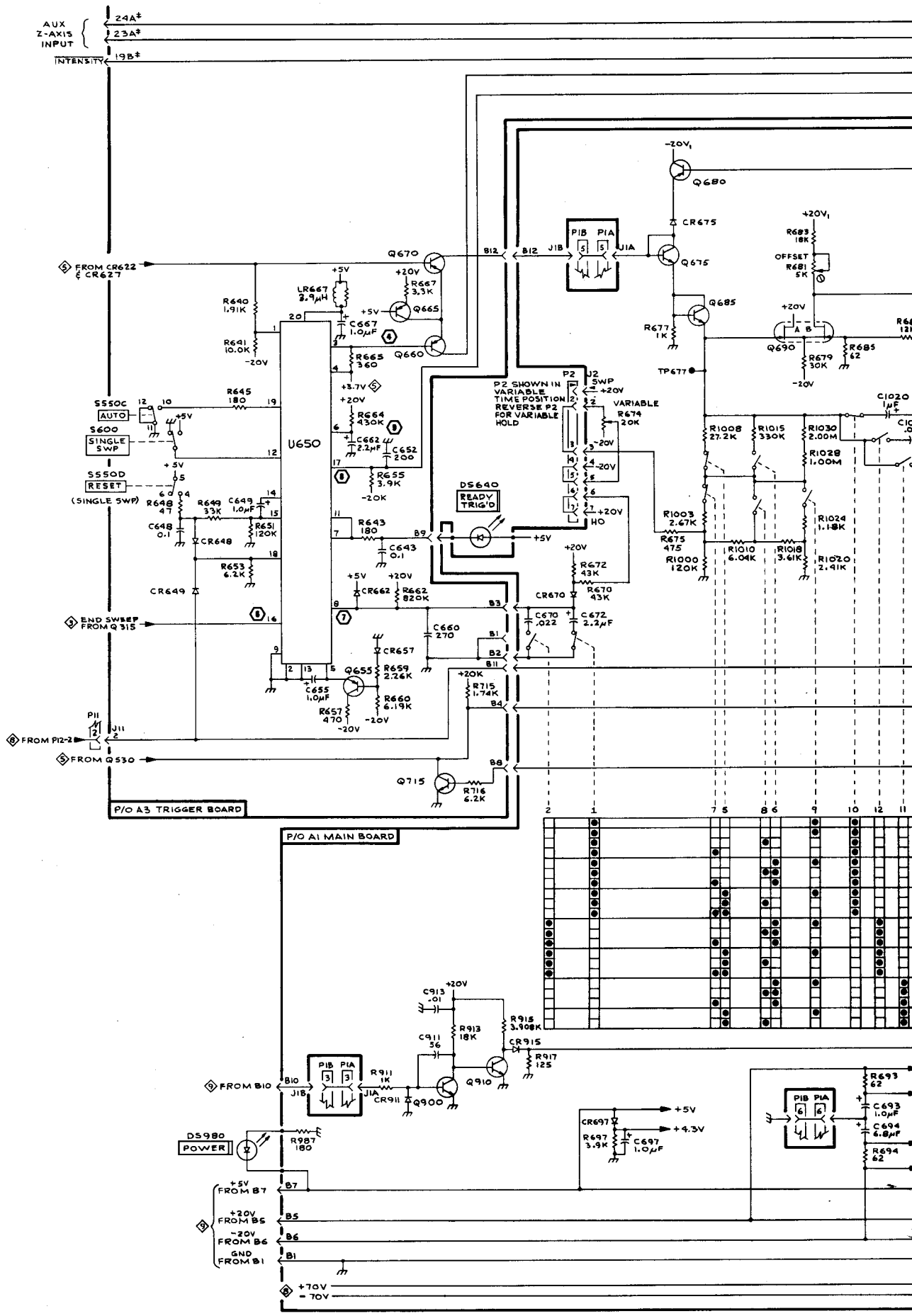
SC502

REV MAY 1982
1878-26



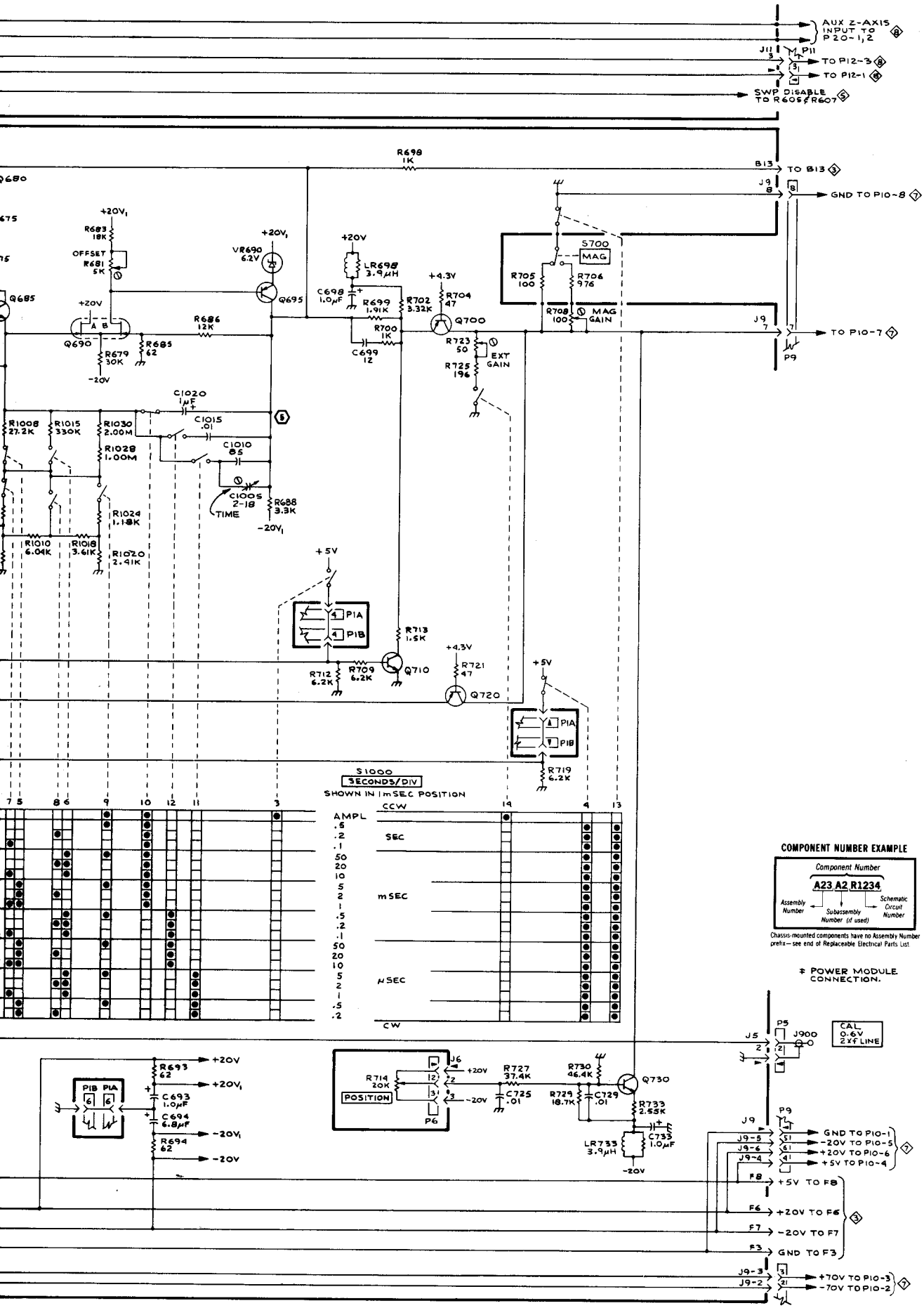
TRIGGERING & GATE SELECT 5

DEH 0575



SC502

REV SEP 1985
1878-27



COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234
Assembly Number · Subassembly Number (if used) · Schematic Circuit Number

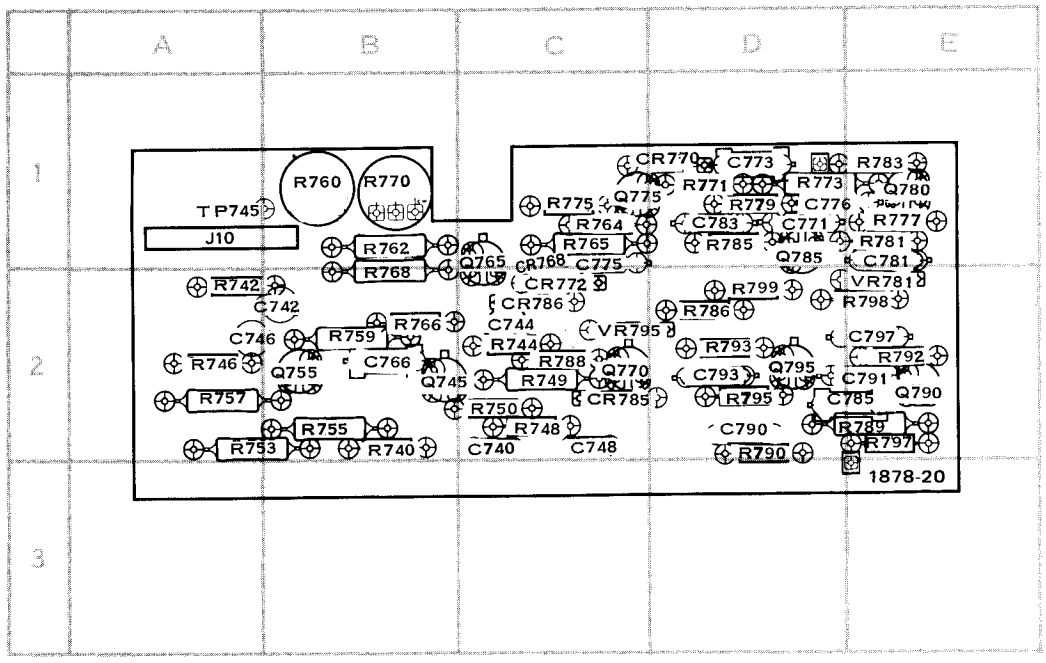
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

* POWER MODULE CONNECTION.

REV SEP 1985
1878-27

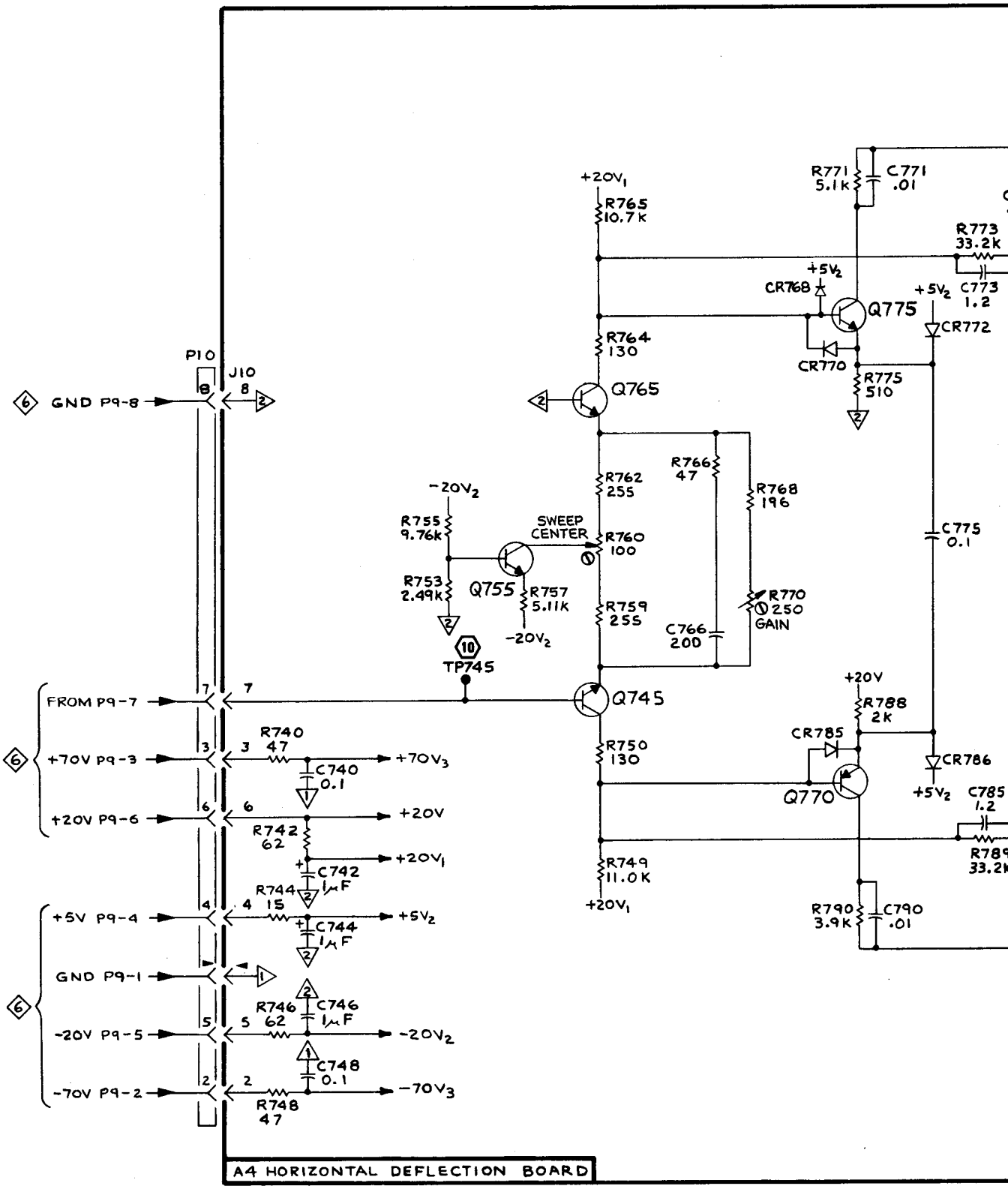
SWEEP GEN - SWEEP CONTROL - HORIZ PREAMP 6

A4 HORIZ DEFL BOARD PARTS LOCATION GRID

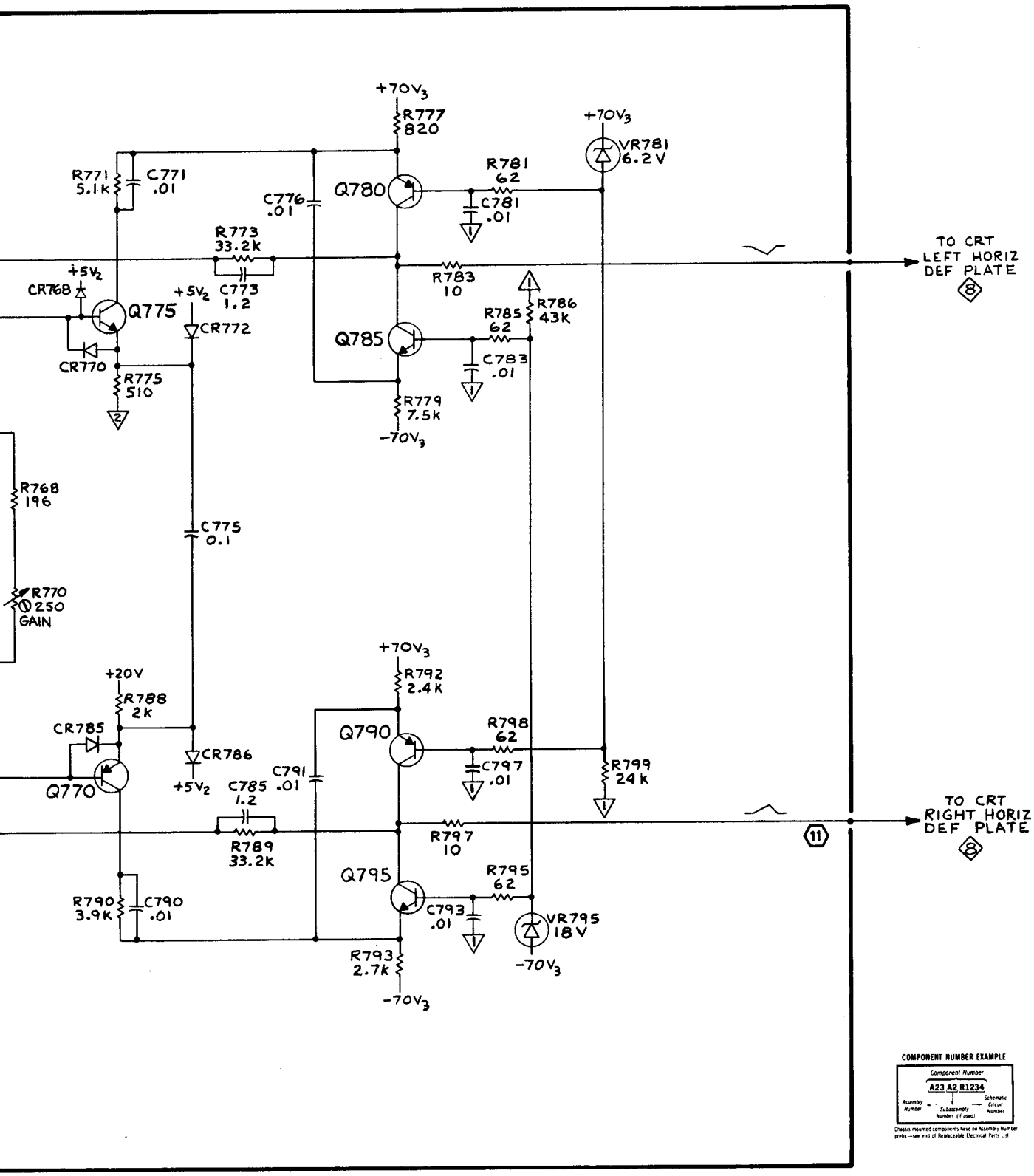


CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C740	C2	Q780	E1	R781	E1
C742	B2	Q785	D1	R783	E1
C744	C2	Q790	E2	R785	D1
C746	A2	Q795	D2	R786	D2
C748	C2			R788	C2
C766	B2	R740	B2	R789	E2
C771	D1	R742	A2	R790	D2
C773	D1	R744	C2	R792	E2
C775	C1	R746	A2	R793	D2
C776	D1	R748	C2	R795	D2
C781	E1	R749	C2	R797	E2
C783	D1	R750	C2	R798	E2
C785	E2	R753	A2	R799	D2
C790	D2	R755	B2		
C791	E2	R757	A2		
C793	D2	R759	B2	TP745	A1
C797	E2	R760	B1		
		R762	B1		
CR768	C1	R764	C1	VR781	E2
CR770	D1	R765	C1	VR795	C2
CR772	C2	R766	B2		
CR785	C2	R768	B2		
CR786	C2	R770	B1		
J10(D)**	A1	R771	D1		
		R773	D1		
Q745	B2	R775	C1		
Q755	B2	R777	E1		
Q765	C1	R779	D1		
Q770	C2				
Q775	C1				

** Numbers or letters inside parenthesis indicate board designation.



REV C APR 1980
1878-28



COMPONENT NUMBER EXAMPLE

Component Number: A23 A2 R1234 (Assembly Number – Subassembly Number (if used) – Schematic Circuit Number)

Chassis mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

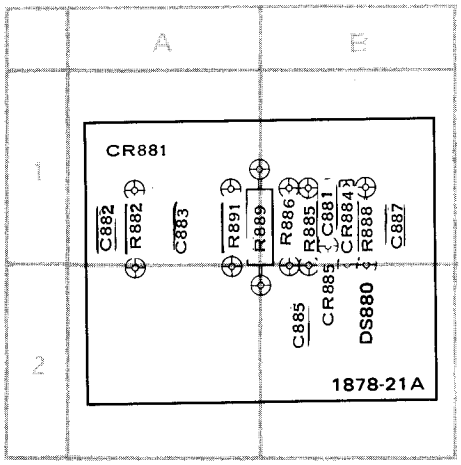
REV C APR 1980
1878-28

HORIZONTAL DEFLECTION AMPLIFIER 7

DAJ
0573

SC 502

A5 AUX BOARD PARTS LOCATION GRID

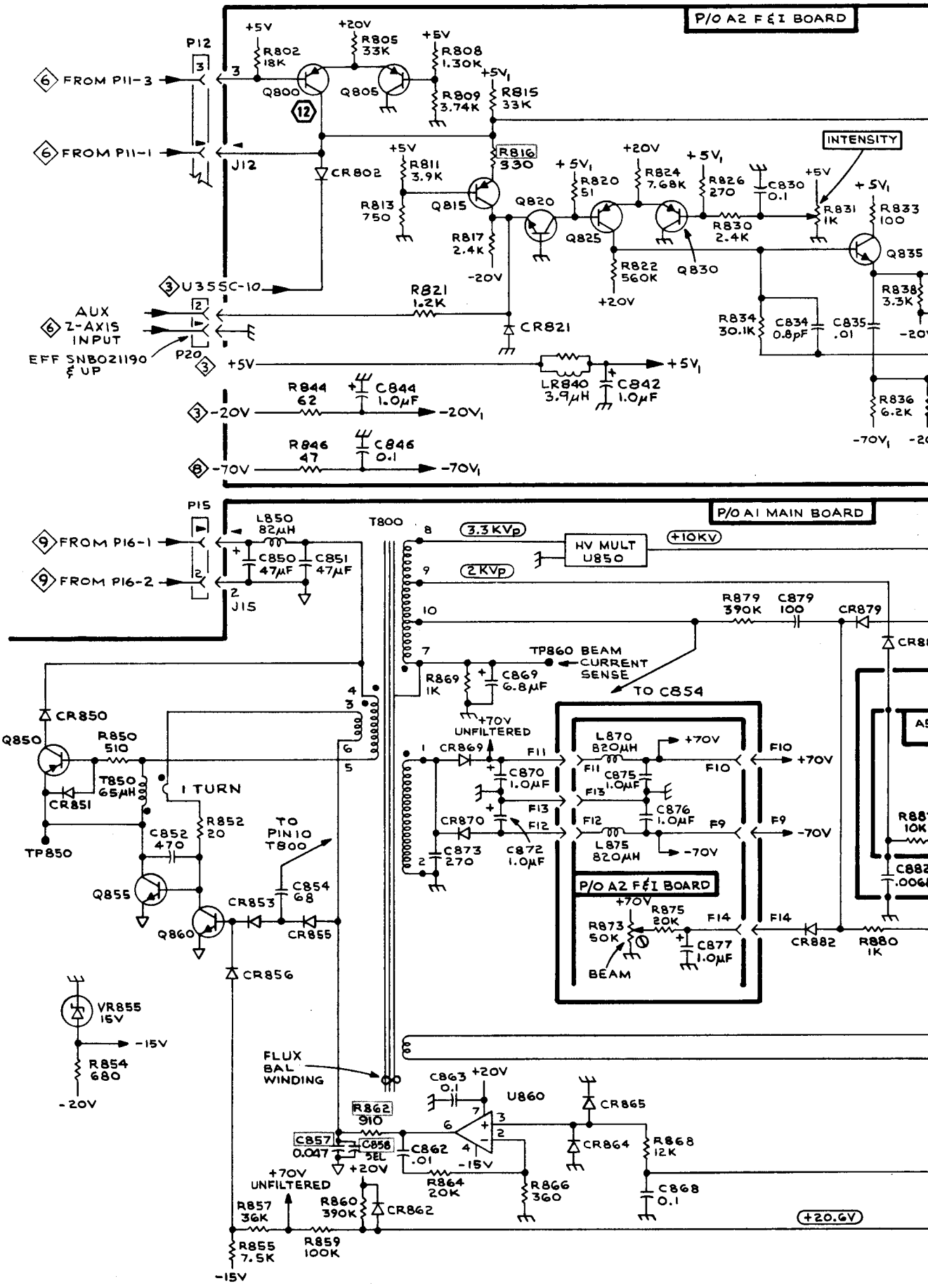


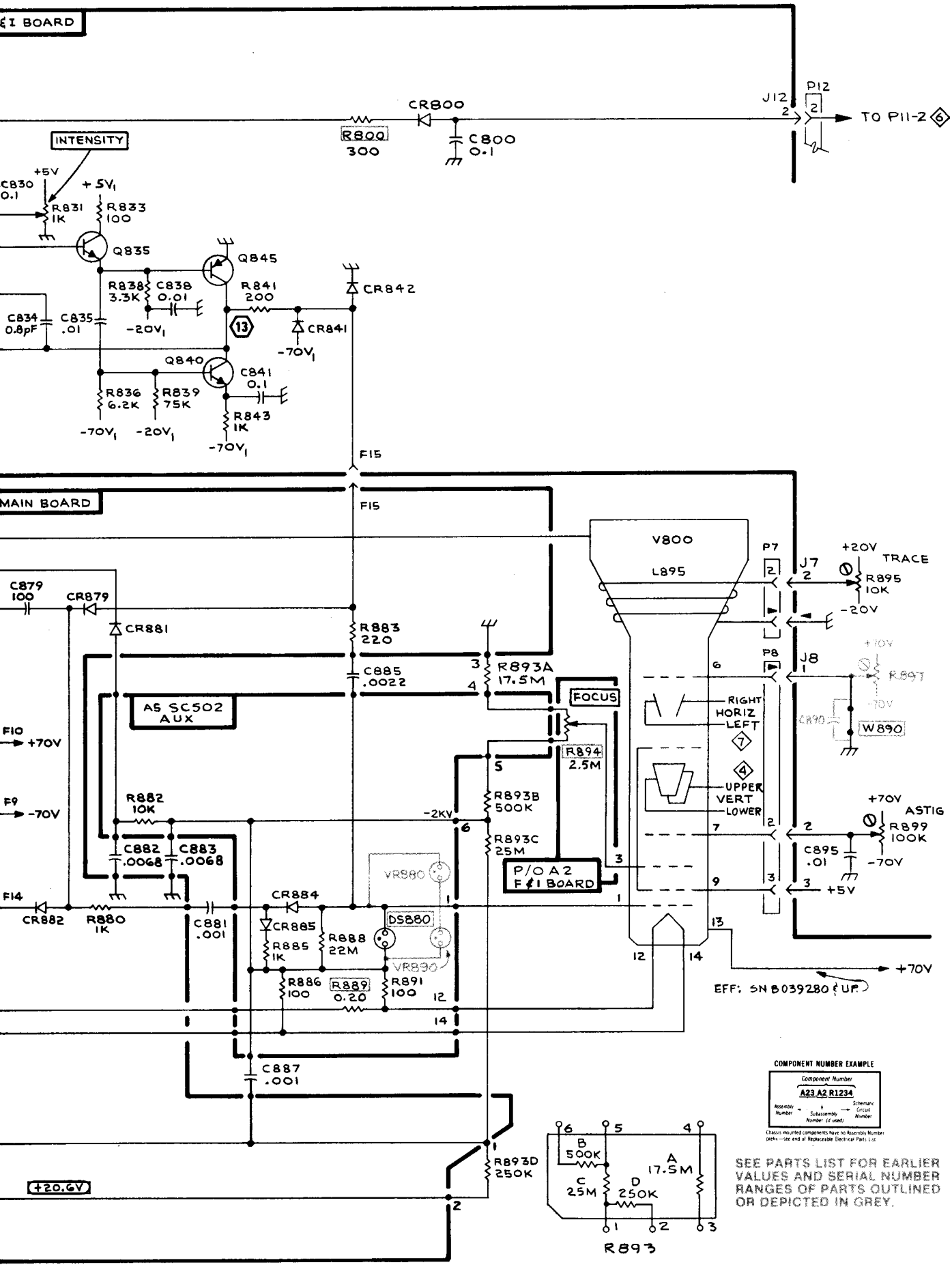
CKT NO	GRID LOC	
C881§	B1	
C882§	A1	
C883§	A1	
C885§	B2	
C887§	B1	
CR884	B1	
CR885	B2	
CR881§§	A1	
DS880*	B2	
R882	A1	
R885	B1	
R886	B1	
R888	B1	
R889	A1	
R891	A1	
VR890 *	B2	Mounted on backside
VR880 *	B2	Mounted on backside

§ Connected between Aux board and Main board.

§§ Connected between Aux and T800.

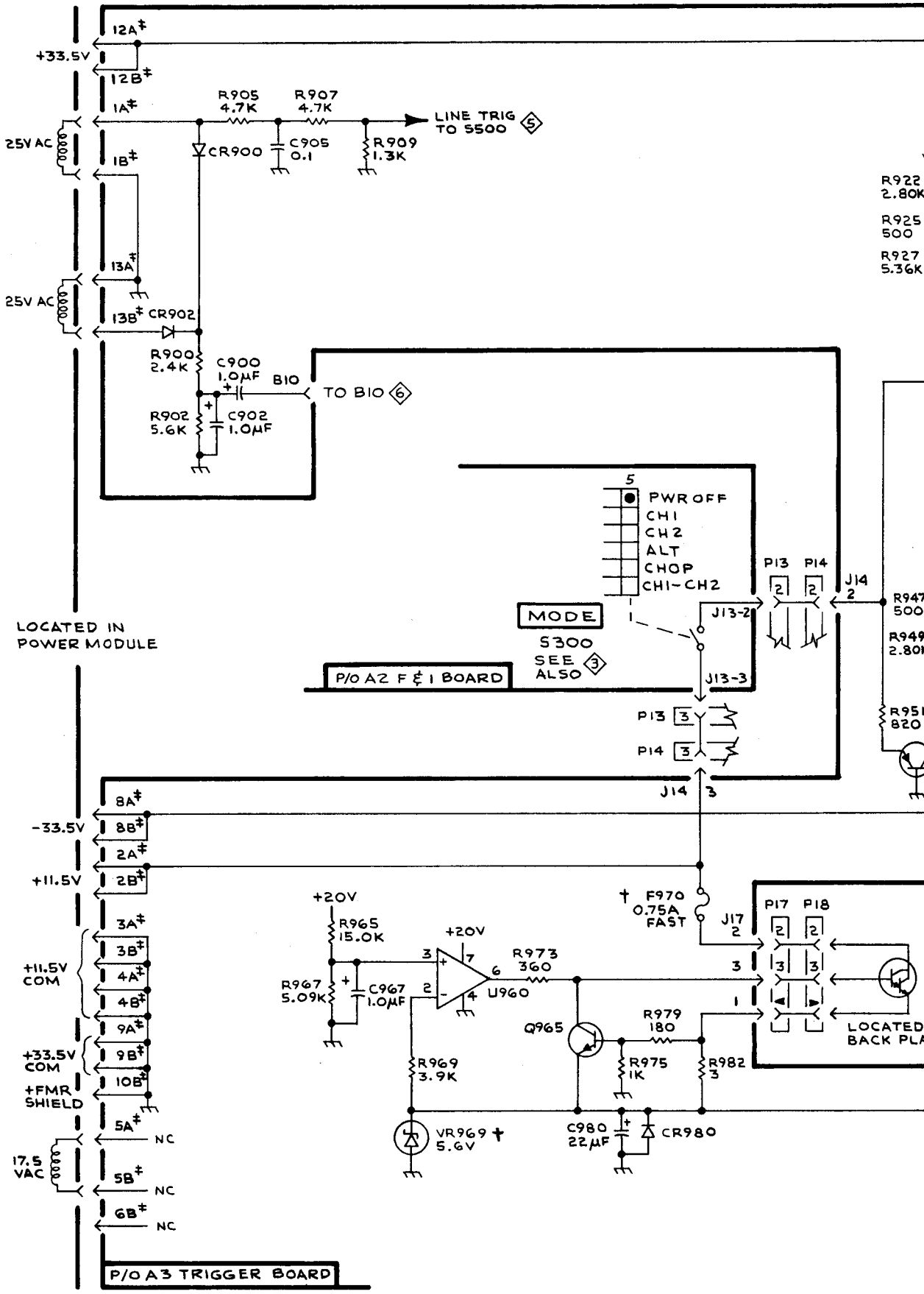
*See Parts List for serial number ranges.


P/O A2 F&I BOARD
P12
FROM P11-3
FROM P11-1
J12
+5V
R802 18K
+20V
R805 33K
R808 1.30K
Q800
Q805
R809 3.74K
+5V1
R815 33K
CR802
R816 330
R811 3.9K
R813 750
Q815
R817 2.4K
-20V
Q820
+5V1
R820 51
Q825
+20V
R824 7.68K
Q830
+5V1
R826 270
R830 2.4K
C830 0.1
+5V
INTENSITY
R831 1K
+5V1
R833 100
Q835
R822 560K
+20V
R821 1.2K
U35SC-10
AUX Z-AXIS INPUT
EFF SN8021190 & UP
P20
CR821
R834 30.1K
C834 0.8pF
C835 .01
R838 3.3K
-20V
+5V
+5V1
LR840 3.9μH
C842 1.0μF
R844 62
C844 1.0μF
-20V1
R846 47
C846 0.1
-70V
-70V1
R836 6.2K
-70V1
P/O A1 MAIN BOARD
P15
FROM P16-1
FROM P16-2
J15
L850 82μH
C850 47μF
C851 47μF
T800
3.3KVp
HV MULT U850
+10KV
2KVp
R879 390K
C879 100
CR879
TP860 BEAM CURRENT SENSE
TO C854
R869 1K
C869 6.8μF
+70V UNFILTERED
CR850
Q850
R850 510
T850 65μH
CR851
1 TURN
TP850
R852 20
C852 470
TO PIN10 T800
Q855
Q860
CR853
C854 68
CR855
CR856
CR869
L870 820μH
+70V
C870 1.0μF
C875 1.0μF
F11
F10
F13
F12
C876 1.0μF
F9
CR870
C872 1.0μF
C873 270
L875 820μH
-70V
P/O A2 F&I BOARD
R873 50K
R875 20K
C877 1.0μF
BEAM
F14
CR882
R880 1K
VR855 15V
-15V
R854 680
-20V
FLUX BAL WINDING
C863 0.1
+20V
U860
CR865
R862 910
C857 0.047
C858 5EL
C862 .01
-15V
CR864
R868 12K
R864 20K
R866 360
C868 0.1
+70V UNFILTERED
R857 36K
R860 390K
CR862
R855 7.5K
R859 100K
-15V
+20.6V

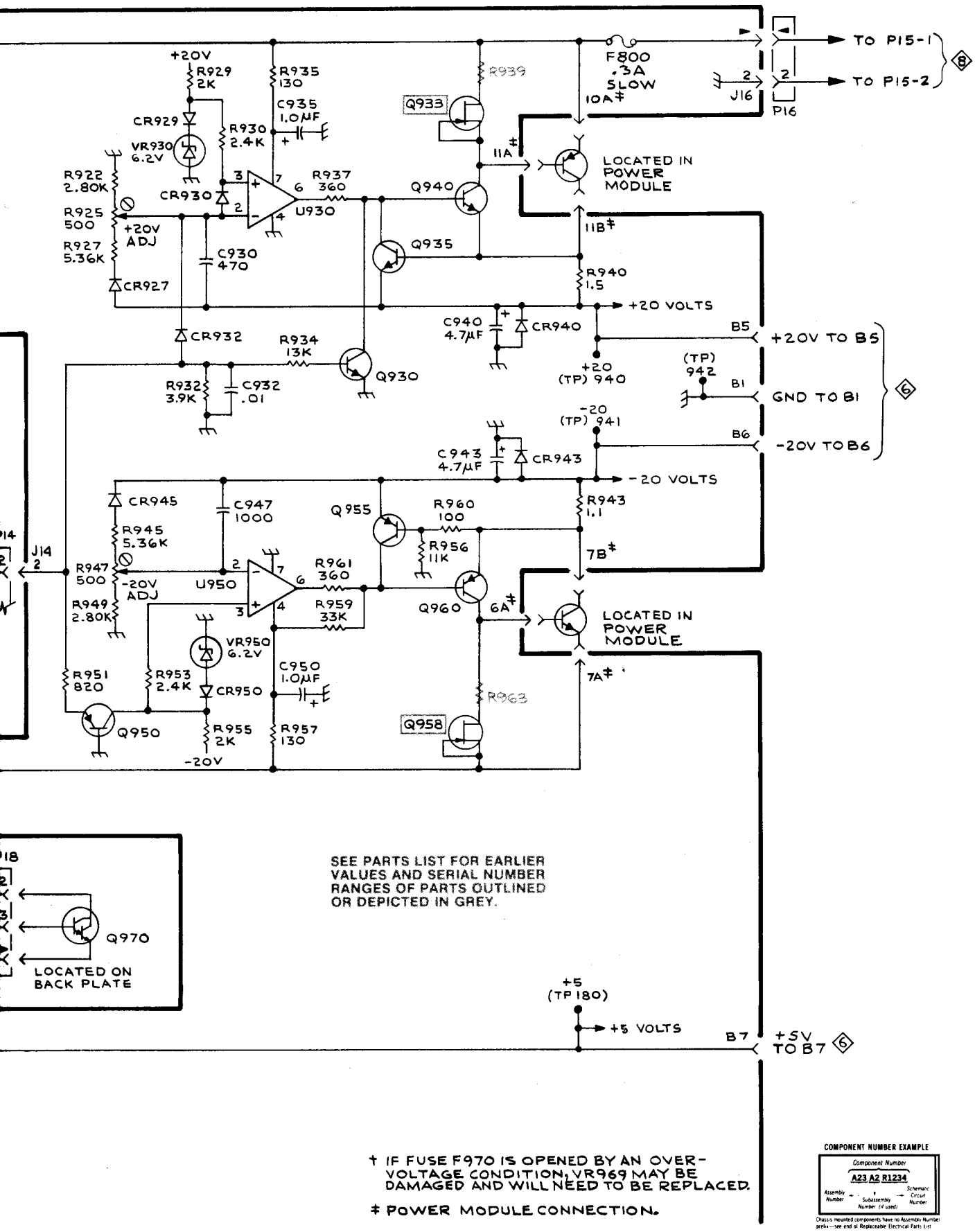


1878-29
REV JAN 1986

Z AXIS & HIGH VOLTAGE 8 EKP 575


12A‡
+33.5V
12B‡
1A‡
R905 4.7K
R907 4.7K
LINE TRIG TO S500 5
25V AC
CR900
C905 0.1
R909 1.3K
1B‡
13A‡
25V AC
13B‡ CR902
R900 2.4K
C900 1.0µF
B10
TO B10 6
R902 5.6K
C902 1.0µF
R922 2.80K
R925 500
R927 5.36K
5
PWR OFF
CH1
CH2
ALT
CHOP
CH1-CH2
P13
P14
J14
2
MODE
S300
SEE ALSO 3
J13-2
J13-3
P/O A2 F & I BOARD
P13 3
P14 3
J14 3
R947 500
R949 2.80
R951 820
LOCATED IN POWER MODULE
8A‡
-33.5V
8B‡
2A‡
+11.5V
2B‡
3A‡
3B‡
+11.5V COM
4A‡
4B‡
9A‡
9B‡
+33.5V COM
10B‡
+FMR SHIELD
5A‡
NC
17.5 VAC
5B‡
NC
6B‡
NC
P/O A3 TRIGGER BOARD
+20V
R965 15.0K
R967 5.09K
C967 1.0µF
+20V
R973 360
U960
Q965
R979 180
R975 1K
R982 3
R969 3.9K
VR969 5.6V
C980 22µF
CR980
† F970 0.75A FAST
J17 2
P17
P18
LOCATED BACK PLA

SC502



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

† IF FUSE F970 IS OPENED BY AN OVER-VOLTAGE CONDITION, VR969 MAY BE DAMAGED AND WILL NEED TO BE REPLACED.

‡ POWER MODULE CONNECTION.

COMPONENT NUMBER EXAMPLE

Chassis mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List

CALIBRATOR & LOW VOLTAGE SUPPLIES ◇9 EKP 575

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
06229	ELECTROVERT INC	86 HARTFORD AVE	MOUNT VERNON NY 10553
07707	USM CORP SUB OF EMHART INDUSTRIES INC USM FASTENER DIV	510 RIVER RD	SHELTON CT 06484
08261	SPECTRA-STRIP AN ELTRA CO	7100 LAMPSON AVE	GARDEN GROVE CA 92642
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
11897	PLASTIGLIDE MFG CORP	2701 W EL SEGUNDO BLVD	HAWTHORNE CA 90250
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125
12697	CLAROSTAT MFG CO INC	LOWER WASHINGTON ST	DOVER NH 03820
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
22670	G M NAMEPLATE INC	2040 15TH AVE WEST	SEATTLE WA 98119
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
45722	USM CORP., PARKER-KALON FASTENER DIV		CAMPBELLSVILLE, KY 42718
71159	BRISTOL SOCKET SCREW CO		WATERBURY CT
71279	MIDLAND-ROSS CORP CAMBION DIV	ONE ALEWIFE PLACE	CAMBRIDGE MA 02138
73743	FISCHER SPECIAL MFG CO	446 MORGAN ST	CINCINNATI OH 45206
74445	HOLO-KROME CO	31 BROOK ST	WEST HARTFORD CT 06110
77900	SHAKEPROOF DIV OF ILLINOIS TOOL WORKS	SAINT CHARLES RD	ELGIN IL 60120
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIVISION	ST CHARLES ROAD	ELGIN IL 60120
78553	EATON CORP ENGINEERED FASTENERS OPERATIONS CLEVELAND DIV	8700 BROOKPARK RD P O BOX 6688	CLEVELAND OH 44101
79136	WALDES KOHINOOR INC	47-16 AUSTEL PLACE	LONG ISLAND CITY NY 11101
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
83385	MICRODOT MANUFACTURING INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
85471	BOYD INDUSTRIAL RUBBER DIV OF A B BOYD CO	2527 GRANT AVE	SAN LEANDRO CA 94579
86928	SEASTROM MFG CO INC	701 SONORA AVE	GLENDALE CA 91201
87308	N L INDUSTRIES INC N L FASTENERS	BARKLEY RD P O BOX 1360	STATESVILLE NC 28677
91500	ASHEVILLE-SCHOONMAKER MICA CO	910 JEFFERSON AVE P O BOX 318	NEWPORT NEWS VA 23607
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
TK0392	NORTHWEST FASTENER SALES INC	7923 SW CIRRUS DRIVE	BEAVERTON OR 97005
TK0435	LEWIS SCREW CO	4114 S PEORIA	CHICAGO IL 60609
TK0507	O HARA METAL PRODUCTS CO	542 BRANNAN ST	SAN FRANCISCO CA 94107
TK0588	UNIVERSAL PRECISION PRODUCTS	1775 NW 216TH	HILLSBORO OR 97123
TK1543	CAMCAR/TEXTRON	516 18TH AVE	ROCKFORD IL 61101
TK1617	CRAFT FACTORY PLASTICS	17145 SW ALEXANDER	ALOHA OR 97007

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	337-1399-04			2	SHIELD,ELEC:SIDE	80009	337-1399-04
-2	200-1837-00	B010100	B023129	2	COVER,PLUG-IN:TOP & BOTTOM	80009	200-1837-00
	200-1837-01	B023130	B026599	2	COVER,PLUG-IN:TOP & BOTTOM	80009	200-1837-01
	200-1837-02	B026600		1	COVER,PLUG-IN:TOP & BOTTOM	80009	200-1837-02
					(ATTACHING PARTS)		
-3	211-0214-00			2	SCREW,MACHINE:4-40 X 0.25,TRH,STL	TK1543	ORDER BY DESCR
					(END ATTACHING PARTS)		
-4	366-1031-03	B010100	B023469	2	KNOB:RED,CAL,0.127 ID X 0.392 OD X 0.466 H	80009	366-1031-03
	366-1031-08	B023470		2	KNOB:GY,CAL,0.127 ID X 0.392 OD X 0.466 H	80009	366-1031-08
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-5	366-1405-00	B010100	B023469	1	KNOB:RED,CAL,0.08 ID X 0.45 OD X 0.466 H	80009	366-1405-00
	366-1405-04	B023470		1	KNOB:WHT,CAL,0.082 ID X 0.45 OD X 0.466 H	80009	366-1405-04
	213-0048-00			1	.SETSCREW:4-40 X 0.125,STL	TK0392	ORDER BY DESCR
-6	366-1567-03	B010100	B023469	2	KNOB:GY,VOLTS/DIV,0.192 ID X 1.125 OD X 0.84 H	80009	366-1567-03
	366-1567-05	B023470		2	KNOB:GY,VOLTS/DIV,0.189 ID X 1.125 OD	80009	366-1567-05
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-7	366-1567-02	B010100	B023469	1	KNOB:GY,SEC/DIV,0.192 ID X 1.125 OD X 0.84	80009	366-1567-02
	366-1567-04	B023470		1	KNOB:GY,SEC/DIV,0.192 ID X 1.125 OD X 0.84 H	80009	366-1567-04
	213-0153-00			2	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-8	366-0215-02	B010100	B023469	2	KNOB:LEVER SWITCH	80009	366-0215-02
	366-0215-05	B023470		2	KNOB:GY,FOR LEVER,0.375 H,W/RTNR SPR	80009	366-0215-05
-9	366-1520-01	B010100	B022399	1	KNOB:GY,0.594 X 0.25 X 0.47	80009	366-1520-01
	366-1690-00	B022400		1	KNOB,LATCH:SIL GY,0.53 X 0.23 X 1.059	80009	366-1690-00
					(ATTACHING PARTS)		
-10	214-1840-00	B010100	B022399	1	PIN,KNOB SECRG:0.12 L X 0.094-0.1 OD,ACETAL	80009	214-1840-00
					(END ATTACHING PARTS)		
-11	366-1023-01	B010100	B023469	2	KNOB:GY,0.127 ID X 0.392 OD X 0.531 H	80009	366-1023-01
	366-1023-07	B023470		2	KNOB:GY,0.127 ID X 0.392 OD X 0.466 H	80009	366-1023-07
	213-0246-00			2	.SETSCREW:5-40 X 0.094,STL	71159	ORDER BY DESCR
-12	366-1391-00	B010100	B023469	3	KNOB:GY,0.081 ID X 0.28 OD X 0.32 H	80009	366-1391-00
	366-1391-01	B023470		3	KNOB:GY,0.081 ID X 0.28 OD X 0.32 H	80009	366-1391-01
	213-0239-00			3	.SETSCREW:3-48 X 0.062,STL	80009	213-0239-00
-13	366-1077-00	B010100	B023469	3	KNOB:GRAY W/SETSCREW	80009	366-1077-00
	366-1077-01	B023470		3	KNOB:GY,0.127 ID X 0.5 OD X 0.531 H	80009	366-1077-01
	213-0153-00			3	.SETSCREW:5-40 X 0.125,STL	TK0392	ORDER BY DESCR
-14	366-1512-00			5	PUSH BUTTON:SIL GY,0.18 SQ X 0.83	80009	366-1512-00
-15	366-1559-00			4	PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-16	----- -----			1	CONNECTOR,RCPT,:(SEE J500 REPL)		
					(ATTACHING PARTS)		
-17	210-0255-00			1	TERMINAL,LUG:0.391 ID,LOCKING,BRS CD PL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-18	----- -----			2	CONN,RCPT,ELEC:(SEE J100,J200 REPL)		
	210-0207-00			2	TERMINAL,LUG:0.385 OD,PLAIN,BRS CD PL	12697	01136902
-19	----- -----			1	RESISTOR,VAR:(SEE R714 REPL)		
					(ATTACHING PARTS)		
-20	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-21	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-22	361-0143-00			1	SPACER,RING:0.125 L X 0.281 ID,AL	80009	361-0143-00
-23	----- -----			1	RESISTOR,VAR:(SEE R560 REPL)		
					(ATTACHING PARTS)		
-24	210-0583-00			1	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-25	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-26	348-0067-00			1	GROMMET,PLASTIC:GRAY,ROUND,0.252 ID	80009	348-0067-00
-27	358-0378-00			1	BUSHING,SLEEVE:0.131 ID X 0.18 OD X 0.125 L	80009	358-0378-00
-28	426-1072-00			9	FRAME,PUSH BTN:SILVER GRAY PLSTC	80009	426-1072-00
-29	220-0633-00			1	NUT,PLAIN,KNURL:0.25-28 X 0.375 OD,BRS NP	80009	220-0633-00
-30	333-1998-00	B010100	B023469	1	PANEL,FRONT:	80009	333-1998-00
	333-1998-01	B023470		1	PANEL,FRONT:	80009	333-1998-01
					(ATTACHING PARTS)		
-31	210-0583-00			2	NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-32	210-0940-00			2	WASHER,FLAT:0.25 ID X 0.375 OD X 0.02,STL	12327	ORDER BY DESCR
-33	355-0170-00			1	STUD,SHLDR&STEP:BINDING POST	80009	355-0170-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-34	211-0537-00			1	SCREW,MACHINE:6-32 X 0.375,TRH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
-35	214-1513-01	B010100	B022399	1	LCH,PL-IN RTNG:PLASTIC	80009	214-1513-01
	105-0719-00	B022400		1	LATCH,RETAINING:PLUG-IN	80009	105-0719-00
					(ATTACHING PARTS)		
-36	213-0254-00			1	SCREW,TPG,TF:2-32 X 0.25,TYPE B,FLH,100 DEG	45722	ORDER BY DESCR
					(END ATTACHING PARTS)		
	105-0718-00	B022400	B024739	1	BAR,LATCH RLSE:	80009	105-0718-00
	105-0718-01	B024740		1	BAR,LATCH RLSE:	80009	105-0718-01
-37	348-0055-00			2	GROMMET,PLASTIC:GRAY,ROUND,0.207 ID	80009	348-0055-00
-38	136-0387-00			1	.JACK,TIP:U/W 0.04 DIA PIN,GRAY	71279	4504352010318
-39	386-3134-01	B010100	B023139	1	SUBPANEL,FRONT:	80009	386-3134-01
	386-3134-03	B023140		1	SUBPANEL,FRONT:PAINTED GRAY	80009	386-3134-03
					(ATTACHING PARTS)		
-40	213-0229-00	B010100	B025259	4	SCR,TPG,TF:6-20 X 0.375,TYPE B,FLH,100 DEG	93907	ORDER BY DESCR
	213-0123-00	B025260		4	SCREW,TPG,TF:6-32 X 0.375,SPCL TYPE,FLH	93907	234-21940-026
					(END ATTACHING PARTS)		
-41	384-1099-00			4	EXTENSION SHAFT:1.58 L X 0.187 SQ,PLSTC	80009	384-1099-00
-42	384-1100-00			1	EXTENSION SHAFT:6.215 L X 0.187 SQ,PLASTIC	80009	384-1100-00
-43	384-0289-00			1	EXTENSION SHAFT:2.813 L X 0.125 STEP OD,STL	TK0588	ORDER BY DESCR
-44	376-0165-00			1	CPLG,SHAFT,RGD:0.127 & 0.07,BLACK NYLON	80009	376-0165-00
	213-0075-00			2	.SETSCREW:4-40 X 0.094,STL	74445	ORDER BY DESCR
-45	384-1056-00			1	EXTENSION SHAFT:6.58 L X 0.123 OD,EPOX GL	80009	384-1056-00
-46	376-0051-01			1	CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD,DELRIN	80009	376-0051-01
	213-0048-00			1	.SETSCREW:4-40 X 0.125,STL	TK0392	ORDER BY DESCR
-47	200-1809-00			1	COVER,VAR RES:MKD CAUTION HIGH VOLTAGE	TK1617	N/A
-48	213-0282-00	B010100	B021604	1	THUMBSCREW:0.375 X 10.7MM,9.525 OD,PLSTC	83385	ORDER BY DESCR
	213-0753-00	B021605	B021639	1	THUMBSCREW:0.375-32 X 0.36,0.75 OD HD,PLSTC	80009	213-0753-00
	213-0282-00	B021640		1	THUMBSCREW:0.375 X 10.7MM,9.525 OD,PLSTC	83385	ORDER BY DESCR
-49	407-1623-00			1	BRACKET,PANEL:REAR	80009	407-1623-00
					(ATTACHING PARTS)		
-50	211-0507-00			3	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-51	----- -----			1	TRANSISTOR:(SEE Q970 REPL)		
					(ATTACHING PARTS)		
-52	211-0097-00			1	SCREW,MACHINE:4-40 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
-53	210-0406-00			1	NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-54	210-0994-00			1	WASHER,FLAT:0.125ID X 0.250D X 0.022	86928	A371-283-20
					(END ATTACHING PARTS)		
-55	342-0202-00			1	INSULATOR,PLATE:TRANSISTOR,MICA	91500	10-21-023-106
-56	214-1061-00			1	CONTACT,ELEC:GROUNDING,CU BE	80009	214-1061-00
-57	426-1245-00	B010100	B023009	1	FR SECT,PLUG-IN:LEFT,TOP AND BOTTOM	80009	426-1245-00
	426-1245-01	B023010		1	FR SECT,PLUG-IN:TOP LEFT	80009	426-1245-01
					(ATTACHING PARTS)		
-58	213-0192-00			1	SCREW,TPG,TF:6-32 X 0.5,SPCL TYPE,FILH,STL	87308	ORDER BY DESCR
	212-0109-00			1	SCREW,MACHINE:8-32 X 0.188,FILH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-59	426-1246-00			1	FR SECT,PLUG-IN:RIGHT SIDE	80009	426-1246-00
					(ATTACHING PARTS)		
-60	213-0192-00			1	SCREW,TPG,TF:6-32 X 0.5,SPCL TYPE,FILH,STL	87308	ORDER BY DESCR
	212-0109-00			1	SCREW,MACHINE:8-32 X 0.188,FILH,STL	83385	ORDER BY DESCR
					(END ATTACHING PARTS)		
-61	255-0334-00			AR	PLASTIC CHANNEL:12.75 X 0.175 X 0.155	11897	122-37-2500
-62	386-3135-00	B010100	B023009	1	PANEL,REAR:	80009	386-3135-00
	386-3135-01	B022010		1	PANEL,REAR:	80009	386-3135-01
					(ATTACHING PARTS)		
-63	211-0504-00	B010100	B028799	2	SCREW,MACHINE:6-32 X 0.250,PNH,STL	TK0435	ORDER BY DESCR
	211-0507-00	B028800		2	SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
-64	211-0097-00			2	SCREW,MACHINE:4-40 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
	213-0192-00			2	SCREW,TPG,TF:6-32 X 0.5,SPCL TYPE,FILH,STL	87308	ORDER BY DESCR
					(END ATTACHING PARTS)		
-65	220-0625-00			2	NUT,SHEET SPR:6-32,STL CD PL,CLIP-ON TYPE	78553	C8090-632-24
-66	386-1316-00			1	.SUPPORT,CRT:REAR	80009	386-1316-00
-67	136-0643-00	B010100	B039279	1	.SKT,PL-IN ELEK:ELCTRN TUBE,12 CONT W/LEADS	80009	136-0643-00
	136-0643-01	B039280		1	.SKT,PL-IN ELEK:ELCTRN TUBE,12 CONT W/LEADS	80009	136-0643-01
	131-0707-00			3	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-	210-0966-00	B021604	B021641	1	WASHER,FLAT:0.312 ID X 0.875 OD X 0.09	86928	ORDER BY DESCR
-68	214-1700-00			1	SPRING,FLAT:73MM X 3.2MM,PH BRZ	80009	214-1700-00
-69	337-2203-00			1	SHLD,IMPLOSION:BLUE POLYCARBONATE	80009	337-2203-00
-70	386-3160-00			1	SUPPORT,CRT:FRONT	80009	386-3160-00
-71	----- -----			1	FORM,COIL:(SEE L895 REPL)		
-72	252-0562-00			AR	PLASTIC EXTR:0.1 X 0.12,POLYETHYLENE	06229	GS2
-73	334-2363-00			1	MARKER,IDENT:MKD DANGER,HIGH VOLTAGE	80009	334-2363-00
	334-1379-00			1	MARKER,IDENT:MKD HI VACUUM	22670	ORDER BY DESCR
	348-0090-00	B028700		1	PAD,CUSHIONING:2.03 X 0.69 X 0.312 SI RBR	85471	R-1047OMED/PSA
-74	337-2140-00			1	SHIELD,CRT:	80009	337-2140-00
-75	200-1780-00			1	COVER,HV:BOTTOM	80009	200-1780-00
					(ATTACHING PARTS)		
-76	211-0097-00			2	SCREW,MACHINE:4-40 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
-77	210-0851-00			2	WASHER,FLAT:0.119 X 0.375 X 0.025,STL	12327	ORDER BY DESCR
					(END ATTACHING PARTS)		
-78	426-1199-00	B010100	B023139	1	FR SECT,PLUG-IN:BOTTOM	80009	426-1199-00
	426-1199-01	B023140		1	FR SECT,PLUG-IN:BOTTOM	80009	426-1199-01
	386-3657-00	B022430	B025769	2	SUPPORT,PLUG-IN:	80009	386-3657-00
	386-3657-01	B025770		2	SUPPORT,PLUG-IN:	93907	ORDER BY DESCR
-79	----- -----			1	DELAY LINE,ELEC:(SEE DL400 REPL)		
					(ATTACHING PARTS)		
-80	211-0097-00			2	SCREW,MACHINE:4-40 X 0.312,PNH,STL	TK0435	ORDER BY DESCR
					(END ATTACHING PARTS)		
					DELAY LINE ASSY INCLUDES:		
-81	131-1721-00			2	.CONTACT,ELEC:DELAY LINE,0.035 DIA MALE	80009	131-1721-00
-82	361-0008-00			1	SPACER,SLEEVE:0.28 L X 0.111 ID,PP	80009	361-0008-00
-83	334-2361-00			3	MARKER,IDENT:MKD DANGER	80009	334-2361-00
-84	----- -----			1	CKT BOARD ASSY:HORIZ DEFL(SEE A4 REPL)		
					(ATTACHING PARTS)		
-85	211-0116-00	B010100	B028339	2	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR
	211-0292-00	B028340		2	SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-86	131-0608-00			8	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-87	129-0455-00			2	.SPACER,POST:0.305 L,4-40 THRU,BRS,CU SN ZN	80009	129-0455-00
					.PL,0.25 OD		
-88	----- -----			1	CKT BOARD ASSY:TRIGGER(SEE A3 REPL)		
					(ATTACHING PARTS)		
	211-0116-00	B010100	B028339	2	SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR
	211-0292-00	B028340		2	SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					(END ATTACHING PARTS)		
					CKT BOARD ASSY INCLUDES:		
-89	343-0496-04			1	.CLIP,SWITCH:FRONT,10MM X 4 UNIT	80009	343-0496-04
-90	343-0497-04			1	.CLIP,SWITCH:REAR,10MM X 4 UNIT	80009	343-0497-04
-91	210-3033-00			8	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS	07707	SE-25
-92	----- -----			1	.ACTR ASSY,PB:(SEE A3S500 REPL)		
-93	----- -----			1	.ACTR ASSY,PB:(SEE A3S600 REPL)		
-94	----- -----			1	.SWITCH,PUSH:(SEE A3S550 REPL)		
-95	361-0385-00			6	.SPACER,PB SW:0.164 L,GREEN POLYCARBONATE	80009	361-0385-00
	361-0384-00			6	.SPACER,PB SW:0.133 L,RED POLYCARBONATE	80009	361-0384-00
-96	131-0608-00			28	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-97	136-0634-00	B010100	B039999	1	.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
	136-0752-00	B040000		1	.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-98	131-0566-00			1	.BUS,CONDUCTOR:DUMMY RES,0.094 X 0.225	24546	OMA 07
-99	136-0252-04			2	.SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-100	136-0577-00			1	.CONN,RCPT,ELEC:CKT BOARD,15 CONTACT	22526	65001-015
-101	136-0260-02	B010100	B039999	2	.SKT,PL-IN ELEK:MICROCKT,16 DIP,PCB MT	09922	DILB16P-108T
	136-0729-00	B040000		2	.SKT,PL-IN ELEK:MICROCKT,16 CONTACT	09922	DILB16P-108T
-102	136-0514-00	B010100	B039999	3	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B040000		3	.SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-103	----- -----			4	.TERM,TEST POINT:(SEE A3TP940,TP941,TP942,		
					.TP980 REPL)		
-104	344-0154-00			4	.CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-00
-105	352-0222-00			3	.HOLDER,CABLE:HORIZ CKT BD MT,DELRIN	80009	352-0222-00
	198-3788-00	B022580		1	.WIRE SET,ELEC:	80009	198-3788-00
-106	----- -----			1	CKT BOARD ASSY:F & I (SEE A2 REPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-					.ACTR ASSY,CAM S:DISPLAY(SEE S300 REPL)		
					.(ATTACHING PARTS)		
-107	211-0116-00	B010100	B028339	4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR
	211-0292-00	B028340		4	.SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					.(END ATTACHING PARTS)		
					.ACTUATOR INCLUDES:		
-108	200-1660-00			1	..COVER,CAM SW:5 ELEMENTS	80009	200-1660-00
-109	131-1248-00			1	..CONTACT,ELEC:SHAFT GND,NI BE	80009	131-1248-00
-110	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-111	214-1704-01			1	..SPRING,FLAT:0.52 X 0.125 X 0.008,CU BE	80009	214-1704-01
-112	214-1127-00			1	..ROLLER,DETENT:0.125 DIA X 0.125,SST	80009	214-1127-00
-113	401-0155-00			1	..BEARING,CAM SW:FRONT,0.454 DIA CAM	80009	401-0155-00
					..(ATTACHING PARTS)		
-114	354-0219-00			1	..RING,RETAINING:EXT,CRESCENT,U/O 0.25 DIA	79136	5103-25-S-ZD-R
					..(END ATTACHING PARTS)		
-115	105-0674-00			1	..ACTUATOR,CAM SW:DISPLAY MODE	80009	105-0674-00
-116	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-117	401-0156-00			1	..BEARING,CAM SW:REAR,0.454 DIA CAM	80009	401-0156-00
-118	131-0604-00			5	..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-119	131-0608-00			21	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-120	----- -----			1	..RES.,VARIABLE:(SEE A2R324 REPL)		
-121	----- -----			1	..RES.,VARIABLE:(SEE A2R831 REPL)		
-122	----- -----			1	..SWITCH,PUSH:(SEE A2S400 REPL)		
-123	361-0382-00			2	..SPACER,PB SW:0.275 L,BROWN POLYCARBONATE	80009	361-0382-00
-124	136-0252-04			28	..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-125	337-2228-00			1	..SHIELD,ELEC:CIRCUIT BOARD	80009	337-2228-00
-126	136-0577-00			1	..CONN,RCPT,ELEC:CKT BOARD,15 CONTACT	22526	65001-015
-127	----- -----			1	..RES.,VARIABLE:(SEE A2R894 REPL)		
					..(ATTACHING PARTS)		
-128	210-0583-00			1	..NUT,PLAIN,HEX:0.25-32 X 0.312,BRS CD PL	73743	2X-20319-402
-129	210-0046-00			1	..WASHER,LOCK:0.261 ID,INTL,0.018 THK,STL	77900	1214-05-00-0541C
					..(END ATTACHING PARTS)		
-130	386-3263-00			1	..PL,VAR RES MTG:	80009	386-3263-00
-131	352-0086-00			1	..HOLDER,TOROID:0.5 DIA,DELRIN	80009	352-0086-00
	672-0512-00	B010100	B041865	1	CIRCUIT BD ASSY:MAIN	80009	672-0512-00
	672-0512-01	B041866	B042044	1	CIRCUIT BD ASSY:MAIN 670-3758-00 W/CAM SW	80009	672-0512-01
	672-0512-02	B042045		1	CIRCUIT BD ASSY:MAIN	80009	672-0512-02
-132	384-1175-00			2	.EXTENSION SHAFT:5.7 L X 0.123 OD,EPOXY GL	80009	384-1175-00
-133	214-2321-01			2	.LEVER,SWITCH:0.25 ID X 0.715 L,W/4-40 THD	80009	214-2321-01
					.(ATTACHING PARTS)		
-134	211-0225-00			2	.SCREW,CAP:4-40 X 0.312,SCH,STL,CD PL,HEX RE	TK0428	ORDER BY DESCR
					.C		
					.(END ATTACHING PARTS)		
-135	131-1314-00			2	.CONTACT,ELEC:GROUNDING,MONEL	80009	131-1314-00
-136	376-0051-01			2	.CPLG,SHAFT,FLEX:0.127 ID X 0.375 OD,DELRIN	80009	376-0051-01
	213-0048-00			8	..SETSCREW:4-40 X 0.125,STL	TK0392	ORDER BY DESCR
-137	----- -----			2	.RES.,VARIABLE:(SEE R177 AND R277 REPL)		
-138	361-0515-00			2	.SPACER,SWITCH:0.176 L,ACETAL	80009	361-0515-00
-139	384-1380-00			1	.EXTENSION SHAFT:5.2 L X 0.081 OD,SST,PSVT	80009	384-1380-00
-140	376-0050-00			1	.CPLG,SHAFT,FLEX:0.081 & 0.127 ID,PP	80009	376-0050-00
	213-0022-00			4	..SETSCREW:4-40 X 0.188,STL	74445	ORDER BY DESCR
-141	----- -----			1	.RES.,VARIABLE:(SEE R674 REPL)		
-142	361-0515-00			1	.SPACER,SWITCH:0.176 L,ACETAL	80009	361-0515-00
					.ACTR ASSY,CAM S:(SEE S100/S150,		
					.S200/S250 REPL)		
					.(ATTACHING PARTS)		
-143	211-0116-00	B010100	B028339	12	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR
	211-0292-00	B028340		12	.SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					.(END ATTACHING PARTS)		
					.EACH ACTUATOR INCLUDES:		
-144	200-1816-00			1	..COVER,CAM SW:14 & 3 ELEMENTS	80009	200-1816-00
					..(ATTACHING PARTS)		
-145	211-0008-00			6	..SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-146	210-0004-00			6	..WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
					..(END ATTACHING PARTS)		
-147	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-148	131-0963-00			2	..CONTACT,ELEC:GROUNDING,PH BRZ,W/BRACKET	TK0507	ORDER BY DESCR
-149	214-1139-03			2	..SPRING,FLAT:0.885 X 0.156 CU BE RED CLR	80009	214-1139-03
-150	214-1752-00			2	..ROLLER,DETENT:0.125 OD X 0.16,SST	80009	214-1752-00
-151	401-0178-00			1	..BEARING,CAM SW:CENTER/REAR	80009	401-0178-00
					..(ATTACHING PARTS)		
-152	354-0390-00			1	..RING,RETAINING:BASIC EXT,U/O 0.375 DIA	79136	5100-37-ZD
					..(END ATTACHING PARTS)		
-153	384-0878-06			1	..SHAFT,CAM SW:1.414 L X 0.248 OD OUTER CONCE	80009	384-0878-06
					..NTRIC W/DRIVER		
					..(ATTACHING PARTS)		
	354-0443-00			1	..RING,RETAINING:EXT CRESCENT,U/O 0.375 DIA	79136	5103-37-MD
					..(END ATTACHING PARTS)		
-154	105-0672-00			1	..ACTUATOR,CAM SW:AC,GND,DC	80009	105-0672-00
-155	210-0406-00			4	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-156	401-0180-00			1	..BEARING,CAM SW:FRONT & REAR,0.80 & 0.83 DI	80009	401-0180-00
					..A CAM DOUBLE BOARD		
-157	384-0880-03			1	..SHAFT,CAM SW:3.121 L X 0.188 OD INTMD CONCE	80009	384-0880-03
					..NTRIC W/DRIVER		
-158	105-0671-00			1	..ACTUATOR,CAM SW:VOLTS/DIV	80009	105-0671-00
					..(ATTACHING PARTS)		
-159	354-0390-00			1	..RING,RETAINING:BASIC EXT,U/O 0.375 DIA	79136	5100-37-ZD
					..(END ATTACHING PARTS)		
-160	210-0406-00			4	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-161	214-1139-03			1	..SPRING,FLAT:0.885 X 0.156 CU BE RED CLR	80009	214-1139-03
	214-1139-02			1	..SPRING,FLAT:0.885 X 0.156 CU BE GRN CLR	80009	214-1139-02
-162	214-1752-00			2	..ROLLER,DETENT:0.125 OD X 0.16,SST	80009	214-1752-00
-163	401-0180-00			1	..BEARING,CAM SW:FRONT & REAR,0.80 & 0.83 DI	80009	401-0180-00
					..A CAM DOUBLE BOARD		
					.ACTR ASSY,CAM S:HORIZONTAL(SEE S1000 REPL)		
					.(ATTACHING PARTS)		
-164	211-0116-00	B010100	B028339	4	.SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR
	211-0292-00	B028340		4	.SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					.(END ATTACHING PARTS)		
					.ACTUATOR INCLUDES:		
-165	200-1817-00			1	..COVER,CAM SW:14 ELEMENTS	80009	200-1817-00
					..(ATTACHING PARTS)		
-166	211-0008-00			4	..SCREW,MACHINE:4-40 X 0.25,PNH,STL	93907	ORDER BY DESCR
-167	210-0004-00			4	..WASHER,LOCK:#4 INTL,0.015 THK,STL	77900	1204-00-00-0541C
					..(END ATTACHING PARTS)		
-168	210-0406-00			2	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-169	131-0963-00			2	..CONTACT,ELEC:GROUNDING,PH BRZ,W/BRACKET	TK0507	ORDER BY DESCR
-170	214-1139-02			2	..SPRING,FLAT:0.885 X 0.156 CU BE GRN CLR	80009	214-1139-02
-171	214-1752-00			2	..ROLLER,DETENT:0.125 OD X 0.16,SST	80009	214-1752-00
-172	401-0180-00			1	..BEARING,CAM SW:FRONT & REAR,0.80 & 0.83 DI	80009	401-0180-00
					..A CAM DOUBLE BOARD		
					..(ATTACHING PARTS)		
-173	354-0390-00			1	..RING,RETAINING:BASIC EXT,U/O 0.375 DIA	79136	5100-37-ZD
					..(END ATTACHING PARTS)		
-174	384-0878-07			1	..SHAFT,CAM SW:2.519 L X 0.248 OD OUTER CONCE	80009	384-0878-07
					..NTRIC W/DRIVER		
-175	105-0673-00			1	..ACTUATOR,CAM SW:HORIZONTAL	80009	105-0673-00
-176	210-0406-00			4	..NUT,PLAIN,HEX:4-40 X 0.188,BRS CD PL	73743	12161-50
-177	401-0178-00			1	..BEARING,CAM SW:CENTER/REAR	80009	401-0178-00
-178	----- -----			1	.CKT BOARD ASSY:MAIN(SEE A1 REPL)		
-179	----- -----			1	..CKT BOARD ASSY:(SEE A5 REPL)		
					..(ATTACHING PARTS)		
-180	211-0507-00			2	..SCREW,MACHINE:6-32 X 0.312,PNH,STL	83385	ORDER BY DESCR
					..(END ATTACHING PARTS)		
-181	385-0016-00			1	...SPACER,POST:1.0 L W/6-32 THD THRU,NYLON	80009	385-0016-00
-182	----- -----			1	.SEMICOND DVC,DI:HV MULTR(SEE U850 REPL)		
					.(ATTACHING PARTS)		
-183	210-0407-00			2	.NUT,PLAIN,HEX:6-32 X 0.25,BRS CD PL	73743	3038-402
					.(END ATTACHING PARTS)		
-184	337-2168-00			1	..SHIELD,ELEC:FRONT	80009	337-2168-00
					..(ATTACHING PARTS)		
-185	211-0116-00	B010100	B028339	2	..SCR,ASSEM WSHR:4-40 X 0.312,PNH,BRS,POZ	77900	ORDER BY DESCR

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-	211-0292-00	B028340		2	..SCR,ASSEM WSHR:4-40 X 0.29,PNH,BRS NI PL	78189	51-040445-01
					..(END ATTACHING PARTS)		
-186	337-2166-00			1	..SHIELD,ELEC:RIGHT,CKT BD MTG	80009	337-2166-00
-187	136-0252-04			77	..SOCKET,PIN TERM:U/W 0.016-0.018 DIA PINS	22526	75060-007
-188	131-1003-00			2	..CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
-189	----- -----			3	..TERM,TEST POINT:(SEE A1TP677,TP850,		
					..TP860 REPL)		
-190	131-0604-00			42	..CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-191	131-0608-00			38	..TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-192	131-0787-00			28	..TERMINAL,PIN:0.64 L X 0.025 SQ PH BRZ	22526	47359-000
-193	136-0514-00	B010100	B039999	1	..SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
	136-0727-00	B040000		1	..SKT,PL-IN ELEK:MICROCKT,8 CONTACT	09922	DILB8P-108
-194	131-1838-00			1	..BUS,CONDUCTOR:7,26 AWG,0.313 L	80009	131-1838-00
	198-2303-00			1	WIRE SET,ELEC:	80009	198-2303-00
-195	131-1538-00			4	.CONNECTOR,TERM:22-26 AWG U/O 0.04 SQ PIN	22526	75369-002
-196	131-0707-00	B010100	B021189	35	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
	131-0707-00	B021190		37	.CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
	131-0708-00			1	.CONTACT,ELEC:28-32 AWG,BRS,CU BE GLD PL	22526	47437-000
-197	210-0774-00			8	.EYELET,METALLIC:0.152 OD X 0.218 L	80009	210-0774-00
-198	210-0775-00			8	.EYELET,METALLIC:0.126 OD X 0.205 L	80009	210-0775-00
-199	352-0169-01			2	.HLDR,TERM CONN:2 WIRE,BROWN	80009	352-0169-01
	352-0169-06			1	.HLDR,TERM CONN:2 WIRE,BLUE	80009	352-0169-06
	352-0169-07			1	.HLDR,TERM CONN:2 WIRE,VIOLET	80009	352-0169-07
	352-0169-00	B021189		1	.HLDR,TERM CONN:2 WIRE,BLACK	80009	352-0169-00
-200	352-0161-03			1	.HLDR,TERM CONN:3 WIRE,ORANGE	80009	352-0161-03
	352-0161-04			2	.HLDR,TERM CONN:3 WIRE,YELLOW	80009	352-0161-04
-201	352-0163-05			1	.HLDR,TERM CONN:5 WIRE,GREEN	80009	352-0163-05
-202	352-0166-08			1	.HLDR,TERM CONN:8 WIRE,GRAY	80009	352-0166-08
-203	175-0862-00			AR	.CABLE,SP,ELEC:3,22 AWG,STRD,PVC JKT,RBN	TK0846	03CF22M19-BBT
	175-0826-00			AR	.CABLE,SP,ELEC:3,26 AWG,STRD,PVC JKT,RBN	80009	175-0826-00
	175-0828-00			AR	.CABLE,SP,ELEC:5,26 AWG,STRD,PVC JKT,RBN	08261	111-2699-955
-204	175-0831-00			AR	.CABLE,SP,ELEC:8,26 AWG,STRD,PVC INSUL,RBN	08261	111-2699-971
-205	179-2198-00			1	WIRING HARNESS:COAX CABLE	80009	179-2198-00
	179-2199-00			1	WIRING HARNESS:CIRCUIT BOARD	80009	179-2199-00
					STANDARD ACCESSORIES		
	070-1878-01			1	MANUAL,TECH:INSTR	80009	070-1878-01

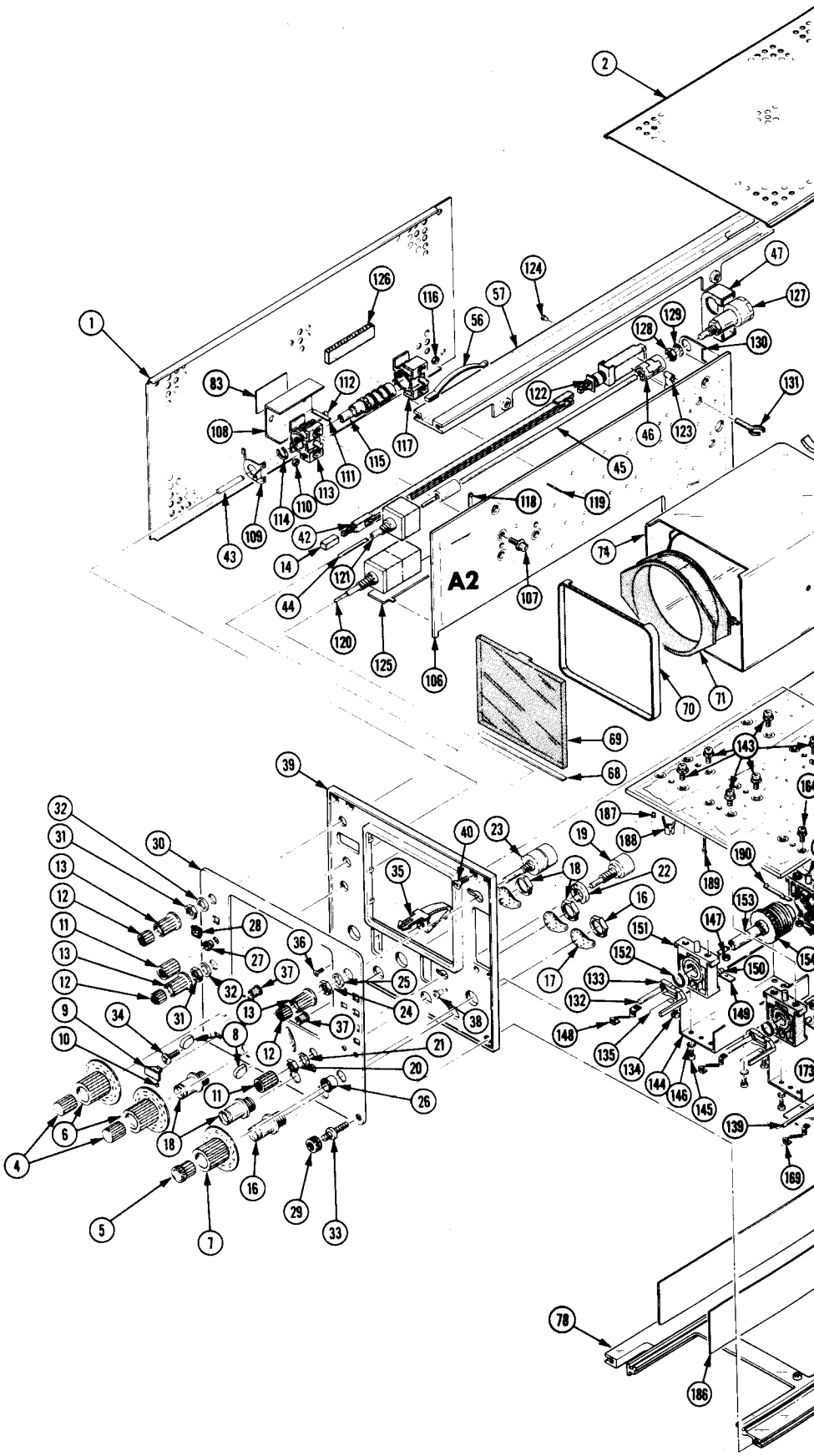

A2

FIG. 1 EXPLODED

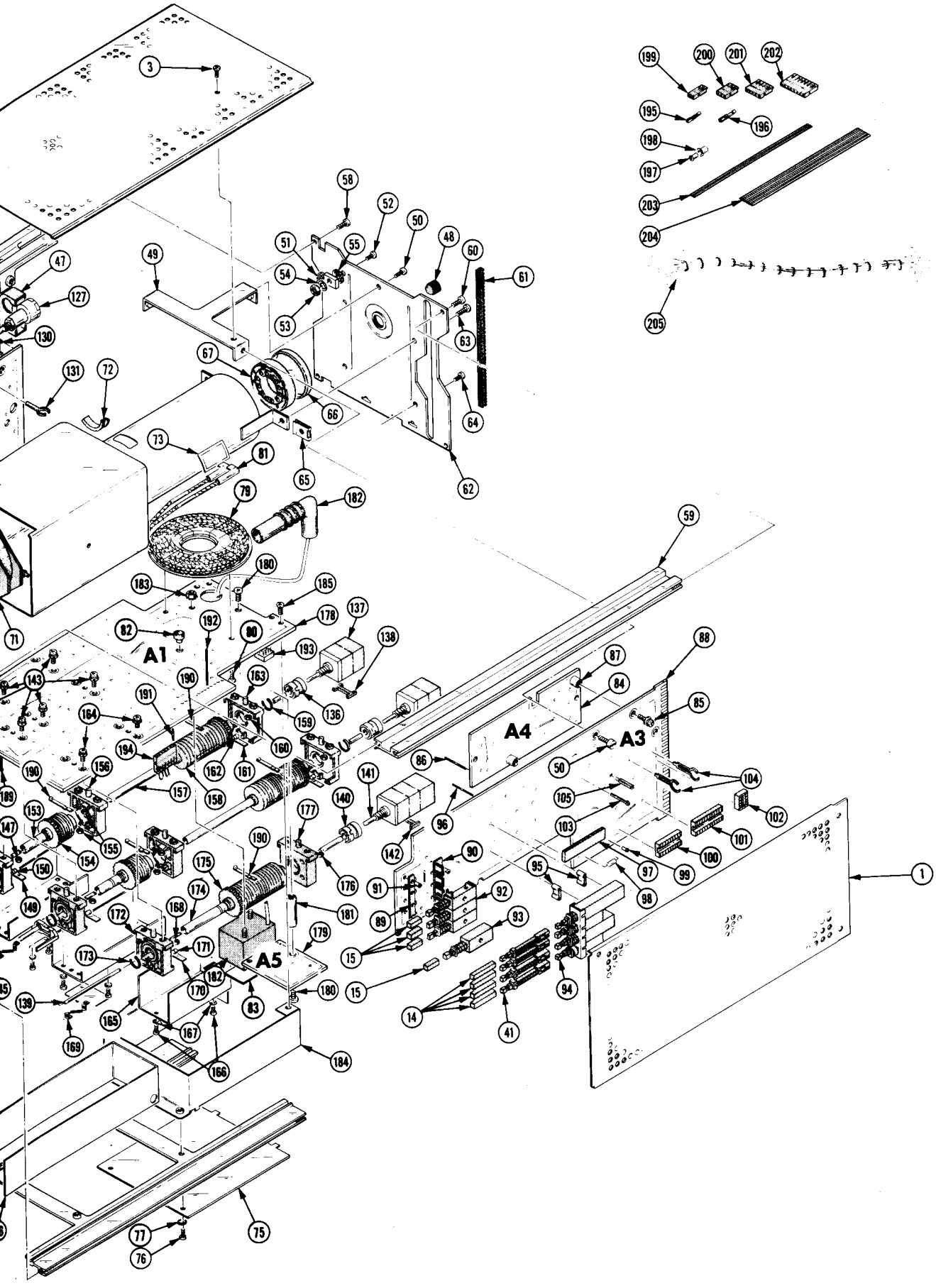


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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						ACCESSORIES		
	070-1878-01			1		MANUAL,TECH:INSTRUCTION	80009	070-1878-01