VOLTECH INSTRUMENTS

AT7600 Wound Component Tester

User Manual

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AT7600 User Manual

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The Voltech AT7600 Wound Component Tester has been developed to provide fast, accurate, and reliable testing of magnetic components. Built on decades of experience in wound component testing, the AT7600 is engineered to deliver reliable performance over many years of continuous use.

This manual provides comprehensive instructions for installation, configuration, operation, and basic troubleshooting, along with key information to help you successfully operate the **AT7600 Wound Component Tester**.

If you experience any difficulties during setup or use, please contact your local supplier or one of our main offices for assistance.

For technical support and sales inquiries, please contact us at:

Website: **www.voltech.com**

Email: **sales@voltech.com**

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Chapter 1: Introduction

This manual provides complete instructions for setting up and operating the Voltech AT7600 Wound Component Tester. Please read this introductory section carefully to ensure safe and efficient installation. Understanding the AT7600's features and functions will help you maximize its performance and capabilities.

1.1 AT7600 Features

Highlights of the key functions, performance capabilities & improvements, of AT7600.

1.2 How to Use This Manual

Explanation of the key conventions used to highlight essential safety and operational information.

1.3 General Safety Instructions

Critical safety information for safe handling, operation, and maintenance of the AT7600. Read this section before using the unit.

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1.1 AT7600 Features

The AT7600 is Voltech's latest Automatic Wound Component Tester. It brings several features designed to enhance testing accuracy, efficiency, and user experience.

Key Features & Capabilities

- **Comprehensive Test Suite**

  Capable of performing over 40 specialized test types, covering low-, medium-, and high-voltage tests, with more test options in development.

- **Higher Throughput & Efficiency**

  Delivers up **to 3× the productivity of its predecessor** (AT3600) and as much as **12× faster performance** than traditional manual testing setups.

- **User-Friendly Design**

  Color touchscreen, piezo (wear-free) buttons, **USB connectivity, and Ethernet** for network integration, **durable** and easy to use in factory environments.

- **Advanced Testing Functions**

  Includes **audit testing**, **diagnostic testing**, and **load compensation** for greater accuracy and quality control.

- **High Voltage Capability**

  Built-in 5 kV AC / 7 kV DC hi-pot testing capability

- **Integrated 20-Node Matrix**

  Test up to 10 windings in 4-wire Kelvin mode without external switching hardware.

- **Patented Technologies**

  Core energization technology for faster test times, and precision current measurement technology for improved accuracy.

1.2. How to Use this Manual

How to Use this Manual – English

The following icon key shows the convention used throughout this manual to help identify key points that should be read and understood.

Important Safety Information. All safety information must be read and understood.

Important Information that explains a general principal that should be understood in order to use the product effectively.

If any information is not clear, then please visit the Voltech website for more information or contact us for assistance.

Mode d'utilisation de ce manuel – Français

L'icône suivante indique la convention utilisée dans l'ensemble de ce manuel afin d'identifier les points clés qui doivent être lus et assimilés.

Informations importantes relatives à la sécurité.
Toutes les informations relatives à la sécurité doivent être lues et assimilées.

Les informations importantes donnent l'explication d'un principe général qui doit être assimilé afin d'utiliser le produit efficacement.

Si des informations ne sont pas claires, veuillez consulter le site Web de Voltech pour obtenir un complément d'information ou nous contacter pour obtenir de l'aide.

Verwendung dieses Handbuchs – Deutsch

Die folgende Symbollegende zeigt die in diesem Handbuch verwendeten Konventionen zur Hervorhebung wichtiger Punkte, die gelesen und verstanden werden müssen.

Wichtige Sicherheitshinweise.
Alle Sicherheitshinweise müssen gelesen und verstanden werden.

Wichtige Informationen, die ein allgemeines Prinzip erklären, das verstanden werden muss, damit das Produkt effektiv genutzt werden kann.

Falls Informationen nicht klar sind, besuchen Sie bitte die Voltech-Website, um dort weitere Informationen zu erhalten, oder kontaktieren Sie uns, damit wir Ihnen weiterhelfen können.

Cómo Usar Este Manual – Español

Las siguientes claves de iconos muestran los avisos convenidos para usarlos en este manual, para poder identificar aspectos importantes que deben ser leídos y comprendidos.

Información importante de seguridad.
Toda la información de seguridad tiene que ser leída y comprendida.

Información importante que explica un principio general que debe ser comprendido para usar el producto con eficacia.

Si alguna información no aparece clara le rogamos visitar el sitio web de Voltech para mayor detalle o contactarnos para solicitar ayuda.

Come usare questo manuale – Italiano

La seguente legenda mostra le icone convenzionali usate in questo manuale per segnalare i punti chiave che richiedono un'attenta lettura e comprensione.

Informazioni importanti per la sicurezza.
Tutte le informazioni riguardanti la sicurezza devono essere lette e comprese.

Informazioni importanti che spiegano un principio generale da comprendere per utilizzare efficacemente il prodotto.

In caso di dubbi in merito a qualunque informazione contenuta nel manuale, visitare il sito web Voltech per chiarimenti o contattare gli uffici Voltech per richiedere assistenza.

Zo gebruikt u deze handleiding – Nederlands

De volgende pictogramtoets toont de conventie die in deze handleiding wordt gebruikt als hulpmiddel bij het identificeren van de belangrijkste punten die gelezen en begrepen moeten worden.

De volgende pictogramtoets toont de conventie die in deze handleiding wordt gebruikt als hulpmiddel bij het identificeren van de belangrijkste punten die gelezen en begrepen moeten worden.

Belangrijke informatie die een algemeen principe verklaart dat men dient te begrijpen om het product effectief te gebruiken.

Ga naar de Voltech-website voor meer informatie als iets in de informatie niet duidelijk is, of neem contact met ons op voor hulp.

Sådan bruger du denne manual – Dansk

Det følgende ikon viser den konvention, der bruges i denne manual til at hjælpe med at identificere de vigtigste punkter, der skal læses og forstås.

Vigtige sikkerhedsoplysninger.
Alle sikkerhedsoplysninger skal læses og forstås.

Vigtige oplysninger, der forklarer et generelt princip, der skal forstås for at kunne bruge produktet effektivt.

Hvis noget er uklart, skal du besøge Voltechs websted for at få flere oplysninger eller kontakte os for at få hjælp.

Så här använder du bruksanvisningen -Svenska

Följande ikoner visar hur viktiga punkter som ska läsas och förstås har markerats i den här bruksanvisningen.

Viktig säkerhetsinformation.
All säkerhetsinformation måste läsas och förstås.

Viktig information som förklarar en allmän princip som måste förstås för effektiv användning av produkten.

Om någon information är oklar kan du besöka Voltechs webbplats för mer information eller kontakta oss för att få hjälp.

Taman oppaan kayttoohjeet – Suomi

Seuraavassa kuvakkeiden selityksessä näkyy tässä oppaassa käytössä oleva käytäntö, jolla on merkitty keskeiset seikat, jotka on luettava ja sisäistettävä.

Tärkeitä turvallisuustietoja
Kaikki turvallisuustiedot on luettava ja sisäistettävä.

Tärkeitä tietoja, jotka selittävät yleisperiaatteen, joka on sisäistettävä, jotta tätä tuotetta voidaan käyttää tehokkaasti.

Jos jotkin tiedot eivät ole selkeitä, saat lisätietoja Voltechin verkkosivustolta tai voit pyytää meiltä neuvoa.

Pouziti teto prirucky – Cestina

Následující symboly jsou používány v celé příručce a usnadňují identifikaci klíčových bodů, které je nutné prostudovat a pochopit.

Důležité bezpečnostní informace.
Všechny bezpečnostní informace je nutné prostudovat a pochopit.

Důležité informace vysvětlující obecné principy, kterým je v zájmu efektivního použití produktu nutné porozumět.

Pokud některé informace nejsou srozumitelné, navštivte web společnosti Voltech, kde naleznete další informace a můžete si vyžádat naši pomoc.

Hogy kell használni ezt a kézikönyvet – Magyar

Az alábbi ikon jelmagyarázat ismerteti az e kézikönyvben végig alkalmazott egyezményes jelölést azon fő pontok azonosítására, amelyek elolvasása és megértése nélkülözhetetlen.

Fontos biztonsági információ.
Minden biztonsági információ elolvasása és megértése kötelező.

Fontos információ egy olyan általános elv ismertetésére, amelyet érteni kell a termék hatékony alkalmazása érdekében.

Ha bármely információ nem világos, kérjük, látogasson el a Voltech weboldalára további tájékoztatásért vagy forduljon hozzánk segítségért.

Jak korzystać z niniejszej instrukcji – Polski

Poniższa legenda z opisem znaczenia ikon przedstawia konwencję stosowaną w niniejszej instrukcji w celu ułatwienia określenia kluczowych informacji do przeczytania i zrozumienia.

Ważne informacje o bezpieczeństwie.
Wszystkie informacje dotyczące bezpieczeństwa należy przeczytać i zrozumieć.

Ważne informacje wyjaśniające ogólną zasadę, którą należy zrozumieć w celu właściwego użytkowania produktu.

Jeśli podane informacje są niejasne, wówczas należy uzyskać dodatkowe informacje ze strony internetowej firmy Voltech lub skontaktować się z nami z prośbą o pomoc.

Kılavuzun Kullanımı - Türkçe

Bu kullanım kılavuzunun tümünde kullanılmış aşağıdaki simgeler (ikon), mutlaka okunup anlaşılması gereken temel hususları göstermektedir.

Önemli güvenlik bilgisi.
Bu türden bütün güvenlik bilgileri mutlaka okunmalı ve anlaşılmalıdır.

Ürünün verimli bir şekilde kullanılması için anlaşılması gereken genel ilkeleri açıklayan önemli bilgiler.

Tam olarak anlayamadığınız şeyleri lütfen Voltech sitesinde ayrıntılı olarak inceleyiniz ya da yardım almak için bizimle temas kurunuz.

1.3. General Safety Instructions

General Safety Instructions - English

Electrical devices can constitute a safety hazard. It is the responsibility of the user to ensure the compliance of the installation with any local acts or bylaws in force. Only qualified personnel should install this equipment after reading and understanding this user manual. These operating instructions should be adhered to. If in any doubt, please contact your supplier.

DANGER!
ELECTRIC SHOCK RISK

WARNING: The AT7600 must be connected to a safety ground (earth). Only insert the power lead into a socket with a protective ground contact. Ensure that the power lead is in good condition and free from damage before use.

Replace the fuses only with the same type and rating: **2.0AT 5X20 ANTISURGE**.

Refer servicing only to qualified personnel who understand the danger of shock hazards.

WARNING: The AT7600 can generate voltages that may be LETHAL. The safety interlock is designed to ensure the safety of operators when used with a Voltech approved safety system. To ensure operator safety, this interlock must always be properly connected to a Voltech approved safety system.

This product has been constructed in compliance with the requirements of EN61010-1, Pollution Degree 2, and Installation Category II: FOR INDOOR USE ONLY.

This ensures the safety of the instrument and the user when normal precautions are followed.

Consignes générales de sécurité – Français

Les appareils électriques peuvent constituer un danger pour la sécurité.
Il incombe à l'utilisateur de s'assurer de la conformité de l'installation avec les lois locales ou les arrêtés municipaux en vigueur.
Seul le personnel qualifié doit installer cet équipement, après avoir lu et assimilé le manuel de l'utilisateur.
Ces consignes d'utilisation doivent être suivies. En cas de doute, veuillez contacter votre fournisseur.

DANGER!
RISQUE D'ÉLECTROCUTION

ATTENTION : L'AT7600 doit être connecté à une prise de terre de sécurité.Ne brancher le cordon d'alimentation que sur une prise ayant un contact de protection avec la terre. S'assurer que le cordon d'alimentation est en bon état et exempt de dommage avant utilisation.

Ne remplacer les fusibles que par des fusibles de mêmes type et calibre : **2.0AT 5X20 TEMPORISÉ.**

Ne confier la révision et la réparation de l'appareil qu'à du personnel qualifié qui a une connaissance des risques d'électrocution.

ATTENTION : L'AT7600 peut générer des tensions susceptibles d'être MORTELLES.Le verrouillage réciproque de sécurité est conçu pour assurer la sécurité des opérateurs lors de son utilisation avec un système de sécurité agréé par Voltech. Afin d'assurer la sécurité de l'opérateur, ce verrouillage réciproque doit être toujours connecté à un système de sécurité agréé par Voltech.

La construction du AT7600 est conforme aux exigences de la norme EN61010-1, Degré de pollution 2, Catégorie d'installation II: POUR UNE UTILISATION INTÉRIEURE UNIQUEMENT.

La sûreté de l'instrument et la sécurité de l'utilisateur sont ainsi assurées lorsque les précautions habituelles sont prises.

Allgemeine Sicherheitshinweise – Deutsch

Elektrogeräte können ein Sicherheitsrisiko darstellen.Es obliegt dem Benutzer, dafür zu sorgen, dass das Gerät nach den aktuellen Gesetzen und Vorschriften installiert wird. Dieses Gerät darf nur von qualifiziertem Personal installiert werden, das dieses Benutzerhandbuch gelesen und verstanden hat. Die Anweisungen in diesem Benutzerhandbuch müssen befolgt werden. Im Zweifelsfall wenden Sie sich bitte an Ihren Lieferanten.

GEFAHR!

STROMSCHLAGGEFAHR

WARNUNG: Die AT7600 muss geerdet werden. Das stromführende Kabel nur an einer Steckdose mit einem Schutzerdekontakt anschließen. Vor Gebrauch prüfen, ob das stromführende Kabel in gutem Zustand und unbeschädigt ist.

Die trägen Feinsicherungen nur durch träge Feinsicherungen desselben Typs und mit demselben **Nennwert ersetzen: 5 x 20 mm, 2,0 A**.

Wartungsarbeiten dürfen nur von qualifiziertem Personal durchgeführt werden, das die Gefahr von Stromschlägen versteht

WARNUNG: Die AT7600 kann Spannungen erzeugen, die TÖDLICH sein können. Der Sicherheitsinterlock ist zum Schutz von Bedienern beim Einsatz mit einem von Voltech zugelassenen Sicherheitssystem vorgesehen. Um den Schutz von Bedienern zu gewährleisten, muss dieses Interlock immer ordnungsgemäß an einem von Voltech zugelassenen Sicherheitssystem angeschlossen sein.

Dieses Produkt erfüllt die Anforderungen von DIN EN 61010-1 Verschmutzungsgrad 2 und Installationskategorie II: NUR FÜR INNENEINSATZ.

Hierdurch wird die Sicherheit des Instruments und des Benutzers gewährleistet, solange normale Sicherheitsvorkehrungen befolgt werden.

Instrucciones Generales de Seguridad – Español

Los dispositivos eléctricos pueden constituir un riesgo de seguridad.
Es la responsabilidad del usuario asegurar el cumplimiento de la instalación con todas las leyes y reglamentos locales vigentes.
Este equipo debe ser instalado solo por personal calificado después de leer y comprender este manual del usuario.
Estas instrucciones de operación deben ser cumplidas. Ante cualquier duda, le rogamos ponerse en contacto con su proveedor.

¡PELIGRO!

Riesgo de Choque Eléctrico

ADVERTENCIA: El AT7600 tiene que ser conectado a una toma de tierra segura. Inserte el cable tomacorriente solo a una toma provista de un contacto protector de tierra. Asegúrese que el cable tomacorriente está en buenas condiciones y sin daños antes de usarlo.

Recambie los fusibles solo con el mismo tipo y potencia nominal: 2.0AT 5X20 CON PROTECCIÓN DE SOBRECARGAS.

El servicio o reparación tiene que ser encargado solo a personal calificado que comprende el peligro de los riesgos de electrocución.

ADVERTENCIA: El AT7600 puede generar voltajes LETALES. El enclavamiento de seguridad está diseñado para asegurar la seguridad de los operarios cuando se usa con un sistema de seguridad aprobado por Voltech. Para asegurar la seguridad del operario, este enclavamiento tiene que ser siempre conectado correctamente a un sistema de seguridad aprobado por Voltech.

Este producto ha sido construido conforme con los requisitos de EN61010-1, Grado de Contaminación 2, y Categoría II de Instalación: SOLO PARA EMPLEO EN INTERIORES.

Esto asegura la seguridad del instrumento y del usuario cuando se cumplen las precauciones normales de seguridad.

Istruzioni generali di sicurezza – Italiano

I dispositivi elettrici possono costituire un pericolo per la sicurezza.
Spetta all'utilizzatore la responsabilità di garantire la conformità dell'impianto alle norme e alle direttive locali vigenti in materia.L'installazione di questo apparecchio deve essere affidata esclusivamente a personale qualificato dopo attenta lettura e comprensione del presente manuale. Attenersi alle istruzioni operative riportate in questo manuale. In caso di dubbi, contattare il proprio fornitore di zona.

PERICOLO!

Rischio di scosse elettriche

VVERTENZA: l'AT7600 deve essere collegato a una rete provvista di messa a terra di protezione. Inserire il cavo di alimentazione solo in una presa munita di messa a terra di protezione. Controllare che il cavo di alimentazione sia integro prima di procedere all'utilizzo dell'apparecchio.

Sostituire i fusibili solo con fusibili dello stesso tipo e amperaggio: 2.0AT 5X20 RITARDATO.

Qualunque intervento sull'apparecchio deve essere affidato esclusivamente a personale qualificato in grado di comprendere il pericolo posto dalle scariche elettriche.

AVVERTENZA: l'AT7600 può generare tensioni potenzialmente LETALI.L'interblocco di sicurezza è progettato per garantire la sicurezza degli operatori se utilizzato con un sistema di sicurezza approvato da Voltech. Per garantire la sicurezza degli operatori, questo interblocco deve essere sempre correttamente collegato a un sistema di sicurezza approvato da Voltech.

Questo prodotto è stato realizzato conformemente ai requisiti della norma EN61010-1, Grado di inquinamento 2, Categoria di installazione II: USARE SOLO IN AMBIENTI INTERNI.

Ciò garantisce la sicurezza dell'apparecchio e degli utilizzatori a condizione che si adottino le normali precauzioni d'installazione e uso.

Algemene veiligheidsinstructies – Nederlands

Elektrische apparatuur kan een gevaar voor de veiligheid vormen. Het valt onder de verantwoordelijkheid van de gebruiker om bij de installatie de naleving van alle van kracht zijnde lokale voorschriften en wetten zeker te stellen. Deze apparatuur dient na het lezen en begrijpen van deze handleiding voor de gebruiker alleen door gekwalificeerd personeel te worden geïnstalleerd. Men dient zich te houden aan deze instructies voor de bediening. Bij twijfel kunt u contact opnemen met uw leverancier.

GEVAAR!

Risico op elektrische schok

AARSCHUWING: De AT7600 moet op een veiligheidsaarding (massa) worden aangesloten.
Steek de stekker van de netstroomkabel alleen in een contactdoos met een beschermend aardcontact. Zorg voor gebruik ervoor dat de netstroomkabel in goede staat verkeert en onbeschadigd is.

Vervang de zekeringen alleen door hetzelfde type en vermogen: 2,0 AT 5X20 ANTISURGE.

Laat onderhoud uitsluitend uitvoeren door gekwalificeerd personeel dat het risico op shockgevaren kent.

WAARSCHUWING: De AT7600 kan spanningen genereren die DODELIJK kunnen zijn.De veiligheidsvergrendeling is ontworpen om de veiligheid van gebruikers zeker te stellen bij gebruik met een door Voltech goedgekeurd veiligheidssysteem. Om de veiligheid van de gebruiker zeker te stellen moet deze vergrendeling altijd correct zijn aangesloten op een door Voltech goedgekeurd veiligheidssysteem.

Dit product is gebouwd conform de vereisten van EN61010-1, Verontreinigingsgraad 2, en Installatiecategorie II: UITSLUITEND VOOR BINNENGEBRUIK.

Hierdoor wordt de veiligheid van het instrument en de gebruiker wanneer men zich houdt aan normale voorzorgen gegarandeerd.

Generel sikkerhedsvejledning – Dansk

Elektriske anordninger kan udgøre en sikkerhedsrisiko. Det er brugerens ansvar at sikre, at installationen overholder lokale love eller bestemmelser, der er i kraft. Kun kvalificeret personale må installere dette udstyr, efter at de har læst og forstået denne brugervejledning. Denne driftsvejledning skal overholdes. I tvivlstilfælde bedes du kontakte din leverandør.

FARE!

Risiko for elektrisk stød

ADVARSEL: AT7600 skal være tilsluttet en jordforbindelse (jord). Isæt kun strømledningen til en stikkontakt med en beskyttende jordkontakt. Sørg for, at ledningen er i god stand og fri for skader inden brug.

Udskift kun sikringer med samme type og effekt: 2.0AT 5X20 OVERSPÆNDING.

Vedligeholdelse må kun foretages af kvalificeret personale, som forstår risiciene for elektrisk stød

ADVARSEL: AT7600 kan generere spændinger, der kan være LIVSFARLIGE.En sikkerhedslåsemekanisme er udviklet til at sikre sikkerheden for operatører, når den anvendes med et Voltech-godkendt sikkerhedssystem. For at sikre operatørens sikkerhed skal denne lås altid være korrekt tilsluttet et Voltech-godkendt sikkerhedssystem.

Dette produkt er konstrueret i overensstemmelse med kravene i EN61010-1, forureningsgrad 2 og installationskategori II: KUN TIL INDENDØRS BRUG.

Dette sikrer instrumentets og brugerens sikkerhed, når normale forholdsregler følges.

Allmänna säkerhetsanvisningar – Svenska

Elektriska enheter kan utgöra en säkerhetsrisk. Det är användarens ansvar att se till att installationen efterlever alla gällande lokala lagar och förordningar.
Endast behörig personal får installera utrustningen efter att ha läst och förstått den här bruksanvisningen. De här driftanvisningarna måste följas. Kontakta återförsäljaren om du är osäker.

FARA!

Risk för elektriska stötar

VARNING: AT7600 måste vara kopplad till en skyddsjordning (jord). Sätt endast i nätsladden i ett eluttag med en skyddande jordkontakt. Se till att nätsladden är i gott skick och inte har några skador före användning.

Byt endast ut säkringar mot samma typ och märkning: 2.0AT 5X20 ANTISURGE.

Service får enbart utföras av behörig personal som förstår risken för elektriska stötar.

VARNING: AT7600 kan generera spänningar som kan vara DÖDLIGA. Säkerhetsförreglingen är utformad för att säkerställa operatörens säkerhet vid användning med ett Voltech-godkänt säkerhetssystem. Säkerhetsförreglingen måste alltid vara ordentligt ansluten till ett Voltech-godkänt säkerhetssystem för att säkerställa operatörens säkerhet.

Den här produkten har tillverkats i överensstämmelse med kraven i SS-EN 61010-1, föroreningsgrad 2 och installationskategori II: ENDAST FÖR INOMHUSBRUK.

På så vis säkerställs instrumentets och användarens säkerhet när normala försiktighetsåtgärder iakttas.

Yleiset turvallisuusohjeet – Suomi

Sähkölaitteet voivat muodostaa turvallisuusuhan. Käyttäjän vastuulla on varmistaa, että asennus on kaikkien paikallisten säädösten ja sääntöjen mukainen. Vain pätevät henkilöt saavat asentaa tämän laitteen tämän käyttöoppaan lukemisen ja sisäistämisen jälkeen. Näitä käyttöohjeita on noudatettava. Jos jokin on epäselvää, ota yhteys tavarantoimittajaan.

VAARA!

Sähköiskuvaara

VAROITUS: AT7600 on liitettävä turvamaadoitukseen.
Työnnä virtajohto vain pistorasiaan, jossa on suojaava maakosketin.
Varmista ennen käyttöä, että virtajohto on hyvässä kunnossa ja ettei se ole vaurioitunut.

Vaihda sulakkeiden tilalle aina samantyyppiset ja luokitukseltaan vastaavat sulakkeet: 2,0 AT 5 × 20 VIRTAPIIKKISUOJAUS.

Teetä huoltotyöt aina pätevillä työntekijöillä, jotka ymmärtävät sähköiskujen vaarat.

VAROITUS: AT7600 voi synnyttää mahdollisesti TAPPAVIA jännitteitä.
Turvalukitus on suunniteltu varmistamaan käyttäjien turvallisuus, kun sitä käytetään yhdessä Voltechin hyväksymän turvajärjestelmän kanssa. Käyttäjän turvallisuuden varmistamiseksi tämä lukitus on aina kytkettävä asianmukaisesti Voltechin hyväksymään turvajärjestelmään.

Tämä tuote on valmistettu standardin EN61010-1, saastumisaste 2 ja asennusluokka II mukaisesti: VAIN SISÄKÄYTTÖÖN.

Tämä varmistaa laitteen ja käyttäjän turvallisuuden, kun normaaleja varotoimia noudatetaan.

Obecné bezpečnostní pokyny – Čeština

Elektrická zařízení mohou být nebezpečná. Je povinností uživatele zajistit při instalaci splnění všech platných místních právních předpisů. Toto zařízení smí instalovat pouze kvalifikovaní pracovníci po prostudování a pochopení této uživatelské příručky.
Tyto provozní pokyny je nutné dodržet. V případě jakýchkoli pochybností se obraťte na dodavatele.

NEBEZPEČÍ!

Riziko úrazu elektrickým proudem

UPOZORNĚNÍ: Zařízení AT7600 musí být připojeno k bezpečnostnímu uzemnění.
Napájecí kabel zapojujte pouze do zásuvky s ochranným uzemňovacím kolíkem. Před použitím se přesvědčte, že je napájecí kabel v dobrém stavu a nevykazuje poškození.

Při výměně pojistek používejte pouze stejný typ se stejným jmenovitým proudem: 2.0AT 5X20 ANTISURGE.

Opravy a údržbu svěřte pouze kvalifikovaným pracovníkům, kteří chápou nebezpečí úrazu elektrickým proudem.

UPOZORNĚNÍ: Zařízení AT7600 může generovat napětí, která mohou být SMRTÍCÍ.
Bezpečnostní blokování je navrženo tak, aby zajistilo bezpečnost při použití s bezpečnostním systémem schváleným společností Voltech. Pro zajištění bezpečnosti obsluhy je nutné, aby toto blokování bylo vždy správně připojeno k bezpečnostnímu systému schválenému společností Voltech.

Tento produkt byl zkonstruován ve shodě s požadavky normy EN 61010-1, stupeň znečištění 2 a kategorie přepěťových instalací II: POUZE PRO POUŽITÍ VE VNITŘNÍCH PROSTORÁCH.

Tím se zajistí bezpečnost zařízení a uživatele při použití běžných preventivních opatření.

Általános biztonsági utasítások – Magyar

Az elektromos készülékek biztonsági kockázatot okozhatnak.
A felhasználónak kell biztosítania, hogy a szerelés megfelel minden hatályos helyi jogszabálynak és előírásnak.Csak szakképzett személyzet szerelheti ezt a készüléket e felhasználói kézikönyv elolvasása és megérése után.Ezt a kezelési utasítást be kell tartani. Bármilyen kétség esetén, kérjük, forduljon a helyi szállítóhoz.

VESZÉLY!

Áramütés kockázata

FIGYELEM: Az AT7600 készüléket biztonságosan le kell földelni. Csak dugja be a tápkábelt a védőföldelő érintkezővel ellátott aljzatba. Használat előtt ügyeljen rá, hogy a tápkábel jó állapotban legyen, és ne legyen rajta semmilyen sérülés.

A biztosítót csak azonos típusú és teljesítményű biztosítóval cserélje le: 2.0AT 5X20 ANTISURGE.

A szervizt csak szakképzett személyzet végezheti, akik jól ismerik az áramütés veszélyét.

FIGYELEM: Az AT7600 nagy feszültséget generálhat, amely adott esetben HALÁLT okozhat.A biztonsági reteszelés arra szolgál, hogy védje a kezelőket a Voltech által jóváhagyott biztonsági rendszer használata közben. A kezelő biztonsága érdekében e reteszelésnek mindig megfelelően csatlakoztatva kell lennie a Voltech által jóváhagyott biztonsági rendszerhez.

E készülék megfelel az EN61010-1, 2. szennyezési fokozat követelményeinek, valamint a II. szerelési kategóriának: CSAK BELTÉRI HASZNÁLATRA szolgál.

Ez biztosítja a berendezés és a felhasználó biztonságát a szokásos óvintézkedések betartása mellett.

Ogólne instrukcje bezpieczeństwa – Polski

Urządzenia elektryczne mogą stwarzać zagrożenie dla bezpieczeństwa. Obowiązkiem użytkownika jest zapewnienie zgodności instalacji z wszelkimi obowiązującymi lokalnymi przepisami lub regulaminami.Niniejsze urządzenie powinno być instalowane wyłącznie przez wykwalifikowany personel po zapoznaniu się i zrozumieniu niniejszej instrukcji użytkownika.Należy przestrzegać niniejszych instrukcji obsługi. W razie jakichkolwiek wątpliwości prosimy skontaktować się z dostawcą.

NIEBEZPIECZEŃSTWO!

Ryzyko porażenia prądem elektrycznym

OSTRZEŻENIE: Urządzenie AT7600 należy podłączyć do uziemienia. Przewód zasilający należy podłączać wyłącznie do gniazdka z uziemieniem ochronnym. Sprawdzić, czy przewód zasilający jest w dobrym stanie technicznym.

Wymieniać bezpieczniki wyłącznie na bezpieczniki tego samego typu i o tych samych parametrach: 2.0AT 5X20 ANTISURGE.

Czynności serwisowe należy zlecać tylko wykwalifikowanemu personelowi, który rozumie zagrożenie porażeniem prądem elektrycznym

OSTRZEŻENIE: Urządzenie AT7600 może wytwarzać potencjalnie ŚMIERTELNE napięcia.
Zainstalowana jest blokada zabezpieczająca, aby zapewnić bezpieczeństwo operatorów podczas stosowania z systemem bezpieczeństwa atestowanym przez firmę Voltech. W celu zapewnienia bezpieczeństwa operatora blokada musi być zawsze właściwie podłączona do systemu bezpieczeństwa atestowanego przez firmę Voltech.

Urządzenie AT7600 zostało zbudowane zgodnie z wymogami normy EN61010-1, stopień zanieczyszczenia 2 i kategoria instalacji II: WYŁĄCZNIE DO UŻYTKU WEWNĄTRZ POMIESZCZEŃ.

Stosowanie właściwych środków bezpieczeństwa zapewni bezpieczeństwo urządzenia i użytkownika.

Genel Güvenlik Talimatları - Türkçe

Elektrikli cihazlar güvenlik tehlikesi oluşturabilirler.
Bulunulan yerin yürürlükteki yasalarına ya da yönetmeliklerine uygun olarak kurulum yapılması kullanıcının sorumluluğundadır.
Sadece bu kullanım kılavuzunu tamamen okuyup anlamış kalifiye kişiler bu cihazı kurabilirler.
Cihazın çalıştırma talimatlarına her zaman uyulmalıdır. Emin olamadığınız şeyleri satıcınıza sorunuz.

TEHLİKE!

Elektrik Çarpması Riski

UYARI: AT7600 cihazının mutlaka toprak emniyeti (topraklama) yapılmalıdır.Kablonun fişini sadece koruyucu topraklama hattı olan prizlere takınız. Kullanmadan önce elektrik fişinin iyi durumda ve hasarsız olduğunu kontrol ediniz.

Sigortaları aynı tip ve aynı sınıf (2.0AT 5X20 ANTISURGE) sigortalarla değiştiriniz.

Sadece elektrik çarpması risklerini bilen kalifiye elemanlara servis yaptırınız.

UYARI: AT7600, ÖLÜMCÜL olabilecek derecede voltaj üretebilir. Voltech onaylı güvenlik sistemleriyle birlikte kullanıldığında operatörlerin güvenliğini sağlamak için güvenli kilidi mevcuttur. Operatörün güvenliğini sağlamak için bu kilidin mutlaka Voltech onaylı güvenlik sistemlerinden birisine düzgün bir şekilde bağlı olması gerekmektedir.

Bu ürün, EN61010-1, Pollution Degree 2 (2. Kirlilik Derecesi) ve Installation Category II: FOR INDOOR USE ONLY (II. Kurulum Kategorisi: SADECE İÇERİDE KULLANILAN CİHAZLAR) standardının gerekliklerine uygun olarak imal edilmiştir.

Bu standart, normal güvenlik tedbirlerine uyulması koşuluyla cihazın ve kullanıcının güvenliğini garantiye alır.

1.4. Package Contents

Included in the AT7600 Wound Component Tester package are the following accessories:

Voltech part numbers (VPN) are provided for any spares you may need to order.

1 x Power Cord	**VPN 77-000**
1 x USB Editor Cable	**VPN 77-077**
1 x RS232 Editor Cable - 9W-9W	**VPN 77-015**
1 x RS232 Server Cable - 9W-25W	**VPN 77-016**
1 x Ethernet CAT5e cable Yellow 2M	**VPN 77-060**
1 x AT7600 Touch Screen Stylus	**VPN 53-440**
1 x AT7600 Screen Protection Accessories Set	**VPN 100-128**
1 x AT Series Safety Interlock Override Plug	**VPN 91-156**

1 x Certificate of Conformance

1 x Certificate of Calibration

1 x AT7600 Thermal Cycle Test Certificate

If any listed items are missing upon unpacking your new AT7600, please contact Voltech Support to request a replacement.

Website: **www.voltech.com**

Email: sales@voltech.co

Chapter 2: System Overview

This chapter introduces the AT7600 Wound Component Tester, covering its purpose, features, compatibility, and key physical aspects to support proper setup and operation.

AT7600 Wound Component Tester

2.1 What is the AT7600?
AT7600 Wound Component Tester Overview

2.2 What is the AT7600 Used For?
Common uses in production and inspection of wound components.

2.3 AT7600 Features Summary
Key functions, test capabilities, and performance highlights.

2.4 Front Panel Description
Layout and components of the front panel.

2.5 Rear Panel Description
Rear panel interfaces, power input, and grounding.

2.6 Air Circulation
Ventilation requirements for reliable performance.

2.7 Tilt Feet
Adjustable feet for angled positioning.

2.8 Lifting Points
Safe handling and transport guidance.

2.9 A Typical Installation
Example setup for production environments.

2.1. What is AT7600?

The Voltech AT7600 Wound Component Tester is a complete integrated test solution for wound components, combining speed, accuracy, and reliability in one unit. It enables 100% testing of transformers, chokes, and other magnetic parts without the need for multiple instruments.

Ideal for manufacturers and OEMs, the AT7600 ensures quality in both production and inspections. It performs all essential tests—Hi-Pot, surge, magnetization, turns ratio, winding resistance, and more on any magnetic component type.

Supporting every stage from prototype to production, the AT7600 helps validate designs to industry standards while streamlining testing into a single, powerful solution.

AT7600 Wound Component Tester

The AT7600 is the latest addition to Voltech’s AT series of precision wound component testers, delivering enhanced performance and capability.

Designed with compatibility in mind, it works seamlessly with the same test fixtures and PC software used by earlier models, including the Atti, AT3600, and AT5600.

The combination of familiar workflows and enhanced functionality makes the AT7600 a streamlined upgrade path for users moving from older models, delivering greater speed, accuracy, and reliability to your testing process.

2.2. What is the AT7600 used for?

The AT7600 Wound Component Tester is designed for fast, accurate, and reliable testing of transformers and other wound components, making it ideal for production lines and goods-inwards environments.

Its versatility allows for various configurations, depending on specific testing needs.

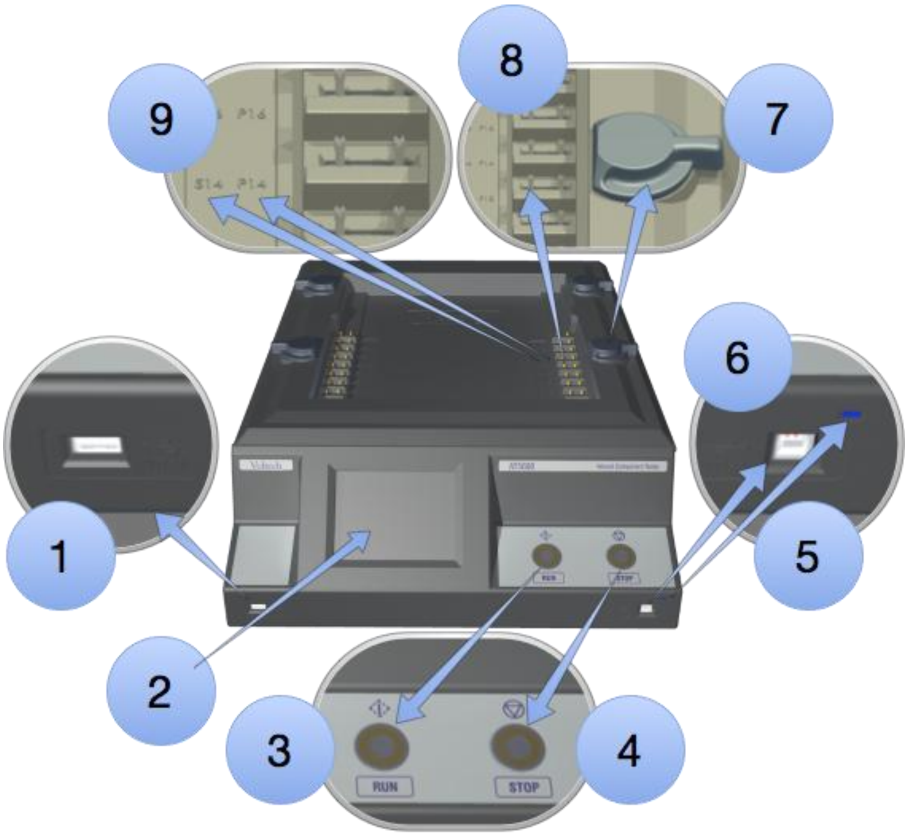
To maximize performance and support seamless integration into your production setup, carefully review this section and the next to gain a complete understanding of the AT7600's capabilities.

2.3. AT7600 Features Summary

Features	ATi	AT3600	AT7600
20-way switching matrix	✓	✓	✓
PC test editor and results server	✓	✓	✓
Test fixture system	✓	✓	✓
Small signal tests (e.g., inductance, capacitance, turns ratio)	✓	✓	✓
Telecoms. tests (e.g., return loss, longitudinal balance)	✓	✓	✓
Insulation resistance	500V	7000V	7000V
Hi-pot (AC)		5000V	5000V
Hi-pot (DC)		7000V	7000V
Surge testing		5000V	5000V
Magnetizing current and open circuit voltage		270V	270V
Watts, Stress Watts		✓	✓
Leakage Current		✓	✓
Hi-pot Ramp (AC)		5000V	5000V
Hi-pot Ramp (DC)		7000V	7000V
Ethernet (For networked communications)			✓
USB (For simple program editing and printing)			✓
Measurements optimized for accuracy and speed			✓
Fast stabilization of magnetizing current			✓
Audit Testing			✓
Diagnostic Testing			✓
Load Compensation			✓

A complete list of available tests—including new releases and detailed descriptions—is also available at ***www.voltech.com***

2.4. Front Panel Description



(1) Front USB 'A' connector

Used for printing test results to a compatible USB printer (Epson TM-T88VII).

(2) Touch Screen Display

A color touch screen LCD serves as the main user interface for the AT7600.

Operate the display using a finger or a touch screen stylus.

NOTE: Avoid using sharp objects on the touch screen to prevent damage.

(3) RUN button and Indicator

Pressing the RUN button starts execution of the programmed test sequence. When activated, a green LED ring surrounding the button illuminates, indicating that measurements are actively being performed.

(4) STOP Button and Indicator

Pressing the STOP button stops execution of the test program. When activated, a red LED ring surrounding the button illuminates, indicating that measurements have stopped.

(5) Power Indicator

The power indicator on the AT7600 lights up when the power supply is switched on.

(6) USB 'B' Connector

Used to connect the AT7600 to a computer, usually for control via the Voltech AT Editor software.

(7) Locking Knob

Locking knobs secure the test fixture in the AT7600 test bay, ensuring stability and reliable connections during testing.

Turn right to left (counterclockwise) to tighten before testing and left to right (clockwise) to loosen before removing the fixture.

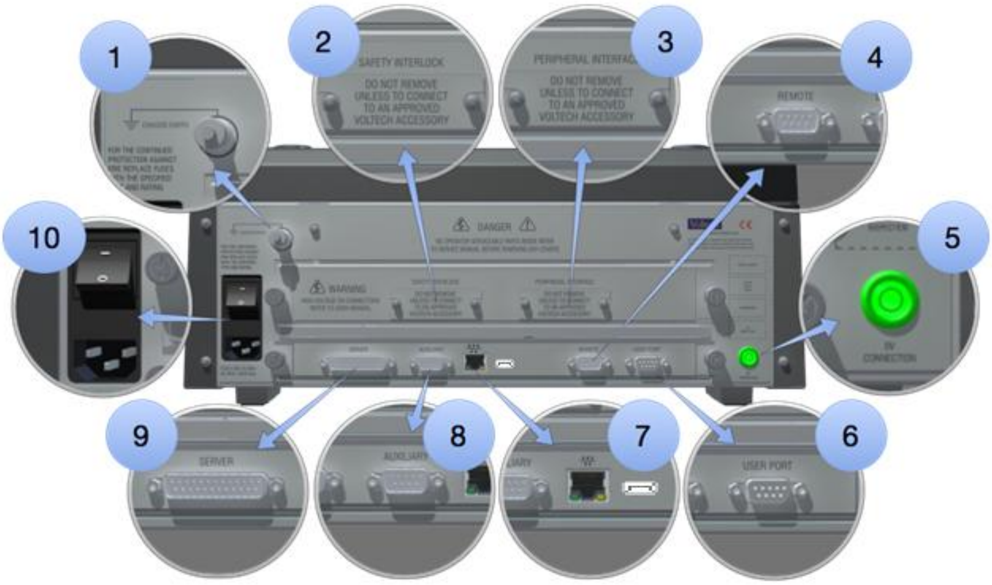
(8) Spring Probes

Forty spring probes are used to make electrical connections with each node of the test fixture. Each node comprises of two spring probes to allow four wire (Kelvin) measurements.

(9) Sense and Power connections

Each of the twenty nodes has separate sense and power connections, labelled on the test bay for easy identification. This setup enables four-wire (Kelvin) measurements, excluding test fixture connections from the readings.

2.5. Rear Panel Description



(1) Chassis Earth

Earth post for connection of the chassis earth when used with an unearthed mains connection.

WARNING: This equipment must be earthed for safe operation.

(2) Safety Interlock

Protected by a cover plate, this connection interfaces with a safety device, such as a light curtain. When the connection is broken, the AT7600 cannot produce any dangerous voltages. To access the port, remove the cover plate using a screwdriver.

WARNING: HIGH VOLTAGE MAY BE PRESENT (≤400 Vpk).

*For more information, refer to **Chapter 6, Safety Systems**.*

(3) Peripheral Interface

Supplied protected by a cover plate, this connects to Voltech accessories. To access the port, remove the cover plate using a screwdriver.

WARNING HIGH VOLTAGE MAY BE PRESENT (<=400Vpk).

*For more information, refer to **Chapter 10.3.4, Peripheral Interface**.*

(4) Remote Port

Used to electrically signal status and control the AT7600. It supports external indicators (Running/Pass/Fail) and input controls (Run/Stop).

For more information, refer to ***Chapter 10.3.3. Remote Port***

(5) Chassis Terminal (0V)

This is the AT7600 chassis 0V potential and it used when connecting peripherals that need to reference the signal potentials. Connection is via a 4 mm banana socket.

WARNING: This terminal must not be used to earth (ground) the AT7600.

(6) User Port

The User Port provides open collector style outputs that are used as electronic switches for control of additional relays and other devices.

For more information refer to ***Chapters 10.3.6 User Port*** *and* ***7.26. OUT – Output to User Port***

(7) Rear USB 'A' Connector and Ethernet Port

The USB 'A' port supports printing of test results to a compatible **Epson TM-T88VII printer**.

The Ethernet port provides a 10/100 Mbps network connection for communication with the AT7600 via TCP/IP.

This is the recommended interface for use with **Voltech AT Series Server Software.**

(8) Auxiliary Port

The Auxiliary Port is an RS232 serial interface used to connect the AT7600 to a PC running Voltech's AT Editor software. This connection allows users to download test programs and configure settings.

(9) Server Port

This RS232 serial port is used for communication with a PC running Voltech's AT Series Server software. It is intended for legacy system support, specifically when

replacing an AT3600 or ATi with the new AT7600, allowing continued use of existing software and infrastructure.

(10) Power Switch and Disconnection Device

Switches the unit on and off by breaking the mains power to the unit.

No power is drawn from the supply when switched off.

Connect the power outlet to this socket using the supplied power cord or an equivalent type conforming to **IEC60320 C13**, with **3 A minimum** current capability and a voltage rating equal to or greater than the mains supply voltage.

Contained within the module are two fuses, which must always be replaced—when necessary—with the same type and rating: **2.0AT 5×20 mm ANTISURGE**.

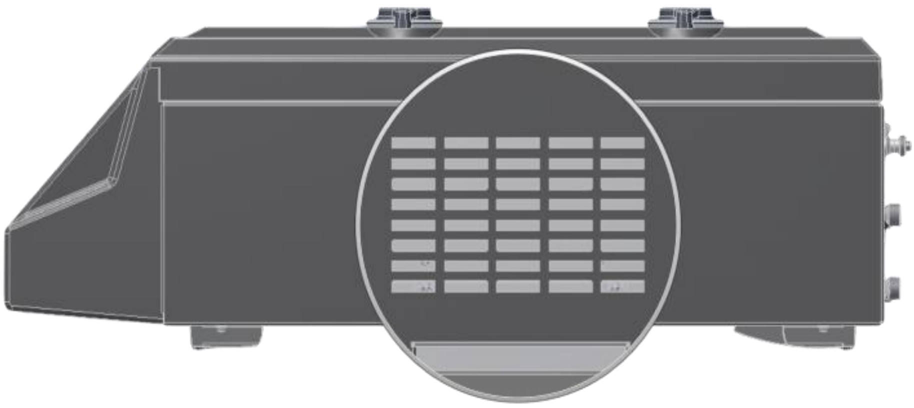
2.6. Air Circulation

The AT7600 uses side vents to circulate air, drawing it in and expelling it to cool internal components.

NOTE: Maintain a minimum clearance of **50 mm** around the side vents.

Do not place other equipment close to the vents to prevent overheating.

Side Vents



If the vents are obstructed, the AT7600 may overheat and display an over-temperature warning message.

This message may also appear if the air filters are blocked.

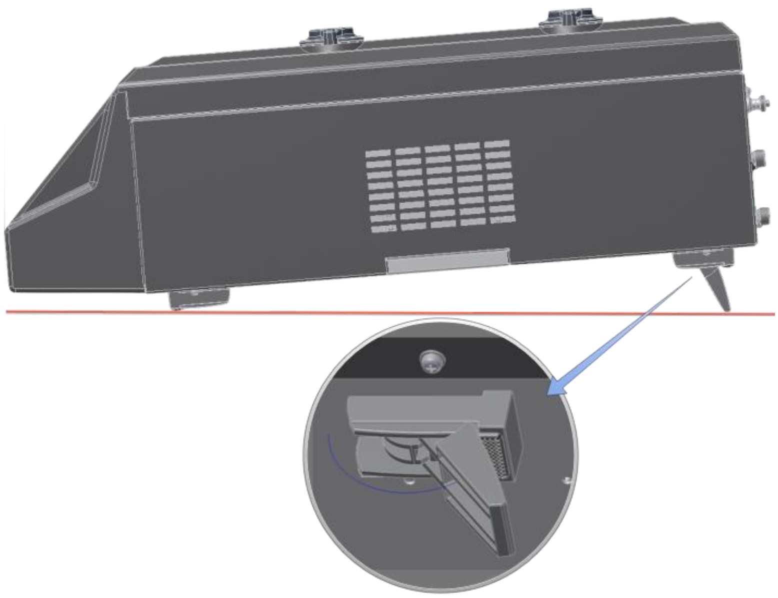
For more information, refer to the Maintenance ***Chapter, Section 11.1: Air Filters****.*

2.7. Tilt Feet

The AT7600 includes adjustable rear feet that allow the unit to tilt, improving visibility of the test pins.

This feature is particularly helpful for operators in specific seating positions or for users of the legacy AT3600, as it provides a similar tilt angle.

Tilt Feet



2.8. Lifting Points

Two lifting points—one on each side—are located beneath the side vents to allow safe manual handling.

Before lifting, always remove any attached fixtures or accessories.

Lift the unit from the rear to minimize strain, placing your fingers inside the designated recesses.

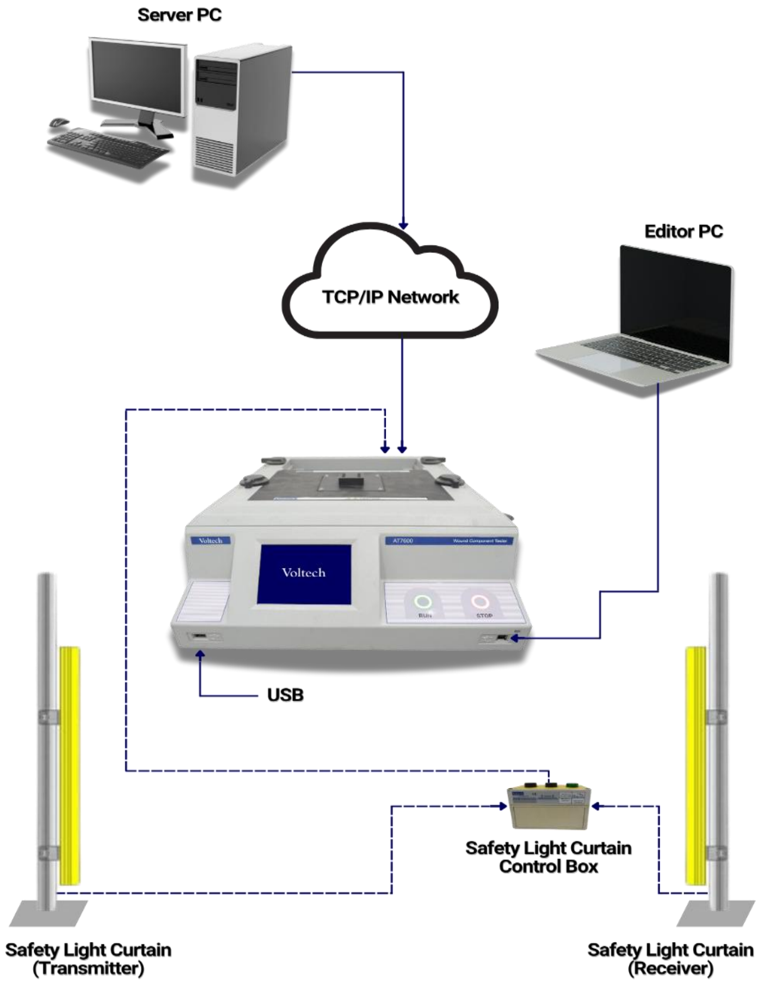
Always follow proper manual handling practices.

If you are unsure how to lift the product safely, consult your health and safety guidelines.

For handling purposes, assume a product weight of 19 kg.

For more information, refer to ***Chapter 10.5 Mechanical*** *for full weight and dimension details.*

2.9. Typical Installation



IMPORTANT

The Editor and Server applications are shown on separate computers in the system diagram to illustrate their functional distinction. However, both software packages can be installed and run **on the same computer**, provided system requirements are met.

Both the Editor and Server can access test programs from, and save measurement results to, any standard network drive. This setup supports secure storage, centralized backup, and operational continuity in the event of a local computer failure.

Voltech

2.9.1. Server PC – Results and Test Program Management

Windows-based Server software used for centralized management of all test programs and storage of test results.

For more information, refer to the ***AT Server .NET User Manual,*** *available for download at:* ***https://www.voltech.com/support/downloads/***

2.9.2. Editor PC – Test Program Development

Intuitive, Windows-based Editor software for creating and modifying test programs.

Test conditions can be entered manually or generated automatically by measuring a sample transformer using the Auto-Programming feature.

No programming skills or prior software expertise required.

Supports up to 150 user-defined tests per program.

For more information, refer to the ***AT Editor .NET User Manual****, available for download at* ***https://www.voltech.com/support/downloads/***

2.9.3. Test Fixture

The test fixture acts as the interface between the AT7600 and the Device Under Test (DUT):

- Ensures proper positioning and alignment of the component.
- Provides consistent contact to test points via the AT7600's spring probes or contact pins.
- Fixtures can be made to order or easily customized from standard fixture kits to enable fast, reliable contact with the device under test.
- Enables fast, repeatable testing across a wide range of transformer types.

For more information, refer to ***Chapter 13 – Test Fixtures.***

2.9.4. Light Curtain (or Other Safety Device)

To ensure operator safety during high voltage testing, a protective safety mechanism is required to prevent contact with live conductors.

The AT7600 includes a Safety Interlock connector on the rear panel**. The safety interlocks must be properly connected before any high voltage test can execute.**

For manual operation, if high voltage tests are required, the Voltech safety system is recommended. This system uses infrared light beams to form a safety curtain, offering operator protection without impacting test throughput.

*For more information, refer to **Chapter 6 – Safety System***

Chapter 3: Using the AT7600

This chapter explains how to operate the AT7600 effectively—from setup to test execution. It is designed to help users understand how to configure, run, and manage tests using the AT7600 system.

3.1. Usage Overview

Provides a general summary of typical AT7600 workflows.

3.2. Test Fixtures

Describes the AT Series fixture system for accurate, repeatable connections to various transformer types.

3.3. Creating Test Programs - AT Editor

Details the use of the AT Editor software to create test programs.

3.4. Utilizing Editor Test Programs

Sending test programs to the Server for AT7600 use.

3.5. Results Printing

Describes available options for printing or exporting test results.

3.6. Recommended Configuration

Centralized setup for managing test programs and results.

3.7. Operating the AT7600 in Production Test

Describes manual and automated operation modes for efficient test execution.

3.1. Usage Overview

The AT7600 system follows a streamlined workflow to ensure accurate and efficient testing of magnetic components:

(1)

INSTALL APPROPRIATE TEST FIXTURE

Use a custom or Voltech-supplied fixture designed to fit the AT7600's fixture bay, ensuring proper electrical contact with the Device Under Test (DUT).

↓

(2)

CREATE A TEST PROGRAM

Define test conditions using the AT Editor software, either through manual input or the Auto-programming feature using a sample transformer.

↓

(3)

SAVE THE TEST PROGRAM

Store the ATP (AT Program file) in a shared Server folder for centralized access by all AT7600 units.

↓

(4)

LOAD AND RUN THE PROGRAM

Transfer the program to the AT7600, perform compensation, and execute the test via either the Editor or Server interface

↓

(5)

STORE AND ANALYZE RESULTS

Save results locally or over the network for reporting, traceability, or further analysis.

3.2. Test Fixtures

The AT7600 Wound Component Tester uses a dedicated test fixture system designed to accommodate various component footprints.

Key Features include:

- Fixtures are built on a standard fixture board that fits into the tester's top surface.
- Utilizes **Kelvin Connections** for optimal measurement accuracy.
- Supports a wide variety of connectors, including those for PCB-mount and flying-lead transformers.
- A single fixture can be used across transformer designs that share the same bobbin or footprint.

SMPS transformer mounted on a custom Voltech Kelvin Pin Fixture for Dual-in-Line transformers in the AT7600 Wound Component Tester.

Custom fixtures are available from Voltech for your specific requirements.

*For more information, visit **www.voltech.com**.*

3.3. Creating Test Programs – AT Editor

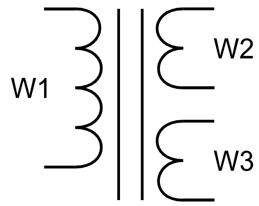
A test program defines a structured sequence of electrical tests to be performed on the Device Under Test (DUT), ensuring it meets functional and safety specifications.

Each distinct transformer design or component variant should have its own dedicated test program, tailored to its electrical and functional specifications.

For example, a typical sequence for a three-winding switch-mode power supply transformer may include:

Program:

Resistance	W1
Resistance	W2
Resistance	W3
Inductance	W1
Turns Ratio	W1 to W2
Turns Ratio	W2 to W3
Hi-Pot	W1 to W2 + W3

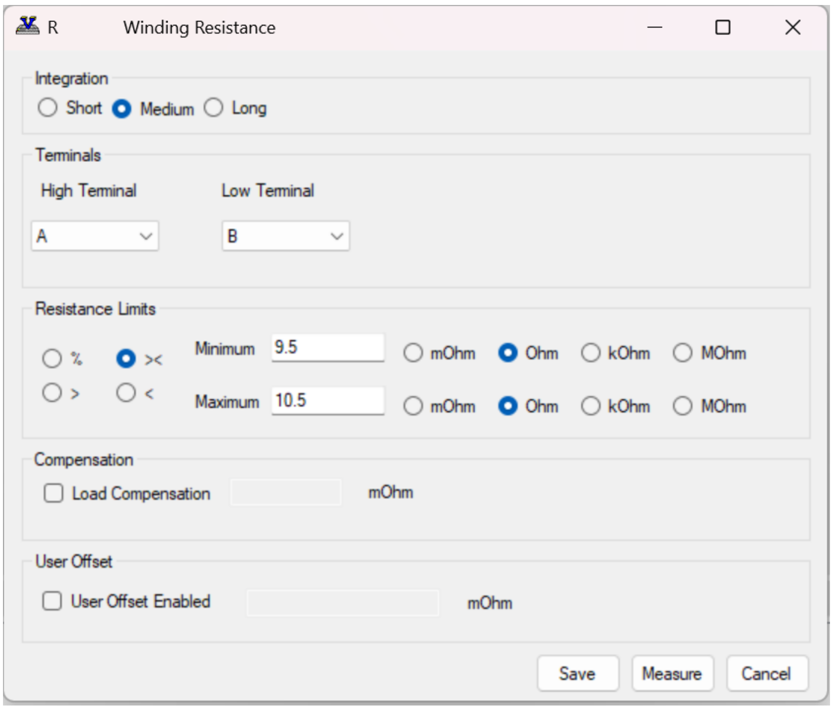


Part Number: SMPSE42-A

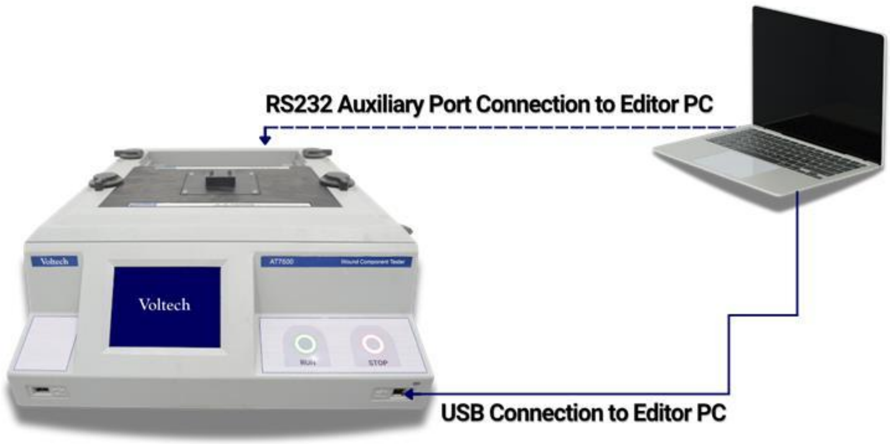
The **AT Editor** is the dedicated test program editor for the AT7600.

It allows users to build and configure test sequences without any coding.

Tests are selected from a predefined list, and parameters such as terminal assignments, test conditions, and limits are set using intuitive dialog box.



The **AT Editor software** establishes communication with the AT7600 primarily via **USB**. Alternatively, it can connect through the Auxiliary Port using an **RS232** connection to a COM port on the host PC, offering flexible integration options.



Using the AT Editor, users can create a test program by selecting specific electrical tests, setting test limits, saving the program (ATP file), and downloading it to the AT7600 for execution.

For full technical details, refer to ***AT Editor .NET User Manual, available for download at https://www.voltech.com/support/downloads***

3.4. Utilizing Editor Test Programs

Programs may also be centrally stored on the AT Server for streamlined access and deployment.

The AT Editor software allows you to create and evaluate each individual test program. It is not intended to manage the large numbers of test programs that may be required daily once they are in ‘production’ use.

Store the program in the AT Server program directory once a program has been developed.

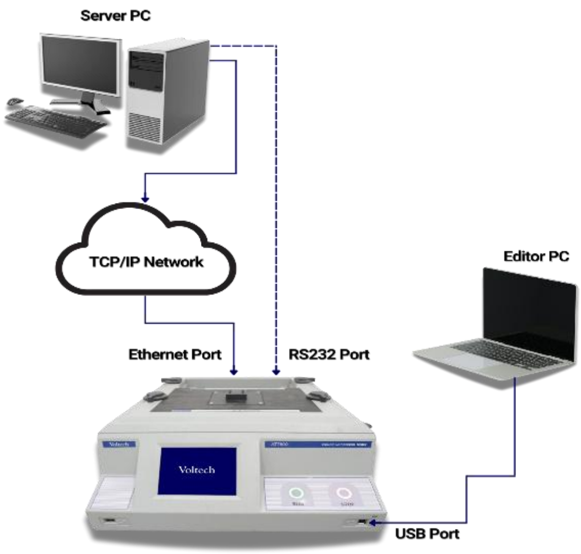
It shall then be made available to the AT7600 to load up and be ready to run through the AT7600 user interface.

3.4.1. Storing Programs on the Server

One of the software packages supplied with the AT7600 is called the **AT Server.** Usually, the Server software is installed onto a PC which is left on during operating hours to distribute test programs to AT7600 units, as well as to log all test results.

The AT7600 includes a 'Server' port on its rear panel for RS232 communication. Program transfer and result logging can also be done using TCP/IP via the Ethernet interfaces on both the tester and the host PC. This allows centralized storage and access to test programs and results.

AT Server and AT Editor on Separate Computers



Transferring Test Programs to the Server

Transferring a new test program from the Editor to the Server can be done in any of the following ways:

- **Directly from PC to PC via an external disk/network connection**

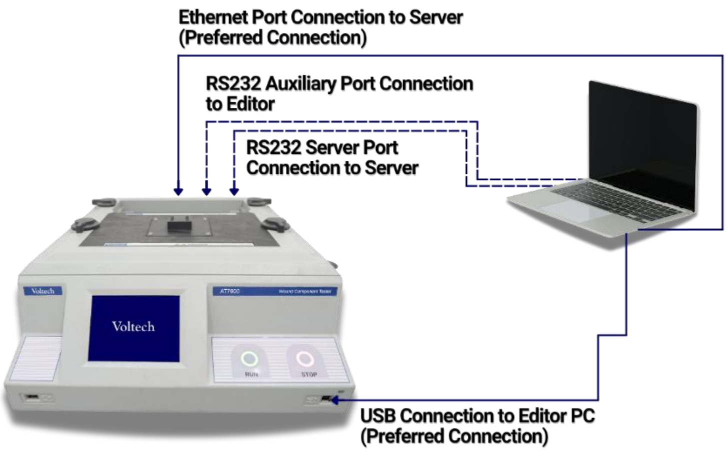
  External disk/network – Using USB drives or shared folders over a LAN to manually transfer ATP files is a standard, supported workflow.

-

- **Via a network connection between the PCs using 'Save As'** in the Editor to transfer the program to the directory used by the Server for programs

'Save As' to server folder – This is the typical method when Editor and Server are either on the same PC or on networked PCs. This method requires that the user has write permissions to the shared program directory specified in the AT Server configuration.

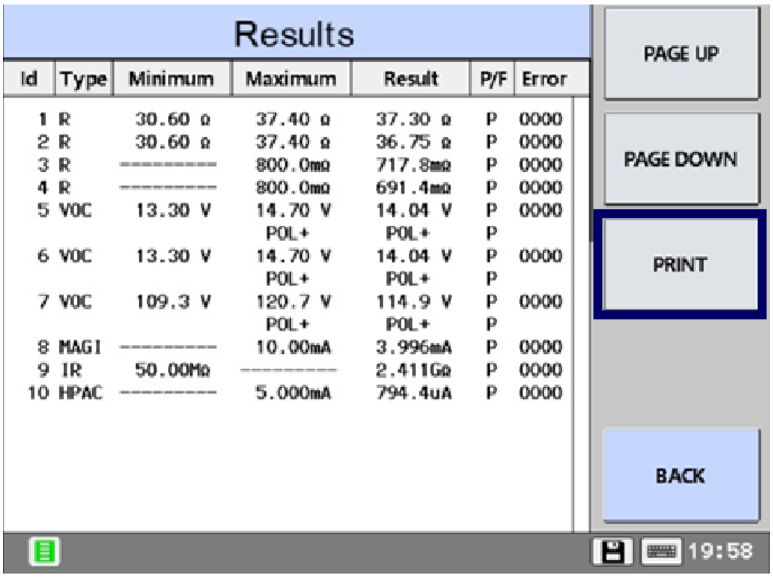
AT Server and AT Editor Installed on the same Computer



When both the AT Editor and AT Server are installed on the same PC, it is recommended to configure the AT Server to use the same default program directory as the AT Editor. This ensures immediate availability of all test programs for both creation and execution.

3.5. Results Printing

The AT7600 can be configured to automatically print results at the end of each program run, and the results can be printed using the **PRINT** soft key through the user interface as detailed in ***Chapter 8.***



Automatic printing is configured as part of the test program using the AT Editor software.

For more information, refer to ***Chapter 2.4.1 – Setting the Program Options in the AT Editor dotNET User Manual****, available for download at:* ***https://www.voltech.com/support/downloads/***

All printing has been tested using the **Epson TM-T88VII printer**.

This printer offers ultra-fast transaction times with industry-leading print speeds up to 500 mm/sec[1] and a high-speed auto cutter.

Although other compatible models may work correctly, Voltech can only guarantee operation with this printer.

For more information, refer to ***Section 5.5, USB Printer Setup***, for complete instructions on configuring the Epson TM-T88VII printer, including setting it to USB Printer Class mode.

3.5.1. Report Format

Test reports are generated using a fixed-width ASCII character format to ensure fast and reliable printing.

Each line is limited to 56 characters and is automatically centered on the printer’s paper width.

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Report Overview Sample

```
--------------------------------------------------
|                VOLTECH INSTRUMENTS              |- Note 1
|            AT7600 PART UNDER TEST REPORT        |
|                                                 |
|S/N:       100011200016                          |- Note 2
|F/W:       0.007.053                             |- Note 3
|OPERATOR:  TEK                                   |- Note 4
|BATCH:     015                                   |- Note 5
|PART NUM:  INDUCTOR                              |- Note 6
|PART S/N:  X00058                                |- Note 7
|DATE:      18-DEC-16 10:34:43                    |- Note 8
|RESULT:    *** FAIL ***                          |- Note 10
--------------------------------------------------
--------------------------------------------------
|ID  TYPE   MINIMUM    MAXIMUM    RESULT   P/F    |
| 1  R      80.00mΩ    100.0mΩ    90.66mΩ  P 0000|- Note 9
| 2  LS     2.000uH    6.000uH    4.403uH  P 0000|
| 3  QL     20.00      30.00      31.45    F 0000|
|                  *** FAIL ***                   |- Note 10
--------------------------------------------------
```

Report Structure Overview (Notes 1–10):

Note 1 - Report title

Note 2 - Serial number of the AT7600 generating the report

Note 3 - AT7600 firmware version

Note 4 - Operator name (if entered at batch start)

Note 5 - Batch number (if set)

Note 6 - Part number under test

Note 7 - Serial number of the device under test (if assigned

Note 8 - Date and time of the test

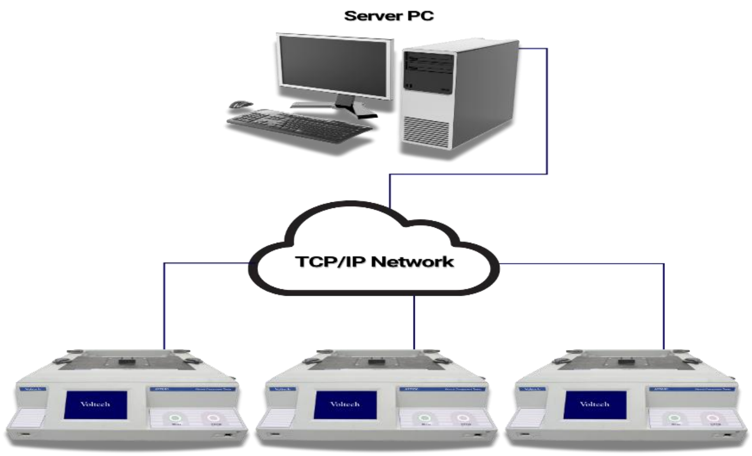
Note 9 - Individual test result lines, each ending with a 4-digit status code

Note 10 - Final test result: PASS or FAIL

3.6. Recommended Configuration

In a typical production setup, multiple AT7600 testers may be installed alongside a centralized AT Server PC used to store test programs and log results.

This configuration supports high-volume test environments with structured data management.



Advantages

- Centralized storage and management of large quantities of test programs (e.g., over 1000).
- Simplified handling and archiving of test results.
- Easy integration of test data into other Windows applications for analysis.
- The Server PC, connected over a network, can be located away from the test area (e.g., in a management office), allowing test results to be reviewed and analyzed where needed.
- Up to 8 AT Series testers can be connected to a single Server PC.

Limitations

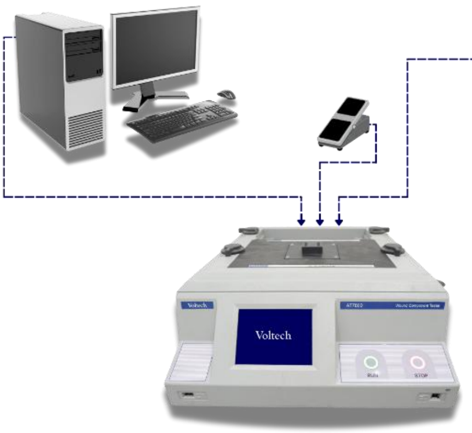
- The Server PC must remain powered on and connected to ensure continuous access for loading test programs and saving results.
- A separate PC (which may be a portable system) is typically required for local connection—via USB or Auxiliary Port—to one AT7600 unit when a new test program needs to be developed and evaluated.

3.7. Operating the AT7600 in Production Test

The AT7600 is designed for use in both manual and automated (robotic) production environments, supporting flexible integration into a wide range of test workflows.

3.7.1. Manual Use

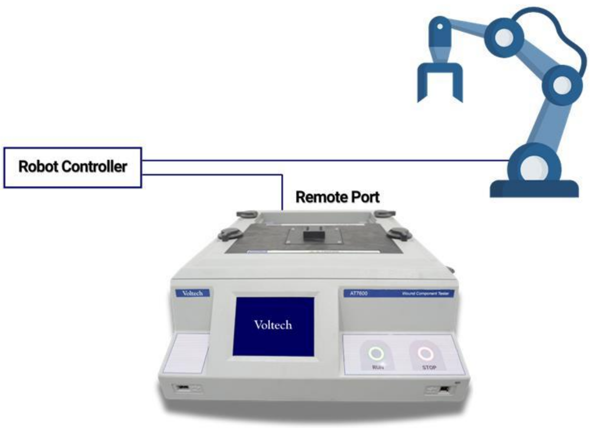
In manual operation, the AT7600 is positioned on a workbench in front of the operator and connected to a PC running the AT Server software for program access and result logging.



3.7.2. Robotic Operation

In automated test environments, the AT7600's Remote Port provides input/output signals that allow integration with robotic or PLC-based control systems.

*For detailed signal descriptions and timing, refer to **Chapter 10.3.3***



The AT7600 should be connected to an AT Server PC to enable full statistical process control (SPC), making real-time result logging available for manufacturing feedback and process monitoring.

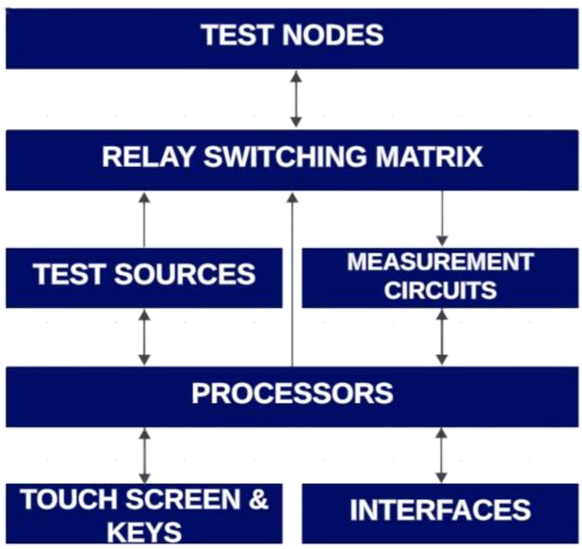
Voltech offers an **API** for advanced software-based control of the AT7600.

This enables users to interface directly with the tester for operations beyond simple trigger-based testing.

For more information, refer to the API Documentation available at ***www.voltech.com***

Chapter 4: AT7600 Functional Description

This chapter provides a detailed overview of the internal architecture and operational principles of the AT7600 Wound Component Tester. While in-depth knowledge is not required for everyday use, understanding its internal systems can support advanced users in troubleshooting, optimization, and integration tasks.



4.1. Behind the Front Panel

Outlines the key internal components and their roles within the AT7600 system.

- 4.1.1. Test Nodes
- 4.1.2. Relay Switching Matrix
- 4.1.3. Test Sources
- 4.1.4. Measurement Circuits
- 4.1.5. Touch Screen & Buttons
- 4.1.6. Interfaces

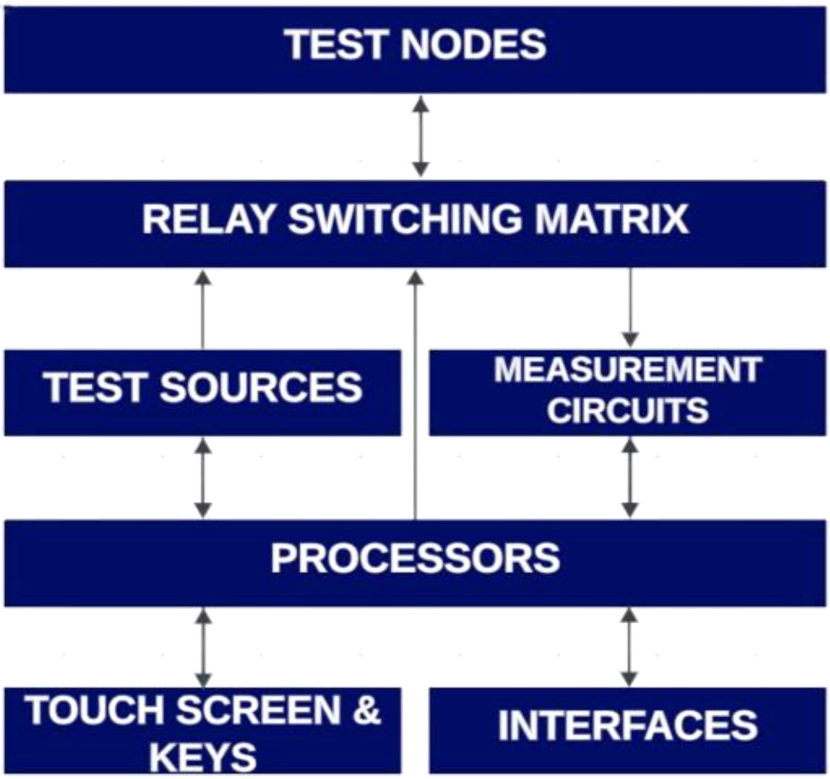
4.2. How Does the AT7600 Tester Run a Test?

Explains how the tester internally assembles and executes each test step-by-step, ensuring speed, repeatability, and safety.

4.1. Behind the Front Panel

While a detailed understanding of the AT7600's internal design is not necessary for day-to-day use, gaining insight into its internal functionality can aid in troubleshooting and optimizing test performance.

The key functional elements of the AT7600 are outlined below.



The following sections outline the internal operation of the AT7600 for users seeking a deeper understanding of its functional blocks.

While not essential for routine operation, this knowledge supports a better understanding of the system's capabilities and behavior.

4.1.1. Test Nodes

The AT7600 features spring-loaded Automatic Test Equipment (ATE) pins on its top surface.

Each test node consists of two separate contacts—a ‘power’ pin and a ‘sense’ pin—forming a Kelvin pair, which enables highly accurate measurement of low-impedance magnetic components.

4.1.2. Relay Switching Matrix

The relay switching matrix dynamically connects test sources and measurement circuits to the required nodes during test execution.

It uses high-speed, high-voltage reed relays capable of handling up to 7000 V in Hi-pot tests, while also switching extremely small voltages and currents required by other tests.

These relays are precisely controlled by the processors to prevent arcing and are rated for millions of operations. The AT7600 uses long-life relays that support long-term reliability in high-volume production environments.

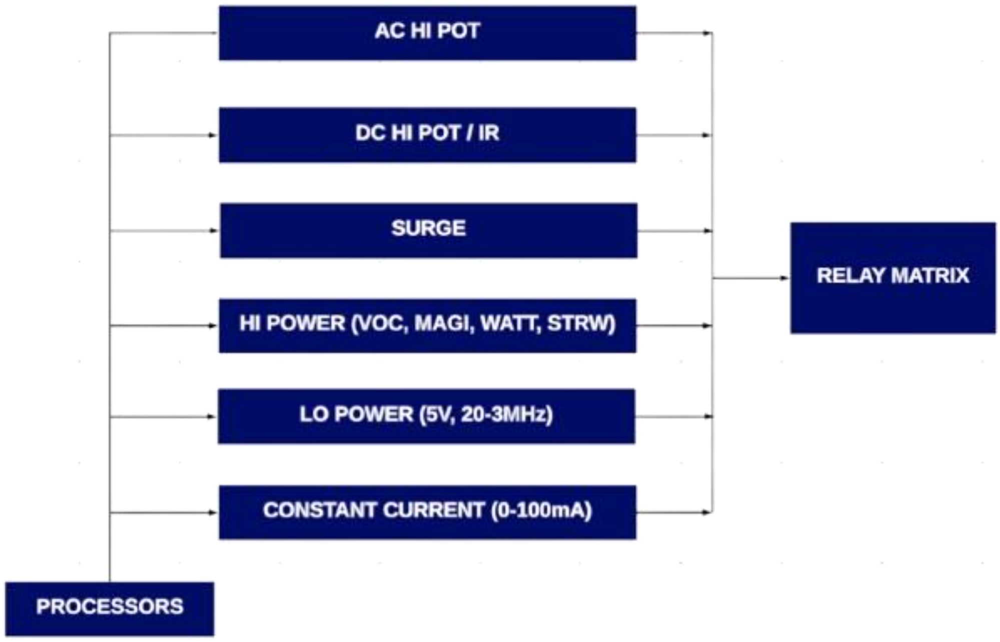
The AT7600 is built on a dual-processor architecture:

- A standard microprocessor which acts as controller, controls the test sources, and drives the relay matrix, the keyboard and display, and the various interfaces.
- A high-speed digital signal processor (DSP) that performs the measurements.

4.1.3. Test Sources

There are six distinct test sources within the AT7600.

The processors automatically select the appropriate source and connect it to the relay matrix for each test as it is executed.



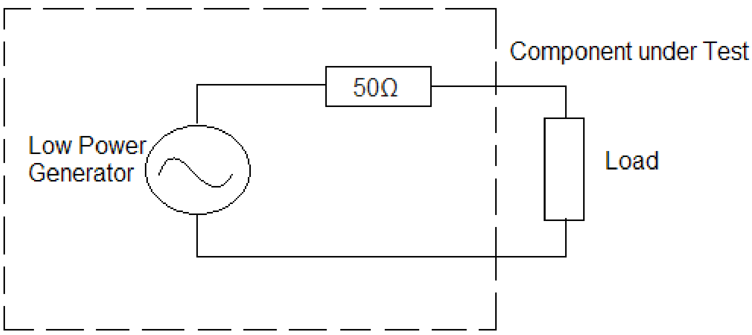
Low Power Generator – 50 Ω Source Impedance

The Low Power Generator provides up to 5 V RMS with a fixed source impedance of 50 Ω, making it suitable for general-purpose testing of low-voltage parameters.

Limit on Test Voltage

The maximum Test Signal which can be delivered depends on the load connected to the source. The maximum Test Signal shall be.

$$V_{out} = V_{LPG} * [Z_{Load} / (Z_{Load} + R_{50\Omega})]$$



Example – LS Test (Series Inductance):

To measure a component with a nominal impedance of **500 Ω** using an LS (Inductance, Series) test, the maximum test signal that can be programmed depends on the voltage or current limits of the selected test source.

The maximum Test Signal that can be programmed is.

$$V_{out} = 5V * [500 / (500 + 50)] = 4.55\ V$$

Limit on Test Current

The maximum current obtainable from the Low Power Generator (LPG), assuming an ideal load, is calculated as:

$$I = V / R$$
$$I = 5\ \text{Volts} / 50\ \text{Ohms}$$
$$I = 100\ \text{mA}$$

This test current may be further limited by the impedance of the device under test and the selected test frequency.

For guidance on selecting optimal test conditions that maximize current and ensure accurate, repeatable measurements, refer to the individual test sections in **Chapter 7, Test and Test Conditions.**

4.1.4. Measurement Circuits

The AT7600 incorporates a range of precision measurement circuits capable of executing the following:

- Voltage measurements from <1 mV to >7000 V
- Current measurements from nanoamperes to amperes
- DC and harmonic signal analysis
- RMS, mean-sense, power (W), and apparent power (VA) analysis

The system's processors automatically select and configure the appropriate measurement circuit for each test during execution.

4.1.5. Touch Screen and Buttons

The front panel includes a color LCD touch screen and dedicated RUN and STOP buttons.

A soft-key menu system dynamically displays only the functions relevant to the current operation, reducing clutter and simplifying navigation.

The main display provides real-time instructions to guide the operator, including prompts for using the RUN and STOP buttons to initiate and terminate tests.

4.1.6. Interfaces

The AT7600 interfaces include USB, Ethernet, Remote, Auxiliary, User Port, and Server Port connections.

For more information, refer to ***Chapter 10.3, Interface Specifications****.*

4.2. How Does the AT7600 Tester Run a Test?

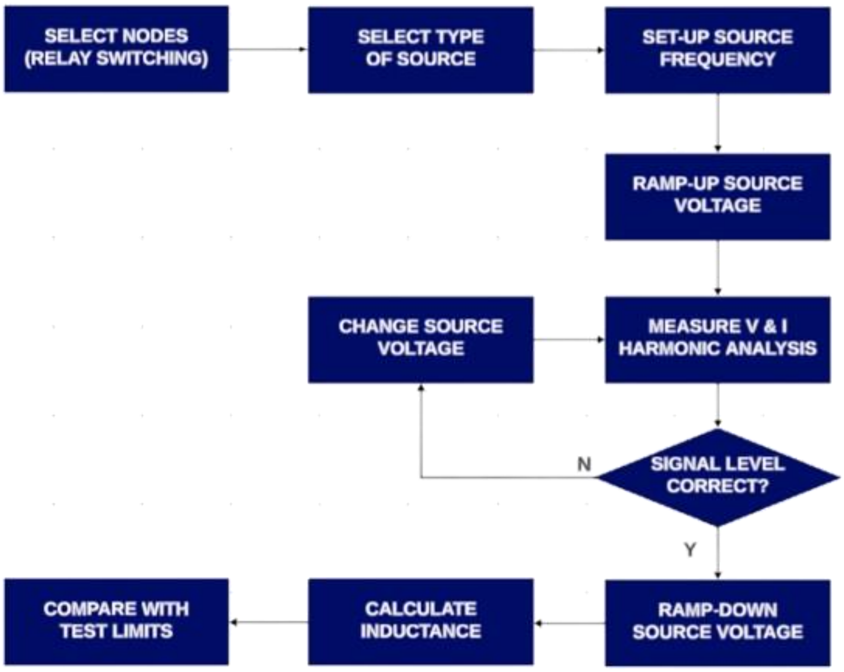
Programming of each test is performed at a high level, so users do not need to understand the internal test execution details to operate the system effectively. However, for users who are interested in the technical process, the following explanation provides insight into how tests are run within the AT7600.

When a test program is loaded into the tester, each test is compiled into a specific sequence of operations involving the components outlined in the functional block diagram *(see section 4.1)*.

The sequence is different for each test, and in some cases, it depends on which is the preceding and following tests in the program.

In all cases, the sequence is optimized to achieve the highest possible measurement speed and accuracy.

Example Test Sequence: Inductance Measurement



For other tests, the sequence may be more complex.

NOTES:

- All relay switching is completed **before the test source is energized**, which eliminates arcing and extends the life of the relays.
- In contrast to some LCR bridges**, AT Series testers** adjust the test source to match the programmed conditions, allowing consistent testing across all components using the same program.
- After the test completes, the source is **safely ramped down** so that any following relay switching happens with no active voltage applied

Chapter 5: Getting Started

This chapter guides users through the initial setup of the AT7600 Wound Component Tester and its supporting software. It covers installation procedures, basic usage tutorials, and peripheral setups. These steps are essential to begin configuring, testing, and getting results effectively.

5.1. Installing the AT7600

Instructions for installation & powering up the AT7600 for first use.

5.2. Installing the AT Editor Software

Introduces the process of installing the test program creation tool on your PC.

5.3. Installing the AT Server Software

Covers the setup of the software used to store test programs and log test results.

5.4. Quick Start Tutorial

Walkthrough of a basic test creation and execution.

5.5. USB Printer Setup

Instructions for configuring the Epson TM-T88VII printer via USB.

5.6. Barcode Reader Setup

Steps for integrating a barcode scanner to speed up part identification.

5.1. Installing the AT7600

Proper setup of the AT7600 is essential for operator safety, ergonomic workflow, and efficient production throughput.

Below is the basic mechanical setup procedure:

- Place the AT7600 on a stable, level work surface where it will be used.

  *For full installation context, refer to **Chapter 2.9, A Typical Installation.***

- Before finalizing the location, review Chapter 6, Safety Systems, for critical precautions regarding high-voltage handling.

- Ensure the PC running AT Editor and AT Server is powered on and accessible.

- Verify that the top surface of the tester is clear of any fixtures or foreign objects.

- Connect the power cable to the tester and a suitable power outlet.

- Switch on the AT7600 Wound Component Tester.

For proper operation, the safety interlock system *(detailed in Chapter 6*) must be correctly installed.

Warm-Up and Self-Test

Allow the unit to warm up for **30 minutes** to reach thermal stability, then run the **SELF TEST** to confirm that the tester is operating correctly.

Simply press the Self-Test soft key on the AT7600 screen to run the test.

Running a self-test at the start of each day—or each time the AT7600 will be used—is recommended to confirm proper functionality.

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5.2. Installing the AT Editor Software

The dotNET AT Editor (version 4.xx) is used for creating, editing, and managing test programs for the AT7600 Wound Component Tester.

Both the software installer and the corresponding user manual (98-125 – AT Editor dotNET User Manual) are available for download from the Voltech website:

www.voltech.com/support/downloads

5.3. Installing the AT Server Software

The AT Server software is typically installed on a separate PC from the AT Editor and must remain continuously connected to the AT7600 to handle test program transfers and result logging.

The software, along with the user manual (98-122 – AT Server dotNET User Manual, covering version 4.xx), is available for download from the Voltech website:

www.voltech.com/support/downloads

NOTE:

The Server software must be installed and running before proceeding with the server-related steps covered in the following Quick Start section.

5.4. Quick Start Tutorial

After successfully installing the AT7600, along with the AT Editor and AT Server software packages as outlined in Sections 5.2 and 5.3, we recommend completing this Quick Start Tutorial to help you become familiar with the basic workflow of the system.

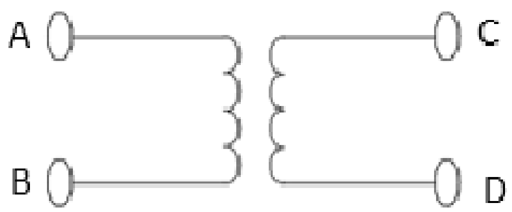
This tutorial provides a hands-on introduction to creating a schematic and configuring a test program using the AT Editor software.

NOTE: The test program you create will only run if your AT7600 has the required test types unlocked.

5.4.1. Creating a Simple Schematic

In this tutorial, you will learn how to configure the AT7600 to test a basic two-winding transformer. The example below walks you through setting up a schematic that defines the component's electrical connections and physical layout.

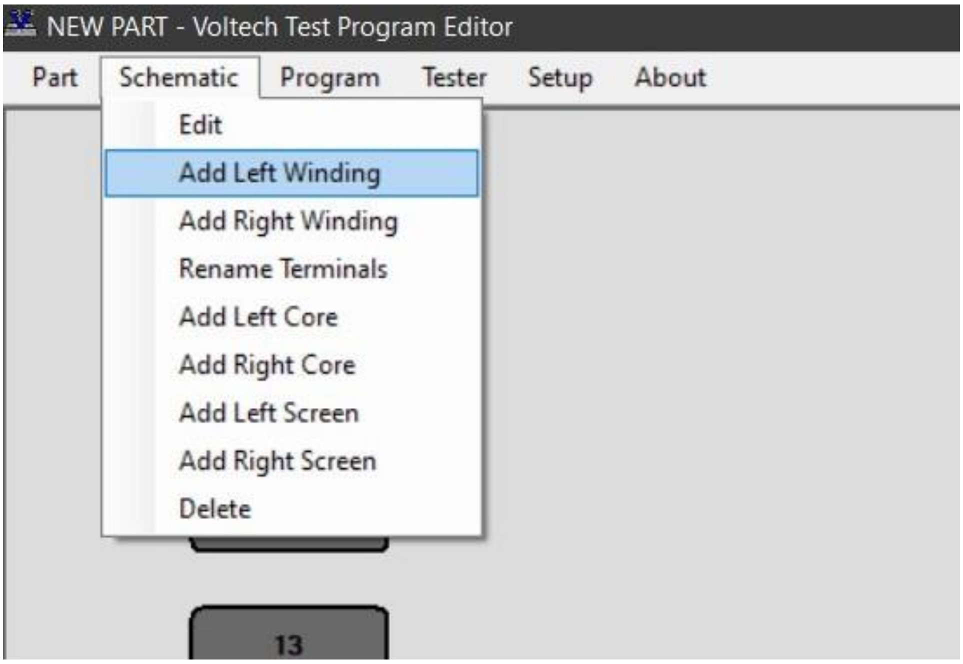
We will use a transformer with the following specifications:



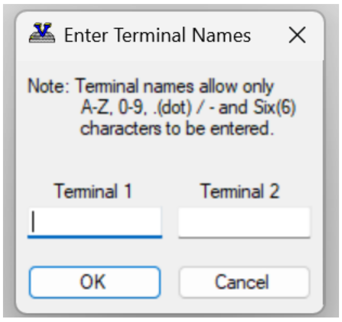
SPECIFICATIONS	
Resistance Winding AB	59-73 Ω
Resistance Winding CD	59-73 Ω
Inductance of Winding AB	>3H
Turns Ratio of AB to CD	1:1 +/- 2%

Start the Editor program by double-clicking the Editor icon using the left mouse button.

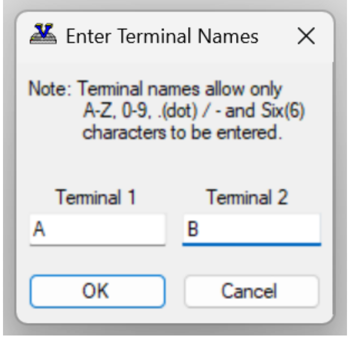
Once the application opens, the first step is to create a schematic diagram representing the transformer we intend to test.



1. Using the left mouse button, click **Schematic** on the top-level menu bar, then select **Add Winding** (Left or Right) from the drop-down menu.
2. A dialog box will prompt you to name the terminals of the winding. The cursor will be positioned in the input field for Terminal 1. Type the desired name (e.g., “A”).



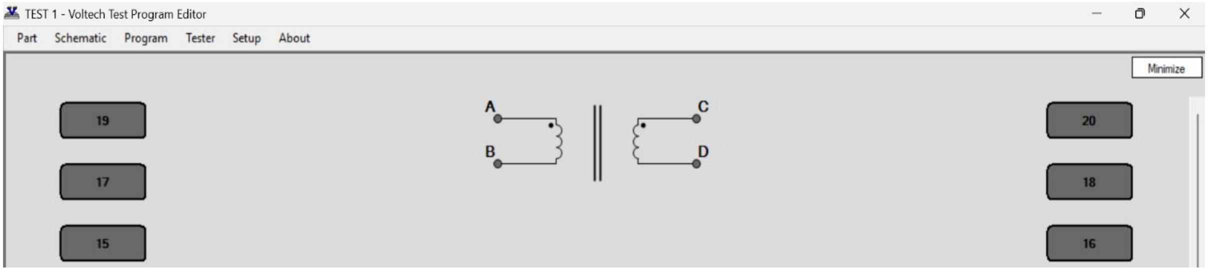
3. Press Tab to move to the Terminal 2 input field or left-click on the Terminal 2 box to activate it. Type the name of the second terminal (e.g., “B”), then click OK or press Enter to confirm.



Repeat steps 1-3 to create a second winding.

4. This time, position the second winding on the right-hand side of the schematic workspace, creating a mirror image of the first winding. Assign different terminal names (e.g., "C" and "D") when prompted.

   At this point, your schematic should resemble the following layout:



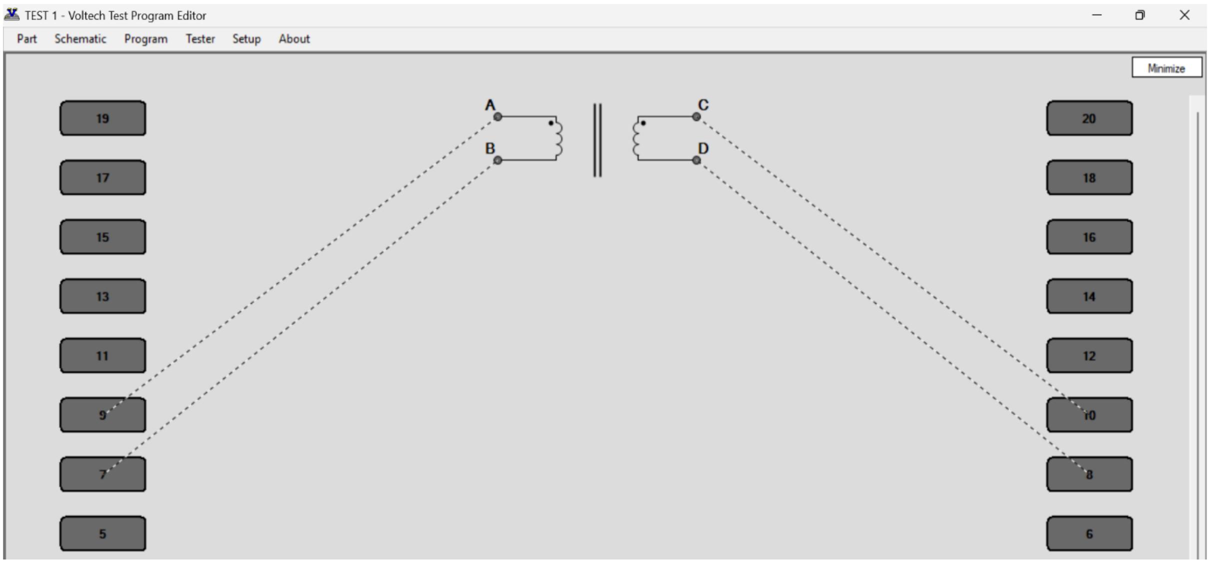
5. Now, connect the winding terminals to the test nodes of the tester:

   Place the mouse pointer over Terminal A, **then press and hold the right mouse button**. While holding the button, **drag the pointer to Test Node** 9, then release the button. A connection (wire) will appear linking Terminal A to Node 9.

   Repeat this procedure to connect the remaining terminals as follows:

   - Terminal B to Node 7
   - Terminal C to Node 10
   - Terminal D to Node 8

Your schematic should now resemble the following layout:



5.4.2. Creating the Test Program

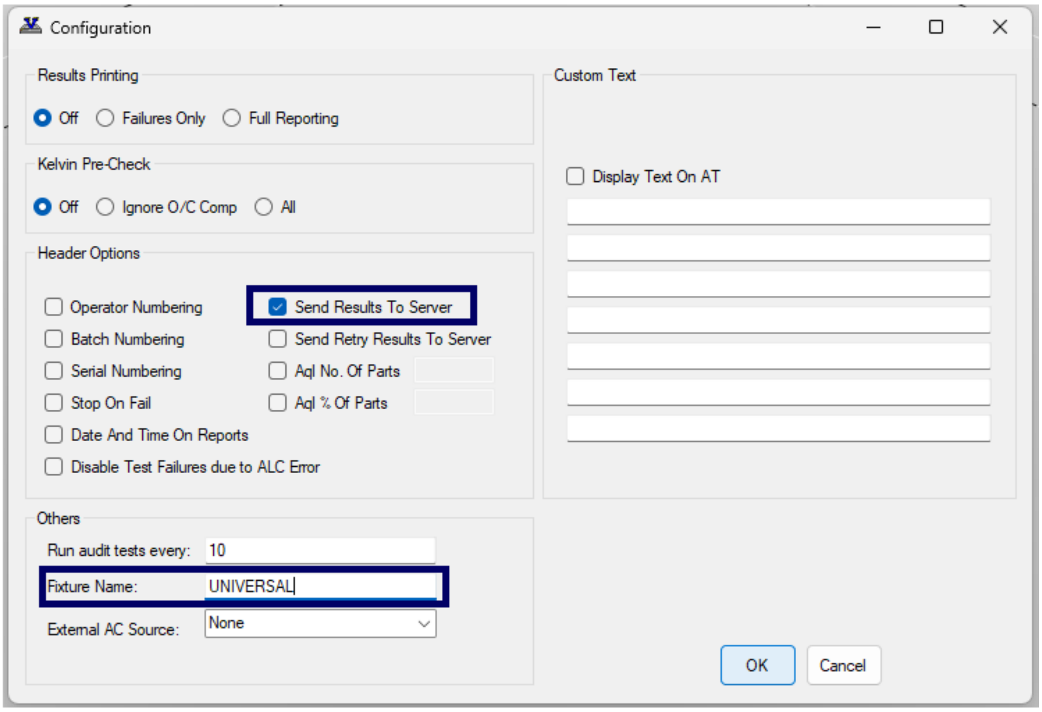
After creating the transformer schematic, you may now create an example program, containing the following four tests:

- Resistance of winding AB (1 mΩ to 209 mΩ)
- Resistance of winding CD (171 mΩ to 209 mΩ)
- Inductance of winding AB (>330 uH)
- Turns ratio AB to CD (1:1 ±2%)

1.Set up the program options:

From the top-level menu bar select: ‘Program’ menu, then select ‘Options.’

The following dialogue box will appear:



Using the left mouse button, click to enable the following option.

‘Send Results to Server’

In the Fixture ID box, enter the name:

‘UNIVERSAL’

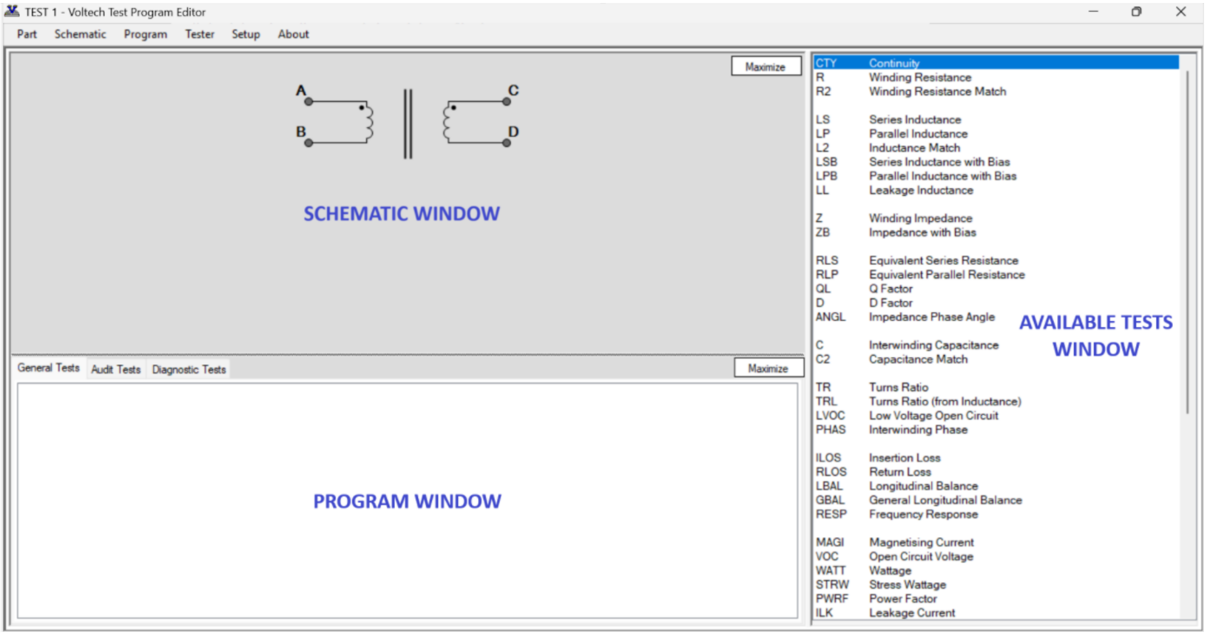
Click on ‘OK’ or press [Return] to accept the changes and close the dialogue box.

You have now created a schematic layout of a four-terminal transformer.

2. Create the test program:

From the top-level Program menu, select Edit.

The screen will now be divided into three main windows:



Top Left – Schematic Window: Displays the schematic of the two windings you created.

Right – Available Tests Window: Lists all test types supported by your AT7600. Tests that are not currently unlocked will appear greyed out.

Lower Left – Program Window: Displays the tests currently added to the program.

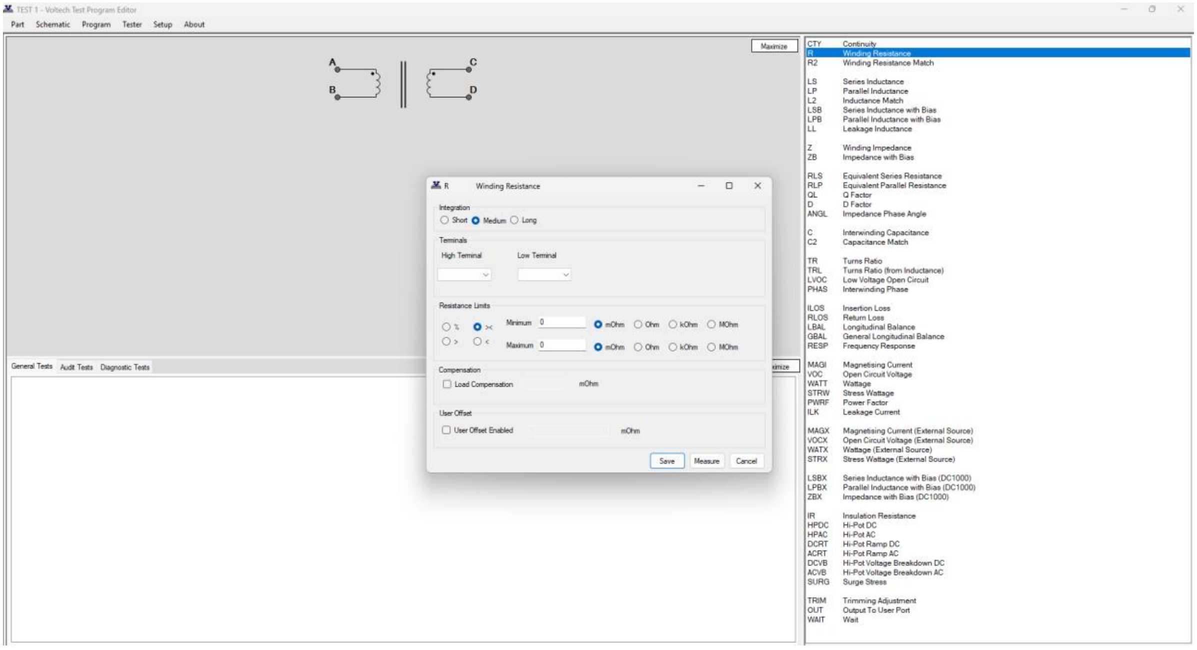
This window includes three tabs:

- General Tests
- Audit Tests
- Diagnostic Tests

In the Program Window, click the General Tests tab.

Then, in the Available Tests window, locate and double-click R Winding Resistance using the left mouse button.

The corresponding test configuration dialog box will appear:

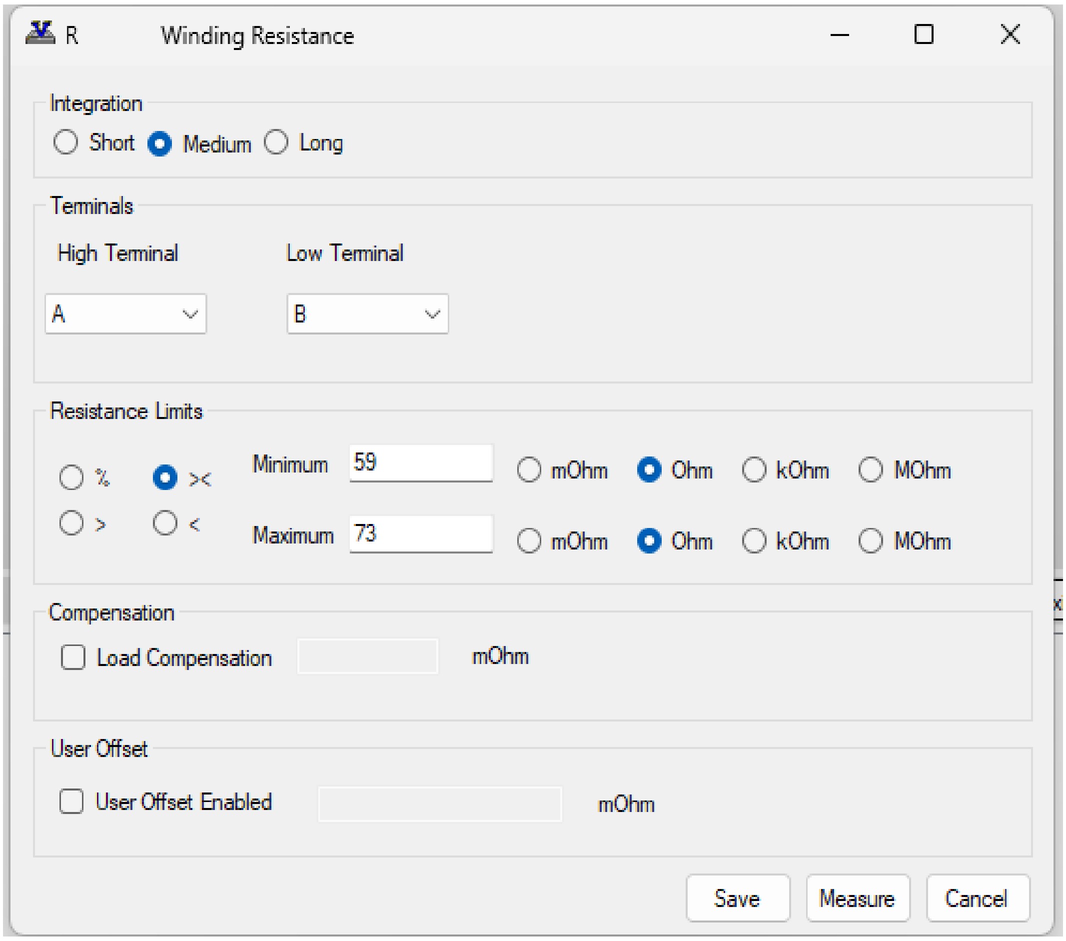


Enter the terminal names. Input 'A' as the high terminal and 'B' as the low terminal, moving between the fill-in boxes using the TAB key or right clicking in the desire box.

Now enter the resistance limits. This can be done in four ways:

- % Click on this button to enter a nominal value with a percentage tolerance (for example, 190 mΩ with 10% tolerance),
- >< Click on this button to enter minimum and maximum values (for example, 171 mΩ and 209 mΩ)
- > Click to enter just a minimum value (for example, > 171 mΩ),
- < Click to enter just a maximum value (for example < 209 mΩ).

In this example, the >< limits will be used:

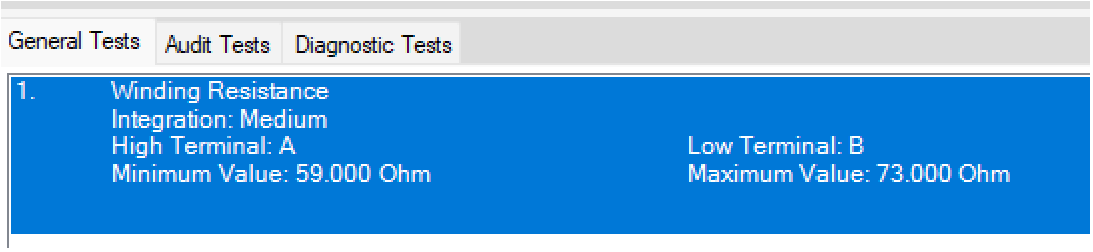


The ‘Ohm’ unit button is selected by clicking the radio button with the mouse.

If the "User Offset Enabled" check box is checked, a value can be entered into the edit box. The value entered (in the units shown) is then **added to any results returned from the AT tester.**

This function can be used to adjust for measurement fixture effects that cannot be compensated for or to compensate the fixture manually, so a compensation stage is not required to obtain the correct readings.

Click on the ‘OK’ button. The test and its parameters will now appear in the ‘Program’ window.

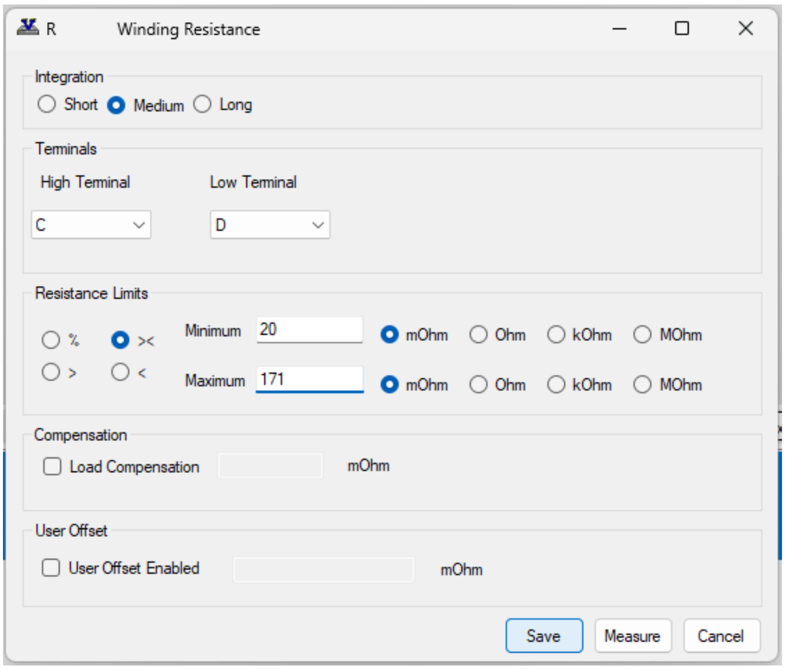


Add the second test by double clicking the left mouse button, select ‘R Winding Resistance’ from the ‘Available Tests’ window.

At the dialogue box, enter the data as before; this time for the second winding:

Integration (Leave as the default - Medium)

- High terminal: C
- Low terminal: D
- Minimum: 20 mΩ
- Maximum: 171 mΩ



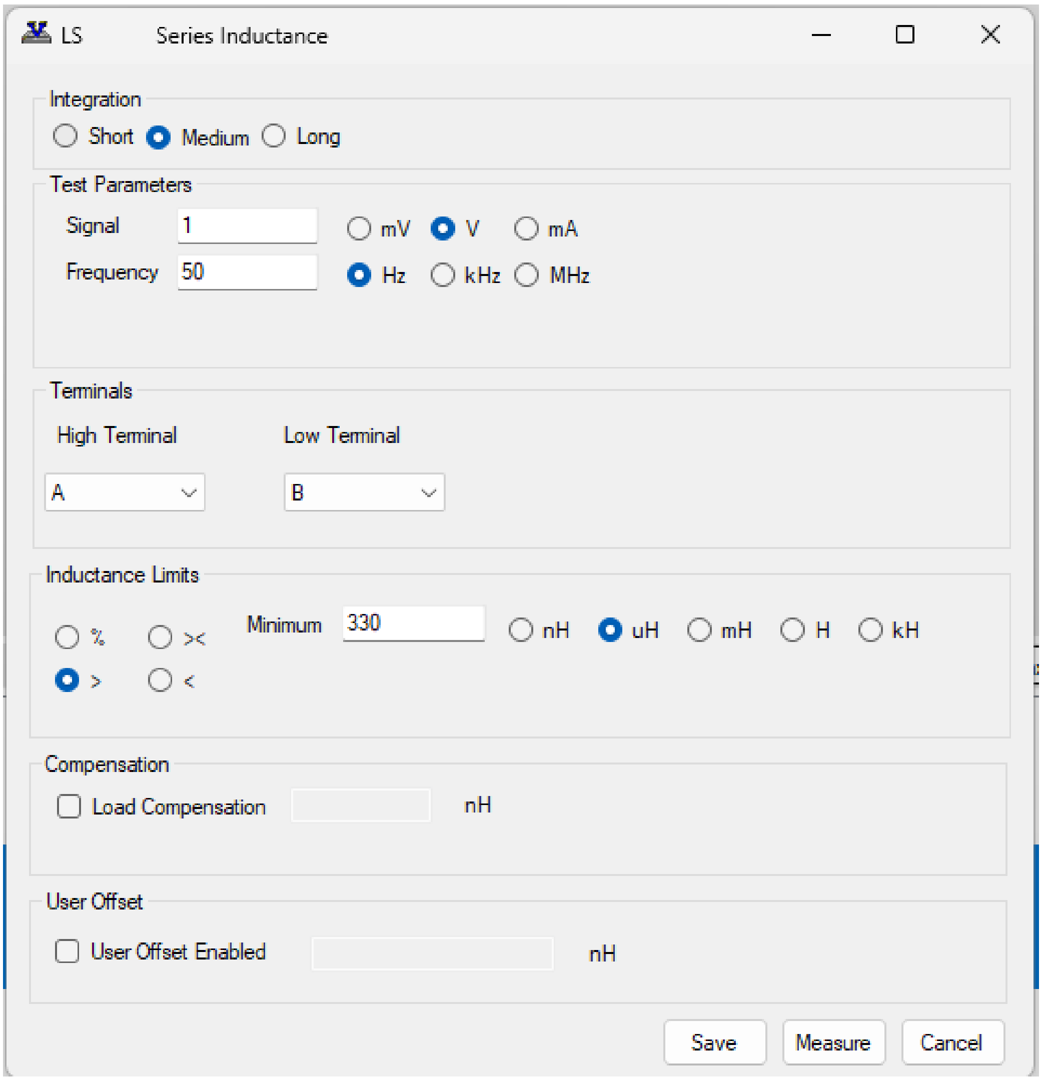
Click on the ‘OK’ button. Again, the test and its parameters will appear in the ‘Program’ window.

Add the third test by double-clicking the left mouse button.

Select **'LS Inductance (Series Circuit)'** from the Available Tests window.

In the dialog box, enter the following data for the inductance test:

- Integration: Leave as the default – Medium
- Signal: **1 V** (click the V units button to set the correct unit)
- Frequency: 50 Hz
- High terminal: A
- Low terminal: B
- Click on the '>' button to select a minimum limit only,
- then enter: Minimum: 330 µH



Click on the 'OK' button. Again, the test and its parameters will appear in the 'Program' window.

Finally, add the fourth test by double-clicking the left mouse button.

Select **'TR Turns Ratio'** from the Available Tests window.

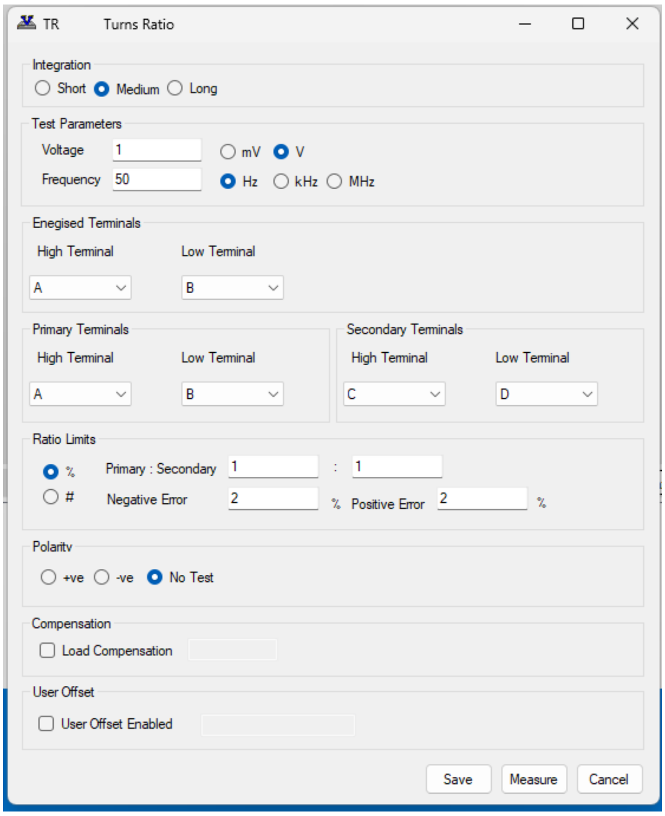
In the dialog box, enter the following data for the turns ratio test:

- Voltage: 1 V
- Frequency: 50 Hz
- Integration: Leave as the default – Medium

The AT7600 measures the turns ratio between the primary and secondary windings, with the option to apply the test voltage through a separate energized winding.

In this example, the energized winding is the same as the primary winding. Enter the terminal assignments as follows:

- Energized high terminal: **A**
- Energized low terminal: **B**
- Primary high terminal: **A**
- Primary low terminal: **B**
- Secondary high terminal: **C**
- Secondary low terminal: **D**



Using the default '%' type of limits, enter:

- Primary to Secondary ratio: **1:1**
- Negative tolerance: **2%**
- Positive tolerance: **2%**

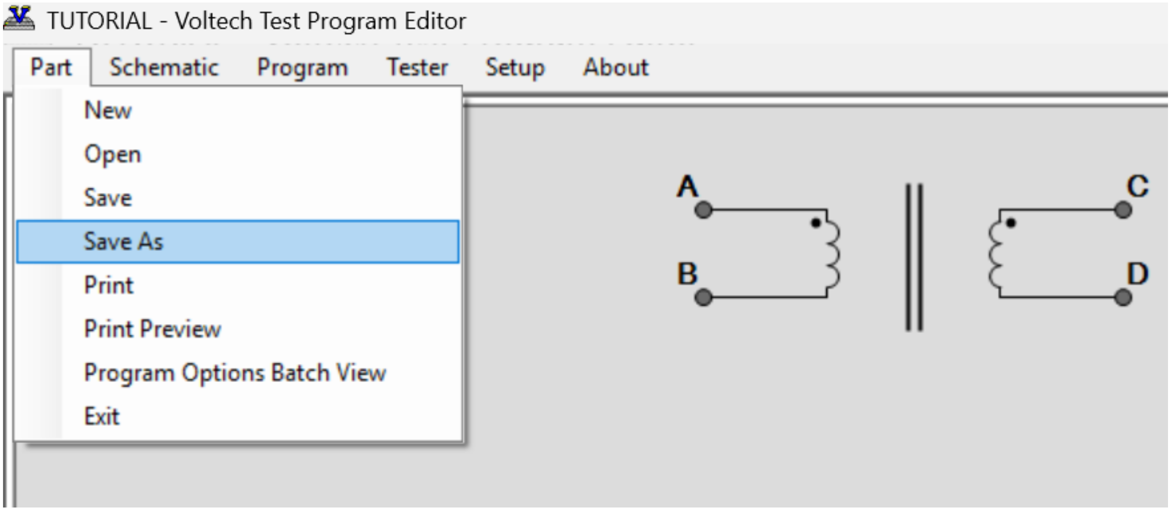
Click the OK button. The test and its configured parameters will now appear in the Program window.

At this point, the lower-left window should display the complete test program. You can use the scroll bars within this window to review each test step and verify that all entries are correct.

3.Save the Program

The editor will not allow a program to be run in the AT unless it has previously been saved:

From the Top Level '**Part'** menu, select '**Save As,**'



In the dialog box, enter **TUTORIAL**—**or any part name of your choice**—as the program name.

Click the **OK** button to close the dialog and save the test program to a directory of your choice and you're done!

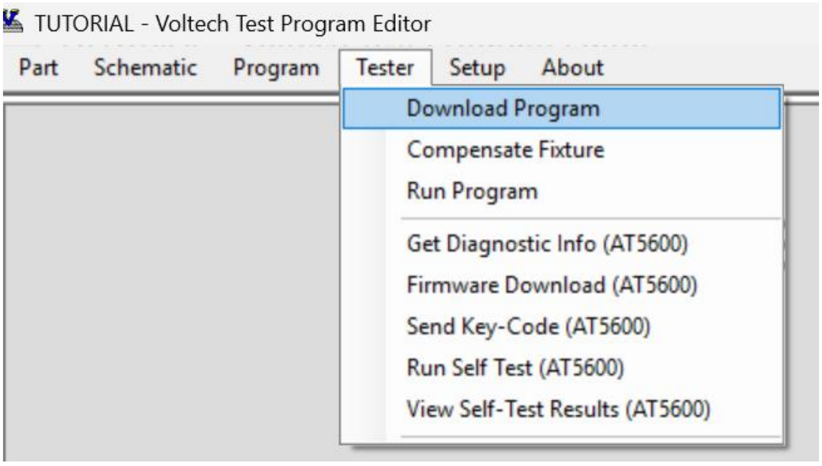
5.4.3. Running the Program from the Editor

Having created the test program, it is now ready to run on your AT7600 under the control of the AT Editor.

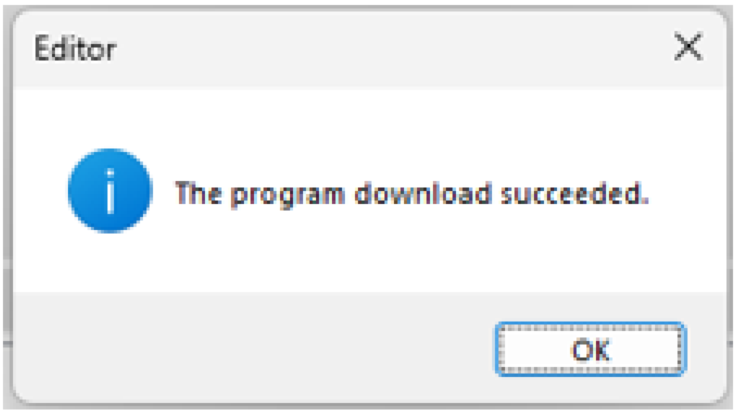
Before proceeding further, make sure that the AT7600 has been powered on and communications are correctly configured in the editor.

To run the program:

1. From the Top Level 'Tester' menu, select 'Download Program'.



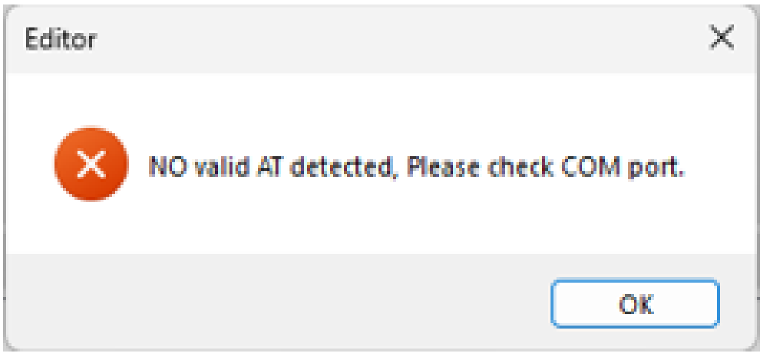
2. The editor will now download the test program to the AT7600. After a few seconds, the message "**Program download succeeded**" should appear. Click OK to close the pop-up.



If the download fails, check your communication settings and try again.

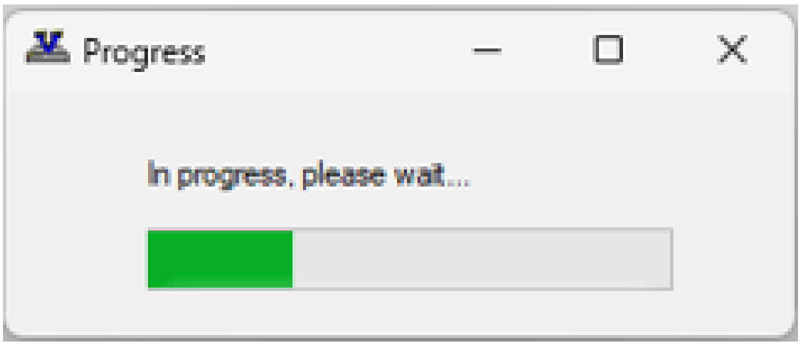
If it still fails, reboot your PC and try once more.

An error message might appear if the communication settings are incorrect or if the AT7600 is not properly connected.



3. From the Top Level **'Tester'** menu, select **'Run Program'**.

The test program will now start running. When it is finished, you will see a dialogue box containing the results of the test.



If the transformer had been connected as in the schematic to nodes 7, 8, 9, and 10 then the results might be:

1	R	191.42	mOhm	PASS	0000
2	R	190.78	mOhm	PASS	0000
3	LS	377.77	uH	PASS	0000
4	TR	1.0076		PASS	0000
		POL +		PASS	

RUN TIME 86 msec

If no transformer is fitted, the test results will not be meaningful. However, you have now successfully installed both the AT7600 and the AT Editor software.

The Results window provides the following options:

1. Re-run the test program
2. Print the test results
3. Save the test results
4. Close the window

Closing the window will return you to the main menu.

5.4.4. Transferring the Program to the Server

Voltech Server software is supplied with every AT7600. It is required for the storage and management of test results and is recommended when working with a large number of test programs.

After creating, saving, and testing the **TUTORIAL** program using the Editor, you can now run it on your AT Series Tester via the Server. The process for transferring the program to the Server archive may vary depending on where the Editor and Server software are installed.

Editor and Server on Separate PCs

In many setups, the Editor and Server software are installed on separate PCs (as illustrated in Section 2.2.2).

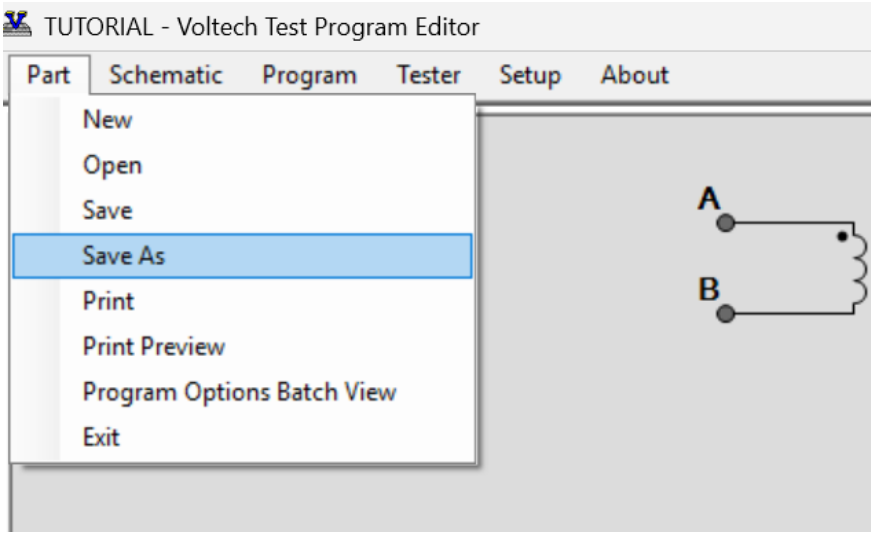
It is common for companies to use a network drive to store test programs in a central location.

You can transfer .ATP files from your PC to the network drive using standard Windows cut and paste operations in File Explorer.

Editor and Server on the Same PC

If the Server and Editor are installed on the same PC, the easiest way to transfer a test program to the Server is by using the Save As option in the Editor:

- From the top-level Part menu, select Save As.
- In the dialog box, navigate to the Server's archive folder.
- Save the program in the appropriate location for the Server to access it.



At the dialogue box, type in the part name TUTORIAL, as before, but change the directory to the one selected for program storage for the Server.

e.g., C:\AT7600\SERVER

Click the OK button to close the dialog box and save the test program in the Server's program directory.

NOTE: The AT Server allows you to change the program storage directory. Be sure to check the current folder setting in the Server configuration, as the directory shown here is the default location.

Running a Program from AT Server

This section of the tutorial demonstrates how to run a test program on the AT7600 using the Server store.

If the Editor and Server are installed on the **same PC and share the same COM port,** you must **reassign the COM port** from the Editor to the Server before continuing:

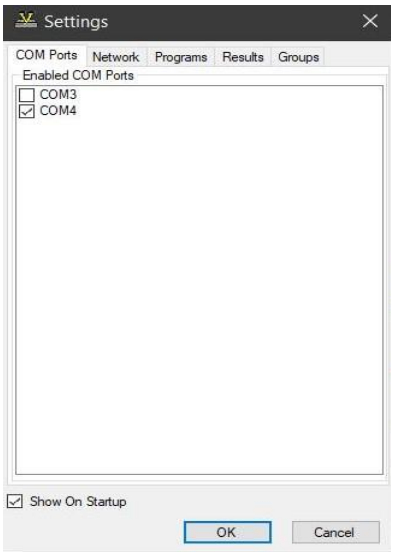
To reallocate the COM port:

1. In the Editor, go to the Part menu and select Exit to close the application.
2. Disconnect the cable between the AT Auxiliary Port and the PC COM port.
3. Connect the cable between the AT Server Port and the PC COM port.
4. Launch the Server software by double-clicking the Server icon on the desktop.
5. In the Server, go to the Setup menu and select Communications from the top-level options.
6. In the Configure Server Communication dialog box, set the correct COM port to establish communication with the tester.

If the Server and Editor are **installed on separate PCs, or already use different COM ports, no changes are necessary**. You may proceed as is—just make sure the COM port assigned to the AT Server is not the same as the one used by the AT Editor.

1. Start the AT Server program by double-clicking with the left mouse button on the Server icon.

Ensure the communication port is set up by clicking on **'Setup menu**, select '**Communications'** from the Top Level. The configure server communication dialog box will now appear.

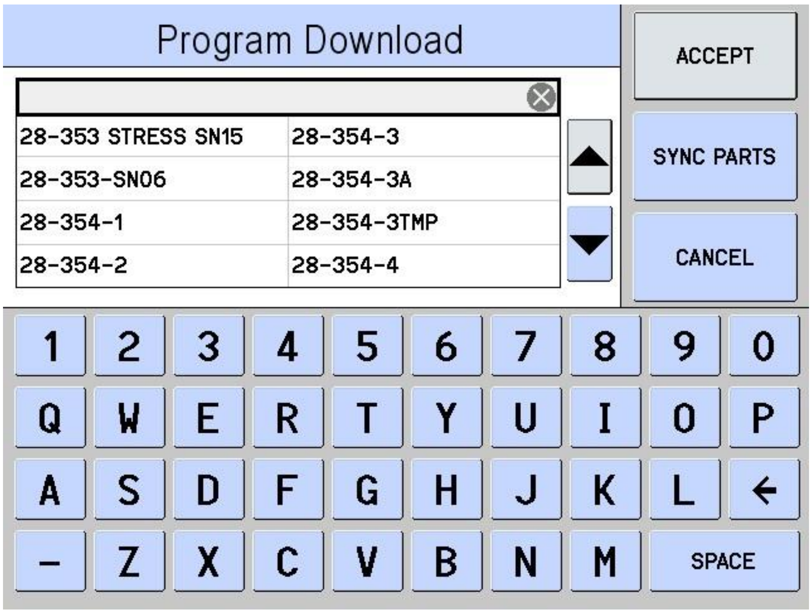


Select the Com Port assigned to the server port to the open channel window, and then click OK.

2. Loading a program from the server

A full description of the Front Panel operation is given in **Chapter 8: Front Panel Operation.**

Using the front panel of the AT7600, from the top-level menu, tap the soft key PART LIST to change to the following display:



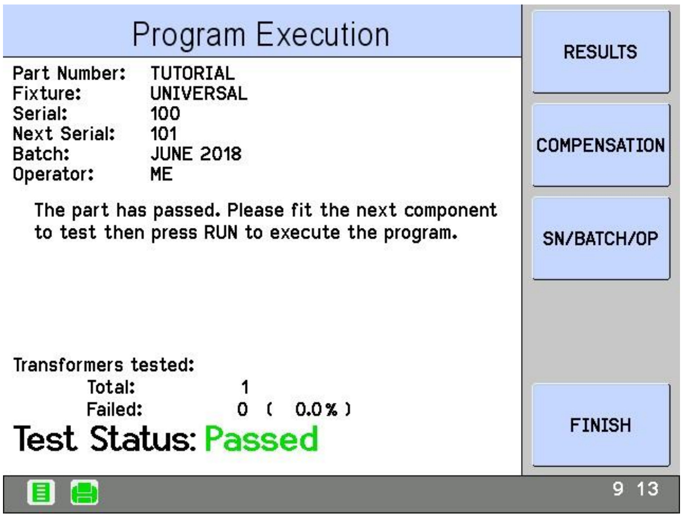
Select the program from the list or tap the data entry box on the main screen.

Enter the Part Number or the program name **TUTORIAL** in our example.

3. Run the test

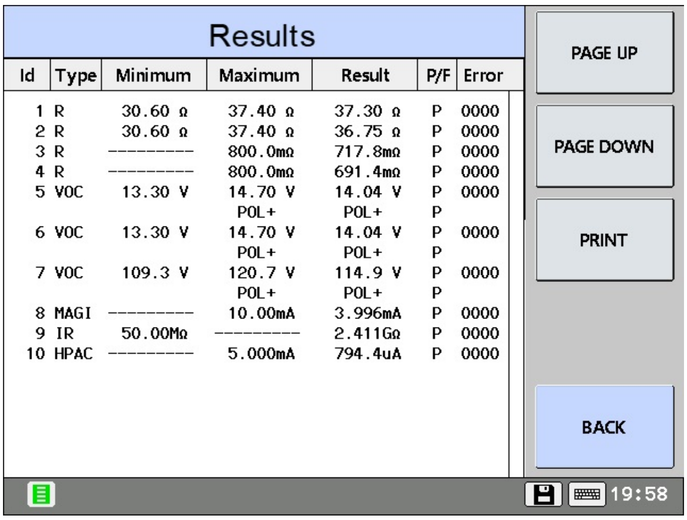
Connect the transformer to the fixture and press the Run button.

When the tester has finished testing, the result shall be displayed as shown.



4. Viewing the Results

To view the test results, tap the RESULTS soft key; you will see the following display:



5.5. USB Printer Setup

The AT7600 can be configured to automatically print test results at the end of each program run.

Automatic printing is enabled as part of the test program using the Editor software.

Epson TM-T88VII USB Printer

NOTE: The Epson TM-T88VII USB printer must be set to **USB Printer Class mode** to operate correctly with the AT7600.

Detailed instructions for setting up the Epson TM-T88VII printer are provided below:

1. Close the paper roll cover of the Epson printer.

2. Turn on the printer while pressing the **Feed** button. The status shall print.

3. After the printing, has been completed, the Paper LED shall be flashing indicating that it is in **set-up mode**.

4. Press and hold the Feed button for more than one second. The printer shall enter the **Mode Selection** mode. The printer shall print the following.

```
Mode Selection

Modes
    0: Exit and Reboot Printer
    1: NV Graphics Information
    2: Receipt Enhancement Information
    3: Customize Value Settings
    4 or more: None

Select Modes by executing following
procedure.
  step 1. Press the Feed button less
          than 1 second as many times
          as the selected mode number.
  step 2. Press Feed button for 1
          second or more.
```

5. Press the Feed button, for less than one second, three times. This will access ***Mode 3. Customize Value Settings*.** Then press and hold the Feed button for more than one second. The printer shall print the following.

```
Customize Value Settings
Modes
   0: Exit
   1: Print Current Setting
   2: Print Density
   3: Print Speed
   4: Automatic Paper Reduction
   5: Auto Paper Feed&Cut at Cover Close
   6: Paper Width
   7: Top Margin
   8: Character/Font Settings
   9: Interface Selection
   10: Interface Settings
   11: Intelligent Settings
   12: Command Execution (Offline)
   13: Power Supply Output
   14: Other Settings

Select Modes by executing following
procedure.
 step 1. Press the Feed button less
         than 1 second as many times
         as the selected mode number.
 step 2. Press Feed button for 1
         second or more.
```

6. Press the Feed button, for less than one second, 10 times. This will access ***Mode 10. Interface Settings***. Then press and hold the Feed button for more than one second. The printer shall print the following.

```
10. Interface Settings

Modes
   0: Return to previous menu
   1: Serial Interface Baud Rate
   2: USB Interface Settings
   3: Interface switch waiting time
   4: Main connection interface
   5: Auto Line Feed
   6: Output Paper-end signals
   7: Error signal output
```

7. Press the Feed button, for less than one second, 2 times. This will access ***Mode 10.2. USB Interface Settings*.** Then press and hold the Feed button for more than one second. The printer shall print the following.

```
10. Interface Settings
  10.2. USB Interface Settings

Modes
   0: Return to the previous menu
   1: Class
   2: IEEE1284 Device ID
   3: USB power-saving function
```

8. Press the Feed button, for less than one second, one time. This will access **Mode 10.2.1. Class.** Then press and hold the Feed button for **more than one second**. The printer shall print the following.

```
10. Interface Settings
  10.2. USB Interface Settings
    10.2.1. Class

Modes
    0: Return to the previous menu
 ]  1: Vendor Class
 *  2: Printer Class

]   means default value
*   means current set value
```

9. Press the Feed button, for less than one second, two times. This will change the printer to **Printer Class**. Then press and hold the Feed button for more than one second.

10. At this point, the changes to the setting have been saved and you can turn off the printer. **The printer is now ready for use.**

5.6. Barcode Reader Setup

The AT7600 supports USB barcode readers, allowing faster and more accurate entry of test-related information. This enhances traceability by associating test results with specific serialized transformers.

The barcode reader can be used to input the following data, which is otherwise entered manually via the touchscreen:

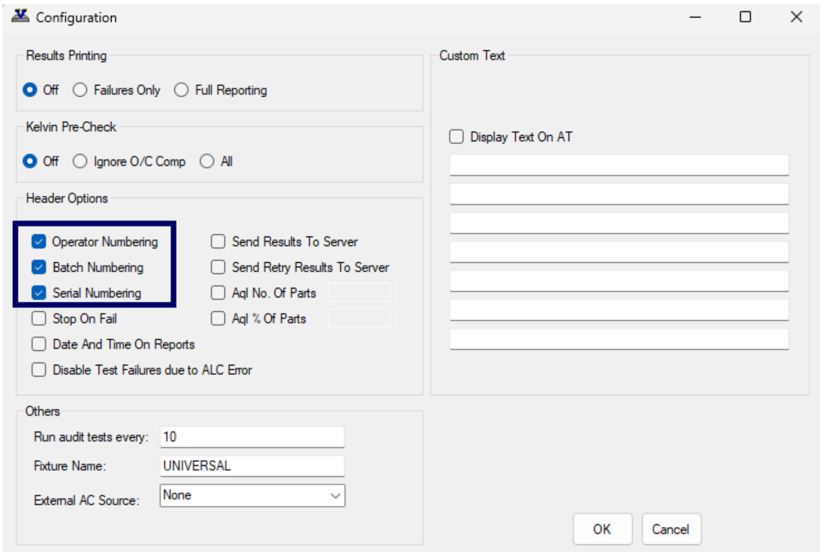
- **Program Name**
- **Operator Name**
- **Batch Number**
- **Serial Number (initial entry and auto incremented after each test run)**

Manual entry via the touchscreen remains available if preferred.

The barcode reader connects directly to either the front or rear USB-A port on the AT7600. No external power supply is required.

NOTE:

Recording of Batch Number, Operator Name, and Serial Number must be enabled in the test program (.ATP file) to be saved as part of the test results.



Supported Barcode Readers

Voltech recommends the ***Honeywell Hyperion 1300G USB barcode reader:***

Honeywell Link: https://automation.honeywell.com/gb/en/products/productivity-solutions/barcode-scanners/general-purpose-handheld/hyperion-1300g-light-industrial-scanner

Other HID-compatible barcode readers may work; however, due to manufacturer-specific differences, full compatibility cannot be guaranteed.

Barcode Reader Set Up

1) Plug the USB barcode reader into the **USB-A** port on the AT7600 (front or rear).

2) On initial connection, the AT7600 will detect the Honeywell 1300G and display a barcode on the screen.

3) Scan the on-screen barcode with the reader to configure it to optimal settings.

This process is equivalent to programming the reader to USB HID POS mode, as described in the Honeywell user manual.

HID Keyboard

The AT7600 supports HID-compliant USB keyboards via the standard Human Interface Device (HID) protocol.

Most modern desktop PC keyboards are compatible.

Once connected—similar to the barcode reader, text entry can be performed using either the USB keyboard or the touchscreen interface.

Valid Characters for Serial / Operator / Batch Input

USB barcode readers and USB keyboards accept the same set of characters as the manual front panel input:

0–9: Numerals

A–Z: Uppercase letters only

"-": Hyphen (minus symbol)

(SPACE): Space character

For more information on barcode reader functionality and data entry options, refer to the following sections of the manual:

Chapter 8.1.14 – Status bar icons

Chapter 8.1.6.2, 8.1.6.3, 8.1.6.4, and 8.1.6.6 – Description of input screens where the barcode reader can be used

Chapter 6: Safety Systems

Testing with the AT7600 involves high voltages and requires safeguards to protect the operator. This chapter outlines essential safety measures, supported equipment, and interlock functions.

6.1 Introduction
Identifies safety risks in high voltage testing and introduces interlock system usage.

6.2 Recommended Safety Systems
Outlines Voltech's safety approach, including use of light curtains for operator protection.

6.3 Safety Notices
Highlights operator responsibilities and the need for qualified installation.

6.4 Typical Installation
Describes enclosure setup and key components of the light curtain system.

6.5 AT7600 Safety Interface
Explains safety indicators and how the system responds to interlock breaches.

6.6 Safe Fixture Design
Provides guidelines for maintaining safe distances between the UUT and safety devices.

6.7 DC1000A Requirements
Refers to safety instructions for using the DC bias source with the AT7600.

6.8 AC Interface Safety
Refers to safety guidance for operating the AC Interface Fixture.

6.1. Introduction

Tests performed with the AT7600 may involve high voltages that pose a risk of injury if appropriate safety measures are not in place.

To help prevent accidental exposure, the rear panels of the AT7600 and certain accessories include a **safety interlock connector.**

This connector prevents test execution unless all three interlock signals are in a **“safe”** state.

In automated environments, safety is typically managed using enclosures and interlocked doors.

In manual setups, physical barriers like interlocked lids may be used, though these can reduce testing speed and efficiency.

The exact implementation of safety systems will vary depending on your production setup.

6.2. Recommended Safety Systems

The AT7600 can generate hazardous voltages during normal operation. To maintain safety without compromising test speed, Voltech recommends using **an infrared safety light curtain.**

Mounted in front of the tester and wider than the unit itself, the light curtain acts as a non-contact barrier—providing operator protection while allowing easy access for loading and unloading transformers.

6.2.1. Description of the Banner Light Curtain System

Voltech recommends a safety light curtain solution available directly from **Banner Engineering**.

To integrate this with the AT7600, a **Voltech cable (Part No. 250-030)** must be purchased separately.

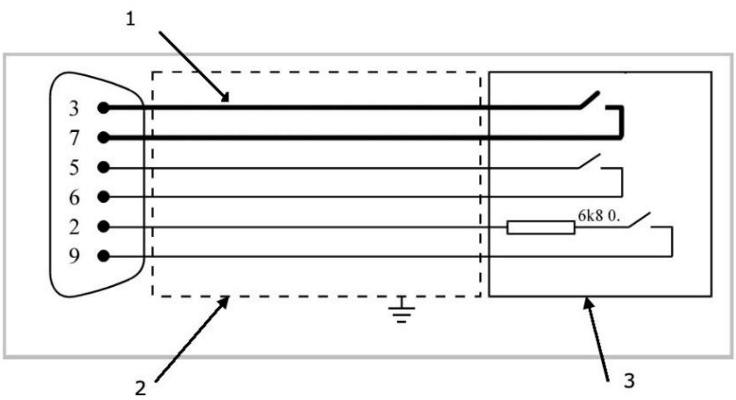
NOTE: This solution is not CE-marked and **may not** be suitable for use in certain regions.

Full details on the required **Banner OEM** parts and installation can be found at www.voltech.com/support/downloads — refer to the *Safety Interlock Cable User Manual v4*.

6.2.2 Constructing Your Own Safety System

The illustration below shows the key principles for building a safety system using the signals available on the 9-way AT7600 Safety Interlock connector.

To activate the interlock, three separate conditions must be satisfied—including the use of a fixed resistor to prevent accidental activation if all pins are shorted together.



NOTES:

1) The connection between pins 3 and 7 must be made with cable rated at **400V / 1A RMS or higher.**

2) The Safety signal cables, and Safety relay must be protected from damage inside a covering which is **earth bonded.**

3) The safety signals may be switched using Safety electromechanical relays, contactors, or any other switches operated by a device that detects an operator has breached the safety barrier(s).

Voltech can supply a pre-made cable suitable for integrating the AT with your own system.

Part number 250-030	Safety Interlock Cable
User manual 98-121	Safety Interlock Cable User Manual

6.3. Safety Notices

Operator Safety

It is the user's responsibility to ensure that the AT7600 and all associated safety systems are correctly installed, maintained, and operated in compliance with applicable safety standards and local regulations.

While devices such as light curtains enhance safety, they should be considered part of a broader safety measures or system.

Installation must be carried out by **a Qualified Safety Professional**, who will assess potential risks, train operators, issue appropriate safety instructions, and verify regulatory compliance.

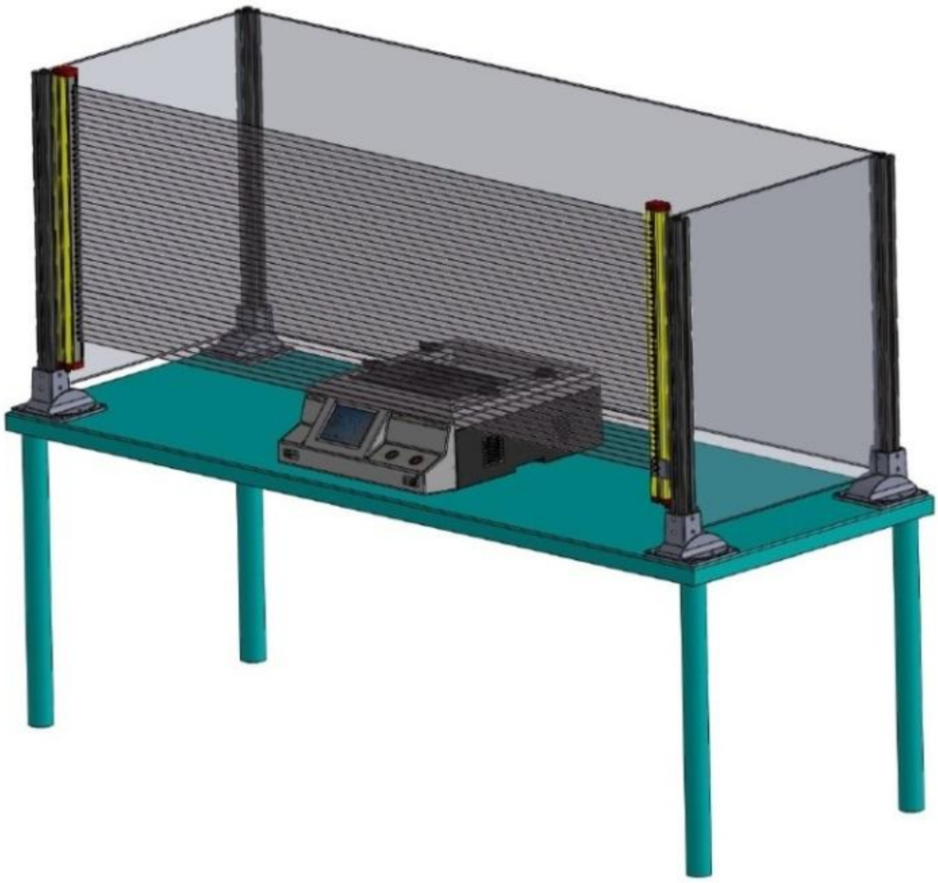
6.4. A Typical Installation of a Safety System

A complete safety system should form a **total enclosure**, preventing access to hazardous voltages on the transformer under test from all sides.

The infrared light curtain only protects the **front-facing side**, where the operator is positioned.

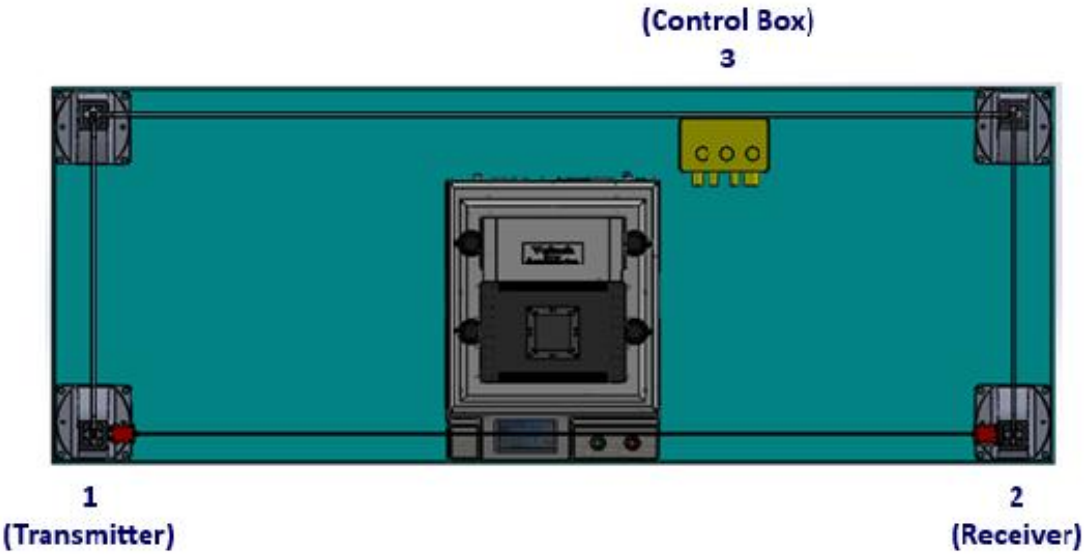
If there is any risk of contact from the **sides, rear, or above**, additional **physical barriers** must be installed to ensure full protection.

A typical installation example is shown below.



The infrared safety system consists of three separate modules:

1. **Transmitter column** – Positioned on the left side, this vertical array emits the light curtain beam.
2. **Receiver column** – Mounted on the right side, it detects any interruption in the beam.
3. **Control box** – Contains the power supply, switching electronics, and the interface to the AT7600.



6.5. The AT7600 Safety System User Interface

This section describes the safety-related operating and warning messages displayed when the AT7600 is used with a safety light curtain.

Refer to the light curtain manufacturer's documentation for its specific setup and operating instructions.

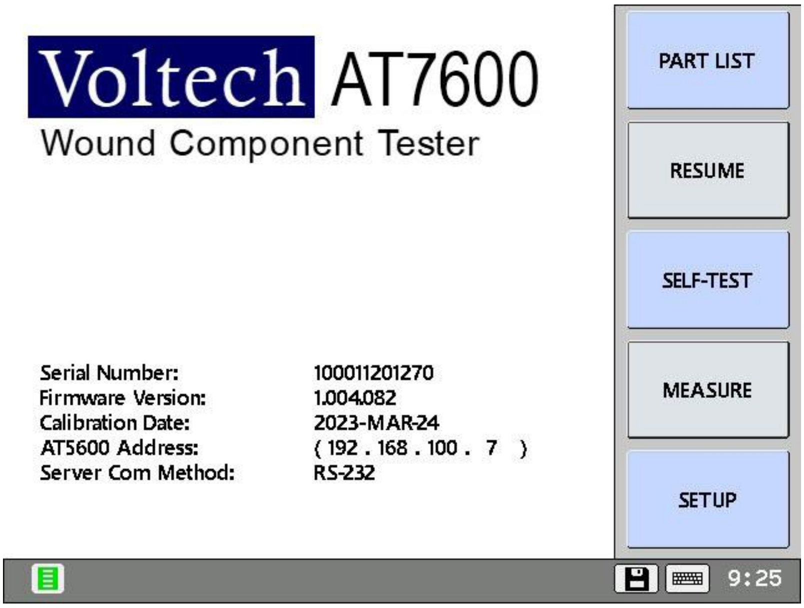
The tester has three distinct points in its operation when it may check the condition of the safety interlock.

Checks are made both before and during:

- Running test during program execution
- Performing the fixture compensation test within a program
- During Self-test

If the light curtain is broken before a measurement begins, the tester will display a red Safety Interlock icon.

If all conditions are **safe**, **a green icon will be shown**, indicating the system is ready for testing.



If the light curtain is beams are **broken** after the measurement has started, then the test will be **stopped**, and the voltage source shut down and the Safety Interlock icon shall change from **Green to Red.**

6.6. Constructing Safe Fixtures

When designing test fixtures, ensure that the external surfaces of the transformer and its connections DO NOT EXTEND beyond the edges of the fixture.

This guarantees a minimum **safe distance of 100 mm** between the transformer and the safety light curtain beam—critical for protecting operators from electric shock.

This distance allows sufficient time for the light curtain to detect intrusion and for the AT7600 to safely shut down all generator signals before an operator’s hand can reach the unit under test or any hazardous area.

6.7. DC1000 DC Bias Current Source

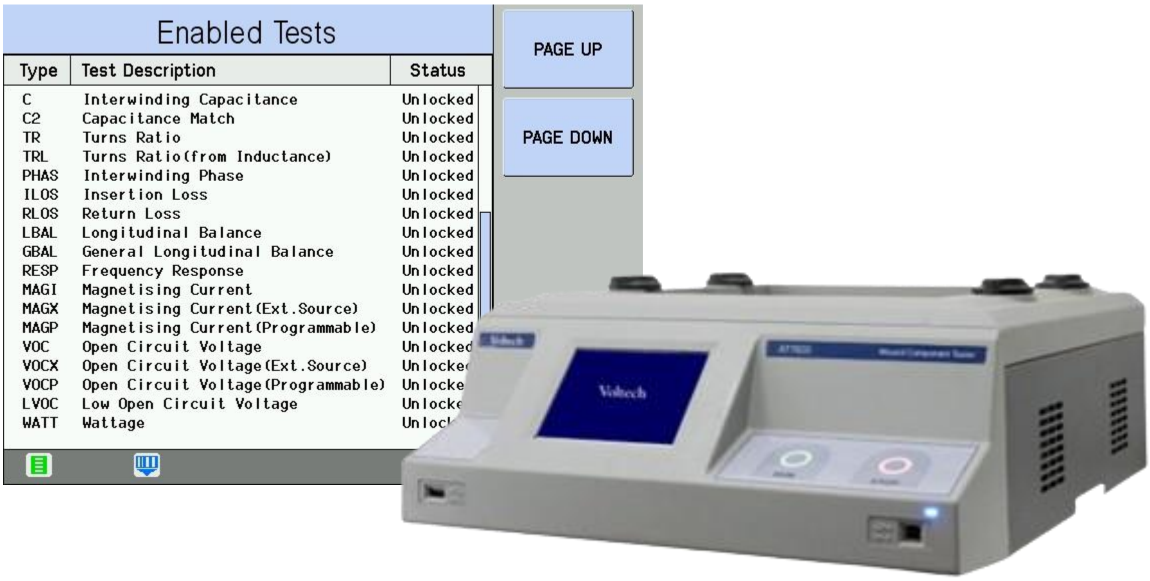
When using the DC1000A with the AT7600, refer to the **DC1000A User Manual** (Document No. 98-102) for all safety requirements.

6.8. AC Interface Fixture

When using the AC Interface Fixture with the AT7600, refer to the **AC Interface Fixture User Manual** (Document No. 98-072) for safety guidance.

Chapter 7: Tests and Test Conditions

This chapter summarizes the electrical tests supported by the AT7600, including standard, high-voltage, and accessory-based options. It also explains how to view available tests, unlock new ones, and access related test features.



7.1 Available Tests

Summarizes the full range of tests supported by the AT7600, including low and high voltage tests, bias testing, and interface-specific options.

7.2 Self-Resonant Frequency

Explains how to measure the frequency at which inductive and capacitive reactance cancel out in a component.

7.3 Explanation of Integration

Outlines how integration settings affect measurement accuracy for certain test types.

7.4 to 7.49 – Test Functions Overview

Provides detailed descriptions of all AT7600 test types used to evaluate electrical and magnetic performance under various voltage, current, and signal conditions.

7.1. Available Tests

The AT7600 supports over 40 electrical test types used for evaluating magnetic and inductive components across a wide range of applications.

To view the tests currently available on your unit, navigate to:

SETUP > UNIT INFORMATION > TEST LIST

Standard AT7600 units include 14 core tests by default.

Additional test types can be evaluated using a free 30-day trial code available upon request from Voltech Support.

For more information on unlocking trial or purchased test options, refer to ***Chapter 2.8 – Customize Tester in the AT Editor dotNET User Manual****, available for download at* ***https://www.voltech.com/support/downloads/***

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7.1.1. Low Voltage Tests

Test	Description	Main Application	Winding Tested	Reason for Test
CTY	Continuity	All transformers		Properly installed fixture
R	DC Resistance	All transformers	All windings	Properly installed fixture. Correct wire used. Integrity of terminations
LS	Inductance (Series circuit)	Most transformers but usually not line frequency transformers	One winding usually the primary	Correct primary turns. Right grade of core material. Core correctly assembled
LP	Inductance (Parallel circuit)	Most transformers but usually not line frequency transformers	One winding usually the primary	Correct primary turns. Right grade of core material. Core correctly assembled
QL	Quality Factor	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
RLS	Equivalent Series Resistance	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
RLP	Equivalent Parallel Resistance	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
D	Dissipation Factor	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
LL	Leakage Inductance	SMPS transformers Communication Transformers Others as applicable	Selected windings	Check windings have been installed in the correct position relative to the core
C	Interwinding Capacitance	High frequency transformers. Isolating transformers		Check winding positioning Check insulation thickness between windings
TR	Turns Ratio and Phasing	Most transformers, but usually not line frequency transformers	All windings	Check windings have corrected turns and phasing
TRL	Turns Ratio by Inductance	As with Turns Ratio but used where there is poor flux linkage between windings.	All windings	Check windings have correct turns and phasing

Test	Description	Main Application	Winding Tested	Reason for Test
LVOC	Low Voltage Open Circuit	All transformers	All other windings	Correct secondary turns. Correct phasing
LSB	Inductance with Bias Current (Series Circuit)	Transformers for use in applications where passing significant (DC) bias current is part of the normal operation	One winding	Correct number of turns. Right grade of core material Core correctly assembled
LPB	Inductance with Bias Current (Parallel Circuit)	Transformers for use in applications where passing significant (DC) bias current is part of the normal operation	One winding	Correct number of turns. Right grade of core material Core correctly assembled
R2	DC Resistance Match	SMPS, audio & telecom	All windings	Checks matching between windings
L2	Inductance Match	SMPS, audio & telecom transformers	All windings	Checks matching between windings
C2	Capacitance Match	SMPS, audio & telecom transformers	All Windings	Checks correct winding position on bobbin
GBAL	General Longitudinal Balance	Audio & telecom transformers	Selected Windings	Checks common mode rejection ratio
LBAL	Longitudinal Balance	Audio & telecom transformers	Selected Windings	Checks common mode rejection ratio
ILOS	Insertion Loss	Audio & telecom transformers	Selected Windings	Checks losses within the transformer
RESP	Frequency Response	Audio & telecom transformers	Selected Windings	Checks losses over a range of frequencies
RLOS	Return Loss	Audio & telecom transformers	Selected Windings	Checks losses returned by a transformer
Z	Impedance	Audio & telecom transformers	Selected Windings	Checks impedance at a given frequency
ZB	Impedance + bias	Audio & telecom transformers	Selected Windings	Checks impedance at a given frequency
ANGL	Impedance Phase Angle	Audio & telecom transformers	Selected Windings	Finds phase shift between Voltage and Current on a winding.
PHAS	Interwinding Phase Test	Audio & telecom transformers	Selected Windings	Measures phase shift between a pair of windings

7.1.2. High Voltage Tests

Test	Description	Main Application	Winding Tested	Reason for Test
HPDC	Hi-Pot (DC)	All transformers especially those used for safety insulation	Between selected windings usually primary to secondary, screens and core	High voltage safety insulation
HPAC	Hi-Pot (AC)	All transformers especially those used for safety insulation	Between selected windings usually primary to secondary, screens and core	High voltage safety insulation
SURG	Surge Stress Test	All transformers, especially those using fine wire	Selected windings	To identify shorted turns
IR	Insulation Resistance	All transformers	Between selected windings	Winding isolation check where safety is not involved
ILK	Leakage Current Test	Medical applications	Between Primary and Secondary Windings	Checks for a common mode current due to capacitance
MAGI	Magnetizing Current	Usually, line frequency transformers	One winding, usually the primary	Correct primary turns. Correct core material properly assembled
VOC	Open Circuit Voltage	Usually, line frequency transformers	All other windings	Correct secondary turns. Correct phasing
WATT	Wattage	50/60Hz Iron core transformers	One winding	Correct core material. Properly assembled
PWRF	Power Factor	Usually, line frequency transformers or Current Transformers	One winding, usually the primary	Power losses over whole transformer.
STRW	Stress Wattage	Line frequency & High Frequency Transformers	One Winding (Usually the primary)	Checks inter-turn insulation, magnetic material, and joints

7.1.3. AT7600 + DC1000A Tests

Test	Description	Main Application	Winding Tested	Reason for Test
LSBX	Inductance with External Bias (Series Circuit)	Wound components that usually carry a significant DC Bias current in normal operation.	Selected Windings	Checks number of turns, right grade of correctly assembled core material, where bias current is greater than LSB test can manage.
LPBX	Inductance with External Bias (Parallel Circuit)	Wound components that usually carry a significant DC Bias current in normal operation.	Select Windings	Checks number of turns, right grade of correctly assembled core material, where bias current is greater than LPB test can manage.
ZBX	Impedance with External Bias	Audio & Telecom	Selected Windings	Checks impedance at a given frequency, while applying a greater bias current than is possible with ZB test.

NOTE:

Tests that involve bias current require one or more **Voltech DC1000A Precision DC Bias Current Sources**.

Contact the Voltech for application support or ordering information.

7.1.4. AC Interface Tests

Test	Description	Main Application	Winding Tested	Reason for Test
MAGX	MAGI (External Source)	Usually, line frequency transformers	One winding, usually the primary	Correct primary turns. Correct core material properly assembled
VOCX	VOCX (External Source)	Usually, line frequency transformers	All other windings	Correct secondary turns. Correct phasing
WATX	WATT (External Source)	50/60Hz Iron core transformers	One winding	Correct core material. Properly assembled
STRX	STRW (External Source)	Line frequency & High Frequency Transformers	One Winding (Usually the primary)	Checks integrity of inter-turn insulation, the magnetic material, and joints

NOTE:

These tests require the use of **the Voltech AC Interface Fixture**.

Contact the Voltech for application support or ordering information.

7.1.5. Other Functionality Options

Test	Description	Main Application	Winding Tested	Reason for Test
OUT	Output to User Port	Switching relays using the 6-way USER OUT port.	n/a	Allows the AT to perform external switching as part of the test program.
WAIT	Wait test	Introduce fixed duration or indefinite pause in program.	n/a	Allows time for core demagnetization or for user to manually fit load resistors or change wiring etc.

7.2. Self-Resonant Frequency

Practical inductive components are not perfect inductors; they have **stray resistances and capacitances** associated with them.

For certain components, especially those with a low inductance value, the impedance of the stray capacitance can become significant when compared to that of the inductance.

$$\boldsymbol{X_L} = 2\pi f L \ (Inductive\ Impedance)$$

$$\boldsymbol{X_C} = \frac{1}{2\pi f C} \ (Capacitive\ Impedance)$$

At a sufficiently high frequency, the capacitive impedance can dominate, making a measurement of the inductance impossible.

Under these circumstances, any measurement instrument may report **negative inductance values** and measurement errors.

Should these symptoms be observed, reduce the test frequency to avoid problems.

The frequency at which the inductive impedance equals the capacitive impedance (XL = XC) is known as the **self-resonant frequency (SRF)** of the component.

At this point, the phase angle of the impedance (which can be measured using the ANGL test) is zero.

At test conditions where the frequency is low enough for problems with capacitive impedance to be negligible, the phase angle will be positive and close to 90 degrees.

Therefore, an **ANGL** test can be used during program development to confirm if measurement problems are due to the chosen test frequency approaching the SRF of the part under test.

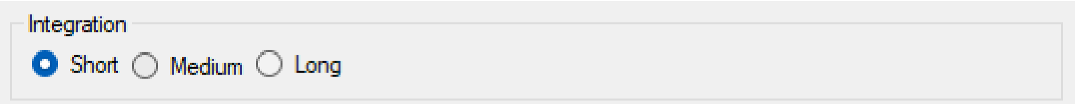
If the angle is significantly less than 90 degrees, consider reducing the test frequency.

Note that stray fixture capacitance will add to the capacitance of the component and reduce the SRF.

Performing **compensation will remove the effect of stray fixture capacitance** on the measurement of capacitance **but cannot remove its effect on SRF**.

7.3. Explanation of Integration

During test execution, the AT7600 uses integration to improve measurement stability and accuracy. Three integration types are available—**Short**, **Medium**, and **Long**—which are selected during test program creation using the AT Editor software.



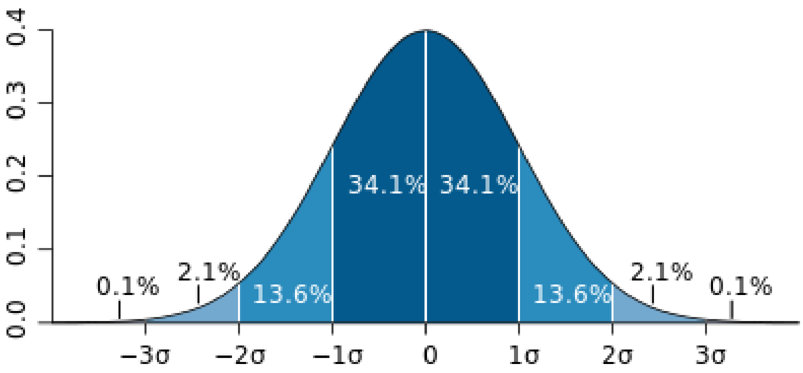
Each measurement result from the AT7600 is derived by averaging a sequence of consecutive sub-measurements.

For example, a resistance test using the 10 sub-measurements shown below would yield a calculated mean value of **10.0 Ω:**

10.20	**9.90**	**9.90**	**9.93**	**9.80**	**9.85**	**10.10**	**9.98**	**10.10**	**9.91**

The AT7600 determines the number of sub-measurements required to produce a result using **statistical analysis** to balance speed and accuracy.

The variation in the values of sub-measurements follows what is termed a "**normal distribution**" in statistical analysis:



A plot of a normal distribution (or bell-shaped curve) where each band has a width of one standard deviation.

As each sample is collected the AT7600 computes the **standard error of the mean**.

$$\mathrm{SE}_{\bar{x}} = \frac{s}{\sqrt{n}}$$

Where:

s is the sample standard deviation (an estimate of the population's standard deviation), and

n is the number of sub-measurements taken.

This is used to calculate the **relative standard error**, which is the standard error divided by the mean and expressed as a percentage.

The greater the number of sub-measurements (n), the lower the resulting relative standard error — improving measurement stability. However, this also increases the time required to complete the test.

The AT7600 offers three integration levels: **Short, Medium, and Long**, allowing the user to balance speed and accuracy.

The following table illustrates the typical relative standard error associated with each integration level:

Integration Level	Relative standard error
Short	1%
Medium	0.3%
Long	0.03%

As a guide to which integration level to set, consider the tolerance that is being set for each measurement.

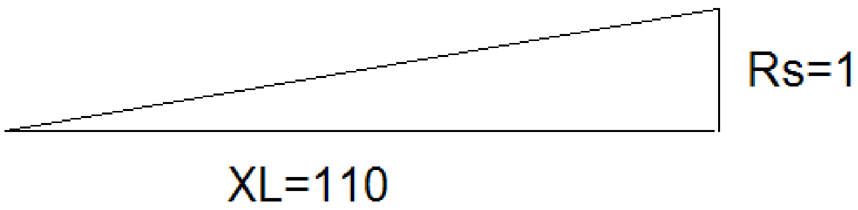
For example, consider the R test for a winding of 11.3 ohms nominal, which has an expected value of 10.8 ohms, and the upper limit of the test set to **12 ohms.**

The uncertainty that the measurement must be made to must be less than

100 * (12 - 11.3) / 11.3 = 6.2%.

For margin, the integration level should be chosen for a relative standard error of no more than half of the uncertainty-in this **case short integration** should be chosen as its relative standard error is much less than half of the uncertainty required.

On the other hand, consider measurement of the Q factor of an inductor with an actual Q of 110: -



The value of Rs represents 1 / 110 = 0.909% of the impedance of the inductor.

If the minimum Q that is acceptable is 100, then Rs must be measured to better than 100* (110 - 100) / 100 = 10% of its nominal value.

The uncertainty of the measurement must be **less than 0.909% * 10% = 0.0909%.**

In this case, **long integration** should be chosen.

For production testing, test limits are usually sufficiently wide to allow **short** (and occasionally medium) integration to be chosen, and this will result in the **shortest possible test times.**

7.4. CTY – Continuity Test

The CTY Test, or Continuity Test, is a simple check to determine whether a circuit is **open** or **closed**. It verifies whether a complete path exists for current to flow, ensuring the circuit is closed and **free of interruptions or breaks**.

On the AT7600, the CTY Test is typically used as the first step in a test program to confirm that the transformer is properly inserted into the test fixture.

The test checks that each winding has a resistance below a user-defined threshold, with the same limit applied across all windings.

This test offers a faster alternative to performing individual resistance (R) tests on each winding.

However, while the **CTY Test provides speed and simplicity**, R tests allow for individual limits per winding, which can help detect manufacturing issues such as the use of incorrect wire gauges.

If speed is a priority, the CTY Test may be preferred over performing separate resistance measurements on each winding.

Specifying the Test Limit

When configuring the test limit, it is important to remember that the same limit will be applied to all windings.

Therefore, you should set a limit **higher than the resistance of the largest winding**.

For most transformers, where winding resistances are typically below 1kΩ, a test limit of 10kΩ is recommended for faster execution.

For more information on programming the test, refer to the ***AT dotNET Editor Manual (Document 98-125, Chapter 2.5).***

For details on test accuracy specifications, see ***Chapter 10.2. Accuracy Specifications – Available Tests***

7.5. R - Winding Resistance

Winding resistance measurement is typically the first test performed on a transformer.

It verifies that the **correct wire diameter** has been used and that the wire has not been **over-tensioned** during the winding process**.**

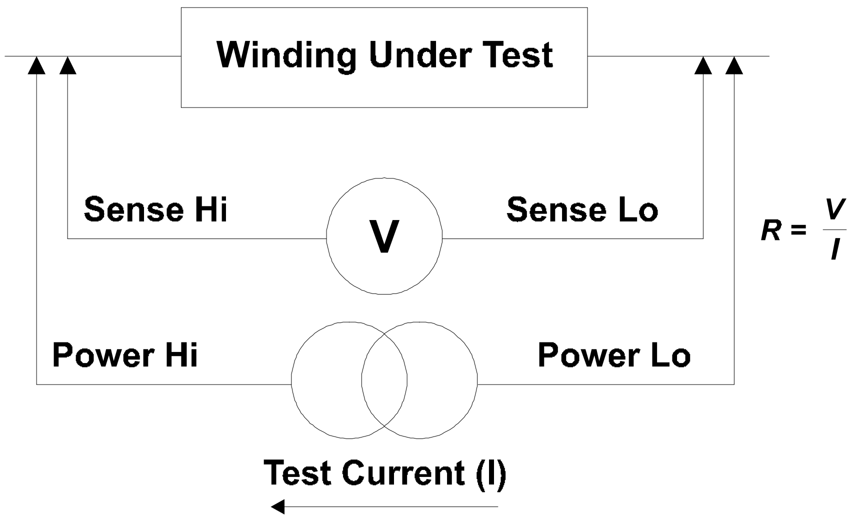
This test also **confirms proper electrical contact** between the test fixture and the transformer—particularly important when Kelvin connections are required.

Kelvin connections eliminate the influence of lead and contact resistance, ensuring highly accurate measurements.

The R Test can be combined with the **STOP ON FAIL** option in the AT7600's dotNET Editor. This allows the test sequence to stop immediately if the transformer fails the initial resistance check, saving time in production by skipping subsequent tests.

To measure winding resistance, the AT7600 applies a constant DC current to the selected winding.

It then measures both the **current** flowing through and the **voltage** across the winding, calculating resistance using **Ohm's Law** (Resistance = Voltage ÷ Current).



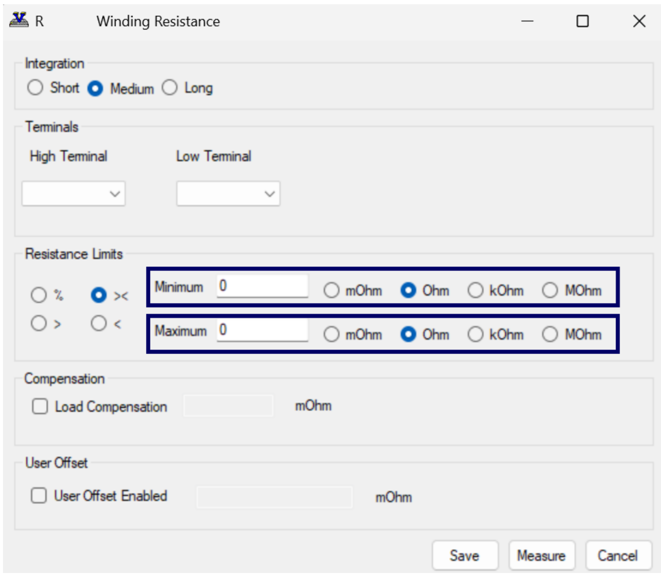
For more information on Kelvin connections, refer to ***Chapter 13.4 – Making Fixture Connections: Kelvin Connections.***

For details on the STOP ON FAIL option, refer to *AT* ***Editor User Manual, Chapter 2.4.1.8 – Stop on Fail.***

Specifying the Test Limits

Maximum Value – Set this limit as tightly as possible to ensure the correct wire gauge has been used in the winding. A higher-than-expected resistance may indicate thinner wire or manufacturing defects.

Minimum Value – This is generally less critical. Set it low enough to ensure that no short circuits are present, such as those caused by solder splashes or bridging between pins.



Test Current

The test signal is set according to the value specified as maximum in the test limits: -

MAXIMUM RESISTANCE	<1Ω	1Ω-10kΩ	10kΩ-50kΩ	>50kΩ
TEST CURRENT	I=1	I=1/R	V=R*100u	V=5

Where:

V = Voltage (V)

I = Current (A)

R = Resistance (Ω)

7.6. RLS or RLP - Equivalent Series or Parallel Resistance

The Equivalent Series Resistance (RLS) and Equivalent Parallel Resistance (RLP) tests measure both the **winding resistance and core-related losses**—such as those caused by eddy currents and hysteresis effects. These losses are not captured by a standard DC Resistance (R) test, which measures only the winding resistance.

By using RLS or RLP, it's possible to identify issues like poor-quality core materials, faulty laminations, or other magnetic inefficiencies.

These tests are often used as alternatives to the **Q factor** test and typically follow the inductance test in a standard test sequence.

Like Q factor measurements, RLS and RLP are especially useful for testing **signal, pulse, and switched-mode power transformers**, where the operating conditions involve small excursions on the B-H curve—staying within its linear region.

Additionally, equivalent resistance tests can help detect subtle winding defects, such as weak or shorted turns in the transformer

Measurement Conditions

When measuring equivalent series (RLS) or parallel resistance (RLP), the tester **applies an AC voltage to the selected winding**, like inductance (LS / LP) and Q factor measurements.

Using **harmonic analysis**, the tester measures both the voltage across and the current through the winding. It then calculates the **impedance**, from which the equivalent series or parallel resistance is calculated.

If an RLS or RLP test follows an **LS** (series inductance) or **LP** (parallel inductance) test using the **same test conditions** (voltage and frequency) on the **same winding**, the tester can **reuse results from** the previous **inductance** test. This optimization helps reduce overall **program execution time**.

The test signal supports a **frequency range** from **20 Hz to 3 MHz** and an **amplitude** from **1 mV to 5 V**.

When following an inductance test, it is typical to use **identical test conditions** for consistency and efficiency.

However, if no preceding inductance test is present, you should **select the test conditions** based on the winding's inductance value—as outlined in ***Chapter 7.7 LS or LP - Inductance (Series or Parallel Circuit)***

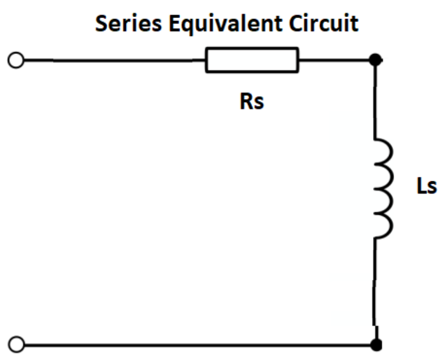
For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.5).***

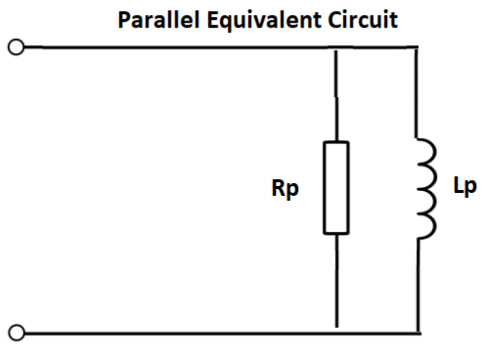
For information on test accuracy specifications, refer to ***Chapter 10.2.2. LS, LP, RLS, RLP, LL and C Tests***

7.7. LS or LP - Inductance (Series or Parallel Circuit)

The AT600 provides two primary methods to verify that a transformer has been assembled correctly: ensuring the proper number of primary and secondary turns, using the correct magnetic core material, and setting the appropriate air gap if required.

Any real inductor can be represented as either an equivalent series RL circuit or a parallel RL circuit.





In an Ideal inductor Rs=0, Rp=infinity, hence LS=LP,

However, in real inductors, the inductance values for series and parallel circuits may differ, which should be considered when specifying test limits.

Inductance is always measured as part of the complex impedance and is expressed in terms of a series or parallel equivalent circuit, depending on whether you choose the LS or LP test.

For signal, pulse, and switched-mode power transformers, where small excursions of the B-H curve are typical (remaining within the linear regions), a primary inductance measurement along with a Turns Ratio test is recommended.

For line frequency transformers, which operate across the full B-H curve, including non-linear regions, the preferred approach is to conduct a magnetizing current test on the primary winding, followed by an open-circuit voltage test on the remaining windings.

Measurement Conditions

To measure inductance, the tester applies an AC voltage across the selected winding; it then measures the voltage across and the current through the winding using harmonic analysis. The measured voltage is divided by the current to obtain the complex impedance and the inductance is calculated.

The test signal can have a frequency in the range 20Hz to 3MHz, and amplitude from 1mV to 5V.

It is not necessary to measure the inductance at the normal operating conditions of the transformer, which could involve, for example, voltage levels of hundreds of volts. This is because the B-H curve can normally be assumed to be linear in the operating region, and the inductance measured at a low level represents the inductance that will appear in use.

Also, it can usually be assumed that the inductance value does not vary significantly with frequency. Therefore, although high frequencies are available with the tester, measurement frequencies above a few hundred kilohertz should be used with caution. This is because the errors caused by the stray inductance and capacitance of your fixture may become much more significant at these frequencies. Compensation can be used to eliminate these errors.

The following table suggests suitable test conditions for different values of expected primary inductance:

INDUCTANCE RANGE			PREFFERED TEST SIGNAL	
			FREQUENCY	VOLTAGE
100nH	→	300nH	3 MHz	50 mV
300nH	→	1uH	1 MHz	150 mV
1uH	→	3uH	1 MHz	250 mV
3uH	→	10uH	300 KHz	500 mV
10uH	→	30uH	100 KHz	500 mV
30uH	→	100uH	30 KHz	500 mV
100uH	→	300uH	10 KHz	500 mV
300uH	→	1mH	3 KHz	500 mV
1mH	→	3mH	1 KHz	500 mV
3mH	→	10mH	300 Hz	500 mV
10mH	→	30mH	100 Hz	500 mV
30mH	→	100mH	50 Hz	1 V
100mH	→	300mH	50 Hz	3 V
300mH	→	1H	50 Hz	3 V
1H	→	3H	20 Hz	3 V
3H	→		20 Hz	5 V

The Test Conditions for Inductance Measurements

Wherever possible, this table should be used for all inductance tests. The inductance range should be chosen based on minimum value of inductance expected. When choosing the test conditions, the following potential problems should be considered:

Voltage / Current levels

The upper voltage limits should be chosen to give a maximum current level of about 50mA RMS. for the lowest inductance expected.

In some cases, this current may cause core saturation, and a lower voltage should be used.

The minimum voltage level must be chosen so that the test current does not become so low that it cannot be sensibly measured.

The lower voltage limits in the table above always give test currents higher than 3μA RMS.

As with any measurement, the best results will be achieved with the largest signals used, so experiment when designing the program to get the largest V or A signal without getting a 0020-status error code.

This is true for any of the “LCR tests” that use the low power generator (e.g., LS, LP, RLS, RLP, Z, Q, etc)

Self-Resonant Frequency

At lower frequencies, the capacitance of the windings can normally be ignored because its impedance is much higher than that of the inductance. However, at extremely high frequencies, this is not so, the capacitance dominates, and inductance cannot be measured. The self-resonant frequency of the transformer is the change-over point between these two regions.

Normally to get a good measurement of inductance, the test frequency should be less than 20% of the resonant frequency of the transformer.

In general, high values of inductance will have a high inter-turn capacitance and hence a low resonant frequency. Where there is a choice of test frequencies always use the lower value, to minimize any problems due to self-resonance.

Non-linear Inductance

Normally inductance measurements should be used for transformers where the B-H characteristics are linear.

However, if inductance measurements are attempted for instance with line frequency transformers where the core material is non-linear even at low signal levels, the measured results can be highly dependent on the applied test signal.

This can be a problem when trying to compare measurements made on commercially available impedance bridges, or component testers, with measurements made using the AT7600.

The test signal in such bridges is usually determined within the instrument and is often at a fixed frequency and at a voltage level which is not guaranteed to be constant for all value of inductance.

Usually, if the actual test conditions of the bridge can be determined, and the tester is then programmed to deliver the same test conditions across the inductance the results will then agree. (See also the comments below on differences caused by the choice of equivalent circuit).

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.6).***

For information on test accuracy specifications, refer to ***Chapter 10.2.2. LS, LP, RLS, RLP, LL and C Tests***

7.8. LSB or LPB-Inductance with Bias Current (Series or Parallel Circuit)

With the LSB and LPB tests, the AT7600 offers two further ways to confirm that the transformer has been assembled properly, with the appropriate number of turns, the right grade of magnetic material for the core, and the correct air gap if required.

These tests would normally be used for transformers designed to be used in applications where a large DC current is flowing through one or more of the windings.

Measurement Conditions

To measure inductance with bias, the tester firstly applies the programmed bias current to the winding under test. When this has stabilized, it then applies an AC voltage across the selected winding and measures the voltage across and the current through the winding using harmonic analysis. The measured voltage is divided by the harmonic current to obtain the complex impedance and the inductance is calculated.

The bias current can be programmed in the range 10mA to 1000mA. The (AC) test signal can have a frequency between 20Hz and 3MHz, and amplitude from 1mV to 5V.

Usually, the signal frequency and voltage are chosen so that, with the expected inductance, the resulting signal current is less than 20% of the bias current.

Recommended test signals would be the same as given in Section 7.7, for the normal inductance test. However, if the recommended levels correspond to too high a signal current, then use a corresponding smaller test voltage.

It is not normally recommended that the test frequency be increased to reduce the signal current, as this may lead to other problems, such as those caused by parasitic inductance and capacitance of the test fixture, and the self-resonant frequency of the transformer itself.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.7).***

For information on test accuracy specifications, refer to ***Chapter 10.2.14 LSB and LPB Tests.***

7.9. QL - Quality Factor

The Q (Quality) factor measurement typically follows the inductance test of the primary winding in a test program. Since the Q factor is proportional to L/R, inductors with low resistance will exhibit a high Q, indicative of an “ideal” inductor.

Q is mathematically defined as the ratio of reactive inductance to AC resistance:

$$(2 \times \pi \times f \times L / RLS).$$

Like inductance tests, the Q factor test is used for signal, pulse, and switched-mode power transformers, where the operational conditions keep the magnetic core within the linear regions of the B-H curve.

In pulse transformers, for instance, Q factor testing is essential for handling high-frequency components of square waves, making it important to assess Q across various frequencies.

Additionally, a Q factor test can help identify shorted turns in a transformer. A shorted turn would increase the current, leading to higher power losses (I^2R), which reduces the transformer’s performance and lowers its Q factor.

For pulse or signal transformers, traditional high-voltage surge tests may be unsuitable, as these components are not designed for such high voltages. In such cases, a Q factor test serves as a better alternative.

Measurement Conditions

To measure the Q factor, the tester follows the same procedure used for measuring inductance. The key difference lies in the final calculation: the voltage is divided by the current to determine the complex impedance, from which the Q factor is derived.

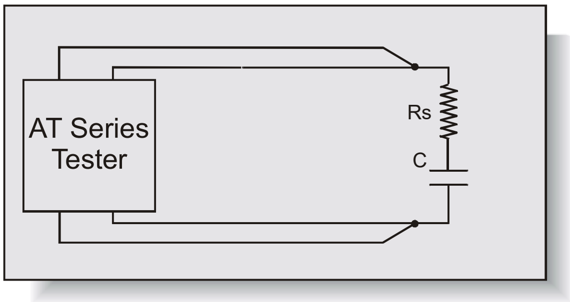
The test signal’s frequency can range from 20 Hz to 3 MHz, with an amplitude between 1 mV and 5 V. Typically, if the QL test follows an inductance test, you should use the same test conditions. However, if no inductance test is performed, select test conditions as outlined in Section 7.7 based on the inductance value of the winding.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.).***

For information on test accuracy specifications, refer to ***Chapter 10.2.3. QL and D Tests.***

7.10. D – Dissipation Factor

Measurement Range	Test Voltage	Test Frequency	Basic Accuracy
0.001 to 1000	1mV to 5v	20Hz to 3MHz	0.50%



The parameter 'D' is most often used as a measurement of the losses in a capacitor. It is analogous to Q for a transformer winding.

For this equivalent circuit, the Dissipation Factor D is defined as:

$$D = \frac{Rs}{Xs} = \frac{Rs}{1/\omega Cs} \quad (\text{where } \omega = 2\pi f)$$

For a given capacitance, the lower the equivalent series resistance, the lower is the value of the dissipation factor or $\tan\delta$, i.e., the 'better' the capacitor.

Dissipation factor is also just the inverse of Q (see above), for both capacitors and inductors, but it is common to talk of Q for inductors and D for capacitors.

The dissipation factor test would normally be used for capacitors of all types. A D factor test will help to determine that the capacitor has been manufactured correctly.

Measurement Conditions

To measure Dissipation Factor, the tester applies an AC voltage across the selected winding and measures the voltage across and the current through the winding. Using harmonic analysis, the measured voltage is divided by the current to obtain a complex impedance from which the Dissipation Factor is obtained.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.9).***

For information on test accuracy specifications, refer to ***Chapter 10.2.3. QL and D Tests.***

7.11. LL - Leakage Inductance

Leakage inductance in a transformer refers to the inductive element caused by incomplete magnetic coupling between the primary and secondary windings.

In an ideal transformer, energy would be perfectly transferred between the windings through magnetic linkage. However, leakage inductance can lead to voltage fluctuations under varying load conditions, which is generally seen as undesirable.

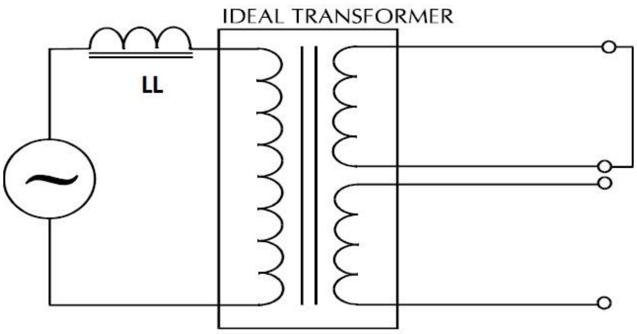
Despite this, leakage inductance can be advantageous in certain cases, as it helps to limit current flow in the transformer and the load without significantly dissipating power, aside from the inherent losses in a non-ideal transformer.

Leakage inductance plays a key role in various applications. For instance, in flyback converter designs for high-frequency switched-mode power supplies, maintaining leakage inductance below a specified threshold is essential for proper functionality.

Typically, leakage inductance (LL) is modeled as an additional inductor on the primary winding that doesn't contribute to power transfer to the secondary, thus acting as a source of loss—hence the term "leakage inductance."

While designers often aim to minimize LL, there are situations where it's deliberately incorporated, such as in microwave power supplies.

In both cases, accurately measuring and controlling LL is vital for ensuring optimal performance.



Measurement Conditions

Leakage inductance is measured by determining the inductance of the 'primary' winding while one or more 'secondary' windings are short-circuited.

During the measurement, the tester automatically compensates for the impedance of the wiring, connections, and relays in the shorting path to ensure accuracy.

After the test, the inductance value is calculated from the measured winding impedance using a series equivalent circuit.

Leakage inductance can be tested using a current range between 20 µA and 100 mA, with a frequency range of 20 Hz to 3 MHz.

The appropriate test current and frequency can be selected based on the expected leakage inductance value, as indicated in the following table.

LEAKAGE INDUCTANCE RANGE			PREFERRED TEST SIGNAL FREQUENCY	PREFERRED TEST SIGNAL CURRENT
100 nH	→	1 uH	300 kHz	50 mA
1 uH	→	10 uH	100 kHz	20 mA
10 uH	→	100 uH	30 kHz	10 mA
100 uH	→	1 mH	10 kHz	5 mA
1 mH	→	10 mH	1 kHz	5 mA
10 mH	→	100 mH	100 Hz	5 mA
100 mH	→	1 H	100 Hz	1 mA
1 H		10 H	50 Hz	500 µA

The Test Conditions for Leakage Inductance Measurement

NOTE: Since leakage inductance is measured with a secondary winding shorted out, be careful to choose a test signal that will not cause excessive currents to flow. This is particularly significant in transformers where the turns ratio is extremely high, and the shorted winding has only a few turns.

If, for example, the primary winding has 300 turns, and the secondary 3 turns, a test current of 10mA flowing through the leakage inductance on the primary side will give rise to a current of 1 Amp flowing in the shorted secondary winding.

To protect transformer windings, the test current when measuring leakage inductance is limited in the table to 50mA maximum.

In addition, the problem of self-resonant frequency listed under the primary inductance test also applies when measuring leakage inductance, so always use the lower of the available band of frequencies.

User Offset

This is used to offset the result returned by the AT by a user defined amount.

i.e., **Result returned = Measured result + User offset**

Normally a user offset would not be required. However, for small values of leakage inductance (<1μH) when there are many additional low terminals, it is not always possible during fixture compensation for the tester to remove all the parasitic errors of the test fixture. In this case, the user offset may be required to fully remove the errors and normalise the result to an LCR reading measured using a perfect short, which is not practical in production testing.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.10).***

For information on test accuracy specifications, refer to ***Chapter 10.2.2. LS, LP, RLS, RLP, LL and C Tests***

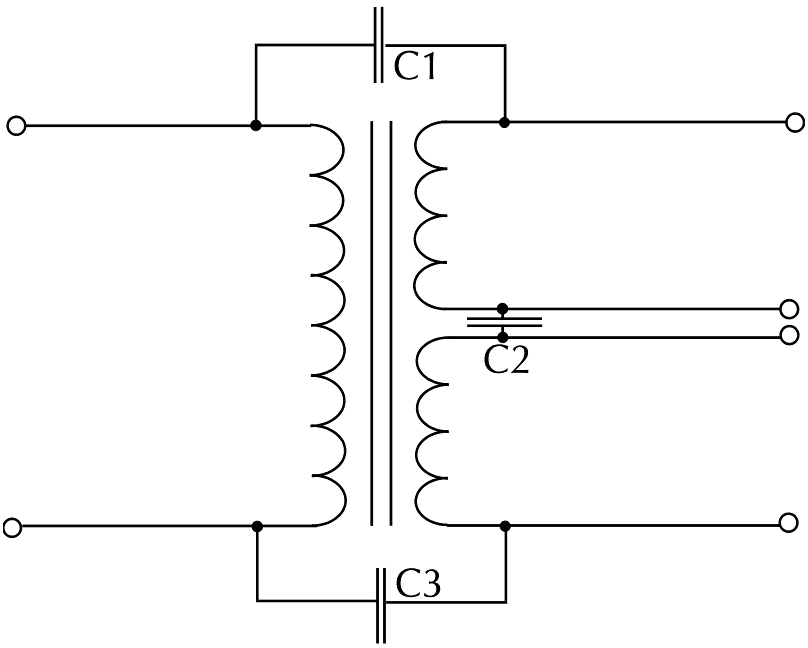
7.12. C - Interwinding Capacitance

Interwinding capacitance in a transformer refers to the capacitance that forms between the windings.

This occurs due to the proximity of the windings and the insulation between them, which serves as the dielectric.

Generally, the capacitance is distributed between the layers within a winding and between the outer layer of one winding and the inner layer of the adjacent winding.

Although this capacitance is spread across the entire winding, it is often represented in a simplified circuit as a single capacitance between two windings.



Interwinding capacitance is particularly significant in transformers used in audio, medical, and instrumentation applications, where isolation between the primary and secondary windings is critical.

It also plays a crucial role in switch-mode transformers, where excessive capacitance can result in noise at the switching frequency being coupled into sensitive circuits connected to the secondary winding.

For applications where the balance of winding capacitances is more important than individual capacitance values, such as in cases requiring matched capacitance across multiple windings, refer to the C2 test.

Measurement Conditions

To measure capacitance, the tester applies an AC voltage between the windings to be tested, usually with all taps on each winding shorted together. It then measures the voltage between the windings, and the resulting current using harmonic analysis. Dividing the voltage by the current gives the inter-winding impedance, from which the capacitance may be calculated.

The test voltage can be in the range of 1mV to 5V at a frequency of 20Hz to 3MHz.

The table below gives the recommended test conditions for different values of capacitance:

CAPACITANCE RANGE			PREFERRED TEST SIGNAL	
			FREQUENCY	VOLTAGE
1 pF	→	10 pF	100 KHz	5 V
10 pF	→	100 pF	100 KHz	5 V
100 pF	→	1 nF	10 KHz	5 V
1 nF	→	10 nF	1 KHz	5 V
10 nF	→	100 nF	100 Hz	5 V

The Test Conditions for Capacitance Measurement

When choosing the test conditions, the following potential problems should be considered:

Current levels

For larger capacitance, particularly at higher frequencies, the current flowing during the measurement can be extremely high, and similarly the measured current could also be exceedingly small for small capacitance at lower frequencies and voltages.

Where possible, you should use the recommended test signal levels in the table above to ensure that the currents which flow can be measured accurately.

Non-linear Capacitance

Normally non-linearity in the stray capacitance of transformers is not a problem, and therefore capacitance is measured with as large a voltage as possible.

Equivalent Circuit

As with inductance, capacitance is measured as a complex impedance, and therefore the result can be expressed in terms of either a series or a parallel equivalent circuit.

It was explained in section 7.7 of this chapter that parallel, and series equivalent inductance do not necessarily have the same values.

The same is true for capacitance; parallel and series equivalents can also be different.

The AT testers always use a parallel equivalent circuit for capacitance measurements.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.11).***

For information on test accuracy specifications, refer to ***Chapter 10.2.2. LS, LP, RLS, RLP, LL and C Tests***

7.13. TR - Turns Ratio

The AT7600 provides two primary methods to verify that a transformer has been assembled with the correct number of primary and secondary turns: the Turns Ratio (TR) test or the Open-Circuit Voltage (VOC) test.

For signal, pulse, and switched-mode power transformers, where the B-H curve remains within its linear regions, the turns ratio (TR) test is preferred. The result of this test is the ratio of voltages measured across specified nodes, and the energized winding can be either the primary or secondary, depending on preference.

For line-frequency transformers, which operate across the full B-H curve (including non-linear regions), the VOC test is the preferred method to verify that the correct number of turns are present in each winding.

It is important to note that a turns ratio test can only measure the ratio of turns between windings and does not directly confirm the absolute number of turns. To ensure the absolute turn count is correct, it is advisable to include an inductance test in the testing program.

Measurement Conditions

During a turns ratio test, a voltage is applied to the energized winding, while the voltages across two other windings are measured using harmonic analysis.

The turns ratio is determined by dividing one measured voltage by the other, with adjustments made to account for winding resistance.

Typically, the winding with the highest number of turns should be energized.

However, in cases where a precise 1:1 ratio between two windings is required, it may be better to energize a third winding with fewer turns to ensure equal measurement errors across the windings under test.

The test signal can be adjusted to have a frequency between 20Hz and 3MHz, with an amplitude range of 1mV to 5V.

Recommended test conditions based on the inductance of the energized winding are outlined in Section 7.7 LS.

Best performance assumes that the energized winding is the one with the highest number of turns.

V Applied and V measured

The signal is usually applied to the primary winding, or the winding which has the largest number of turns. However, if by doing this, the expected voltage on the winding with the smallest number of turns falls below 1mV, then the test voltage should be increased.

Best repeatable measurements will be obtained ONLY if the V Energized, V applied, and V measured are ALL > 1mV.

This may also require an increase in the test frequency so that the current taken by the driven winding does not become too large, but in general this frequency increase should be kept as small as possible to avoid problems caused by stray capacitance at high frequencies

Where Matching in Groups is Important

In some transformer designs, the turns ratio between a primary winding and a secondary winding is not as important as the ratio between different primaries or different secondaries.

To make the most accurate measurements in such cases apply the test signal to the primary winding and measure the turns-ratio from primary to one of the secondaries.

Then, leaving the primary energized as above, measure the turns ratio between the secondaries.

Next, energize a secondary winding (possibly at a different voltage and / or frequency depending on its inductance) and measure the turns ratio between the various primaries.

In this way windings, which should be matched are treated equally during the test.

7.13.1. Best Practice for Centre Taps / Auto transformers

(Also Applies to tests TR, TRL, LVOC, VOC, VOCX)

When testing TR (or similar) on windings where the energized/primary are on the same coil as the secondary, it is important to minimize the effect of common mode signals to get the best measurement.

This can be achieved by programming the energized nodes so that the secondary winding is always at the LO end of the primary.

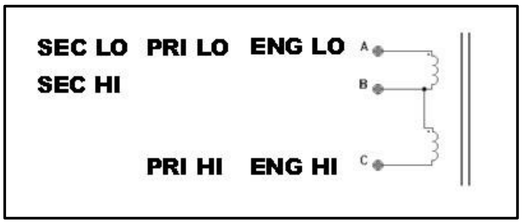
As the AT EDITOR allows you to choose any node it is best to consider this when programming the test.

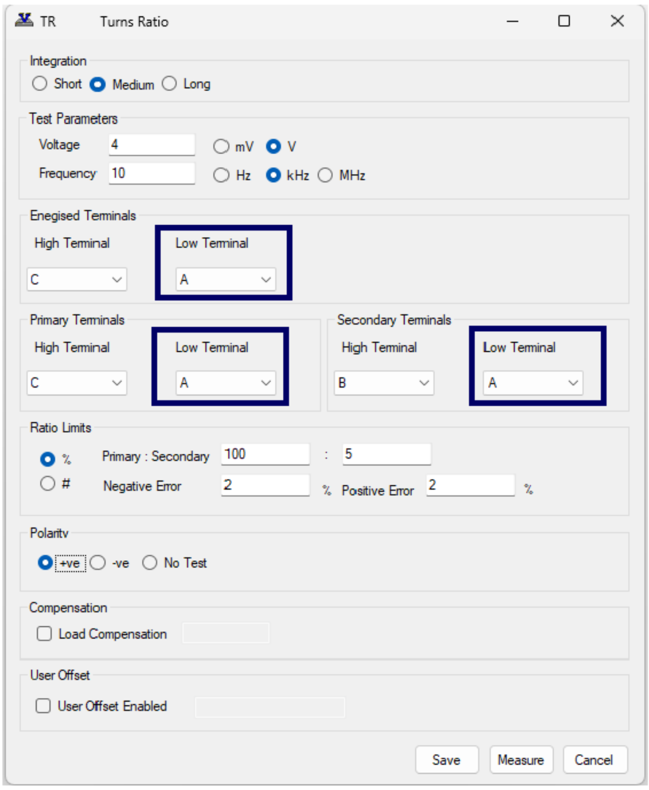
Please consider the following two examples which illustrate this point.

A. Best Practice set up – USE this configuration.

All the LO terminals are defined as "A"

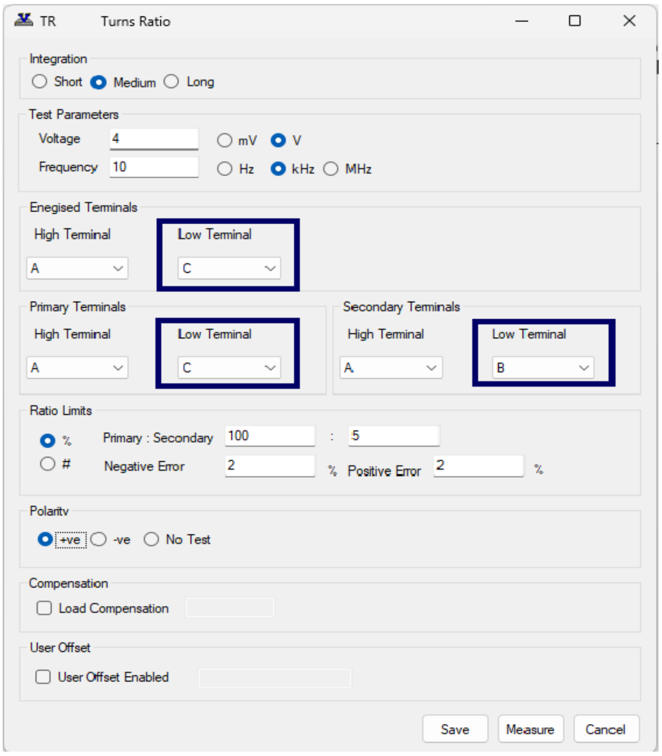
The secondary is at the LO end of A-C ; SEC LO is at 0 V





B. NON-OPTIMAL set up – AVOID this configuration.

The secondary is at the HI end of A-C; hence SEC LO is not at 0V, potentially causing a common mode effect.



Specifying the Test Limits

When specifying turns ratio tests, it is preferable to avoid limits which are unnecessarily tight, and which may therefore lead to measurement difficulties.

For example, if two equal secondary windings should have 10 turns each, the ratio should be 1:1. One turn in error would produce a ratio error of 10% or -10% (i.e., 11:10 or 10:11), and therefore limits of +5% and -5% would be suitable to detect the error.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.12).***

For information on test accuracy specifications, refer to ***Chapter 10.2.4. TR Test***

7.14. TRL - Turns Ratio by Inductance

Turns Ratio test verifies the correct ratio between primary and secondary turns, ensuring the proper operation of the transformer.

It helps detect issues such as tap-changer malfunctions, incorrect winding configurations, and open winding connections.

The AT7600 offers two ways to verify that the transformer has the correct number of primary and secondary turns.

Turns ratio by Voltage (TR) - ideal for signal pulse and switched-mode power ideal for signal, pulse, and switched-mode power transformers, where the magnetic conditions stay within the linear regions of the B-H curve.

Turns ratio by Inductance (TRL) - ideal for transformers that has poor magnetic coupling between primary and secondary winding. It measures the inductance of both the primary and secondary and calculates the turns ratio from these measured inductance values so removes the effects of leakage inductance, magnetizing current and DC resistance of windings.

The TRL test then returns the calculated magnitude of the square root of primary inductance over secondary inductance.

Keep in mind, turns ratio tests (whether TR by voltage or TRL by inductance) only show the ratio between windings, not the actual number of turns.

You should include at least one inductance test to ensure the absolute number of turns is correct.

Measurement Conditions

Inductance values can change based on flux density, so it is important to energize both windings at the same signal to get an accurate turns ratio.

TRL is most accurate for transformers with turns ratios between 30:1 and 1:30.

Higher ratios can result in less accurate measurements due to large differences in inductance.

Setting the Test Parameters

To do this you will need to know the inductance of the primary and secondary windings.

The optimum test conditions are chosen for an inductance value that is between the primary and secondary (Lm).

$$L_m = \sqrt{L_p \times L_s}$$

Where:

L_m = Intermediate inductance

L_p = Primary inductance

L_s = Secondary inductance

V_p = Primary voltage

V_s = Secondary voltage

V_m = Intermediate voltage

N_p = Primary turns

N_s = Secondary turns

Look up the recommended test signal for this inductance.

The recommended test conditions depend on the Intermediate inductance of both windings; they are given in the table in Section 7.7 LS,

Enter the recommended frequency for this inductance as the test frequency.

The primary and secondary voltages can be calculated from the following:

$$V_s = V_m\sqrt{\frac{N_s}{N_p}} \qquad V_p = V_m\sqrt{\frac{N_p}{N_s}}$$

If you calculate V_s or V_p to be greater than 5V, you should set 5V as your test signal.

If you calculate V_s or V_p to be less than 1mV, you should set 1mV as your test signal.

AUTO Secondary Test Conditions

Optionally, The AT Editor will also allow you to specify the V/F on the primary, and AUTO conditions for the secondary.
With this selected, the AT will energize secondary for the L measurement at the same voltage as if the primary were energized.

In summary, the AT process for the AUTO setting is.

1. Measure the inductance and voltage on the primary.

2. Leaving the generator on, measure the secondary voltage

3. Connect the generator to the secondary at the voltage measured in step 2 and measure the inductance.

Specifying the Test Limits

When specifying turns ratio tests, it is preferable to avoid limits which are unnecessarily tight, and which may therefore lead to measurement difficulties.

For example, if two equal secondary windings should have 10 turns each, the ratio should be 1:1.

One turn in error would produce a ratio error of 10% or -10% (i.e., 11:10 or 10:11), and therefore limits of +5% and -5% would be suitable to detect the error.

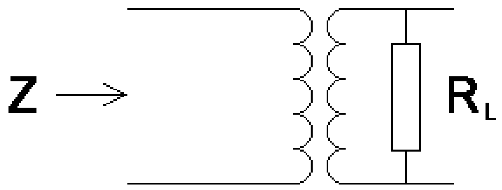
Please also see
AT dotNET Editor manual (98-125 2.5.13) for specific advice on programming the test
10.2.5 for test accuracy specification

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.13).***

For information on test accuracy specifications, refer to ***Chapter 10.2.5. TRL Test***

7.15. Z, ZB – Impedance, Impedance with Bias

The impedance test measures the impedance of a transformer winding by applying a specified voltage and frequency and by measuring the current that flows, calculating the magnitude of the complex impedance.

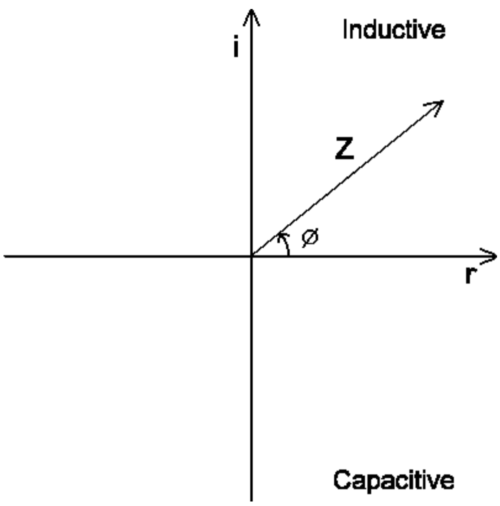


Measurement Conditions

Z or ZB can be measured with or without a load on the secondary.

The AT does not need any “knowledge” of the load, as it is the effective Z of the whole transformer from the point of the selected windings that is reported.

The test voltage is applied to the input winding, and the voltage and current measured. From the measured results the impedance is calculated.



For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.14/15).***

For information on test accuracy specifications, refer to ***Chapter 10.2.23 Z & ZB Test***

7.16. R2 – DC Resistance Match

The DC resistance match test – as opposed to an ordinary DC resistance measurement (R) - is used on audio and telecommunications transformers, where it is important that the resistance of different pairs of windings is controlled and matched to a specified ratio.

The absolute value of the resistances may be of less importance to the performance of the transformer than the match between two resistances.

Measurement Conditions

To measure DC resistance match, the tester makes two DC resistance measurements (see the R test) and compares the two results.

Limits for the match of the two measured resistances may be set in terms of the ratio between them (e.g., 1:1 ± 5%).

By adding further DC resistance match tests to the test program, any number of DC resistances can be tested for match.

Choosing Test Conditions

For optimum accuracy and performance, use the test conditions shown in the DC resistance section of this chapter for each of the two windings.

Choosing Test Limits

The test limits are the specific resistances for both X and Y terminals together with + and – percentage limits.

Use the AT Editor's 'Measure' button (together with a sample part) if you are unsure of the resistance values.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.16).***

For information on test accuracy specifications, refer to ***Chapter 10.2.18 L2, C2 and R2 Tests***

7.17. L2 – Inductance Match

The inductance match test calculates the ratio between two inductances on two windings. An equivalent series inductance measurement is performed on each winding by measuring the complex impedance.

This test is suitable for switched mode power supply transformers, and audio & telecommunication transformers. It checks matching between windings.

Measurement Conditions

When calculating, inductance match the tester performs two inductance measurements.

Firstly, the unit applies an AC voltage across the first winding; it then measures the voltage across and the current through the winding using harmonic analysis.

The measured voltage is divided by the current to obtain a complex impedance and the inductance is calculated. T

his is then repeated for the second winding. The inductance match is the ratio of first to second winding inductance.

The test signal can have a frequency in the range 20Hz to 3MHz, and an amplitude from 1mV to 5V.

Generally, it is not necessary to measure the inductance at the normal operating conditions of the transformer, which could involve, for example, voltage levels of hundreds of volts. This is because the B-H curve can normally be assumed to be linear in the operating region, and the inductance measured at a low level represents the inductance that will appear in use.

Also, it can usually be assumed that the inductance value does not vary significantly with frequency. Therefore, although high frequencies are available with the tester, measurement frequencies above a few hundred kilohertz should be used with caution. This is because the errors caused by the stray inductance and capacitance of your fixture may become much more significant at these frequencies. Compensation can be used to eliminate these errors.

The following table suggests suitable test conditions for different values of expected average inductance:

AVERAGE INDUCTANCE (Geometric Mean)			PREFERRED TEST SIGNAL	
			FREQUENCY	VOLTAGE
100nH	→	1uH	300KHz	10mV
1uH	→	10uH	100KHz	30mV
10uH	→	100uH	30KHz	50mV
100uH	→	1mH	10KHz	100mV
1mH	→	10mH	1KHz	100mV
10mH	→	100mH	100Hz	100mV
100mH	→	1H	100Hz	300mV
1H	→	10H	50Hz	1V
10H	→	100H	50Hz	5V
100H	→	1KH	50Hz	5V
1kH	→	10KH	20Hz	5V

Test Conditions for Inductance Match Measurement

Wherever possible, this table should be used for all inductance tests. The inductance range should be chosen based on minimum value of inductance expected.

When choosing the test conditions, the following potential problems should be considered:

Current levels

The upper voltage limits should be chosen to give a maximum current level of about 100mArms for the lowest inductance expected. In some cases, this current may cause core saturation, and a lower voltage should be used.

The minimum voltage level must be chosen so that the test current does not become so low that it cannot be sensibly measured. The lower voltage limits in the table above always give test currents higher than 3µA RMS.

Self-Resonant Frequency

At lower frequencies, the capacitance of the windings can normally be ignored because its impedance is much higher than that of the inductance. However, at extremely high frequencies, this is not so, the capacitance dominates, and inductance cannot be measured.

The self-resonant frequency of the transformer is the change-over point between these two regions.

Normally to get a good measurement of inductance, the test frequency should be less than 20% of the resonant frequency of the transformer.

In general, high values of inductance will have a high inter-turn capacitance and hence a low resonant frequency.

Where there is a choice of test frequencies **always use the lower value**, to minimize any problems due to self-resonance.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.17).***

For information on test accuracy specifications, refer to ***Chapter 10.2.18. L2, C2 and R2 Tests***

7.18. C2 – Capacitance Match

The interwinding capacitance match test calculates the ratio between two capacitance measurements on two groups of windings.

It is measured by applying a specified AC voltage between two separate windings and the voltage across and current flow between the two windings is measured to obtain a complex impedance. This is performed to the two groups in turn.

This test is suitable for switched mode power supply, audio, and telecommunication transformers. It checks that the windings are installed in the correct positions on the bobbin.

Measurement Conditions

When calculating the capacitance match, the tester performs 2 capacitance measurements.

Firstly, the tester applies an AC voltage between first group of windings to be tested, usually with all taps on each winding shorted together. It then measures the voltage between the windings, and the resulting current using harmonic analysis. Dividing the voltage by the current gives the inter-winding impedance, from which the capacitance may be calculated.

This is then repeated for the second winding group. The capacitance match is the ratio of first to second winding group capacitances.

The test voltage can be in the range of **1mV to 5V** at a frequency of **20Hz to 3MHz.**

The table below gives the recommended test conditions for different values of average capacitance:

AVERAGE CAPACITANCE (Geometric Mean)			PREFERRED TEST SIGNAL	
			FREQUENCY	VOLTAGE
1 pF	→	10 pF	100 KHz	5 V
10 pF	→	100 pF	100 KHz	5 V
100 pF	→	1 nF	10 KHz	5 V
1 nF	→	10 nF	1 KHz	5 V
10 nF	→	100 nF	100 Hz	5 V

The Test Conditions for Capacitance Match Measurement

When choosing the test conditions, the following potential problems should be considered:

Current levels

For larger capacitances, particularly at higher frequencies, the current flowing during the measurement can be extremely high, and similarly the measured current could also be exceedingly small for small capacitances at lower frequencies and voltages.

Where possible, you should use the recommended test signal levels in the table above to ensure that the currents which flow can be measured accurately.

Non-linear Capacitance

Normally non-linearity in the stray capacitance of transformers is not a problem, and therefore capacitance is measured with as large a voltage as possible.

Equivalent Circuit

As with inductance, capacitance is measured as a complex impedance, and therefore the result can be expressed in terms of either a series or a parallel equivalent circuit.

As mentioned in section 7.7, parallel and series equivalent inductance do not necessarily have the same values. The same is true for capacitance; parallel and series equivalents can also be different.

The tester uses a parallel equivalent circuit for capacitance measurements and does not give you a choice of a series equivalent.

This will present no problems, as on most transformers the difference between the two values is usually negligible and can be ignored.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.18).***

For information on test accuracy specifications, refer to ***Chapter 10.2.18. L2, C2 and R2 Tests***

7.19. GBAL – General Longitudinal Balance

The General Longitudinal Balance (GBAL) test is designed to measure the Common Mode Rejection Ratio (CMRR) of transformers connected to a balanced line.

The Common Mode Rejection Ratio (CMRR) of an electronic device is a measure of the device's ability to reject common-mode signals - signals that appear simultaneously and in-phase at both inputs.

The test involves two measurements, where a voltage is applied to the transformer and the resulting voltage is measured to calculate the CMRR.

Since there are three standard methods for measuring CMRR, the GBAL test provides separate X and Y terminals for each of the two measurements.

For more precise testing, Voltech offers the LBAL test, which is specifically designed for measuring longitudinal balance.

This test is commonly used for audio and telecommunication transformers to verify their effective CMRR.

Measurement Conditions and Types

Unfortunately, there are several published specifications for measuring longitudinal balance. These are all different and potentially give different results for the same transformer.

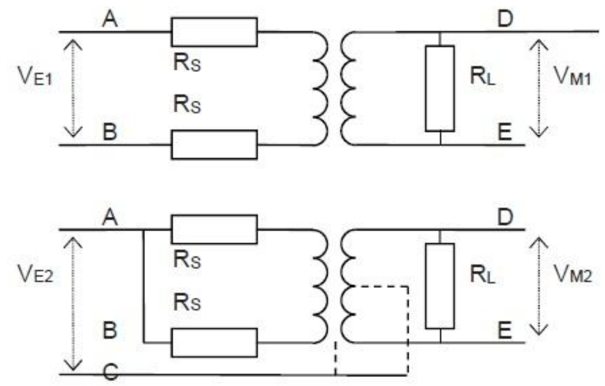
To allow each user the freedom to test to his preferred method, the GBAL test has been configured with the greatest flexibility. It therefore consists of two separate measurements which the user can program, and the result is the ratio between the two expressed in dB.

Operation

For the reasons outlined above, the test consists of two separate user programmed measurements, each with its own ‘energized’ and ‘measured’ terminals.

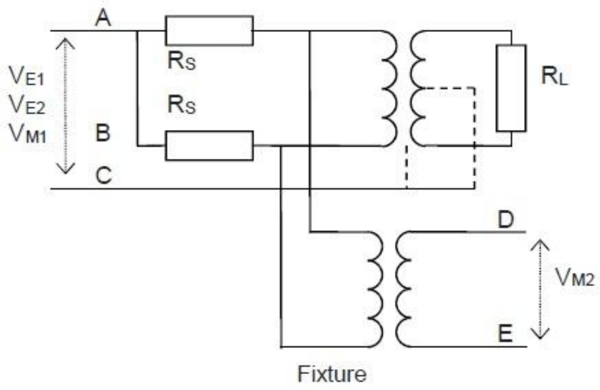
This approach is illustrated below with reference to three standard methods:

1) Preferred method (the method of the LBAL test, used by many transformer manufacturers)



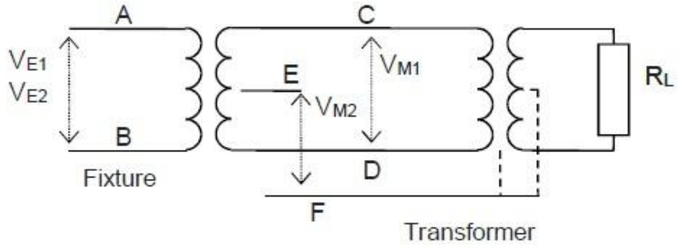
Measurement				
	Energized		Measured	
	Hi	Lo	Hi	Lo
1	A	B	D	E
2	A+B	C	D	E

2) IEEE 455 method (used in Canada, Europe, and ROW)



Measurement				
	Energized		Measured	
	Hi	Lo	Hi	Lo
1	A+B	C	A	C
2	A+B	C	D	E

3) FCC 68.310 method (used in USA)



Measurement				
	Energized		Measured	
	Hi	Lo	Hi	Lo
1	A	B	C	D
2	A	B	E	F

The source and load resistors (and the fixture transformer for the IEEE and FCC methods) are assumed to be on the fixture but are not shown on the AT Editor schematic.

They are switched in circuit using an OUT test that must be inserted in the program before the GBAL test. (The relay patterns associated with inserting and removing fixture resistors have deliberately not been included in the GBAL test dialogue for two reasons: a) it would make the dialogue too complicated, and b) it is not always necessary - e.g., in the case of a fixture where the resistors are permanently fitted in circuit).

After the two measurements, have been taken, the longitudinal balance is calculated from the ratio of the two outputs:

GBAL = 20 log | VM1 / VM2 |

+ (optionally) compensation for test fixture scaling

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.19).***

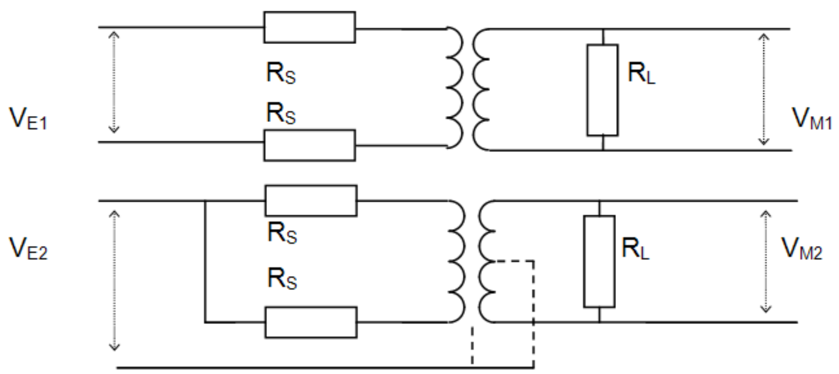
For information on test accuracy specifications, refer to ***Chapter 10.2.19. GBAL Test***

7.20. LBAL – Longitudinal Balance

The longitudinal balance test is Voltech's **preferred method** to measure what is effectively the Common Mode Rejection Ratio of a transformer designed to connect to a balanced line.

Two measurements are performed each by applying a voltage to the transformer and measuring the resulting voltage to calculate the CMRR. This test is suitable for audio & telecommunication transformers and checks the effective common mode rejection ratio of the transformer.

Measurement Conditions



LBAL = 20 Log [Vm1 / Vm2]

The source and load resistors are assumed to be on the fixture but are not shown on the editor schematic. They are switched in circuit using an OUT test that must be inserted in the program before the LBAL test. (The relay patterns associated with inserting and removing fixture resistors have deliberately not been included in the LBAL test dialogue for two reasons: a) it would make the dialogue too complicated, and b) it is not always necessary - e.g., in the case of a fixture where the resistors are permanently fitted in circuit).

The test consists of two measurements: a) with the input applied as a differential signal, and b) with the input applied as a common mode voltage relative to a common Low point, which could be the centre tap of the secondary winding, the transformer core or an interwinding screen. In each case the output is measured, and the longitudinal balance is calculated from the ratio of the two outputs.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.20).***

For information on test accuracy specifications, refer to ***Chapter 10.2.20. LBAL and ILOS Tests***

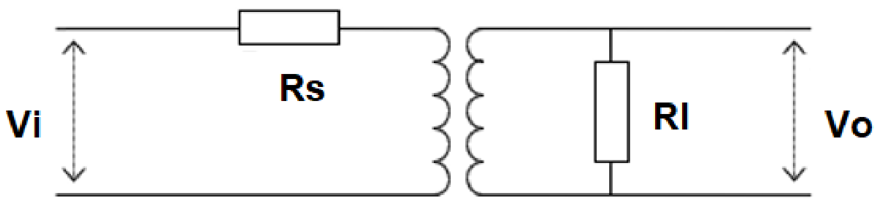
7.21. ILOS – Insertion Loss

The insertion loss test measures the output power delivered by a transformer to a load, compared to the maximum power theoretically available.

A voltage is applied to the input winding, and both the input and output voltages are measured to calculate the loss.

This test is ideal for audio and telecommunication transformers, assessing the effective losses when the transformer operates in its intended application.

Measurement Conditions



ILOS = 10 Log [(Vi * Vi * Rl) / (4 * Vo * Vo * Rs)]

The source and load resistors are assumed to be on the fixture but are not shown on the Editor schematic.

They can be switched in circuit using an OUT test that must be inserted in the program before the ILOS test.

Alternatively, they can be permanently fitted in circuit. This can influence other tests, most obviously DCR. Please see later section on a programming/ Fixturing tip for this.

The test voltage is applied to the input winding, and the voltages measured on the input and output windings.

From the ratio of input and output voltages, and the resistance values (specified by the user in the test dialogue), the insertion loss is calculated.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.21).***

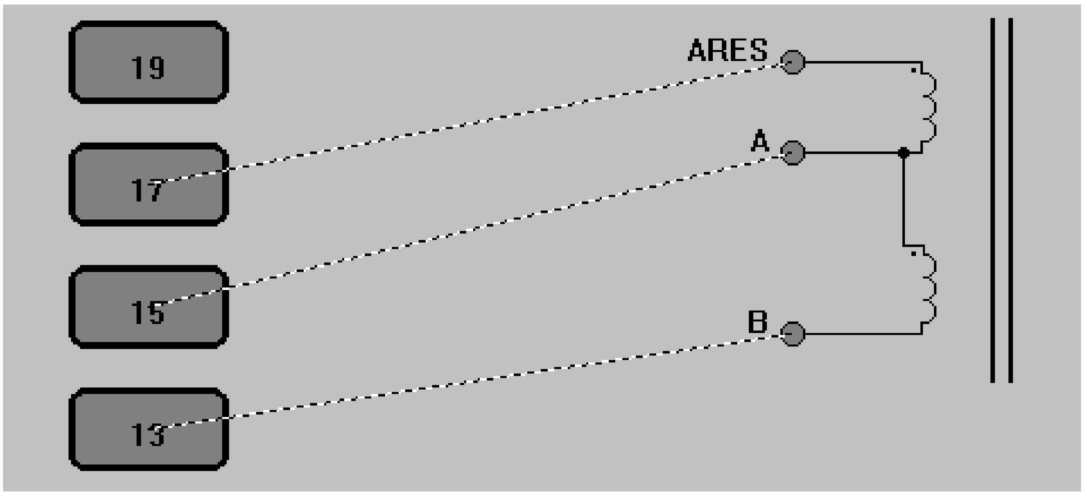
For information on test accuracy specifications, refer to ***Chapter 10.2.20. LBAL and ILOS Tests***

7.21.1. Fixturing and Programming tip for using Source Resistors

The use of the source and load resistors will obviously have an impact on your other measurements, which could be accommodated for in adjusting suitable limits for the known configurations and loading.

Alternatively, you can construct the fixture to use two AT node connections to connect to one transformer pin: one with a resistor, and one without.

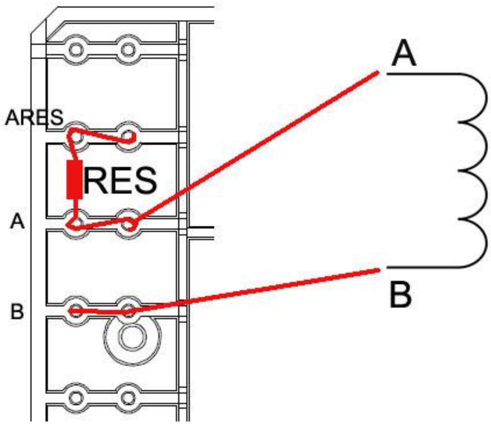
Consider the simple example below of an inductor with terminals A and B. An additional dummy ARES winding is added. This represents the A terminal connected with a resistor in series to the AT nodes.



2-Wire Connections

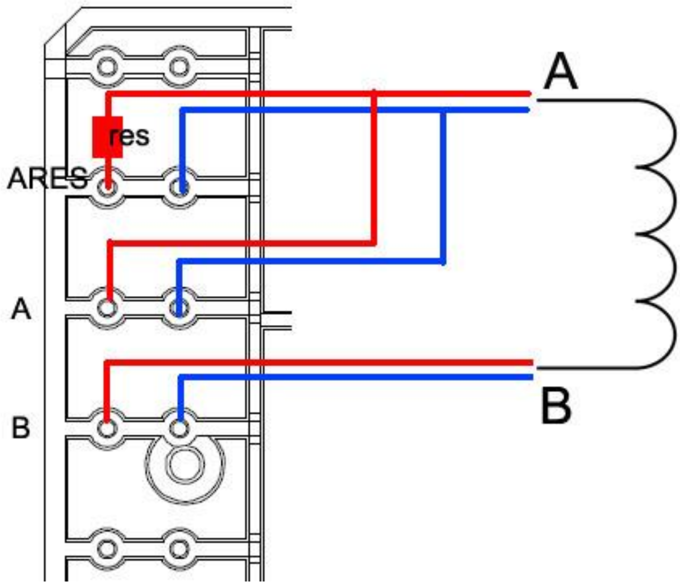
In a simple two wire connection, this would be constructed on the fixture as below. Tests requiring the resistor would use the ARES-B nodes.

You can still perform a DCR direct measurement of the inductor using the true A+B nodes.



4-Wire Connections

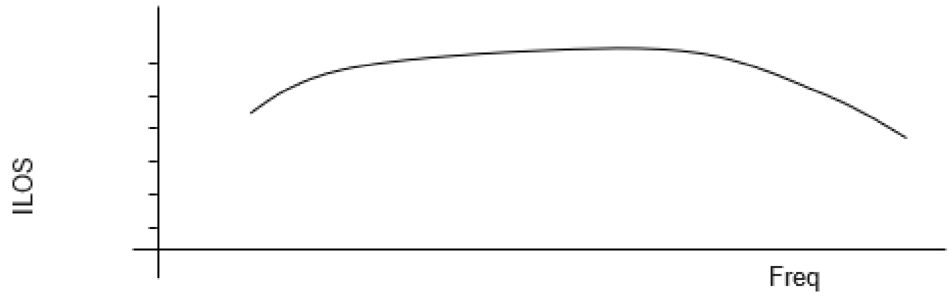
If you wish to maintain a full 4-wire connection to A and B, you can use the wiring configuration shown below as a reference:



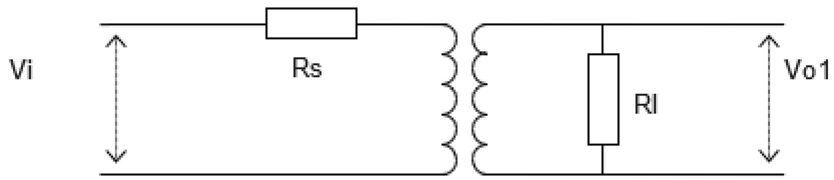
7.22. RESP – Frequency Response

The frequency response test, RESP, may be used to check that the variation in power loss of a telecommunications or audio transformer over a specified frequency range is less than specified limits.

Measurement Conditions



The RESP test consists of many Insertion Loss (ILOS) tests repeated at different frequencies.



The resistors shown are fitted to the test fixture and should be switched out of circuit when making other measurements such as resistance and inductance. This can be done by fitting relays to the fixture and switching them at appropriate points in the test program using OUT tests.

The first ILOS test is made at a reference frequency that is usually near the middle of the band of frequencies of interest. The result of this test is the 0dB reference level. Further ILOS tests are then carried out at user selected frequencies and the results referred to the reference dB level.

If all the referred ILOS results are at or inside the specified limits, the result of a RESP test is the preferred ILOS result that is closest to the limit. If any of the referred ILOS results are outside the specified limits, the RESP result is the preferred ILOS result that is furthest away from the limit.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.22).***

For information on test accuracy specifications, refer to ***Chapter 10.2.21. RESP Test***

7.23. RLOS – Return Loss

The Return loss test measures the impedance mismatch between the transformer and a transmission line of a specified impedance. It is defined as

RLOS = 10 LOG [(Incident Power) / (Reflected Power)]

An ideal transformer would thus have a large RLOS value, which is counter intuitive, given the name.

In the case of the AT7600, RLOS is calculated from a measurement of the complex impedance (Zl) on the energized winding, and the specified reference (Zr) impedance on the secondary.

This test is suitable for audio & telecommunication transformers and checks the effective input impedance of the transformer in the application.

Measurement Conditions

$$RLOS = 20 \log (| Z_R + Z_\ell | / | Z_R - Z_\ell |)$$

The load resistor is assumed to be on the fixture but not shown on the Editor schematic (although its real and Imaginary values must be entered as part of the test programming).

It can be switched in circuit using an OUT test that must be inserted in the program before the RLOS test.

It is also possible to use a fixture where the resistor is permanently fitted in circuit, but this would of course affect other measurements (most obviously, DCR on the secondary), but is feasible, the limits could be adjusted to accommodate this.

The test voltage is applied to the input winding, and the voltage and current measured. From the measured results, and the reference impedance value (specified by the user in the test dialogue), the return loss is calculated.

The impedances used are complex, where:

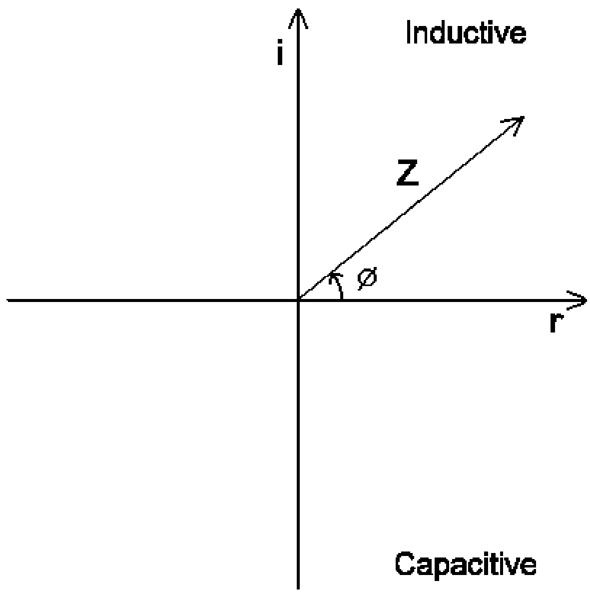
$$Z_R = R_R + j\,X_R$$

$$Z_\ell = R_\ell + j\,X_\ell$$

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.23).***

For information on test accuracy specifications, refer to ***Chapter 10.2.22. RLOS Test***

7.24. ANGL – Impedance Phase Angle



The impedance phase angle test measures the angle ∅ of the impedance vector Z, as shown in the diagram.

It represents the phase difference between the fundamental current flowing through a winding and the fundamental voltage across it.

This test is normally used for audio and telecommunication transformers along with the Z test to check the complex impedance presented to the transformers input and output.

Measurement Conditions

To perform the test, an AC voltage is applied across the winding under examination, and the complex impedance is calculated by measuring the test voltage and the resulting current.

Before setting the test voltage or current, it is important to determine the expected impedance of the winding at the test frequency.

Use the table below to select the appropriate test voltage or current. Locate the correct impedance range for your winding and then refer to the corresponding test voltage or current value.

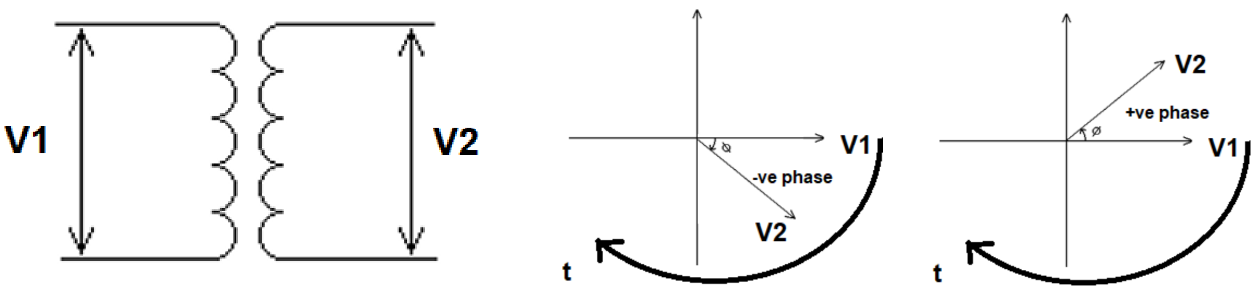
Note that inductive components will produce a positive phase angle, while capacitive components will yield a negative phase angle.

IMPEDANCE RANGE	TEST VOLTAGE	TEST CURRENT
1 MΩ to 100 kΩ	5 V	-
100 kΩ to 10 kΩ	5 V	30 µA
10 kΩ to 1 kΩ	5 V	300 µA
1 kΩ to 100 Ω	3 V	3 mA
100 Ω to 10 Ω	500 mV	10 mA
10 Ω to 1 Ω	100 mV	50 mA
1 Ω to 100 mΩ	10 mV	50 mA
100 mΩ to 10 mΩ	1 mV	50 mA
10 mΩ to 1m Ω	-	50 mA

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.24).***

For information on test accuracy specifications, refer to ***Chapter 10.2.24. ANGL Test***

7.25. PHAS – Interwinding Phase



This test is useful for most types of transformers, although unusual with line frequency transformers and tests for the phase angle between windings.

It is most useful for determining the phase effect of audio and telecommunications transformers when placed in a transmission line.

When V2 lags behind V1 the results will be a negative phase, and vice versa.

Measurement Conditions

When programming the test enter the test frequency, choose the test voltage from the following table.

When selecting your energized winding, check that your transformer does not have a large step-up turns ratio between this winding and any other windings as this may cause high voltages to be present during the test.

If this is the case, then energize the winding with the most turns.

Impedance of Energized Winding Max	Impedance of Energized Winding Min	Test Voltage
1 MΩ	100 kΩ	5 V
100 kΩ	10 kΩ	5 V
10 kΩ	1 kΩ	5 V
1 kΩ	100 Ω	3 V
100 Ω	10 Ω	0.5 V
10 Ω	1 Ω	100 mV
1 Ω	100 mΩ	10 mV
100 mΩ	10 mΩ	1 mV

Convention for Returned Result

For phase tests, the convention of the result returned by the AT **depends on the mean of the limits you have requested.**

The Mean of the Min and max limits are calculated, and the results will be expressed within the range:

(Mean – 180 deg) and (Mean +180deg)

For example,

A, if the Limits are -5 Deg to + 5 Deg then the mean is 0Deg and the result will be in the range -180 deg to 180 deg.

B, if the Limits are 85 Deg to 95 Deg then the mean is 90 Deg and the result will be in the range -90 deg to +270 deg.

C, if the Limits are 40 Deg to 60 Deg then the mean is 50 Deg and the result will be in the range -130 deg to +230 deg.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.25).***

For information on test accuracy specifications, refer to ***Chapter 10.2.25. PHAS Test***

7.26. OUT – Output to User Port

OUT is used where additional switching (other than performed by the nodes of the AT) is required for parts of the test program.

The User Port on the tester has associated with it 6 ‘Relay Driver’ outputs. The OUT test allows programming of the User Port relay driver outputs to perform additional relay switching as part of the test program.

An example of this would be an application where a transformer has two separate primary windings. An OUT test could be used to connect them in series, allowing them to be tested as a single primary with twice the working voltage.

A second example is the switching of additional resistors mounted on the test fixture allowing tests to be included in a program on a transformer with a loaded secondary winding.

Specifying Test Conditions

User Port Outputs

Each of the relay driver outputs (numbered 0 – 5) is an open collector output which can be set to On or Off as desired:

On = Connected to GND (0V)

Off = Open circuit (Floating)

NOTE:

The relay drivers are set as and when the tester encounters an OUT test.

The settings given will latch until another OUT test is encountered.

Therefore, if the settings are required for one part of the test program only, 2 OUT tests will be required, 1 to turn the appropriate relay drivers on and 1 to turn them back off.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.26).***

7.27. IR - Insulation Resistance

An insulation resistance (IR) test measures the overall resistance between two points separated by electrical insulation. It evaluates the effectiveness of the dielectric material in preventing the flow of electrical current.

An Insulation Resistance (IR) test is recommended as a good practice for most transformers to verify the integrity of the insulation between different windings or between a winding and a screen.

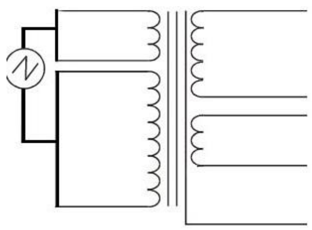
It is used when winding isolation is essential to the transformer's function, but not required for safety purposes, for which a Hi-Pot (EHT) test is more appropriate. For example, an IR test can be executed between two primary windings, two secondary windings, or for transformers with added safety failsafe protection where screen is included, primary or secondary winding and a screen.

Although like HPDC or HPAC testing, the IR test does not involve ramp-up or dwell time, making it quicker to execute.

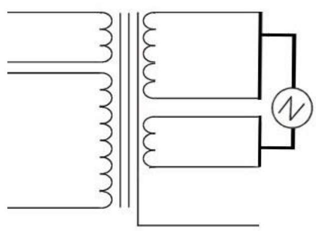
While Hi-Pot tests focus on detecting flashovers, the IR test provides insight into the long-term reliability of the insulation, even if the transformer passes the Hi-Pot test.

The standard industry voltage for IR tests is 500V DC, but the AT7600 offers flexibility with a voltage range of 100 V to 7 kV DC, depending on your requirements.

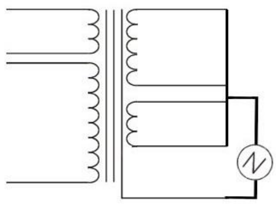
Example Use Case on a Multi Winding Transformer



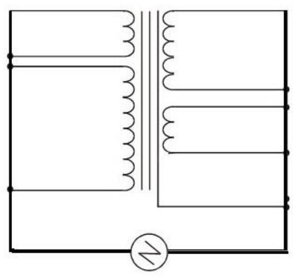
IR1 – Pri A **to** Pri B @ 500V



IR2 – Sec A **to** Sec B @ 500V



IR3 Sec A+B **to** Screen @500V



HPAC – Pri A+B **to** Sec A + B + Screen @2500V

Measurement Conditions

To measure insulation resistance, the tester applies a DC voltage between two groups of windings, with all windings in each group shorted together.

The voltage and current are measured, and the insulation resistance are calculated by dividing the applied voltage by the measured current.

For more accurate results, you can configure the tester to perform a compensation measurement on the empty fixture at the start of the test, allowing it to subtract fixture-related errors from subsequent readings.

The test voltage can range from 100V to 7kV.However, it is typically recommended to use a voltage slightly higher than twice the highest peak working voltage of the winding.

For example, when testing the insulation between two primary windings of a line-frequency transformer operating at 240V, a test voltage of 800V would be appropriate.

Specifying the Test Limits

While the AT7600 is capable of measuring insulation resistance values exceeding 1GΩ, it is generally unnecessary to specify such a high value.

Lower values, such as 100MΩ, are sufficient for most applications and will speed up the test process.

Best Practice for Multiple Winding or Large Transformers

After any HPAC, HPDC or IR test, the unit will turn off the sources, and switch in an internal discharge resistor to remove any latent voltages on any windings used in the test.

Any voltage present is monitored until it has decayed, then the relays opened ready for the next test. This is defined in 9.2.3 “Voltage Present Error.”

On large transformers where one winding (or a screen or core connection) are not used in the high voltage test, then these are left floating with respect to ground

As the controlled discharge only applies to nodes used in the test, these unused nodes could be left in a dangerous state, especially if the UUT is large or highly capacitive.

Hence it is **always best practice** to use **ALL available nodes** in a high pot test. Typically, by selecting the winding to test as HI, and all others to LO.

This ensures that the whole transformer is electrically controlled during the test and fully discharged after.

This prevents hot switching of the relays in the AT which can potentially cause damage on the subsequent tests if floating voltages are left.

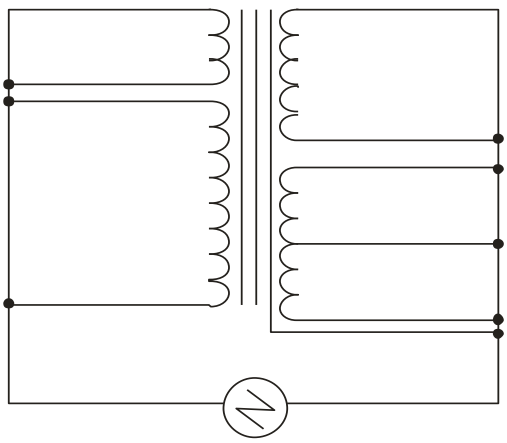
For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.34).***

For information on test accuracy specifications, refer to ***Chapter 10.2.11. IR Test***

7.28. HPDC - DC HI-POT (EHT)

Hi-Pot or EHT testing (to check for insulation breakdown between windings or between windings and the screen or core) is often specified for power line transformers or for switched mode power transformers in applications where safety is important. It is typically performed between all primary windings connected, and all secondary windings plus the screen connected.

DC Hi-pot is preferred where the transformer has a high natural capacitance, and so a HPAC test, especially at higher voltages, would draw too much current. However, HPDC can be used on any transformer.



Specifying the Measurement

During the test, a DC voltage is applied across two groups of windings with the windings in each group being shorted together. The voltage and current are monitored throughout the dwell time; if either the test voltage cannot be maintained, or the current is too large, then a failure will be recorded.

In programming the tester, you may select the voltage (from 100V to 7KVdc), the current trip level (1µA to 3mA), and the ramp up and dwell times, all to suit the specification of the transformer under test.

Many transformer specifications require Hi-Pot testing to be carried out with a dwell time of 60 seconds. Although the transformer must be designed and constructed to meet this, it is widespread practice to reduce the dwell time for production testing. This is recognized by IEC 742, which permits a dwell time of 2 seconds for production testing. Although not required by IEC 742, it is good practice to increase the test voltage by, for example, 10% when performing reduced-time testing, to provide additional security for the test.

IEC742 has been replaced by IEC61558, which specifies 1 second for production testing. Details are available on the IEC website: **www.iec.ch.**

Best Practice for Multiple Winding or Large Transformers

After any HPAC, HPDC or IR test, the unit will turn off the sources, and switch in an internal discharge resistor to remove any latent voltages on any windings used in the test.

Any voltage present is monitored until it has decayed, then the relays opened ready for the next test. This is defined in 9.2.3 “Voltage Present Error.”

On large transformers where one winding (or a screen or core connection) are not used in the high voltage test, then these are left floating with respect to ground.

As the controlled discharge only applies to nodes used in the test, these unused nodes could be left in a dangerous state, especially if the UUT is large or highly capacitive.

Hence it is **always best practice** to use **ALL available nodes** in a high pot test. Typically, by selecting the winding to test as HI, and all others to LO.

This ensures that the whole transformer is electrically controlled during the test and fully discharged after. This prevents hot switching of the relays in the AT which can potentially cause damage on the subsequent tests if floating voltages are left.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.37).***

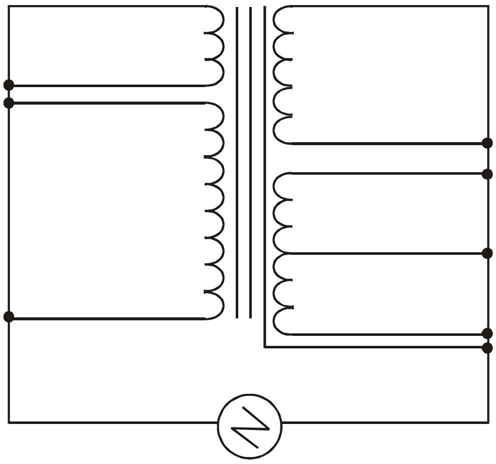
For information on test accuracy specifications, refer to ***Chapter 10.2.12. HPDC Test***

7.29. HPAC - AC HI-POT (EHT)

Hi-Pot or EHT testing is commonly used to detect insulation breakdown between windings or between windings and the screen or core.

This test is often specified for power line transformers and switched-mode power transformers, especially in safety-critical applications.

Typically, the test is performed by connecting all primary windings together and all secondary windings plus the screen together.



Specifying the Measurement

During the Hi-Pot test, an AC voltage is applied across two groups of windings, with the windings in each group shorted together.

The voltage and current are continuously monitored throughout the dwell time.

If the test voltage cannot be maintained or the current exceeds the acceptable limit, the test is recorded as a failure.

When programming the AT7600, you can configure the following parameters to match the transformer specifications:

Voltage: 100 V to 5 kV RMS.

Frequency: 50 Hz - 1 kHz

Current trip level: 10 µA to 30mA peak

Ramp-up time and dwell time

Many transformer specifications require a dwell time of 60 seconds for Hi-Pot testing.

However, it is common practice to reduce dwell time during production testing. IEC 742 allows for a reduced dwell time of 2 seconds for production, though it is recommended to increase the test voltage by at least 10% during reduced time testing to ensure reliability.

IEC 742 has been replaced by IEC 61558, which specifies a dwell time of 1 second for production testing.

Further details are available on the IEC website www.iec.ch .

During a Hi-Pot test, the output voltage is continuously monitored and adjusted to ensure accuracy.

If the programmed voltage cannot be maintained, the tester will automatically register a 'FAIL,' trigger a red indicator, send a failure signal to the server (if connected), and sound an alarm (if enabled).

This method complies with the production requirements of EN 61558-1 (1998), UL 1411 (5th Edition), and other related standards.

Types of Failure with Testing using HPAC

1. Measurement failure

The average RMS current measured during the dwell time exceeds your programmed Pass/Fail limit.

2. Breakdown (error code = “3400”)

A sudden breakdown of insulation which results in a sudden catastrophic failure of the part.

This is reported as a status error code “3400” even if the RMS value up to that point appears to be “good”, and within pass limits, this is still flagged as a failure. The sudden breakdown will occur so quickly that there is not enough time for this to be reflected in a larger RMS measurement.

This is a hardware trip for **any measurement >10 mA**

Best Practice for Multiple Winding or Large Transformers

After any HPAC, HPDC or IR test, the unit will turn off the sources, and switch in an internal discharge resistor to remove any latent voltages on any windings used in the test.

Any voltage present is monitored until it has decayed, then the relays opened ready for the next test. This is defined in 9.2.3 “Voltage Present Error.”

On large transformers where one winding (or a screen or core connection) are not used in the high voltage test, then these are left floating with respect to ground.

As the controlled discharge only applies to nodes used in the test, these unused nodes could be left in a dangerous state, especially if the UUT is large or highly capacitive.

Hence it is always best practice to use ALL available nodes in a high pot test. Typically, by selecting the winding to test as HI, and all others to LO.

This ensures that the whole transformer is electrically controlled during the test and fully discharged after.

This prevents hot switching of the relays in the AT which can potentially cause damage on the subsequent tests if floating voltages are left.

AT7600 HIPOT Generator and the IEC Standard

The AT7600 is designed to meet the transformer testing requirements of IEC 62368-1 and IEC 61010-1 and the UL equivalents.

These standards do not require power for production Hi-pot testing of the transformers but only specify the test voltage and duration of test (also referred to as the “dwell time.”)

The IEC standards allow the test duration to be reduced to 1-2 seconds if the test voltage is increased by 20% above requirement.

This obviously gives a large improvement in test throughput for manufacturers, if each of the specific designs can withstand the extra 20% of test voltage.

This would obviously need checking by batch pre-testing to confirm suitability, before fully implementing.

The IEC standard contains derating graphs which explain in more detail the allowed reduction of test time, against the corresponding increase of test voltage needed.

The AT7600 HIPOT generator has a rating of 250 VA.

Even with a winding capacitance as high as 10nF, the required current at 5 kV 60Hz is only 19.1 mA, corresponding to a VA requirement of only 96 VA.

Hence the 250VA has plenty of excess capacity to generate the voltages required for even the largest transformers

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.28).***

For information on test accuracy specifications, refer to ***Chapter 10.2.13. HPAC Test***

7.30. SURG - Surge Stress

The Surge Stress test is commonly used to detect short circuits between adjacent turns in a winding.

While it can be applied to any transformer, it is especially effective for transformers with many turns of very fine wire.

Fine wire presents a higher risk of failure due to its thinner enamel coating and the large number of turns typically wound with it. The combination of the wire's length and thinness increases the likelihood of manufacturing defects.

In such cases, the enamel coating is extremely thin, making it prone to scratches that can expose the copper beneath.

Although a scratch may not immediately cause a short circuit, it creates a weak point that could fail over time.

To identify potential faults that may develop later, a higher-than-normal test voltage is applied during this test.

Measurement Method

Each SURG test can be programmed to consist of many DC impulses.

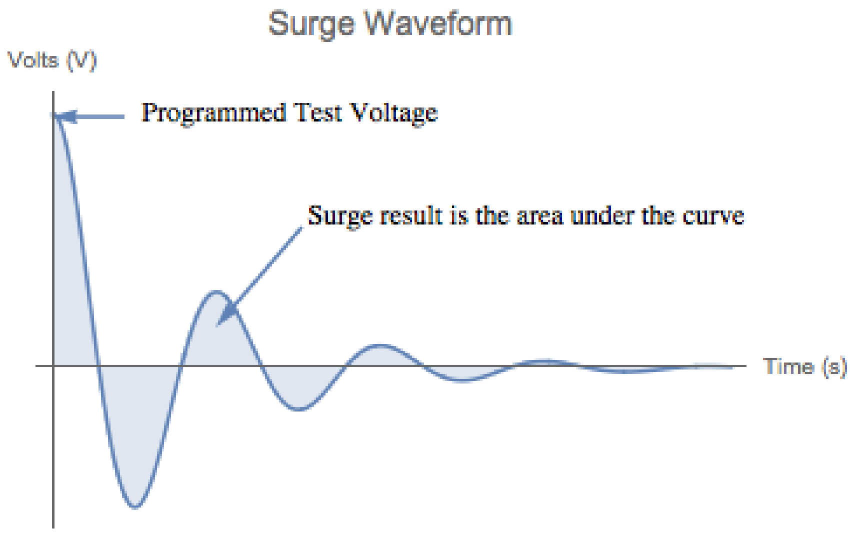
It is recommended to use a small number of impulses (normally 3) to demagnetize the core before taking the reading from the last impulse.

More impulses may also help find defective wire insulation.

For multiple impulses, The AT7600 will return the LOWEST result of all the impulses programmed.

For each impulse, the AT7600 will charge an internal capacitor to the programmed test voltage. This stored DC charge will then be suddenly discharged into the part under test, and the resulting transient voltage will be analyzed.

The surge result is the area under the waveform curve. A typical transient waveform is shown below.



Transient Analysis

During the decay phase after the impulse has been fired, the AT7600 measures both the voltage amplitude along the transient, and the time over the decay.

The AC waveform (and frequency/amplitude/decay rate) is a function of the characteristics of your UUT and the AT7600 Capacitors used to discharge the DC spike.

An ideal inductor with no losses or resistance would resonate indefinitely.

A good “real” transformer will have a clean and sustained transient with a long decay period.

A bad transformer with a shorted turn will have a heavily damped response with a shorter decay period.

The measurement performed is to calculate the ‘area’ underneath the graphical plot of the decaying transient.

For the calculation used, both negative peaks and positive peaks add to the total area. The area, measured in Volts-seconds, is much smaller for the faulty winding with a shorted turn

Specifying the Test Limits

It is difficult to predict the Volts-seconds 'area' under the curve from theoretical calculations, so the limits should be calculated from measurements taken from a known good part.

The recommended method is to use the Measure Mode to obtain some values from several parts.

Notes and Hints on Use of the SURG Test

Even though the energizing pulses are applied to one winding, it is important to note that this voltage will then be induced on to all windings on the transformer under test, in the same Volt/turn ratio.

To prevent damage to the UUT, or to the AT7600, the SURG test should always be applied to the winding with the greatest number of turns. You should also check that the design of the other windings that will be energized can withstand the induced voltage.

It is also important to note that the Volt Second numerical result of the test is characteristic of the whole transformer, not just the energized winding. The Surge test tests all windings on the transformer.

Please also note that the maximum Surge signal is dependent on the inductance of the part under test if the LS inductance is below 125 uH. Please see 10.2.17 for definition of this.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.35).***

For information on test accuracy specifications, refer to ***Chapter 10.2.17. SURG Test***

7.31. WATT – Wattage

The Wattage test is a measure of the input power required to energize a transformer at no load.

A Wattage test is an excellent check on the magnetic quality of the iron core and the magnetic joints and would typically be used with iron core transformers with an operating frequency of around 50Hz.

The test measures all losses caused by eddy currents in the core, hysteresis losses in the core and by the DC resistance of the winding being tested.

It should be noted that if you deploy the WATT test after a MAGI and VOC test, using the same V/F/Nodes then you will pay no time penalty for the test as the measurements are already made by the preceding two tests.

Measurement Conditions

During the Wattage test, a constant, user specified AC voltage is applied across the winding in question. All other windings are held open circuit during this test.

The AT7600 measures the voltage across and current through the winding. The Wattage is the product of the in-phase components of the current and voltage.

If, in the program, the WATT test follows either a VOC or MAGI test which has the same test conditions (voltage and frequency), and is applied to the same winding, then the measurement results from the previous tests can be re-used, saving program execution time.

The test signal can have a frequency in the range 20Hz to 1.5KHz, and an amplitude from 1V to 270V, and a power of up to 40W.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.39).***

For information on test accuracy specifications, refer to ***Chapter 10.2.15. WATT and STRW Tests***

7.32. WATX - Wattage (External Source)

The Wattage test measures the power needed to energize a winding, usually the primary, with the remaining windings open circuit. It is usual to configure the test signal to the normal operating conditions of the transformer to determine the power needed to energize the transformer.

This test uses an external source to provide the test signal which must be coupled to the tester via a Voltech AC Source Interface (contact your supplier for details). See the AC Source Interface user manual for details of how to configure external AC sources for use with an AT7600.

This test is suitable for line frequency transformers (25-400Hz) and checks the no-load losses in the transformer.

Measurement Conditions

During the Wattage (External Source) test, a constant, user specified AC voltage from an external source is applied across the winding in question. All other windings are held open circuit during this test.

The AT7600 measures the voltage across and current through the winding. The Wattage is the product of the in-phase components of the current and voltage.

If, in the program, the WATX test follows either a VOCX or MAGX test which has the same test conditions (voltage and frequency), and is applied to the same winding, then the measurement results from the previous tests can be re-used, saving program execution time.

The test signal can have a frequency in the range 20Hz to 5KHz, and an amplitude from 5V to 600V depending on the type of external source used. The current rating of a single AC Source Interface is 10A RMS. See also the WATT test which uses the AT7600s internal generator which can provide up to 270V AC at 40W.

Trimming of Requested Voltage (using Step-up transformer with AC Interface)

When using the AC interface with a step-up transformer, the AT7600 uses the Class D drive (used on VOC MAGI WATT and STRW) and routes it thought the AC interface. The AT7600 calculates a nominal value for the voltage needed to get the target value based on your requested voltage, and the programmed ratio of your chose transformer. The AT7600 will then attempt to trim to get the exact value that is needed.

If either of the following two conditions are exceeded, the AT will report a trimming failure (0020):

- If the trimming requires deviation of more than 60% from the nominal (i.e., 100V nominal, but trimming requires excess of 160 V or less than 40 V)

- If the trimming requires outputting more than 230.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.46).***

For information on test accuracy specifications, refer to ***Chapter 10.2.16. WATX and STRX Tests (External Source).***

7.33. STRW – Stress Watts

The Stress Wattage (STRW) test evaluates a transformer for insulation breakdown by measuring the energizing power of a winding, typically the primary, while keeping the other windings open circuit.

Unlike the **WATT** test, this test applies a voltage—usually twice the normal operating voltage—over a specified time and continuously monitors the power to detect any breakdowns based on changes in the power measurement.

It is suitable for sub-miniature line frequency transformers, large line frequency bobbin-wound transformers, and some high-frequency (HF) transformers. The test checks the integrity of inter-turn insulation, magnetic material, and joints.

Measurement Conditions

NOTE: The maximum power for this test is 40W.

A constant voltage source is applied to the winding under test, while both the RMS voltage and power are measured.

If needed, the voltage can be adjusted to the user-specified level, and the measurement repeated.

This process is carried out multiple times until the dwell time has passed, and the result is the measured power.

The test is typically conducted at twice the working voltage and frequency to stress the insulation, aiming to trigger an inter-turn breakdown at weak points in the wire enamel.

Any breakdown is identified by an increase in the measured power.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.40).***

For information on test accuracy specifications, refer to ***Chapter 10.2.15. WATT and STRW Tests***

7.34. STRX – Stress Watts (External Source)

The Stress Watts (External Source) test tests the transformer for breakdown of winding insulation by measurement of the energizing power of a winding, usually the primary, with the remaining windings open circuit.

This test applies the voltage from an external AC source (usually at twice the normal operating voltage and frequency), and measures the power drawn.

This test is suitable for large line frequency bobbin wound and some HF transformers. It checks the integrity of inter-turn insulation, the magnetic material, and joints at higher than the normal operating voltage.

This test uses an external source to provide the test signal which must be coupled to the tester via a Voltech AC Source Interface.

For details on configuring external AC sources with the AT7600, refer to the AC Source Interface User Manual available at www.voltech.com .

Measurements Conditions

A constant voltage (supplied by an external source) is applied to the winding under test. Both the RMS voltage and the power are measured. If necessary (and depending on the source type used), the voltage can be trimmed to the user specified value, and the measurement repeated. The measurement is repeated many times until the dwell time has elapsed. The result given is the measured power.

The test can detect winding insulation defects in the following way:

The winding insulation is stressed using the increased voltage (increased volts per turn).

Increasing the frequency in proportion to the voltage increase ensures that the magnetic core of the transformer is exercised over the same area as it would be at the normal operating voltage and frequency. - The core losses remain the same.

A significant increase in the power drawn when tested at increased voltage and frequency indicates a failure of the winding insulation that would not be detected at normal operating conditions.

The test signal can have a frequency in the range 20Hz to 5KHz, and an amplitude from 5V to 600V depending on the type of external source used. The current rating of a single AC Source Interface is 10A RMS. See also the STRW test which uses the AT7600s internal generator which can provide up to 270V AC at 40W.

Trimming of Requested Voltage (using Step-up transformer with AC Interface)

When using the AC interface with a step-up transformer, the AT7600 uses the Class D drive (used on VOC MAGI WATT and STRW) and routes it thought the AC interface. The AT7600 calculates a nominal value for the voltage needed to get the target value based on your requested voltage, and the programmed ratio of your chose transformer. The tester will then attempt to trim to get the exact value that is needed.

If either of the following two conditions are exceeded, the AT will report a trimming failure (0020):

- If the trimming requires deviation of more than 60% from the nominal (i.e., 100V nominal, but trimming requires excess of 160 V or less than 40 V)
- If the trimming requires outputting more than 230.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.47).***

For information on test accuracy specifications, refer to ***Chapter 10.2.16. WATX and STRX Tests (External Source).***

7.35. MAGI - Magnetizing Current

The AT7600 provides two main methods to verify that a transformer is correctly assembled, ensuring the proper number of primary and secondary turns, the right core material, and the correct air gap (if required).

Magnetizing current and open circuit voltage tests are preferred for line-frequency transformers, as they operate over the full B-H curve, including non-linear regions.

These tests allow for performance verification at the actual operating voltage and frequency, unlike conventional 5V LCR-style tests.

(For other transformer types, such as pulse transformers or those used in switched-mode power supplies, inductance and turns ratio tests are generally preferred.)

Measurement Conditions

When measuring magnetizing current, you should normally program the test to apply the highest working voltage at the lowest working frequency to the primary winding.

In the case of a transformer with a split primary the test can be conducted equally well by energizing just one of the primary windings, as opposed to the two in series.

The expected current will be greater for the single winding, rising in proportion to the turns ratio:

$$I_A = I_{AB} \times (N_{AB} / N_A)$$

Where:

I_A = The current to be specified when testing with winding A

I_{AB} = The current for windings A and B in series

N_A = The number of turns on winding A

N_{AB} = The number of turns on A and B in series

As an alternative, the formula above can be written using the voltage ratio between the two windings, rather than the turns ratio.

In principle, you may measure the magnetizing current using any winding, or any series combination of windings, with the current limit adjusted according to the formula above, because the Ampere-turns required to magnetize a transformer to a given flux level is independent of which winding is used.

In practice, the magnetizing current waveform may have a transient component following the switch-on of the test voltage, which is the inrush effect.

To give you repeatable and accurate results, the measurement does not start until any transient has settled.

In addition, to give you the quickest test execution time, the AT7600 uses an intelligent switch-on sequence which minimizes such transient effects and gets the transformer to steady operating conditions much faster.

Specifying the Test Limits

The AT7600 offers you two ways to specify the test limits:

- Using a true RMS measurement (the most common method)
- Using a mean-sense measurement that is scaled to RMS for sine waves.

However, you may wish to use the second method if, for example, your test limits have been established by a previous measurement on a low-cost multi-meter which uses this technique.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.37).***

For information on test accuracy specifications, refer to ***Chapter 10.2.6. MAGI Test***

7.36. MAGX - Magnetizing Current (External Source)

The AT7600 offers two basic alternative ways to confirm that the transformer has been assembled properly, with the appropriate number of primary and secondary turns, the right grade of magnetic material for the core, and the correct air gap if required.

Magnetizing current and open circuit voltage are the preferred tests for line frequency transformers, designed to operate over the full extent of the B-H curve, including the non-linear regions.

(For other transformers, such as pulse transformers and those used in switched mode power supplies, inductance and turns ratio are the preferred tests.)

This version of the **MAGI test uses an external source** to provide the test signal which must be coupled to the tester via a Voltech AC Source Interface.

For details on configuring external AC sources with the AT7600, refer to the AC Source Interface User Manual available at **www.voltech.com.**

Measurement Conditions

When measuring magnetizing current, you should normally program the test to apply the highest working voltage at the lowest working frequency to the primary winding.

In the case of a transformer with a split primary, the test can be conducted equally well by energizing just one of the primary windings, as opposed to the two in series. The expected current will be greater for the single winding, rising in proportion to the turns ratio:

IA = IAB x (NAB / NA)

Where:

I_A = The current to be specified when testing with winding A

I_{AB} = The current for windings A and B in series

N_A = The number of turns on winding A

N_{AB} = The number of turns on A and B in series

As an alternative, the formula above can be written using the voltage ratio between the two windings, rather than the turns ratio.

In principle, you may measure the magnetizing current using any winding, or any series combination of windings, with the current limit adjusted according to the formula above, because the Ampere-turns required to magnetize a transformer to a given flux level is independent of which winding is used.

In practice, the magnetizing current waveform may have a transient component following the switch-on of the test voltage. To give you repeatable accurate results, the measurement does not start until any transient has settled.

The test signal can have a frequency in the range 20 Hz to 5 kHz, and an amplitude from 5V to 600V depending on the type of external source used. The current rating of a single AC Source Interface is 10A RMS. See also the MAGI test which uses the AT7600s internal generator which can provide up to 270V AC at 40W.

Trimming of requested Voltage (when using Step-up transformer with AC Interface)

When using the AC interface with a step-up transformer, the AT7600 uses the Class D drive (used on VOC MAGI WATT and STRW) and routes it thought the AC interface.

The AT7600 calculates a nominal value for the voltage needed to get the target value based on your requested voltage, and the programmed ratio of your chose transformer. The tester will then attempt to trim to get the exact value that is needed.

If either of the following two conditions are exceeded, the AT will report a trimming failure (0020):

- If the trimming requires deviation of more than 60% from the nominal (i.e., 100V nominal, but trimming requires excess of 160 V or less than 40 V)

- If the trimming requires outputting more than 230V

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.44).***

For information on test accuracy specifications, refer to ***Chapter 10.2.7. MAGX Test (External Source)***

7.37. VOC - Open Circuit Voltage

The AT600 provides basic alternative ways to verify that a transformer is assembled correctly, with the appropriate number of primary and secondary turns.

Open circuit voltage (VOC) testing is the preferred method for line-frequency transformers that operate across the full B-H curve, including its non-linear regions.

VOC testing is favored over turns ratio (TR) testing because it assesses performance under operating conditions, particularly at the limits of the B-H curve.

For transformers such as pulse transformers and those used in switched-mode power supplies, turns ratio measurement is generally the preferred method.

While the VOC test can only indicate the voltage ratio between windings, it does not determine the exact number of turns.

To ensure the correct absolute number of turns, it is recommended to include a magnetizing current (MAGI) test in the program.

Measurement Conditions

Open circuit voltage is measured by applying an AC test voltage to a chosen winding, typically the primary, and recording the voltage induced in another winding.

For efficient testing of multiple windings, follow these guidelines:

- Group **all** open circuit voltage tests **consecutively** in the program.
- Use the same energized winding, with consistent test voltage and frequency for each test.

If a magnetizing current test uses the same energized winding, test voltage, and frequency, place it immediately before the first VOC test.

Specifying the Test Limits

The AT7600 offers you three ways to specify the test limits:

- Using a normal AC (RMS) measurement.
- Using a rectified (mean) measurement.
- Using a DC (mean) measurement.

The AC (RMS) value would be used, but you could use the rectified (mean) or DC (mean) measurements if, for example, you are testing transformers fitted with a rectifying diode.

To give the best accuracy, the DC measurement is averaged over the period of the test frequency.

In addition, the VOC test can be used to test the polarity (or phasing) of the windings, if this is required.

VOC Using Constant Current

The VOC test also allows you to specify a constant target current rather than a Voltage as you specified test conditions.

In this case the AT EDITOR dialog box will ask for a Nominal Voltage.

The AT uses this nominal voltage as a starting position for testing. The tester will then attempt to trim V to get the exact value current that is needed.

If either of the following two conditions are exceeded, the AT will report a trimming failure (0020):

If the trimming requires deviation of more than 60% from the nominal (i.e., 100V nominal, but trimming requires excess of 160 V or less than 40 V)

If the trimming requires outputting more than 270V.

For best practice advice on minimizing common mode effects when testing autotransformers or center taps, refer to ***Chapter 7.13.***

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.38).***

For information on test accuracy specifications, refer to ***Chapter 10.2.8. VOC Test***

7.38. VOCX - O/C Voltage (External Source)

The AT7600 offers two basic alternative ways to confirm that the transformer has been assembled properly, with the appropriate number of primary and secondary turns.

Open circuit voltage measurements are the preferred tests for line frequency transformers, designed to operate over the full extent of the B-H curve, including the non-linear regions.

(For other transformers, such as pulse transformers and those used in switched mode power supplies, a measurement of turns ratio is the preferred test.)

Clearly an open circuit voltage test cannot tell you the actual number of turns on a winding, only the ratio between one winding and the next. You should therefore also include a magnetizing current test (MAGI or MAGX) in your program, to give confidence that the absolute number of turns is correct as well as the ratio.

This version of the VOC test uses an external source to provide the test signal which must be coupled to the tester via a Voltech AC Source Interface (contact your supplier for details).

For details on configuring external AC sources with the AT7600, refer to the AC Source Interface User Manual available at **www.voltech.com.**

Measurement Conditions

Open circuit voltage is measured by applying an AC test voltage (supplied by an external source) to a selected winding (usually a primary winding), and measuring the resulting voltage produced on another winding.

If there are several windings to be tested, then the program will execute more quickly if the following points are observed:

Place all the open circuit voltage (VOCX) tests consecutively at the same point in the program.

Use the same energized winding, with the same test voltage and frequency for each test.

If there is a magnetizing current (MAGX) test which has the same energized winding and the same test voltage and frequency, place this immediately before the first open circuit voltage test.

The test signal can have a frequency in the range 20Hz to 5 kHz, and an amplitude from 5V to 600V depending on the type of external source used. The current rating of a single AC Source Interface is 10A RMS. See also the MAGI test which uses the AT7600s internal generator which can provide up to 270V AC at 40W.

Specifying the Test Limits

The AT7600 offers you three ways to specify the test limits:

- Using a normal AC (RMS) measurement.
- Using a rectified (mean) measurement.
- Using a DC (mean) measurement.

The AC (RMS) value would be used, but you could use the rectified (mean) or DC (mean) measurements if, for example, you are testing transformers fitted with a rectifying diode.

To give the best accuracy, the DC measurement is averaged over the period of the energizing frequency. In addition, the VOCX test can be used to test the polarity (or phasing) of the windings, if this is required. This is not available when some types of external source

Trimming of Requested Voltage (using Step-up transformer with AC Interface)

When using the AC interface with a step-up transformer, the AT7600 uses the Class D drive (used on VOC MAGI WATT and STRW) and routes it through the AC interface.

The AT7600 calculates the nominal value for the voltage needed to get the target value based on your requested voltage, and the programmed ratio of your step-up transformer. The tester will then attempt to trim to get the exact value that is needed.

If either of the following two conditions are exceeded, the AT will report a trimming failure (0020):

- If the trimming requires deviation of more than 60% from the nominal (e.g., 100V nominal, but trimming requires excess of 160 V or less than 40 V)
- If the trimming requires outputting more than 230 V

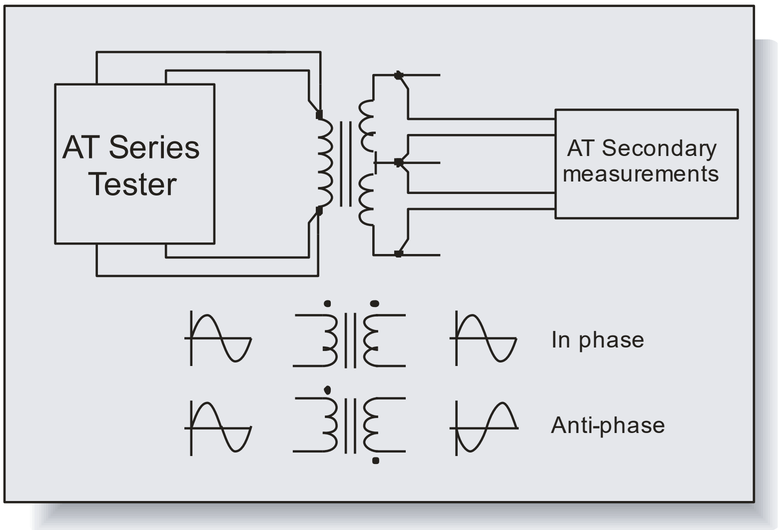
For best practice advice on minimizing common mode effects when testing autotransformers or center taps, refer to ***Chapter 7.13.***

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.45).***

For information on test accuracy specifications, refer to ***Chapter 10.2.9. VOCX Test (External Source)***

7.39. LVOC – Low Voltage Open Circuit

Measurement Range	Test Voltage	Test Frequency	Basic Accuracy
100µV to 650V	1mV to 5V	20Hz to 3MHz	0.10%



The low voltage open circuit test is used to confirm that windings have the correct ratio of turns between them, and that the phasing of the windings is correct.

This test is used for signal, pulse, and switched mode power transformers where the normal operating conditions require only small excursions of the B-H curve, never extending beyond the linear region.

On the AT7600, high voltage open circuit tests (VOC or VOCX) are available for testing line frequency transformers at their operating point (up to 270V, 1 kHz and 2A).

Measurement Conditions

To measure low voltage open circuit, the test signal is applied to one winding called the energized winding.

The voltages across another winding (or the same, energized winding) are measured. The low voltage open circuit measurement is the RMS value of the voltage measured and can be an AC or a DC voltage.

It is recommended that you choose the winding with the highest number of turns as the one to be energized.

Choosing Test Conditions

The recommended test conditions depend on the inductance of the energized winding; they are given in the table below assuming that the energized winding is the one with the highest number of turns:

INDUCTANCE OF THE ENERGIZED WINDING			PREFERRED TEST SIGNAL	
			FREQUENCY	VOLTAGE
100nH	→	1µH	300kHz	10mV
1uH	→	10µH	100kHz	30mV
10uH	→	100µH	30kHz	50mV
100uH	→	1mH	10kHz	100mV
1mH	→	10mH	1kHz	100mV
10mH	→	100mH	100Hz	100mV
100mH	→	1H	100Hz	300mV
1H	→	10H	50Hz	1V
10H	→	100H	50Hz	5V
100H	→	1kH	50Hz	5V
1kH	→	10kH	20Hz	5V

V Applied and V Measured

The signal is usually applied to the primary winding, or the winding which has the largest number of turns.

However, if by doing this, the expected voltage on the winding with the smallest number of turns falls below 1mV, then the test voltage should be increased. Best repeatable measurements will be obtained ONLY if both the V applied, and V measured are BOTH >1mV.

This may also require an increase in the test frequency so that the current taken by the driven winding does not become too large, but in general this frequency increase should be kept as small as possible to avoid problems caused by stray capacitance at high frequencies.

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.29).***

For information on test accuracy specifications, refer to ***Chapter 10.2.10. LVOC Test***

7.40. ILK – Leakage Current

Leakage current refers to the small current that flows through or around insulating material when subjected to an electric field.

This current is caused by the electric field's influence on the insulating material.

The leakage current test is crucial for transformers used in specific applications, particularly in the medical field, where it is an additional safety requirement.

This test measures the leakage current resulting from real-world interwinding capacitance between the selected windings under test. In medical applications, even small currents as low as 100 µA can be considered hazardous, making this an essential safety check.

Outside of medical applications, leakage current can impact the isolated side of measurement equipment, making this test valuable for instrumentation transformers as well. While a traditional capacitance (C) test would reveal the interwinding capacitance, it typically operates at 5V, not at the transformer’s actual operating voltages.

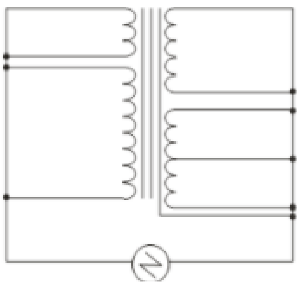
Medical standards also require a direct measurement of the leakage current itself, rather than just the capacitance.

Measurement Conditions

The test is typically carried out by applying the test voltage between all the primary terminals shorted together, and all the secondary terminals and screen shorted together.

The voltage and frequency applied are normally the operating voltage and frequency of the transformer.

The energization voltage can be 0-270V, 20-1500 Hz.



For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.36).***

For information on test accuracy specifications, refer to ***Chapter 10.2.26. ILK Test***

7.41. LSBX – Inductance with External Bias (Series Circuit)

DC Bias	Measure Range	Test Voltage	Test Frequency	Basic Accuracy
0.1A to 250A	1nH 1MH	1mV to 5V	20Hz to 3MHz	0.2% @ Q>10

NOTE: This test requires the use of one or more **Voltech DC1000A Precision DC Bias Current Source.**

When using this test, ensure that the terminal you pick as HIGH in the editor program is also the node that is connected to the AHi output of the DC1000A. Similarly, the node you specify as LOW should also be the node that is connected to the ALo output of the DC1000A.

The inductance of a transformer winding while an external bias current is flowing through it may be tested using series or parallel equivalent circuit models.

Initially the DC bias current is set up and allowed to stabilize. An AC voltage is applied across the selected winding; the voltage across and current through the winding is then measured using harmonic analysis. The measured voltage is divided by the current to obtain a complex impedance and the inductance is calculated.

For Legacy AT3600 Users

The DC1000 can be easily integrated with the AT series testers to give automated and integrated DC Bias testing, combined with the wide range of tests provided by the AT Series.

If you are integrating the DC1000 with any of the high voltage AT tests (IR, HPAC, HPDC,) it is important that the DC1000A is ONLY connected to nodes used as the LO terminals in these high voltage tests. This will prevent damage to the DC1000A.

Any terminals used for LSBX, LPBX & ZBX, **cannot** be used as “HI” terminals for IR HPAC, HPDC, in the same program. The AT7600 and AT Editor will check for this and warn you if you are attempting to do this.

For more information:

DC1000A Manual is available on **www.voltech.com/downloads**

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.41).***

For information on test accuracy specifications, refer to ***Chapter 10.2.27. LSBX and LPBX Tests***

7.42. LPBX – Inductance with External Bias (Parallel Circuit)

DC Bias	Measure Range	Test Voltage	Test Frequency	Basic Accuracy
0.1A to 250A	1nH 1MH	1mV to 5V	20Hz to 3MHz	0.2% @ Q>10

NOTE: This test requires the use of one or more **Voltech DC1000A Precision DC Bias Current Source**.

When using this test, ensure that the terminal you pick as HIGH in the editor program is also the node that is connected to the AHi output of the DC1000. Similarly, the node you specify as LOW should also be the node that is connected to the ALo output of the DC1000A**.**

The inductance of a transformer winding while an external bias current is flowing through it may be tested using series or parallel equivalent circuit models.

Initially the DC bias current is set up and allowed to stabilize. An AC voltage is applied across the selected winding; the voltage across and current through the winding are then measured using harmonic analysis. The measured voltage is divided by the current to obtain complex impedance and the inductance is calculated.

For Legacy AT3600 Users

The DC1000A can be easily integrated with the AT series testers to give automated and integrated DC Bias testing, combined with the wide range of tests provided by the AT Series.

If you are integrating the DC1000A with any of the high voltage AT tests (IR, HPAC, HPDC,) it is important that the DC1000A is ONLY connected to nodes used as the LO terminals in these high voltage tests. This will prevent damage to the DC1000A.

Any terminals used for LSBX, LPBX & ZBX, **cannot** be used as “HI” terminals for IR HPAC, HPDC, in the same program. The AT7600 and AT Editor will check for this and warn you if you are attempting to do this. The AT3600 and old AT Editor did not give this warning, but it is still a valid best practice for the AT3600.

For more information:

DC1000A Manual is available on **www.voltech.com/downloads**

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.42).***

For information on test accuracy specifications, refer to ***Chapter 10.2.27. LSBX and LPBX Tests***

7.43. ZBX - Impedance with External Bias

DC Bias	Measure Range	Test Voltage	Test Frequency	Basic Accuracy
0.1A to 250A	1mΩ to 1MΩ	1mV to 5V	20Hz to 3MHz	0.2%

NOTE: This test requires the use of one or more **Voltech DC1000A Precision DC Bias Current Source**.

When using this test, ensure that the terminal you pick as HIGH in the editor program is also the node that is connected to the AHi output of the DC1000. Similarly, the node you specify as LOW should also be the node that is connected to the ALo output of the DC1000A.

The Winding Impedance with External Bias test measures the impedance of a selected winding while applying a DC current from the DC1000 through the winding. An AC voltage is also applied across the winding from the AT. This test can be used with inductors to measure the change in impedance with a bias current.

For Legacy AT3600 Users

The DC1000 can be easily integrated with the AT series testers to give automated and integrated DC Bias testing, combined with the wide range of tests provided by the AT Series.

If you are integrating the DC1000 with any of the high voltage AT tests (IR, HPAC, HPDC,) it is important that the DC1000 is ONLY connected to nodes used as the LO terminals in these high voltage tests. This will prevent damage to the DC1000.

Any terminals used for LSBX, LPBX & ZBX, **cannot** be used as “HI” terminals for IR HPAC, HPDC in the same program. The AT7600 and AT Editor will check for this and warn you if you are attempting to do this. The AT3600 and old AT Editor did not give this warning, but it is still a valid best practice for the AT3600.

For more information:

DC1000A Manual is available on **www.voltech.com/downloads**

For detailed guidance on programming this test, refer to the ***AT .NET Editor Manual (Document 98-125, Section 2.5.43).***

For information on test accuracy specifications, refer to ***Chapter 10.2.28. ZBX Test***

7.44. WAIT – Fixed duration or Indefinite Test Delay

The **WAIT** test can be used in two main ways to give greater control over the timing of the test program execution.

1) Fixed Duration Delay

To allow a fixed duration to pause during a test program.

Use cases:

- To allow time for the UUT to demagnetize after a high voltage or high bias test before proceeding with the rest of the test in a program.
- To allow a fixed time for external apparatus (e.g., your own external hydraulic or pneumatic systems) to operate
- To allow any relays operated by an OUT (User Port) test to settle and stabilize, if you find that the speed of execution is too rapid to allow for such devices to settle into their switched state.

The programmed delay can be **1 millisecond to 60 Seconds.**

Once the requested time has elapsed the program test sequence is automatically resumed.

During the delay time the interlock is still active and a break to the interlock will result in a controlled program halt as normal.

2) Wait for User

To allow an infinite to wait to the program sequence to allow the operator to make changes to wiring before allowing the program to resume execution.

Use cases:

- To allow the operator to add (or then later to remove) a load resistor or other component from the UUT.

- To allow any change to wiring configuration, either manually or by switches / relays to be implemented manually.

This mode allows users to:

A. Implement a semi-automatic switching process where the volume of parts being tested may not make it cost effective to build a fully automatic switching fixture using the OUT test.

B. Perform proof-of-concept testing on small volume prototype batches before financially committing to a fixture using the OUT test to switch relays.

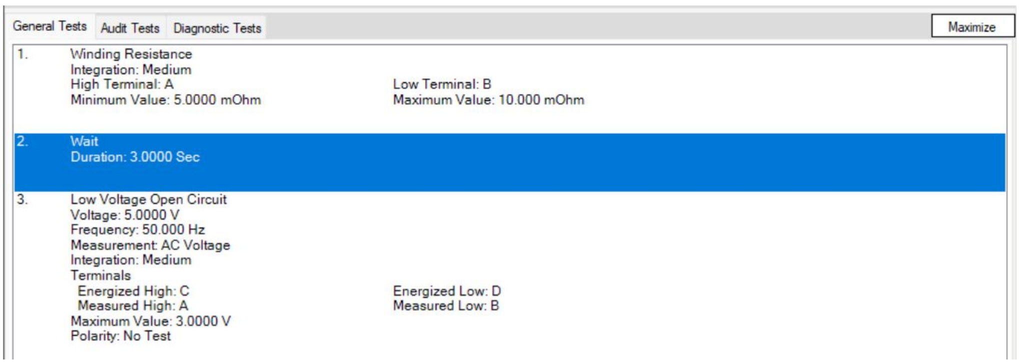
In this case the AT7600 interlock is deactivated once all signals are confirmed to be **OFF**, to then allow the user to touch the UUT to make amendments to the UUT.

Once the user presses RUN to continue, the interlock is re-enabled to ensure user safety, and the test program is resumed.

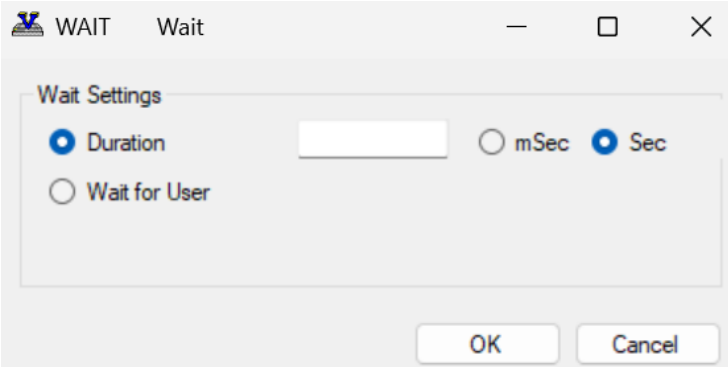
Most importantly, this allows you to make configuration changes during a test program so that the full test sequence is still recorded as one set of results.

Specifying Test Conditions

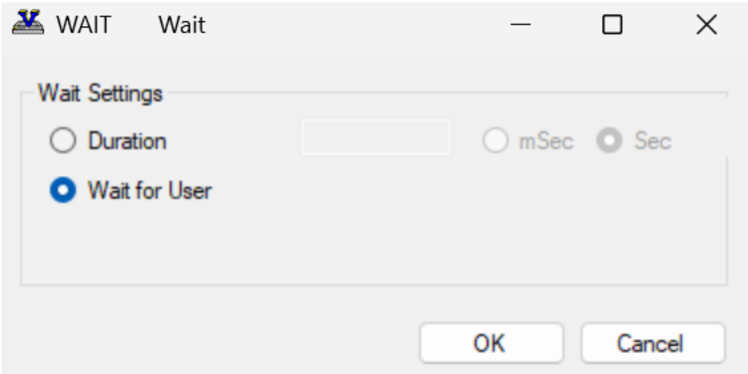
In the AT Editor inset the WAIT test where you would like the pause to occur.



A) Select DURATION for a fixed duration and enter the duration of the pause. This can be 0.001 - 60.000 Seconds.



B) Select Wait for User to request a halt to the program until the user restarts by using the RUN button.

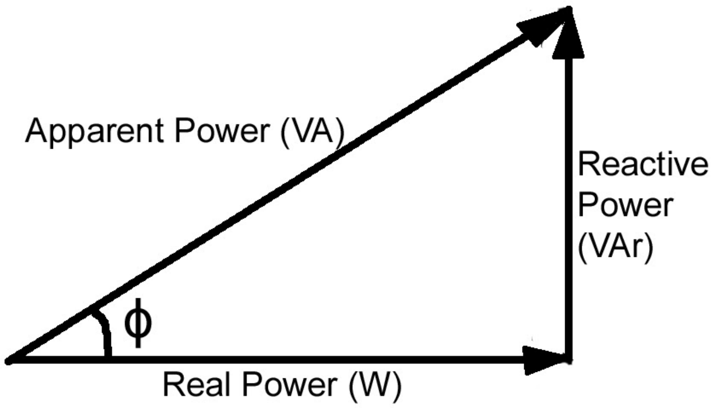


7.45 PWRF – Power Factor Test

Power factor is defined as the ratio of real to apparent power used in any circuit.

Electrically it is defined as:

Power Factor = [Real Power / Apparent Power] = [Watts / (Volts x Amps)]



As can be seen from the above vector diagram,

COS (ϕ) = Power Factor

Theoretically, power factor can range from -1 to +1. (Negative power factors indicate energy being returned from the load.) In the case of a passive transformer, this PF will usually be between 0 and 1, with the ideal being a power factor of 1.

The AT7600 allows you to make a direct measurement of this important parameter in two ways:

1) True Power factor

This includes the fundamental and all harmonic content of Volts and Amps and Watts

2) Displacement Power Factor

This measures only the fundamentals of Volts and Amps and Watts

There is a third term “**Distortion Power Factor**,” that is only of the harmonic content, but this is rarely used as it carries little meaning in practical applications.

It can also be easily calculated from:

True PF = Displacement PF * Distortion PF

The PWRF test can be used on any transformer but is most applicable to any mains / line voltage transformer where external standards and regulations require transformers used on equipment to be efficient and not lossy.

Low power factors indicate an inefficient use of energy that could result in thermal heating of windings and cores, resulting in lower life spans, as well as the obvious financial operating cost of the electrical power lost.

PWRF is also important for current transformers, where an ideal CT would have no winding resistance, no magnetising current on the winding and no core losses, all of which will result in measurement error.

The PWRF test provides a convenient single test for confirming integrity of complete products - i.e., Core material consistency, DC Resistance and Magnetizing current.

Measurement Conditions

During the Power Factor test, a constant, user specified AC voltage is applied across a selected winding.

All other windings are held open circuit during this test.

The AT7600 measures the voltage across the winding and current through the winding.

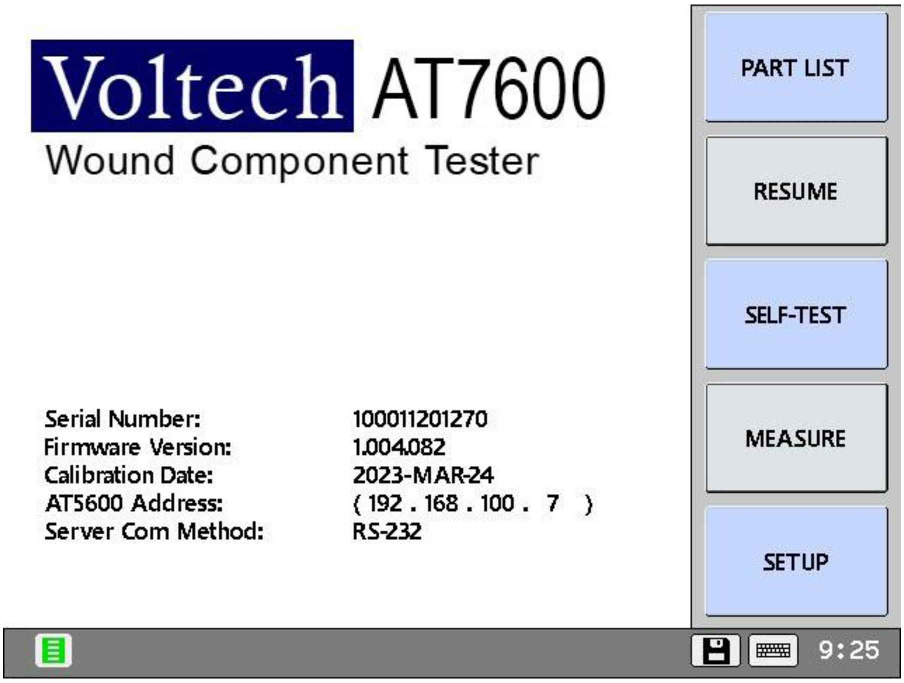
The Wattage is also measured as the product of the current and voltage waveforms.

If, in the program, the PWRF test follows either a VOC or MAG or WATT test which has the same test conditions (voltage and frequency), and is applied to the same winding, then the measurement results from the previous tests will be reused, saving on program execution time.

The test signal can have a frequency in the range **20Hz to 1.5KHz**, and an amplitude from **1V to 270V**, and a power of up to **40W.**

Chapter 8: Front Panel Operation

This chapter provides a detailed guide to the AT7600's front panel interface. It explains how users interact with the system using the capacitive touch screen display, dedicated RUN and STOP hardware buttons, and structured input fields.



8.1 Introduction

Introduces the AT7600 front panel interface, including the touch screen, RUN/STOP buttons, and user input areas. Covers navigation, setup, and basic interaction for operating the tester.

8.2 Testing Wound Components

Explains how to initiate and monitor tests for wound components using the front panel. Includes steps for entering traceability data, running tests, and viewing results.

8.1. Introduction

The AT7600's front panel provides direct access to the system's operational controls. It includes a capacitive touch screen display, RUN and STOP buttons, and on-screen fields for entering part-related and traceability information. This section describes each of these functions in detail.

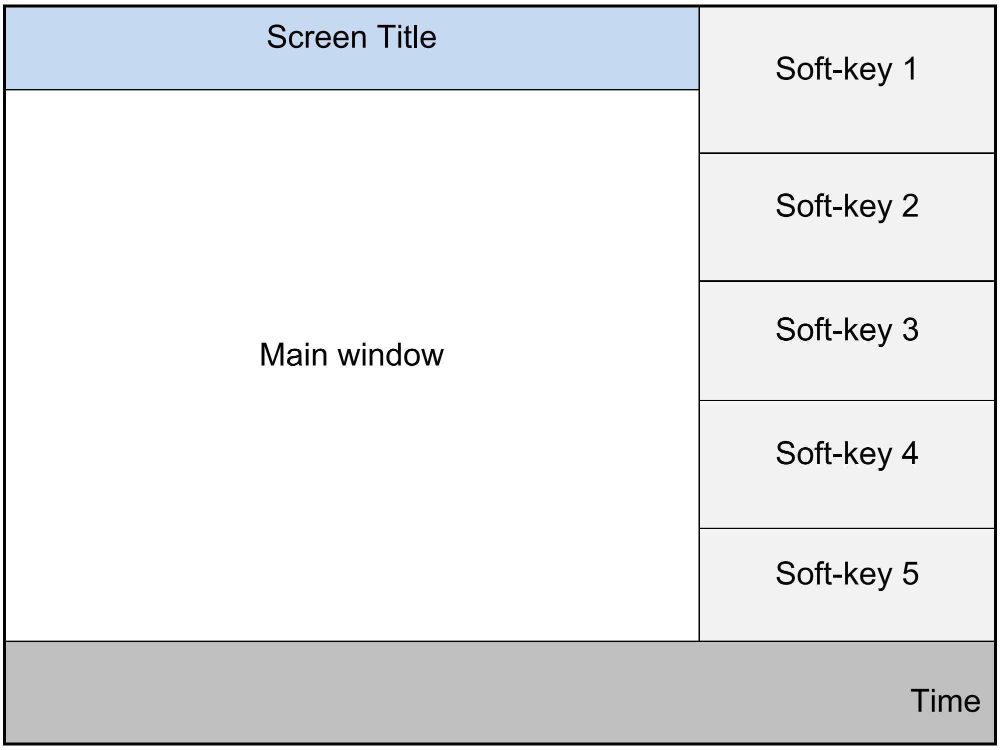
8.1.1. Touch Screen Display

The AT7600 features a color touch screen display, activated by light finger pressure on any touch-sensitive area.

The screen layout is consistent throughout the menu system and includes a screen title at the top, a main window on the left, and a soft-key area on the right.

Each soft-key changes function depending on the active menu. Its current function is indicated within the soft-key border by text or a symbol, also referred to as the **soft-key name**.

Up to five soft keys may be displayed on any given screen.

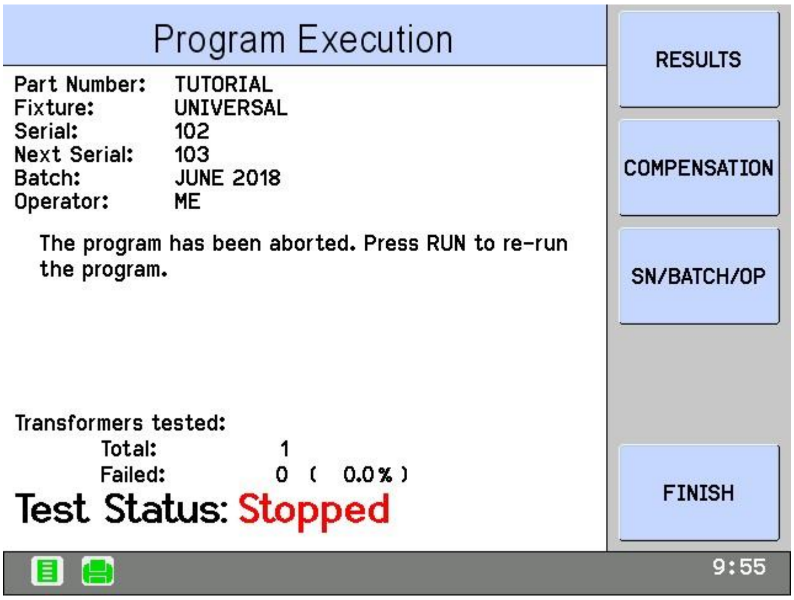


8.1.2. RUN & STOP Buttons

The **RUN** and **STOP** buttons are **high-sensitivity piezo switches** that require only light pressure to activate, with no perceivable movement.

This design minimizes operator fatigue and ensures extremely high switch reliability. Each button is surrounded by an indicator light, **GREEN** for **RUN** and **RED** for **STOP**.

The green indicator illuminates while a test program is running, and the red indicator lights when the program has been stopped.



8.1.3. User Input

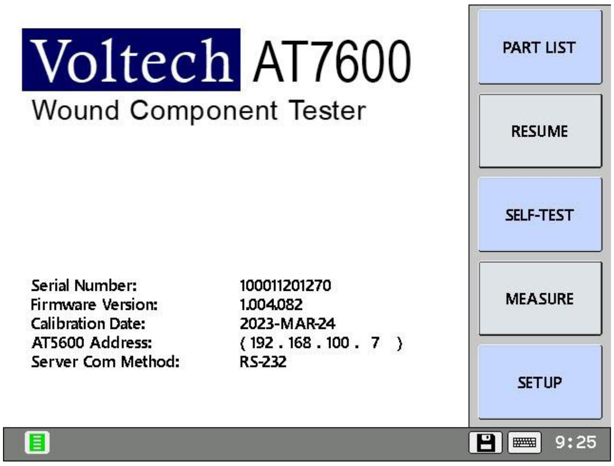
User input can be made into the AT7600 using the touch screen, buttons, or accessories connected to available interface ports. The touch screen allows users to tap and select items, and it can display a soft keyboard for text entry. A foot switch or other control device may also be connected via the remote port.

8.1.4. Splash Screen

When the AT7600 is powered on, a splash screen will briefly appear while the system performs internal checks and initializes its operating system.

8.1.5. Power On

Once the AT7600 has initialized and powered up, it will wait for user input. The screen displayed at this point is the top-level menu, providing access to all major system functions.



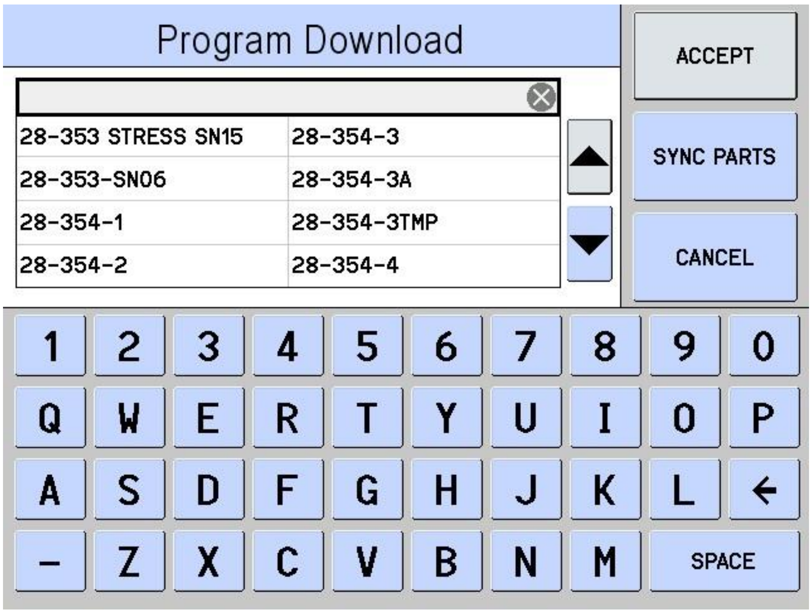
SOFT-KEY	FUNCTION
PART LIST	Load a test program from AT SERVER software
RESUME	Re-load the last test program
SELF-TEST	Checks the internal functionality of the AT7600
SET UP	Changes the AT7600 options
UNIT INFO	Information on the AT7600

8.1.6. Part List

This is the normal operating screen of the AT7600 used during production testing of transformers.

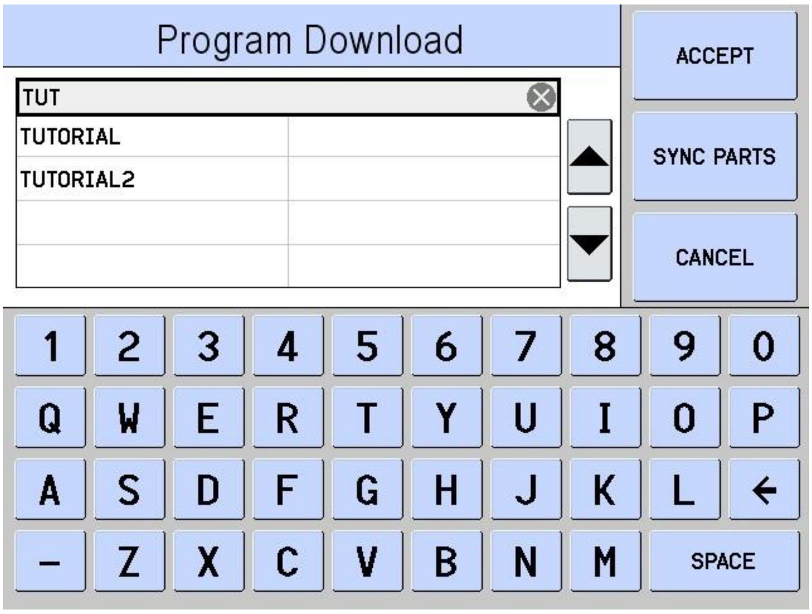
- Before using the PART LIST screen for testing, ensure the following setup steps have been completed:
- Test programs have been created for the transformers you wish to test.
- The programs are stored on the AT Server, which is connected to the tester and actively running. The tester must be configured to use the Server via either Ethernet or RS232.
- Test fixtures have been created and set up for the transformers being tested.

To access the PART LIST screen, go to the top-level menu and tap the soft-key PART LIST. This will open the following display:



SOFT-KEY	FUNCTION
ACCEPT	Loads the selected test program in AT7600
BACKSPACE	Clears the last character entered
PAGE UP	Page up the list of programs
PAGE DOWN	Page down the list of programs
CANCEL	Return to the top-level screen.
SYNC PARTS	Syncs the list of programs from the AT Server to AT7600.

8.1.6.1. Entering a Part Number



The screen displays a list of all test programs stored in the **AT SERVER**'s designated programs directory.

This directory may be located either on the **AT SERVER PC** itself or on a network drive accessible to the AT SERVER.

To select a test program:

- Use the **Page Up** and **Page Down** soft keys to scroll through the list.
- Tap directly on a program name to select it. The selected program will appear in the top grey selection box.
- Alternatively, you may type the program name (or part of it) using the on-screen keyboard. As you type, the list will automatically filter to show only matching names.

Once the desired program is selected, tap the soft key **ACCEPT** to confirm your choice.

To clear the current selection, tap the **"X"** icon to the right of the selection box.

Test programs (*.ATP) created using the Test Program Editor may have any combination of the following three options enabled or disabled:

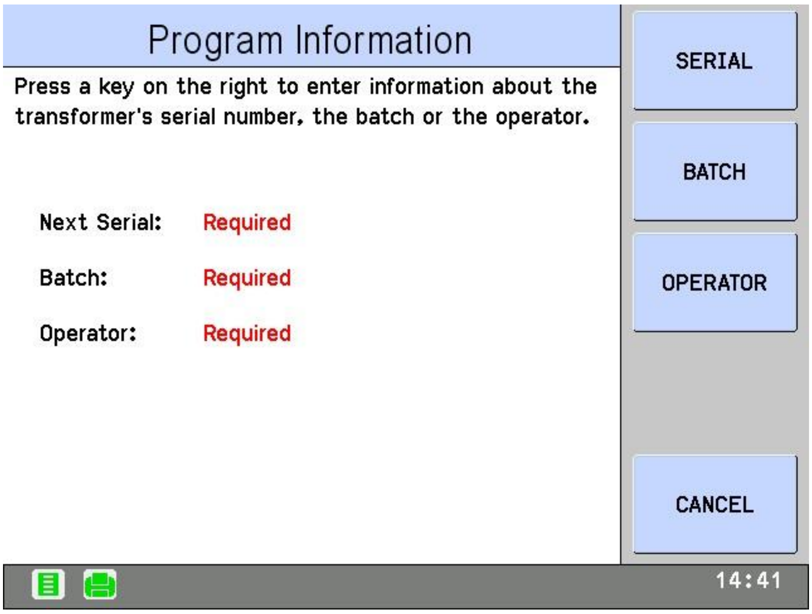
- Serial Number
- Batch Number
- Operator Name

If any of these options are enabled, the corresponding data entered by the operator will be included in the test results sent back to the AT Server.

This additional information can be used for various purposes, such as generating detailed production reports.

Note: These options are defined per test program, they are not global settings for the AT7600. This allows different transformers to require different operator inputs as needed.

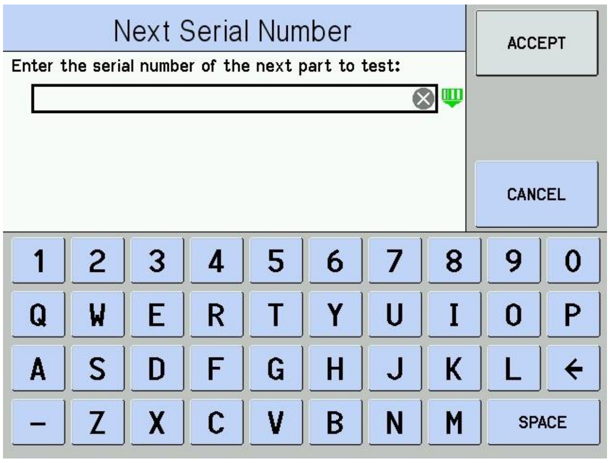
If any of these options have been **enabled** in the selected test program, the following screen will appear when the program is loaded:



8.1.6.2. Serial Number

You may enter the Serial Number of the transformer under test as part of the production record.

To do this, tap the soft-key **Serial Number.** The following screen will appear:



- Enter the serial number, then tap **ACCEPT** to confirm.
- A green icon next to the entry field indicates that the field supports input from a barcode reader.
- Use the BACKSPACE (<–) soft-key to delete the last character entered.
- Tap the “X” icon within the entry field to clear all text.

Serial numbers may be **alphanumeric**. If the last characters are numeric, the tester will automatically **increment** those digits after each test cycle.

Note: To allow for correct auto-incrementing, include enough **leading zeros** if the number range is expected to exceed a certain number of digits.

For example:

- TX001 → will increment to TX002, TX003, etc.
- TX099 → becomes TX100
- TX999 (no leading zero) would result in a different increment pattern.
    - TX999 → TX000 → TX001

Valid Characters for Serial Number, Operator Name, and Batch Number

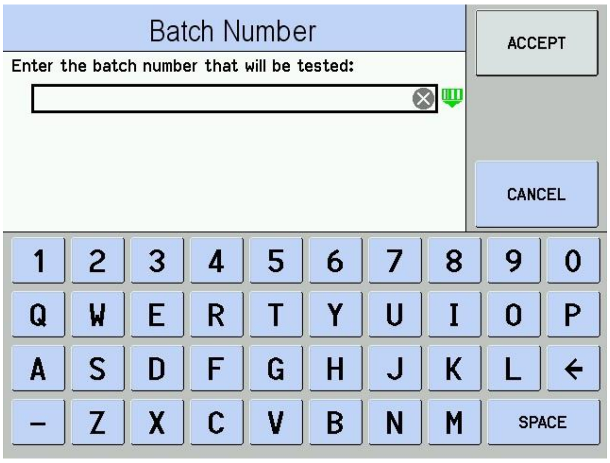
Whether entered manually, via barcode scanner, or USB keyboard, only the following characters are accepted — matching those available from the on-screen keyboard:

- **0–9**: Numerals
- **A–Z**: Uppercase letters only
- **“–”**: Minus symbol
- **“ ”**: Space character

8.1.6.3. Batch

You may enter the **Batch Number** for the transformer under test as part of the production record.

To do this, tap the soft-key **BATCH**. The following screen will appear:



- Enter the batch number, then tap ACCEPT to confirm.
- A green icon next to the entry field indicates that the field supports input from a barcode reader.
- Use the BACKSPACE (<–) soft-key to delete the last character entered.
- Tap the “X” icon within the entry field to clear all text.

Valid Characters for Serial Number, Operator Name, and Batch Number

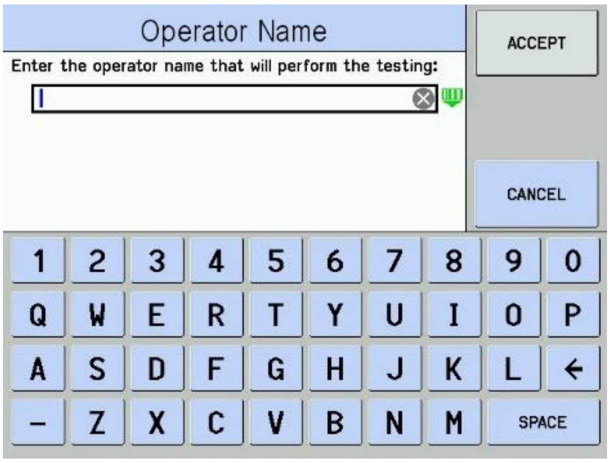
Whether entered manually, via **USB barcode scanner**, or **USB keyboard**, only the following characters are accepted. These match the character set available on the AT7600's on-screen keyboard:

- **0–9**: Numerals
- **A–Z**: Uppercase letters only
- **"-"**: Minus symbol
- **" "**: Space character

8.1.6.4. Operator

You may enter the **Operator Name** as part of the production test record.

To do this, tap the soft-key **OPERATOR**. The following screen will appear:



- Enter the operator name, then tap **ACCEPT** to confirm.
- A **green icon** next to the entry field indicates that the field supports input from a **barcode reader**.
- Use the **BACKSPACE (<–)** soft-key to delete the last character entered.
- Tap the **"X"** icon within the entry field to clear all text.

Valid Characters for Serial Number, Operator Name, and Batch Number

Whether entered manually, via **USB barcode scanner**, or **USB keyboard**, only the following characters are accepted. These match the character set available on the AT7600's front panel keyboard:

- **0–9**: Numerals
- **A–Z**: Uppercase letters only *(lowercase letters are not supported)*
- **"-"**: Minus symbol
- **" "**: Space character

8.1.6.5. Compensation

Compensation is a process used to improve the accuracy of measurement results by accounting for the effects of test fixtures, leads and cabling.

These external elements can introduce small resistances, inductances or capacitances that may distort the true readings of your component under test.

By performing compensation routines, the AT7600 can measure and subtract the unwanted influences, ensuring that your results reflect only the properties of the component itself.

There are three types of compensation available in AT7600:

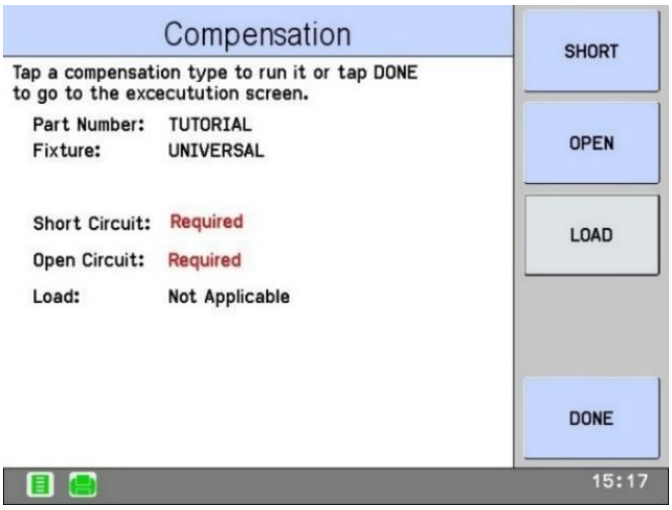
COMPENSATION	DESCRIPTION
Short Circuit (SC)	Measures and cancels residual impedances in the test path when terminals are **shorted**.
Open-Circuit (OC)	Measures and cancels out stray capacitances or impedances when the test path is **open**.
Load Compensation	Uses a **known standard part** to normalize measurements. This is useful when high accuracy is required.

Compensation Usage

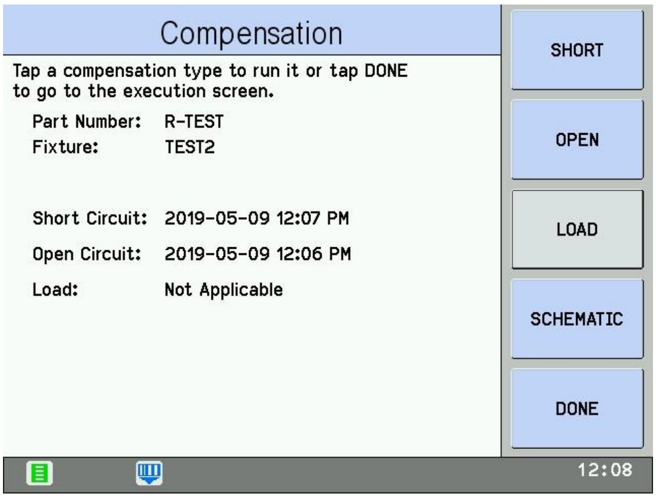
SC + OC compensation **is strongly recommended** whenever possible.
Load compensation is optional but useful when you want to normalize results to a known standard, typically a unit you've measured and designated as your reference.

When you **load a test program**, the AT7600 will:

- Show which types of compensation apply (marked as **Required** or **Not applicable**) or;



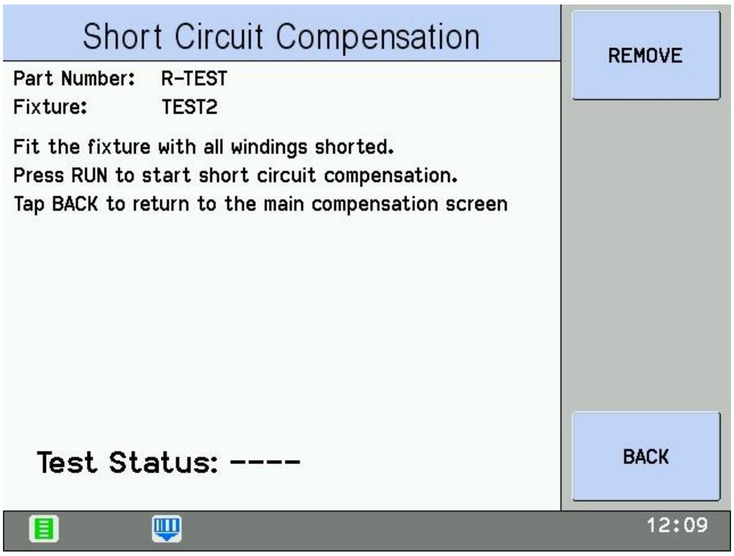
- Shows the date/time of the most recent compensation, if performed.



If you wish to skip compensation, simply press **DONE** softkey.

Performing Short Circuit Compensation

When the SHORT soft key is tapped, the following screen shall appear:

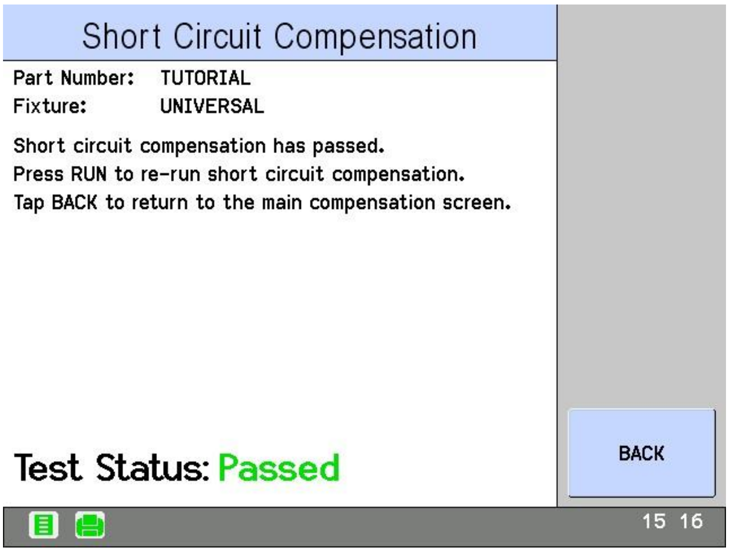


1. Fit the fixture with all windings shorted and tap the **RUN** button to begin the Short Circuit Compensation process. (Instructions can also be seen on the AT7600 Screen)

2. Use the following soft keys as needed:

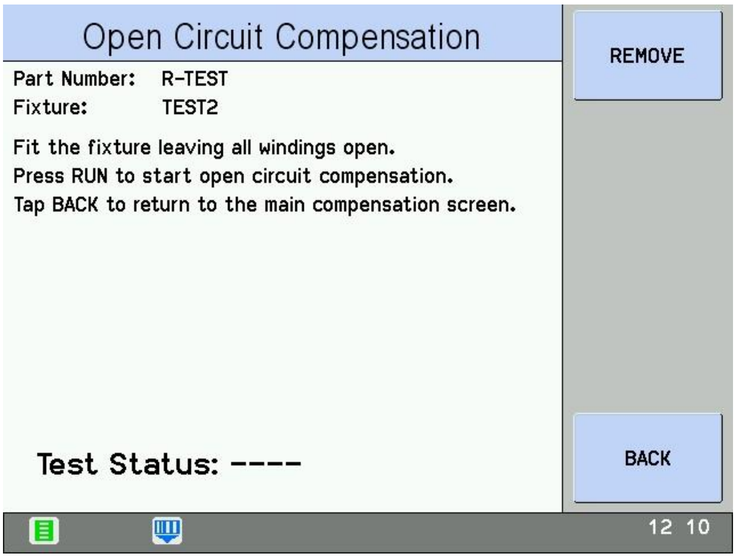
   Remove – Clears any previously applied short circuit compensation
   Back – Returns to the previous menu without making any changes

3. Once the AT7600 completes the short circuit compensation, the following screen will be displayed:



Performing Open Circuit Compensation

When the OPEN soft key is tapped, the following screen shall appear:

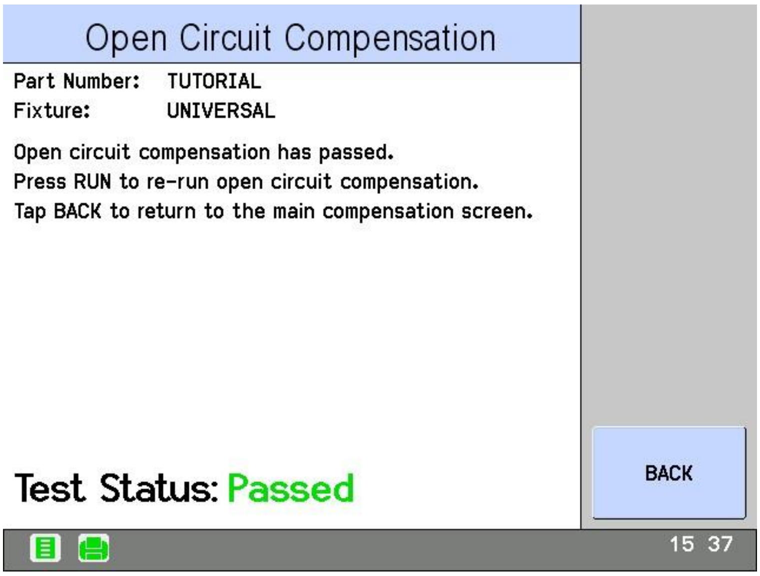


1. Fit the fixture leaving all windings open. Then tap the **RUN** button to begin the open circuit compensation.

2. Use the following soft keys as needed:

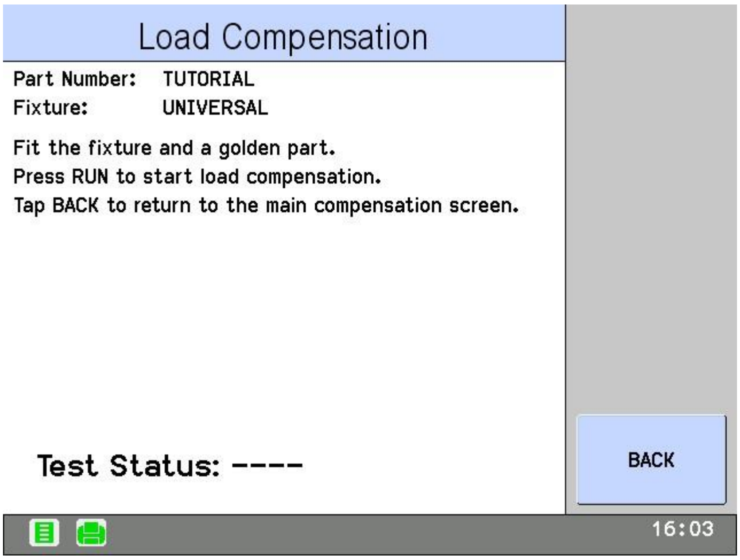
Remove – Clears any previously applied open circuit compensation
Back – Returns to the previous menu without making any changes

3. Once the AT7600 completes the open circuit compensation process, the following confirmation screen will appear.



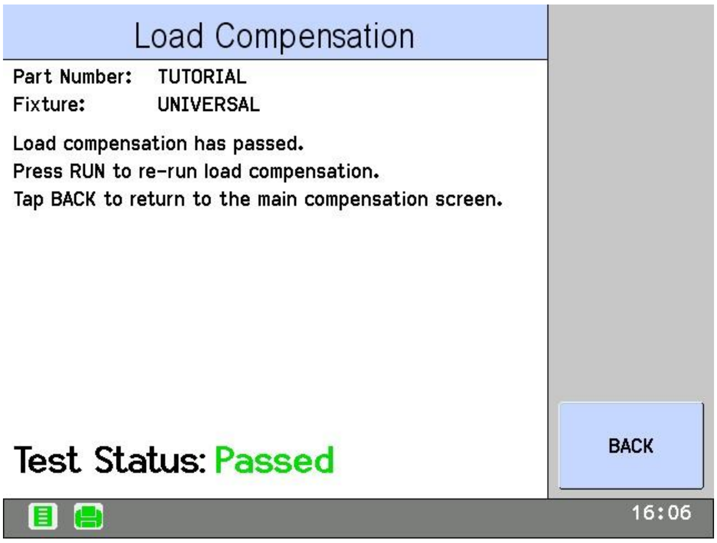
Performing Load Compensation

When the LOAD soft key is tapped, the following screen shall appear:



1. Fit the fixture and a "**golden part**". Then tap the **RUN** button to begin the open circuit compensation. Golden part is a known-good, **reference component** that will be used in load compensation to provide a standard measurement baseline. (Instructions can also be seen on the AT7600 Screen).

2. Once the AT7600 has completed the load compensation process, the following screen will appear, tap the **BACK** soft key to return to the previous menu.

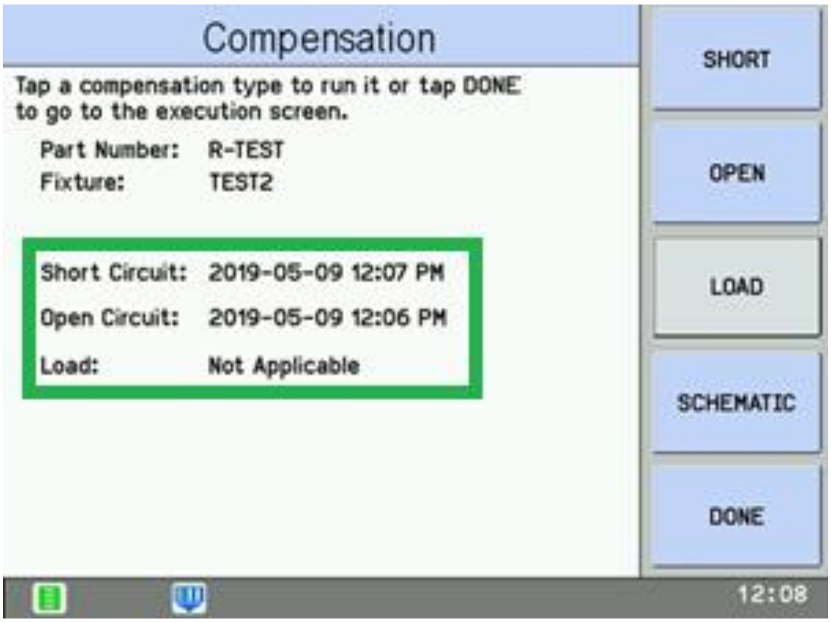


Automatic Compensation Storage

How does Automatic Compensation Storage work?

Every time a compensation is successfully applied it is also stored in the AT7600.

If the same program is then re-loaded again, the last valid compensation is automatically loaded, and the date and time of the stored compensation is shown on the screen:



- Each AT7600 stores the last valid compensation in memory for up to 2,000 test programs.
- Only one stored compensation is allowed per test program.
- A new compensation can be performed at any time, if preferred—for example, before every batch.

Key Points:

1) Perform and store compensation only after the unit has been powered on for at least 30 minutes and has successfully passed the self-test.

2) Compensation storage **does not** retain information about the specific cables or fixtures used.

- If multiple similar fixtures are used across units, subtle differences may occur.
- Cables, clips, Kelvin blades, and fixture contacts can degrade or accumulate dirt over time. Regular maintenance is recommended, as compensation is intended to correct for these connection characteristics.

3) Stored compensation factors are unique to both the individual unit and the fixture/cabling used. For this reason, stored compensation cannot be transferred from one AT tester to another.

Conditions That Invalidate Stored Compensation

1) The test program has been modified since the last compensation.

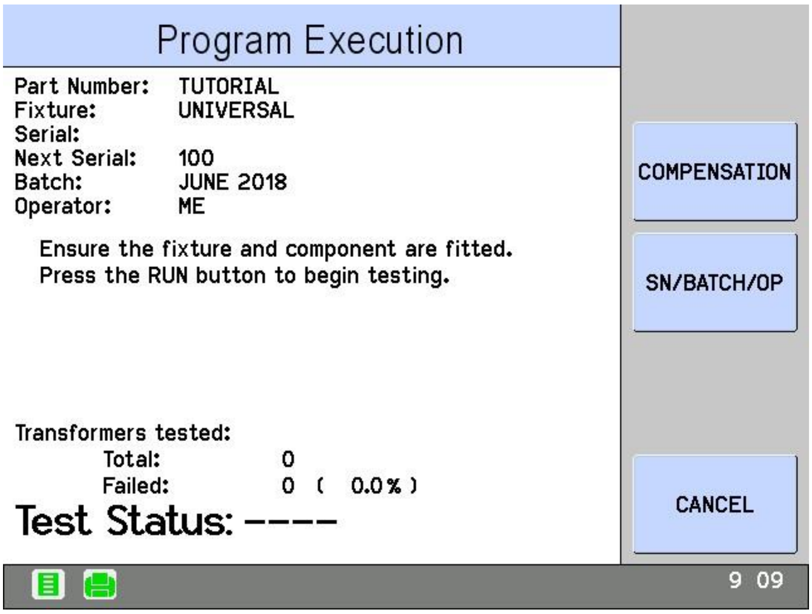
- Any change—such as adjusting test signal frequencies, adding or removing tests, or reordering them—invalidates the stored compensation.

- The AT7600 automatically performs a checksum of your test program to ensure no changes have occurred and that the stored compensation remains valid.

2) You manually removed the saved compensation using the REMOVE buttons on the compensation screen.

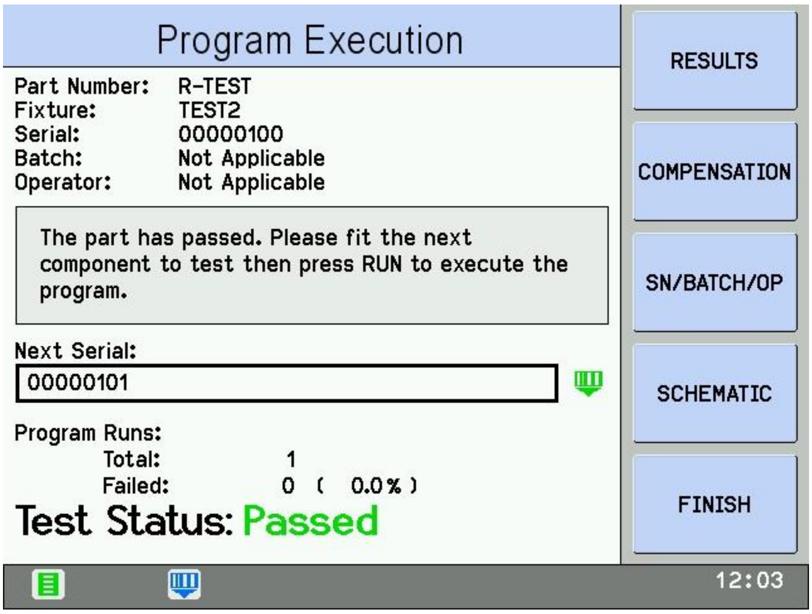
3) The test program has not yet been compensated after upgrading firmware.

8.1.6.6. Run Screen



Once the test program is loaded into the AT7600, connect the transformer to the fixture and press **Run** to start testing.

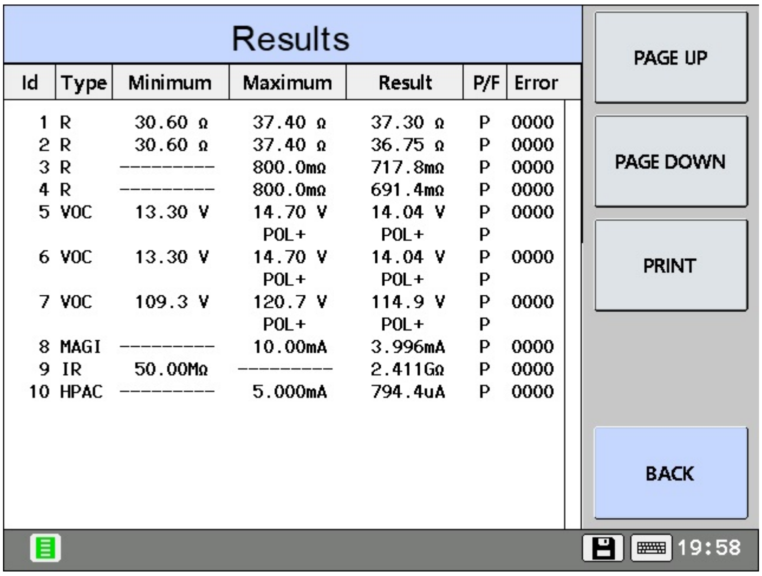
After the test completes, the following display will appear:



SOFT KEY	FUNCTION
RESULTS	Shows the results of the test
COMPENSATE	Used to perform Open, Short or Load Compensation
SN/BATCH/OP	Used to change the serial number of the part under test, or Batch Number and Operator Number. The key is enabled only if the options are selected in the test program
SCHEMATIC	Provides a simplified view of your test program schematic.
FINISH	Returns to Main Menu

8.1.6.7. Results

To display the test results, tap the RESULTS soft key; you will see the following display:



SOFT KEY	FUNCTION
PAGE UP	Scrolls up the list
PAGE DOWN	Scrolls down the list
PRINT	Prints the results if a printer is connected in the AT7600 via USB.
BACK	Returns to testing mode

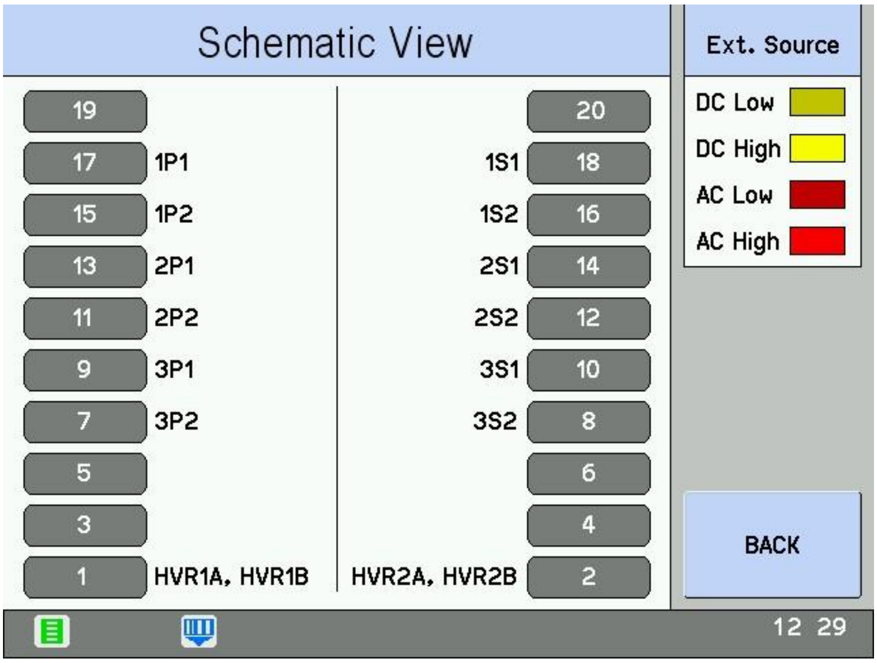
8.1.6.8. Schematic

This screen provides a simplified schematic view of your test program.

It allows the operator to verify the required connections for the item under test without returning to the AT Editor screen.

The sub-screen can be accessed at any time from both the **COMPENSATION** and **RUN** screens.

An example is shown below:



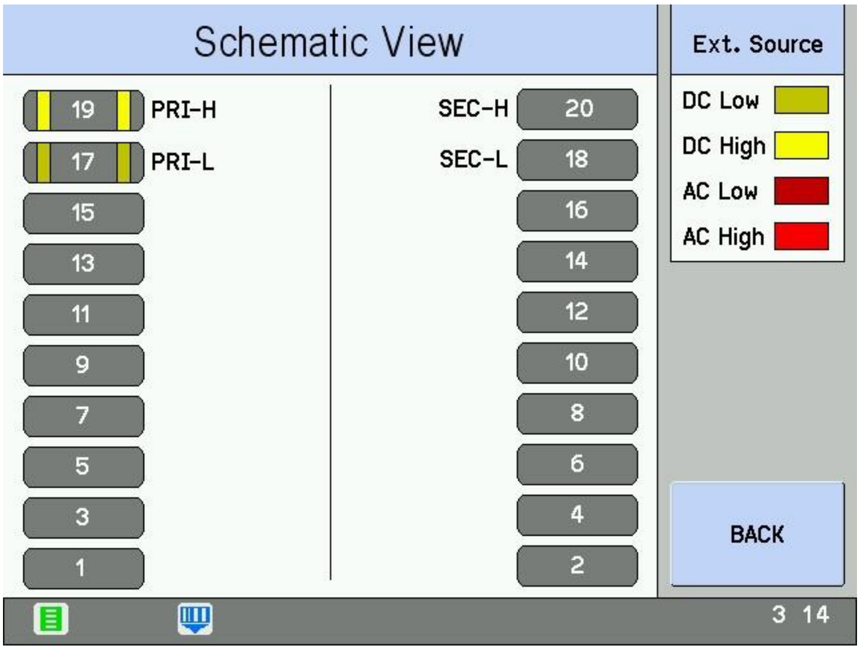
- The grey boxes labeled **1–20** represent the AT test nodes.
- The numbers shown inside each box correspond to the programmed transformer terminals.
  In the example above, transformer pin **"1P1"** should be connected to **node 17**, and so on.

Schematic View for Programs using the DC1000A 25A DC Bias Source

If your test program includes LSBX, LPBX, or ZBX tests that require the DC1000A, the corresponding nodes are highlighted with light and dark yellow bars.

Polarity is important:

- Connect the DC1000 high output to the light-yellow node.
- Connect the DC1000 low output to the dark-yellow node.

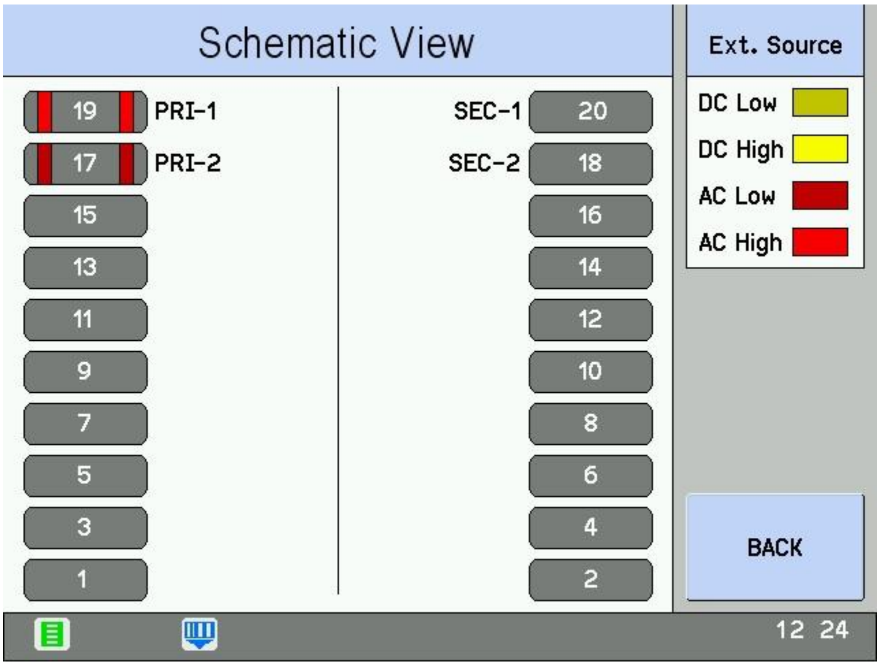


Schematic View for Programs using the AC Interface Fixture

If your test program includes VOCX, MAGX, WATX, or STRX tests that require the AC Interface Fixture, the corresponding nodes are highlighted with light and dark red bars.

Polarity is important:

- Connect the ACIF high output to the light-red node.
- Connect the ACIF low output to the dark-red node.



8.1.7. Self-Test

The **self-test** is a sequence of checks performed by the tester to ensure that the unit is operating correctly.

Although it does not verify that all measurements meet specification, it confirms that the majority of functions are working as intended.

The AT7600 automatically detects and reports most faults that could lead to incorrect measurements.

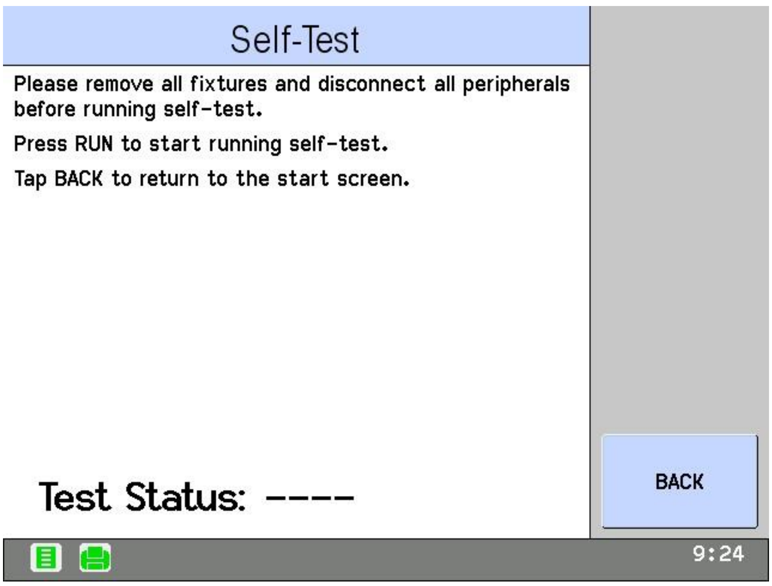
However, for added confidence, it is recommended to run a self-test at the beginning of each day or before using the AT7600.

Self-Test Tip

Before starting a system self-test, ensure that no fixture is fitted and that nothing is in contact with any of the test nodes on the top surface of the AT7600.
The self-test will only run if the Safety Interlock is in the safe condition.

CAUTION:
When the Safety Interlock is correctly connected and in the safe condition, high voltage—up to **7,000 V**—will be present on all test nodes on the top surface of the AT7600.

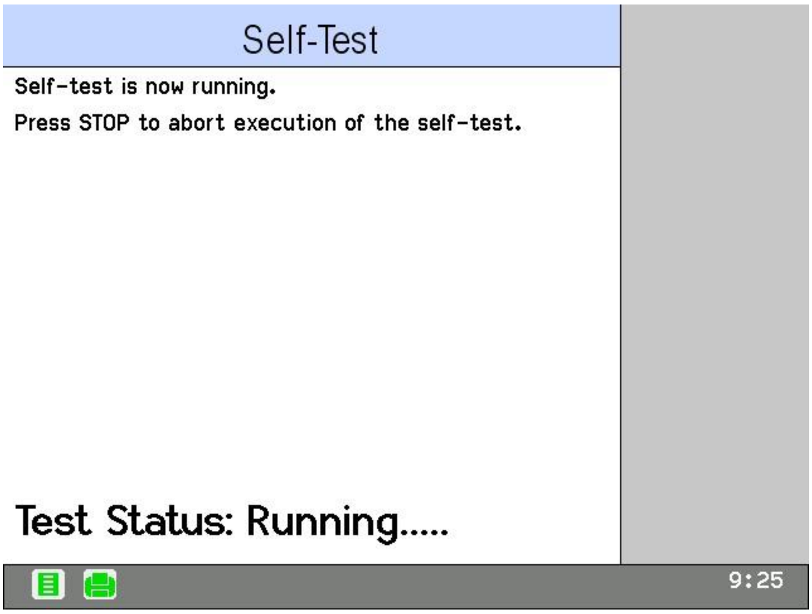
You can run a Self-Test at any time by tapping the SELF-TEST soft key on the top-level screen. After selecting SELF-TEST, the display will appear as shown below:



BACK – Return to the main menu.

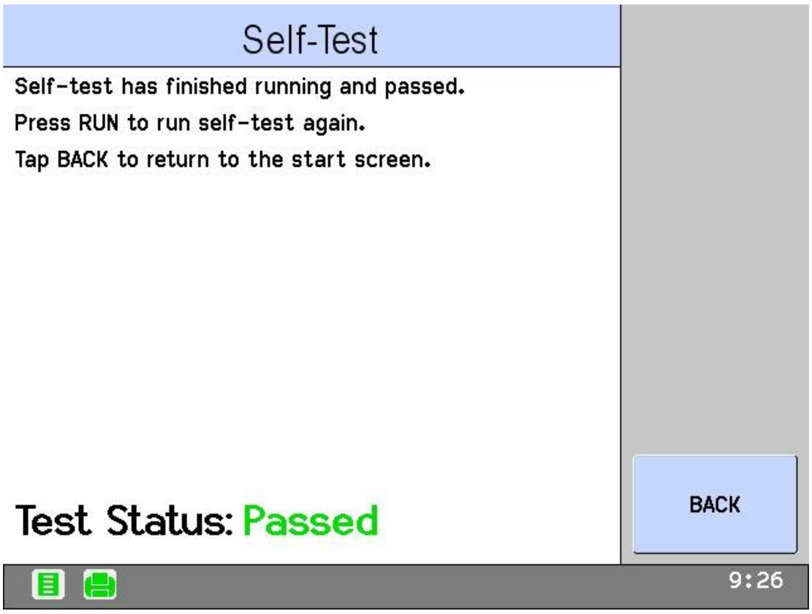
Press the RUN button on the front panel to begin the Self-Test.

As the self-test is running, the front panel display will indicate the Test Status: Running as shown below.



Press the STOP button to abort the self-test.

At the end of the self-test, you shall see the following screen:



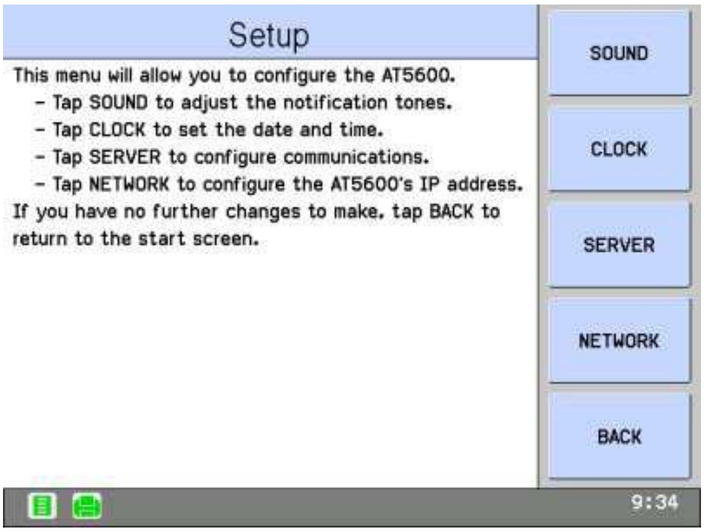
If the Self-Test detects a failure, please contact Voltech Application Support at www.voltech.com

8.1.8. Setup

Setup allows you to adjust the AT7600 options that affect how the unit runs tests and stores results.

You can change the system parameters at any time by tapping the **SETUP** soft key on the top-level screen.

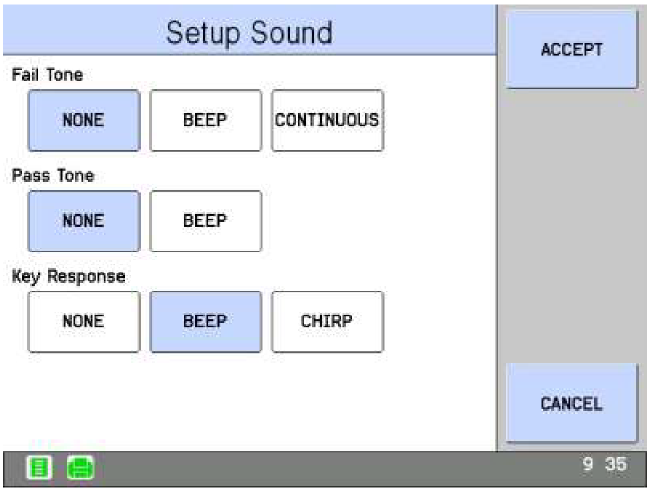
After selecting **SETUP**, the display will appear as shown below:



SOFT KEY	FUNCTION
SOUND	Changes the Internal Beeper options
CLOCK	Changes the time and date of the internal time clock
SERVER	Setups the Server mode method (RS232 or TCP/IP)
NETWORK	DHCP or Static IP if using Ethernet
BACK	Returns to previous screen

8.1.9. Sound

The SOUND soft key allows you to adjust the internal beeper settings or turn off the sound for functions such as failure indicators, pass indicators, and soft keyboard clicks.



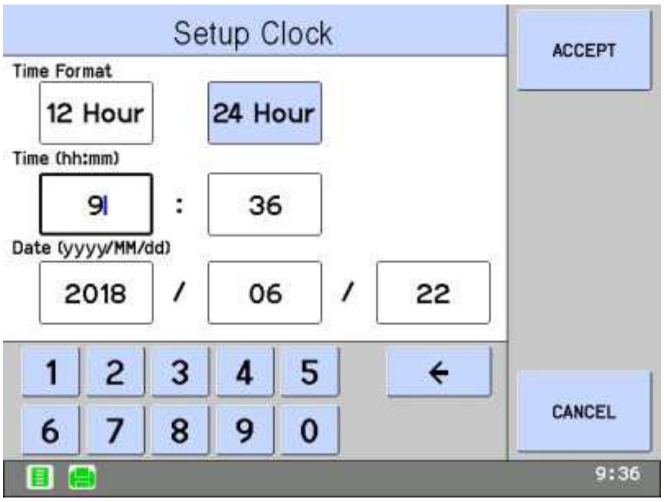
SOFT KEY	FUNCTION
ACCEPT	Changes the Internal beeper settings
CANCEL	Returns to previous screen

8.1.10. Clock

The CLOCK soft key allows you to adjust the time and date of the internal Real-Time Clock.

You can also select either a 12-hour or 24-hour time format.

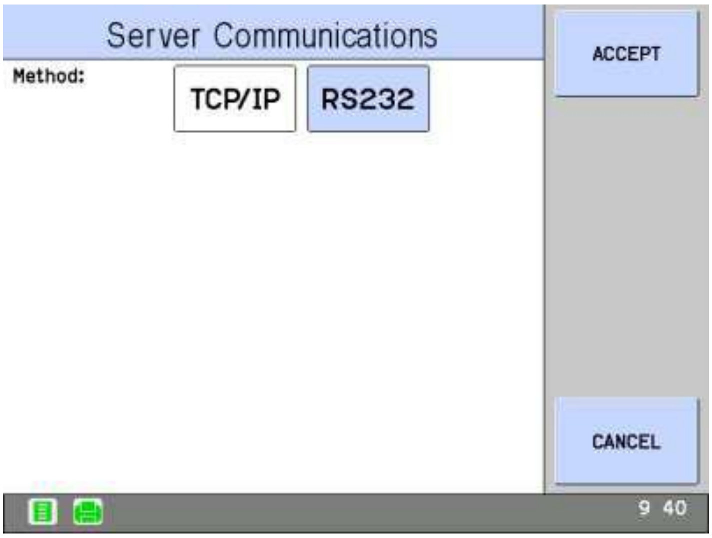
After tapping the *CLOCK* soft key, the display will appear as shown below:



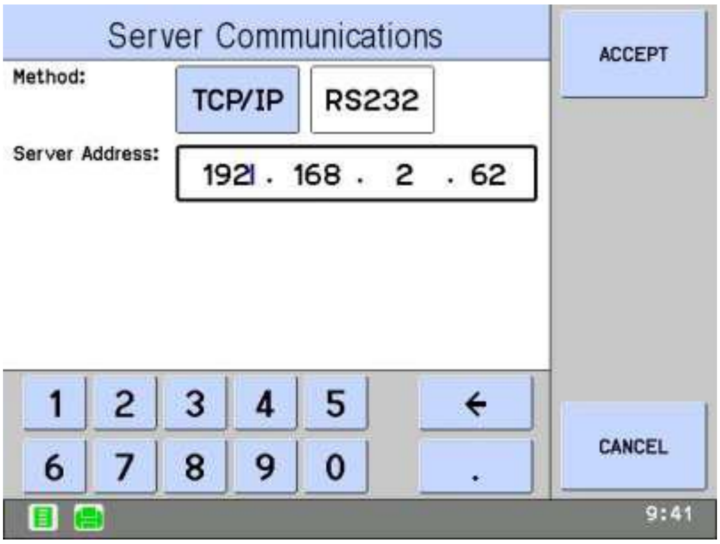
SOFT KEY	FUNCTION
ACCEPT	Saves the changes and returns to previous screen
BACKSPACE	Clears the last character entered
CANCEL	Returns to the previous screen without accepting changes

8.1.11. Server

Select the method of communication with the server. The available options are RS232 or TCP/IP (Ethernet).



If you select TCP/IP (Ethernet), enter the IP address of the PC running the AT SERVER software.



SOFT KEY	FUNCTION
ACCEPT	Saves the changes and return to previous screen
CANCEL	Returns to previous screen without changes

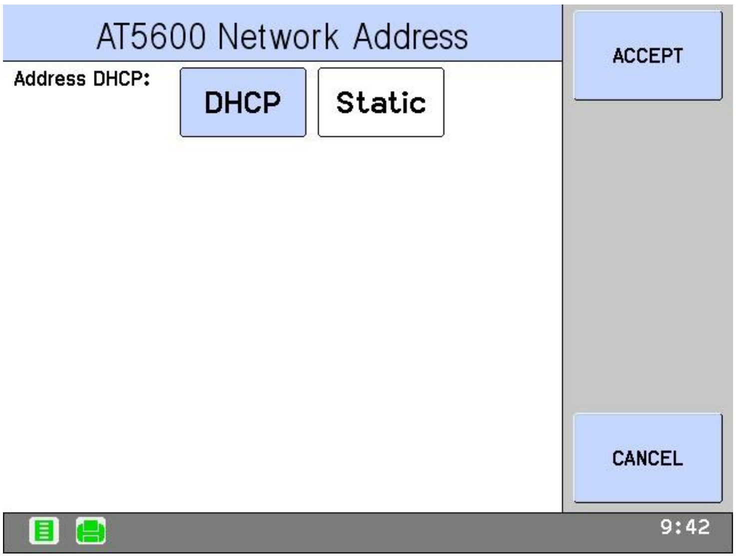
8.1.12. Network

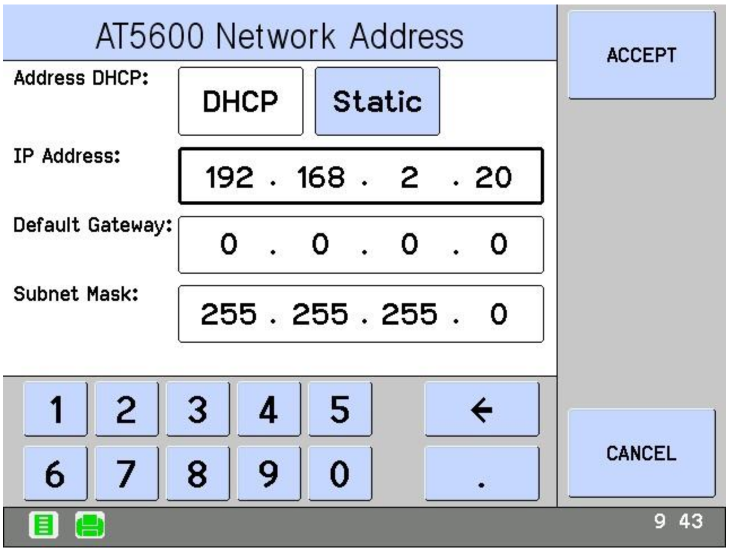
This soft key allows the user to configure how the AT7600 connects to the internal network when using Ethernet.

When **DHCP** is selected, the AT7600 will automatically acquire an available IP address from your network.

When **Static** is selected, the parameters must be set manually, such as Static IP, Default Gateway, and Subnet Mask.

If you are unsure of the correct mode or setup information for your installation, please consult your IT department.





8.1.13. Compatibility

This feature allows you to quickly load-compensate an entire test program against a set of AT3600 results, using a golden part as the transfer standard.

Compatibility Mode is particularly useful when you are working with test limits tighter than the AT3600 or AT7600 specifications and wish to maintain a single program for use across both instruments.

For example, it is especially relevant for the SURGE test. SURGE results represent the Volt-second characteristic of both the unit under test (UUT) and the internal hardware of the AT36/AT76 instrument in use. Because of differences in design, the AT7600 and AT3600 may produce different (yet valid and repeatable) readings on the same part.

Compatibility Mode addresses this by scaling the AT7600 results to match the AT3600 results, while still applying your usual Pass/Fail limits.

How it Works

If compatibility mode is enabled on an AT7600, then on a program download.

The AT7600 will request the average results of any previous PASS AT3600 test data that is already stored in the dotNET AT Server.

The program is then load compensated against a physical golden test part, and the scaling factors saved as the load compensation in the AT7600.

The test program is not altered in anyway, so is still valid for AT3600/ATi use.

The load compensation is only stored in the specific AT7600 and can be removed or reapplied using the compensation screen.

The feature can be turned OFF at any time to revert to normal AT7600 measurements.

Using AT3600 Compatibility Mode

Follow these steps to enable and apply AT3600 Compatibility Mode:

1. Connect the AT3600 to the .NET AT Server.
2. Run test results from the AT3600 for your chosen test program into the .NET AT Server.
    - This may be done using a batch of parts or by repeatedly testing the same part.
    - For best results, we recommend saving at least 10 PASS results to the .NET AT Server.
3. On the AT7600, go to SETUP > COMPATIBILITY, set *AT3600 Compatibility Mode* to ON, and press ACCEPT.
4. Connect the AT7600 to the same .NET AT Server and load the same test program into the AT7600.
5. Run compensation routines: the Compensation screen will display the standard *Short* and *Open* compensation options. Run these as required.
6. Load compensation required: the screen will also indicate that *Load Compensation* is required.
7. Fit the golden transfer standard part (the same part tested on the AT3600) into the AT7600 and run Load Compensation.
8. Save the load compensation: just like Short and Open compensation, the Load Compensation is stored in the AT7600 and can be removed or re-applied at any time.
9. Run your batch of parts on the AT7600 in the usual manner.
10. Scaled results: all results will be automatically scaled to match AT3600 measurements while still applying your defined Pass/Fail limits.

NOTE:

The Load compensation nominal values that will be used will only be taken from previous AT3600 Passed results.

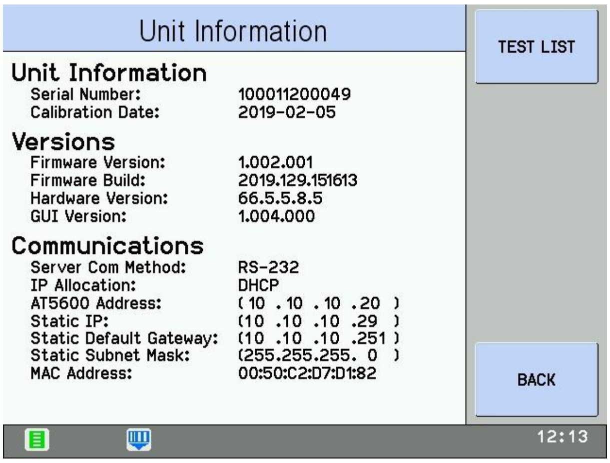
Any AT3600 results that predate the last test program edit will be ignored – for example you could have edited the program to add extra tests or change V or F – These are not considered as the test program has changed.

8.1.13 .2. Language

This feature allows you to switch the AT7600 interface language. Currently, the available options are **English** and **Chinese**. Additional languages will be supported in future updates.

8.1.14. Unit Information

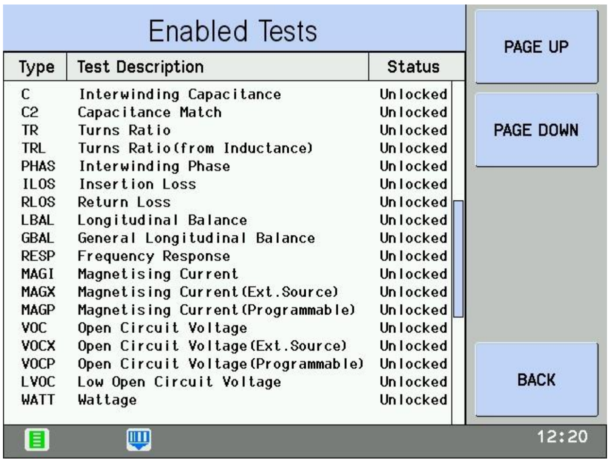
This page displays basic unit information.



SOFT KEY	FUNCTION
BACK	Return to previous screen
TEST LIST	Displays enabled test options

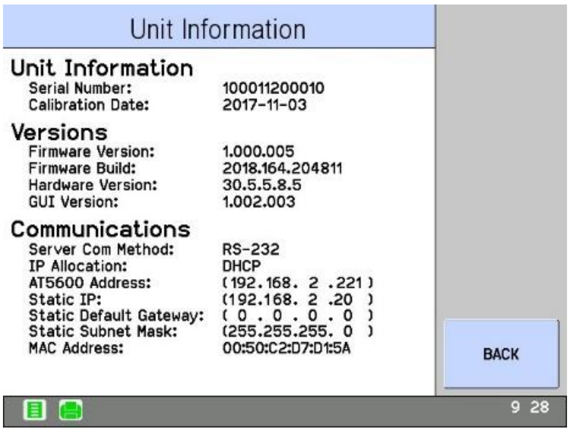
TEST LIST

Displays the available tests on this unit.

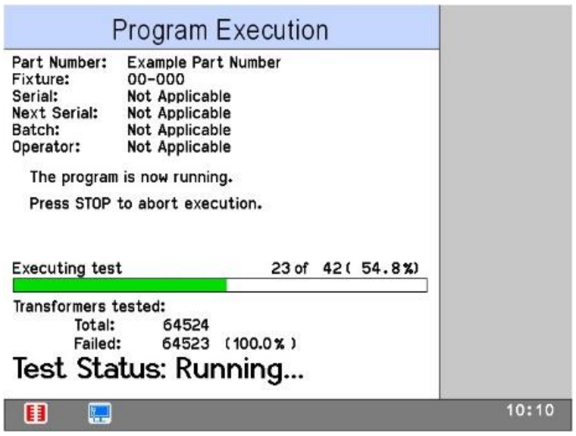


STATUS	DESCRIPTION
UNLOCKED	Permanently available to use
TRIAL	Available in demo mode until the 30-day demo expires.
LOCKED	Not available

8.1.15. Status Bar Icons



INTERLOCK CLOSED



INTERLOCK OPEN and COMMS icon

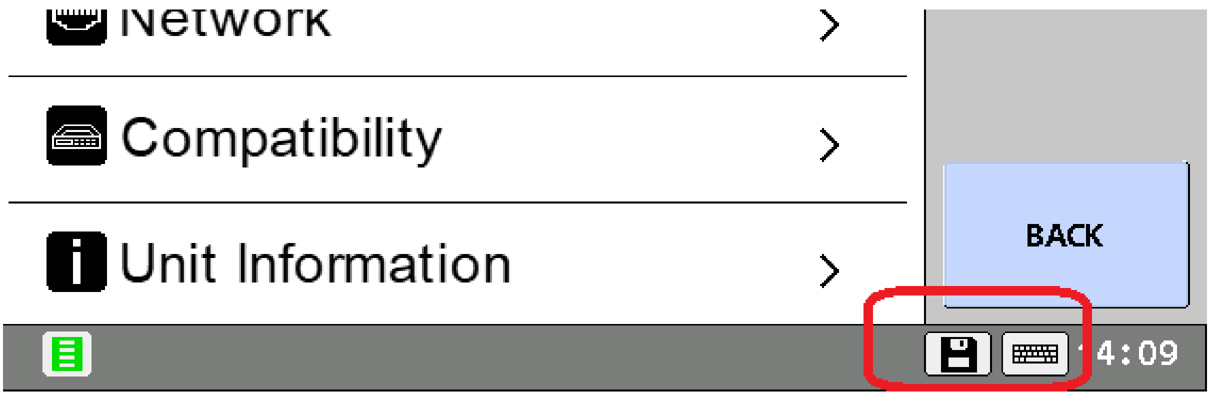
Safety Interlock Icon (first, left)

Green – Interlock closed, testing can proceed.

Red – Interlock open, testing is prevented.

Communications Icon (second)

Displayed when the unit is actively communicating with the AT SERVER (sending test results) or when under control of the AT EDITOR.



USB-A 1 + 2 Port Icons

To the left of the clock are two icons showing the status of the two USB A ports (“1” on the front left of the unit, “2” on the rear of the unit)

Printer Icon

Displayed only when a valid USB printer is connected to the AT7600 USB-A port.

Keyboard Icon

Displayed when a valid USB keyboard is connected to the USB-A port.

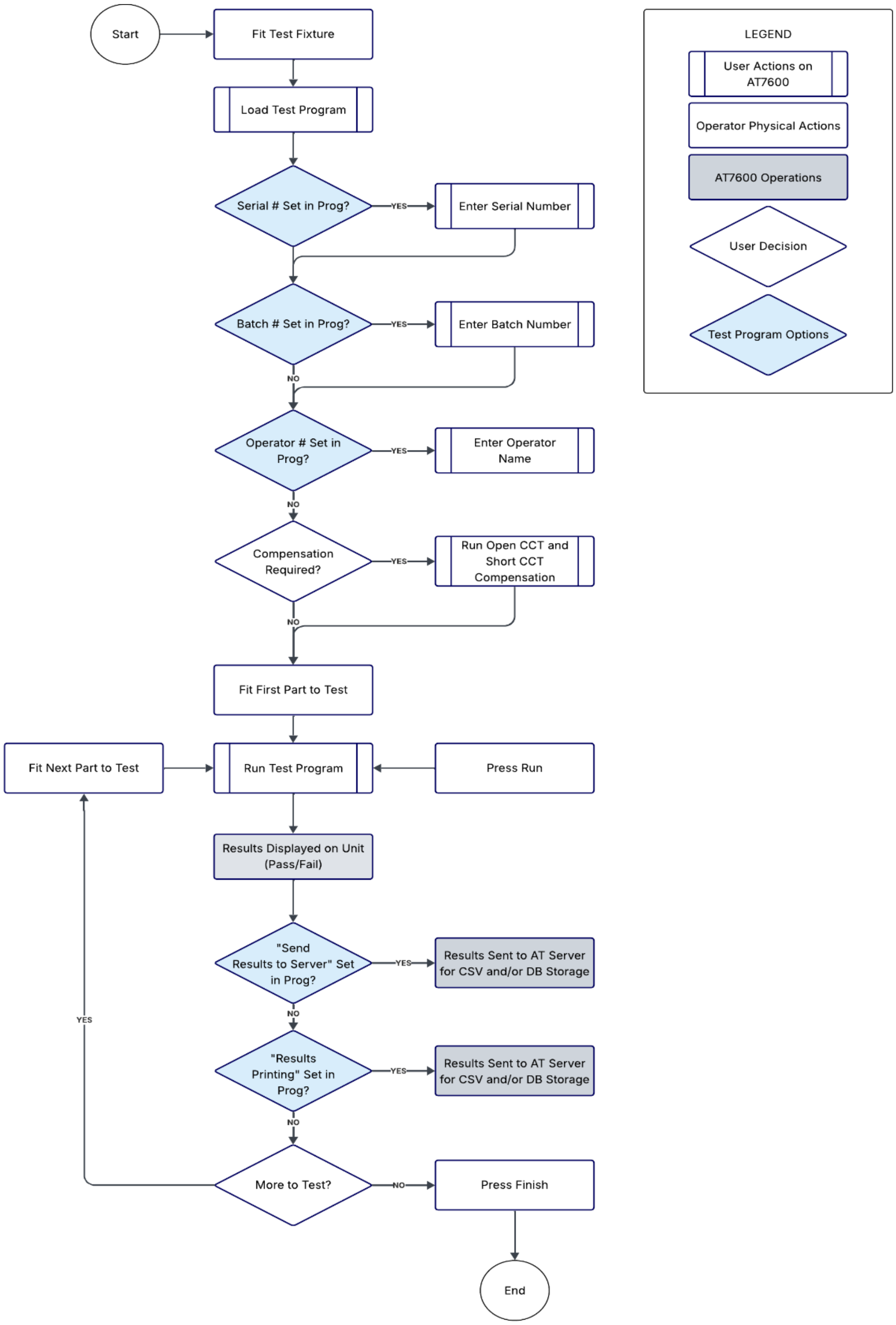
Barcode Reader Icon

Displayed when a valid USB barcode reader is connected to the USB-A port.

8.2. Testing Wound Components

8.2.1. A Typical Workflow

The below shows the basic test execution flow, and the possible sequence of user inputs (set in the AT EDITOR program options) during testing.



8.2.2. Traceability

To provide traceability of results, the system allows optional tagging with a **serial number, batch number, and operator name**.

This information, along with the measurements and pass/fail verdict, can be:

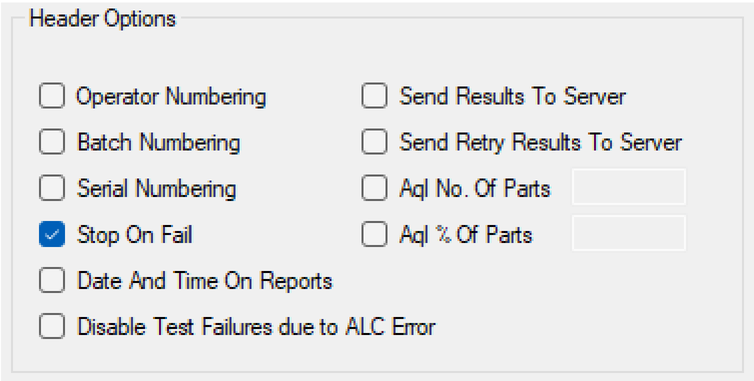
A) Printed using a USB printer.

B) Saved together with the results in CSV, MS SQL, or MS Access formats, provided that the *Save Results to Server* option is enabled in the ATP program.

8.2.3. STOP ON FAIL Function

The test program can be started either by pressing the **RUN** button or by providing a **RUN input** to the remote port using a foot switch or another device.

Enabling the **STOP ON FAIL** option (configured in the AT EDITOR test options) gives you additional control in the event of a test failure.

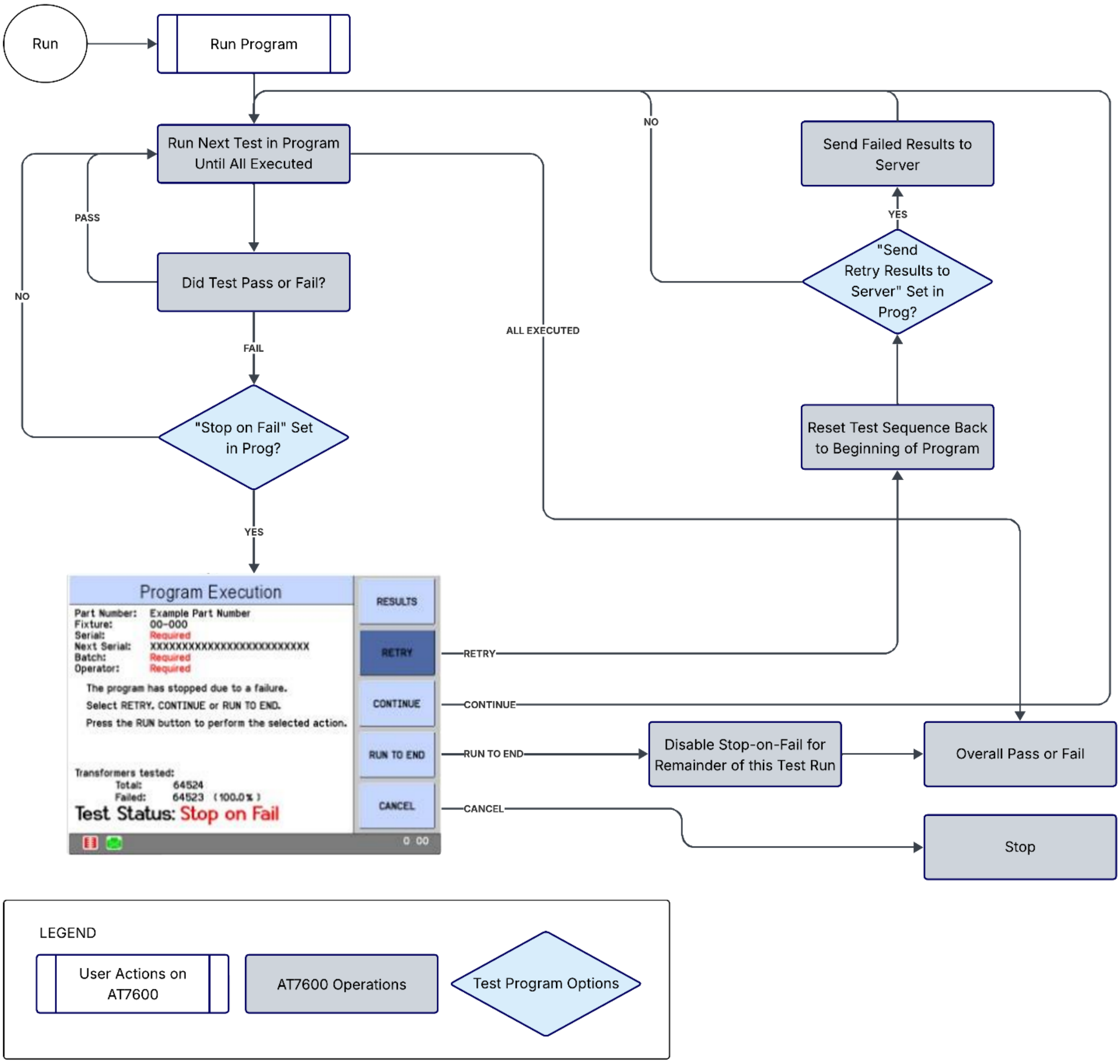


Stop on Fail Option on AT Editor

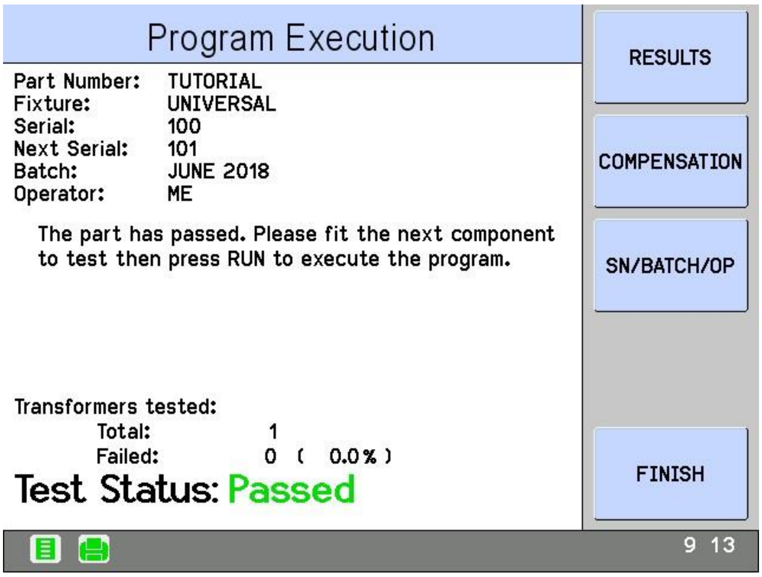
This feature:

- Prevents “false” FAIL results caused by misconnections from being recorded to the Server.
- Saves time on longer test programs by halting execution immediately when a genuine failure occurs.

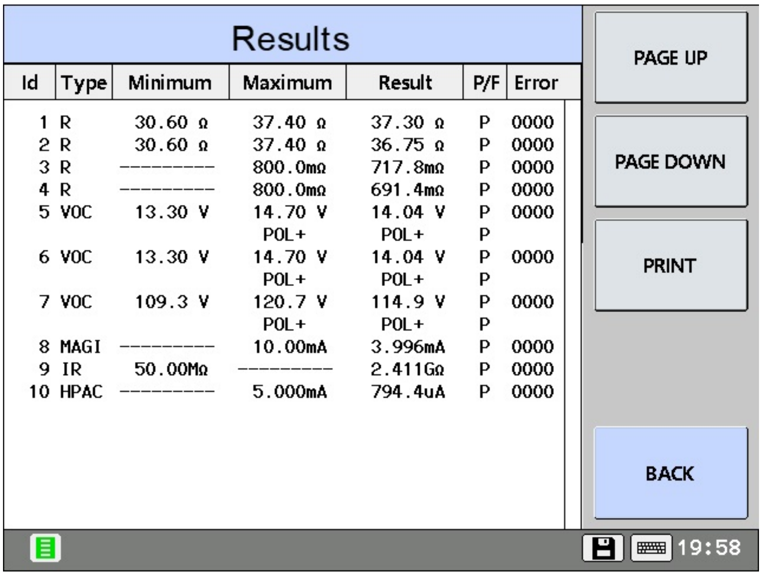
A detailed description of this functionality is provided below.



8.2.4. Getting the Results



The Test Status of the last part (Pass or Fail) is clearly shown in the main window and tapping the results soft key will display a results grid, showing the results of all tests executed in the test program.

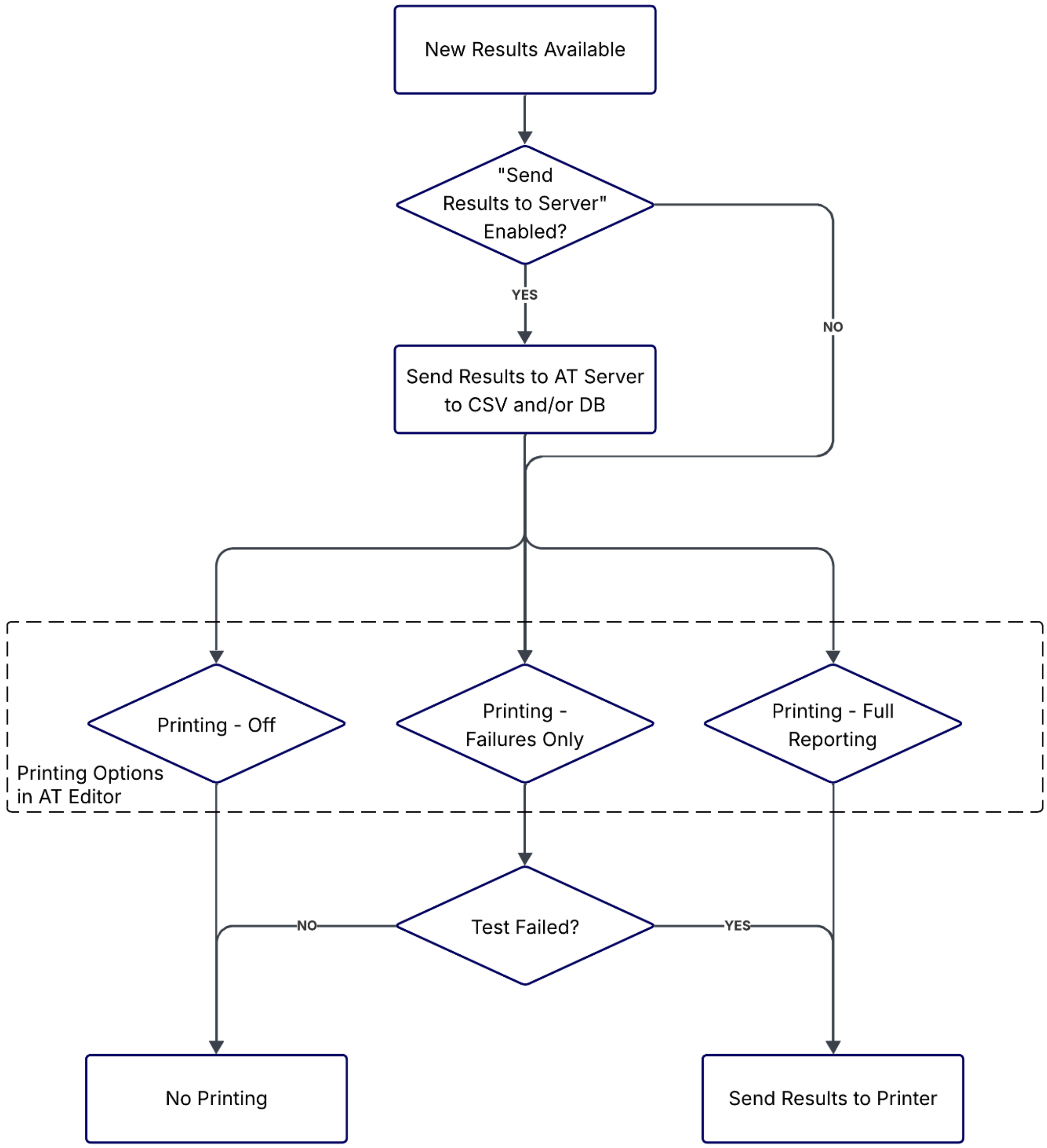


If the “Send results to Server” program option has been set, then the results will be sent back and recorded in the server software.

Results Printing

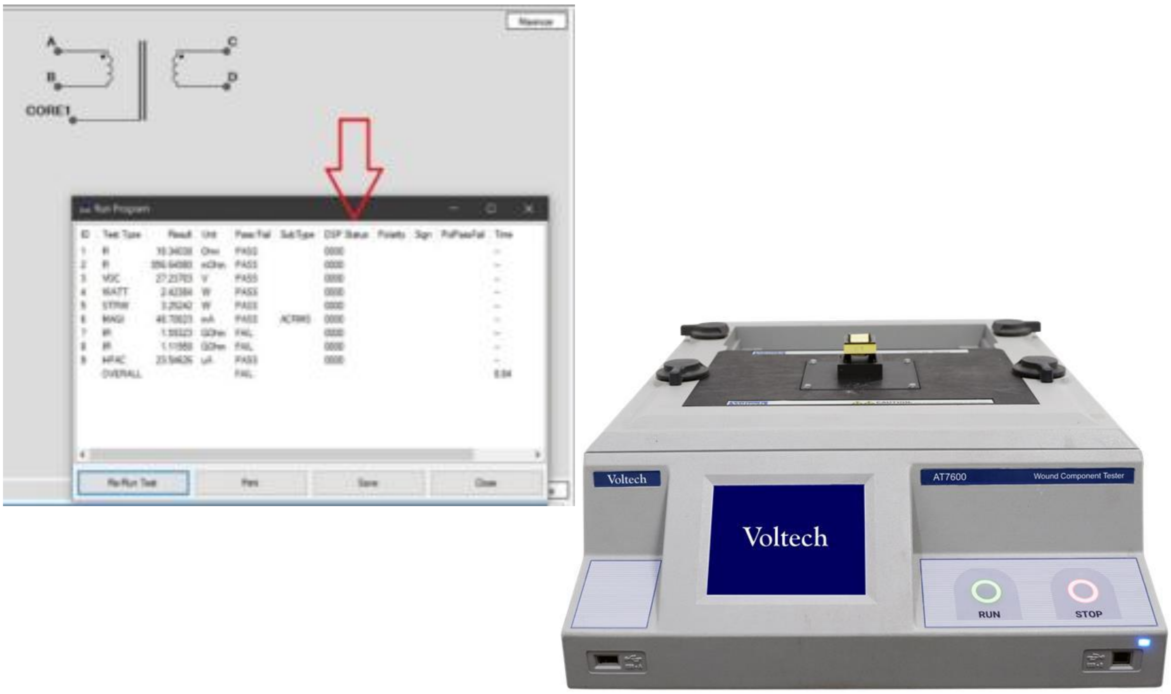
If the test program options have been configured to allow printing, then a printout will automatically be sent to the USB printer.

The PRINT soft key can also be used to manually trigger a print of the results, even if printing is not enabled in the test program.



Chapter 9: Troubleshooting

This chapter provides guidance on identifying, analyzing, and resolving issues that may occur during system operation. It explains how to interpret status codes and use them to diagnose problems effectively.



9.1 Measurement Error Codes

This section lists the error codes that may appear during measurements, along with their meanings. Understanding these codes allows you to quickly identify the source of a problem, whether it is due to misconnection, invalid test parameters, or hardware limitations.

9.2 Correcting Errors

This section provides step-by-step instructions on how to address common errors. It outlines recommended actions to resolve issues efficiently and ensure reliable test results.

9.1. Measurement Error Codes

The **AT7600** provides measurement error codes alongside all measurement results to give additional context on the integrity of the data. These codes identify warnings or conditions that may affect measurement accuracy.

During each test, voltage and current signals are continuously **generated, stabilized, measured, and trimmed**. If a problem occurs during any of these four stages, a unique error code is produced and displayed with the results.

This information is presented as a **Measurement Status Code (MSC)**, a 4-digit hexadecimal number. A detailed list of codes is provided in **Section 9.1.3**.

The MSC is composed of binary flags (0s and 1s), with each bit representing a specific measurement property as either *true* or *false*. Typical examples include conditions such as **voltage over-range** or **current over-range**, which assist the operator in diagnosing the cause of an error.

For the operator, the **Measurement Status Code (MSC)** is a useful diagnostic tool. It can indicate whether a fault is caused by a **fixture issue** or an **incorrectly seated part**, or whether it requires a review of the **test parameters** in use.

In cases of more serious faults, the MSC provides detailed information that can be submitted to **Voltech application support** to assist with further diagnosis.

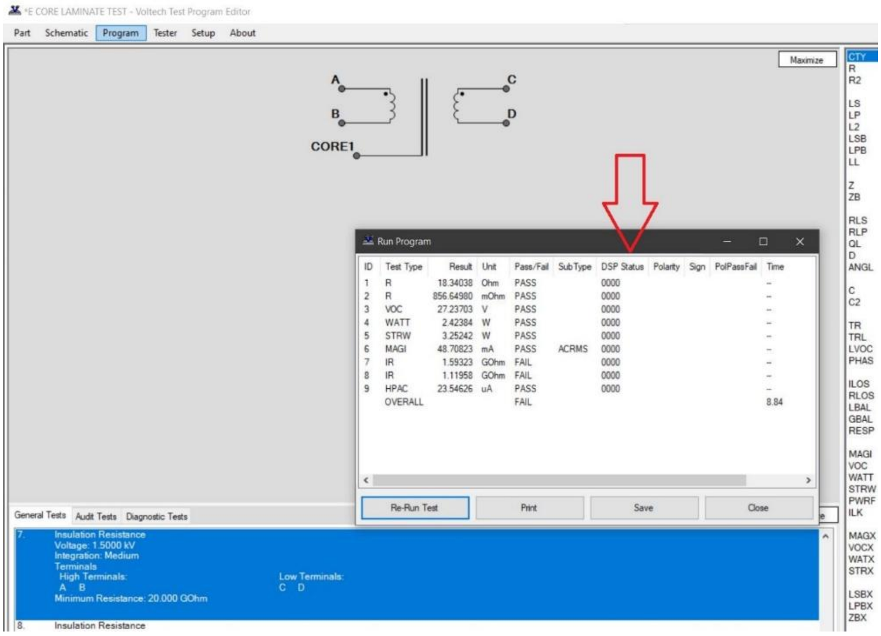
9.1.1. Test Error Codes

If the test fails, the **Results** screen will display a list of all detected failures.

Should the **AT7600** fail its self-test, contact **Voltech application support**, and provide the details of the reported failures.

9.1.2. Editor Error Codes

Measurement Status Codes are also shown when using the Editor software after running a program. They are shown to the right of each test result.



9.1.3. Status Codes

Each bit in the status code represents a measurement property.

Multiple conditions may be indicated at the same time. For example, if both a voltage over-range (xxx1) and a current over-range (xxx2) occur during a measurement, the status code is 0003 (i.e., bits 0 and 1 are set, giving the binary value 0000000000000011).

If a test is interrupted, an additional code is applied in bits 12–15 of the status code.

Refer to the *Status Error Codes Table* on the next page.

Status Error Codes

HEX CODE	DESCRIPTION
0000	Test passed with no errors.
xxx1	Voltage over-range occurred.
xxx2	Current over-range occurred.
xxx4	Ramp-up process has been aborted; too much load.
xxx8	Error reported by the DC bias unit or that the DC bias unit did not respond to a command.
xx2x	The test signal could not be trimmed to required value; incorrect test parameters for the load.
xx4x	An error occurred after ramp-down; current did not decay away in time.
x1xx	Current limit fail (Hi-pot tests only); test current exceeded pre-programmed limit.
x2xx	The measured voltage did not go away in time; something on the fixture is staying charged.
#4xx	The test has been interrupted (see table below).
Where # = reason for the interrupt.	
1	The safety interlock was broken during the test
2	Power more than limit requested. Power is above 40 W. If this power level is exceeded, we abort the test
3	A Hi-pot current trip has terminated the test, i.e., a flashover (spark) has occurred, or the current has exceeded the AT's current capabilities (can occur on HPAC, HPDC, and IR).
4	A STOP input has terminated the test from the STOP input of the remote port or the STOP button on the front panel
5	An 8KV overvoltage has been detected and terminated the test.
6	Class D overload. A hardware trip to protect the unit if >4A has been detected for greater than a few microseconds.
7	An over-temperature interrupt has terminated the test; unit has become too hot.
8	An auxiliary fault interrupt has terminated the test; this can be created by an accessory attached to the peripheral port.
9	Unit rebooted during the test sequence.

9.1.4. Common Error Codes

In most cases, the error code will be 0000, indicating that the test was executed under the required and stable conditions.

The following are examples of error codes you may occasionally encounter:

3400 – Hi-Pot Flashover

This code indicates a Hi-Pot flashover.

When testing a defective part that fails an HPAC or HPDC test, this code is expected. Regardless of the measured result, the test will return a FAIL. The failure is due to a sudden flashover.

Note that HPAC or HPDC tests may also fail based on current flow exceeding the programmed mA or μA limit.

0020 – Signal Trim Error

This code may appear during “LCR”-style tests when the requested voltage or frequency cannot be achieved due to the interaction of the UUT with the 50-ohm output impedance of the LPG (Low Power Generator).

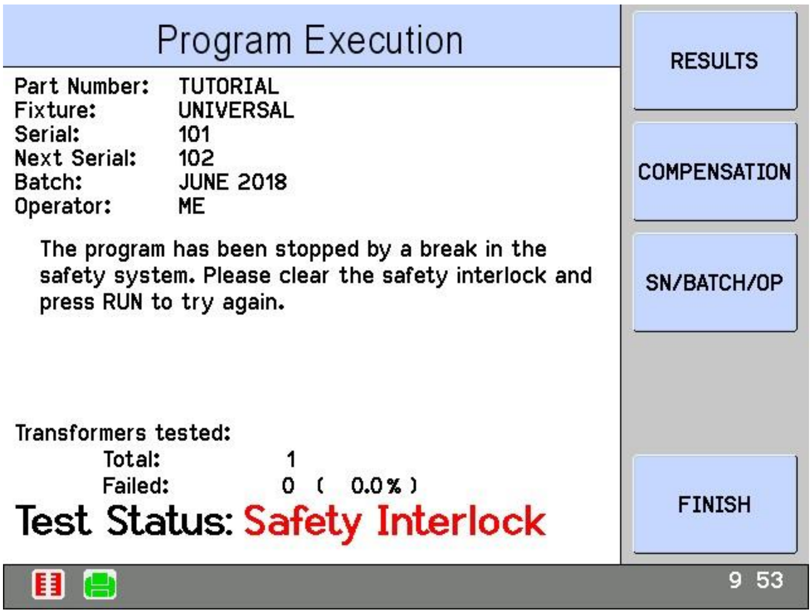
For a technical description of this effect - which is also common to standard LCR meters, refer to Section 4.1.5.

9.2. Correcting Errors

The AT7600 may display error messages related to safety interlocks, temperature, or residual voltages. This section explains the meaning of these errors and provides the steps required to correct them before testing can continue.

9.2.1. Safety Interlock Error

The safety interlock system must use all three control lines. If any of these lines are not switched correctly, the safety interlock icon on the AT7600 will turn **red**.



9.2.2. Temperature Error

If the AT7600 exceeds its safe operating temperature, an **Over Temperature** error will be displayed in the error message window.

Overheating may be caused by the following:

- Clogged air filters
- Blocked air vents
- Excessive ambient temperature
- Internal fault

When a temperature error is reported on screen or in the Measurement Status Codes, ensure that adequate clearance is maintained around the air vents.

For more information, refer to Section 2.6, and clean the air filters as instructed in Section 11.1.

9.2.3. Voltage Present Error

This error indicates that voltage may still be present on the AT7600 fixture.

After any HPDC, HPAC, or IR test, the nodes used in that test are internally connected to a discharge resistor (330 kΩ for DC, 50 kΩ for AC) to ensure that residual voltages are removed before the relays open and the next test begins.

This prevents hot switching of the relays and protects the longevity of the instrument.

If, after a maximum of three seconds, the voltage has not decayed to below 100 V or 5 mA, a **VPRES** error is generated. This is typically displayed as error code **0240** or **0040**.

With AC Interface

If this error occurs, power to any external AC sources must be switched off first, followed by power to the AT7600.

Once it is confirmed that all hazards have been removed, the fixture should be disconnected from the AT7600. The unit can then be powered back on, and a system self-test initiated to verify whether the AT7600 has developed a fault.

If the AT7600 passes the self-test, the error is likely caused by one of the following:

1. An external source connected incorrectly
2. A faulty Voltech AC interface fixture
3. Capacitance charging within the part under test

Without AC Interface

If no external source is connected, the error is most likely due to capacitance charging during a Hi-Pot test (typically HPDC).

The capacitance must be limited to **30 nF**.

While the AT7600 is capable of discharging values above this limit, in the event of a single internal fault, the part may not discharge correctly (even if the safety interlock is broken).

Any capacitance greater than 30 nF may present a hazard to the operator.

Chapter 10: Specifications

This chapter provides the complete specifications of the AT7600, covering test performance, accuracy for all available measurements, supported interfaces, environmental and mechanical requirements, and compliance information.

10.1 Specification Summary

Overview of low voltage, high voltage, DC1000/DC1000A, and AC Interface test capabilities.

10.2 Accuracy Specifications

Detailed accuracy data for all available test types.

10.3 Interface Specifications

Electrical and communication interface details, including ports and safety interlock.

10.4 Environmental Conditions

Operating and storage environment requirements.

10.5 Mechanical

Physical dimensions and weight of the AT7600.

10.6 EMC Compliance

Electromagnetic compatibility, including Declaration of Conformity.

10.1. Specification Summary

This section provides an overview of the AT7600 test specifications under standard operating conditions.

Specifications are based on the use of **LONG integration**.

Using **SHORT** or **MEDIUM** integration provides faster operation, but as fewer samples are taken, measurement accuracy may be reduced.

The following subsections summarize the specification data for **Low Voltage Tests**, **High Voltage Tests**, **DC1000/DC1000A Tests**, and **AC Interface Tests**.

10.1.1. Low Voltage Tests

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
CTY	Continuity	10 kOhm	to	50 kOhm	-		-	-		-	n/a
R	DC Resistance	500 uOhm	to	50 kOhm	-		-	-		-	0.10%
LS	Inductance (series)	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
LP	Inductance (parallel)	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
QL	Quality Factor	0.001	to	1000	1 mV	to	5 V	20 Hz	to	3 MHz	0.50%
RLS	Equivalent Series Resistance	10 mOhm	to	10 Mohm	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
RLP	Equivalent Parallel Resistance	10 mOhm	to	10 Mohm	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
D	Dissipation Factor	0.001	to	1000	1 mV	to	5 V	20 Hz	to	3 MHz	0.50%
LL	Leakage Inductance	1 nH	to	1 kH	1 mA 1 mV	to	100 mA 5 V	20 Hz	to	3 MHz	0.10%
C	Interwinding Capacitance	100 fF	to	1 mF	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
TR	Turns Ratio +Phase	1:100 k	to	100 k:1	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
TRL	Turns Ratio by Inductance	30 - 1	to	1 - 30	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
LVOC	Low Voltage Open Circuit	1 mV	to	650V (3)	1mV	to	5 V	20 Hz	to	3 MHz	0.10%
*LSB	Inductance with DC Bias (Series)	1 nH	to	1 MH	1 mV 1 mA	to	5 V 1 A	20 Hz	to	3 MHz	0.05%
*LPB	Inductance with DC Bias (Parallel)	1 nH	to	1 MH	1 mV 1 mA	to	5 V 1 A	20 Hz	to	3 MHz	0.05%
R2	DC Resistance Match	1-1000	to	1000-1	-		-	-		-	0.20%
L2	Inductance Match	1-10000	to	10000-1	1 mV	to	5 V	20 Hz	to	3MHz	0.10%
C2	Inter-winding Capacitance Match	1-1000	to	1000-1	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
GBAL	General Balance	0 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
LBAL	Longitudinal Balance	0 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
ILOS	Insertion Loss	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
RESP	Frequency Response	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	1.0dB
RLOS	Return Loss	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	
Z	Impedance	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
*ZB	Impedance + Bias	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
ANGL	Impedance Phase	-360°	to	360°	1 mV	to	5 V	20 Hz	to	3 MHz	0.05°
PHAS	Inter-winding Phase	-360°	to	360°	1 mV	to	5 V	20 Hz	to	3 MHz	0.05°

***NOTES:**

- *LSB & LPB the AC Test Signal Range is **20uA to 100mA***
- *The AT7600's constant current generator has a maximum voltage limit of **10V** for bias testing (**ZB, LSB, and LPB** tests). Exceeding this limit may result in an overvoltage error (xxx1).*

10.1.2. High Voltage Tests

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
HPAC	AC Hi-Pot	1 uA	to	30 mA (4)	100 V	to	5 kV	50 Hz	to	1 kHz	3.00%
HPDC	DC Hi-Pot	1 uA	to	3 mA	100 V	to	7 kV	-		-	3.20%
SURG	Surge Stress	1 mVs	to	1 kVs	100 V	to	5 kV	-		-	3.00%
IR	Insulation Resistance	100 kOhm	to	100 GOhm	100 V	to	7 kV	-		-	1.00%
ILK	Leakage Current	1 uA	to	10 mA	1 V	to	270 V	20 Hz	to	1 kHz	0.50%
MAGI	Magnetizing Current	1 mA	to	2 A (3)	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.10%
VOC	Open Circuit Voltage	100 mV	to	650 V (3)	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.10%
WATT	Wattage	1 mW	to	40 W	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.30%
STRW	Stress Wattage	1 mW	to	40 W	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	1.00%
PWRF	Power Factor	0	to	1	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.5%

10.1.3. DC1000 / DC1000A Tests

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
LSBX	Series Inductance + DC1000 Bias	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
LPBX	Parallel Inductance + DC1000 Bias	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
ZBX	Impedance +DC1000 Bias	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%

10.1.4. AC Interface Tests

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
MAGX	Magnetizing Current (Ext Source)	50 mA	to	10 A (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	0.10%
VOCX	Open Circuit Voltage (Ext Source)	100 mV	to	650 V (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	0.10%
WATX	Wattage (Ext. Source)	100 mW	to	6 kW (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	1.00%
STRX	Stress Wattage (Ext. Source)	100 mW	to	6 kW (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	1.00 %

Specification Table Notes

1. **AR** = basic relative accuracy (for the full specification, refer to later sections).
2. Depends on external source type.
3. 650 Vrms for AC measurements, or 900 V for DC measurements. Maximum 40 W for VOC, MAGI, WATT, and STRW tests.
4. Peak value.
5. DC bias current accuracy is ±10% of the requested value.
6. 40 W when using ACIF with step-up/step-down transformer.
    - 6 kW maximum when using ACIF with an external AC power amplifier (Note: amplifier choice may result in a lower maximum power).

IMPORTANT

WATX and STRX tests are a function of the voltage and magnetizing current on the energized winding. These tests are only valid if voltage > 100 mV **and** current > 50 mA, as per MAGX requirements, even if only WATX/STRX is being performed.

Test Frequency Accuracy

- F ≤ 16 kHz: ±0.25 Hz ±0.01% of requested frequency
- 16 kHz < F ≤ 250 kHz: ±4 Hz ±0.01% of requested frequency
- F > 250 kHz: ±64 Hz ±0.01% of requested frequency

Signal Level Accuracy

- Voltage: ±1 mV ±(2.5% ±0.01%/kHz) of test signal
- Current: ±100 µA ±(2.5% ±0.01%/kHz) of test signal

Applicable Tests (BOLD in Table)

- For use with AC Interface: **MAGX**, **VOCX, WATX, STRX**
- For use with DC1000/DC1000A: **LSBX, LPBX, ZBX**

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10.2. Test Accuracy Specifications

This section defines the accuracy specifications for each test supported by the AT7600.

10.2.1. R Test

The accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + A_C + A_V + A_I$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)

where:

$$A_R = 0.10\%$$

$$A_C = 0.08\%$$

$$A_V = 0.03\% + \frac{0.1\%}{V_M}$$

$$A_I = 0.03\% + \frac{0.001\%}{I_M}$$

where:

V_M	is the measured voltage (V)
I_M	is the measured current (A)

The test signal is set according to the value specified as maximum in the test limits:

Maximum Resistance R	<1Ω	1Ω-10kΩ	10kΩ-50kΩ	>50kΩ
Test Current	I=1	I=1/R	V=R*100u	V=5

Where: V = Volts (V)

I = Current (A)

R = Resistance (Ω)

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10.2.2. LS, LP, RLS, RLP, LL and C Tests

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I + A_Q}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)
A_Q	is the correction for Q factor (%)

where:

$$A_R = 0.05\ \%\ \ for\ LS\ LP\ RLS\ RLP, or\ 0.1\%\ forLL, C$$

$$A_C = 0.08\ \% + (0.0000\ 1\% * F_M)$$

$$A_V = 0.08\ \% + \frac{0.02\ \%}{V_M}$$

$$A_I = 0.08\ \% + \frac{0.0001\ \%}{I_M}$$

$$A_Q = 0.08\ \% + \frac{0.2\ \%}{Q_M} \qquad (For\ LS, LP, LL\ \&\ C)$$

$$A_Q = 0.08\ \% + (0.2\ \% * Q_{M)} \qquad (For\ RLS\ \&\ RLP)$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)
Q_M	is the measured Q factor.

10.2.3. QL and D Tests

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_I + A_{QD}}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_I	is the correction for current level (%)
A_{QD}	is the correction for Q or D factor (%)

where:

$$A_R = 0.50\ \%$$

$$A_I = 0.08\ \% + \frac{0.0001\ \%}{I_M}$$

$$A_{QD} = 0.2\ \% * [Q_M + (\frac{1}{Q_M})]\ (For\ Q\ factor)$$

$$A_{QD} = 0.2\ \% * [D_M + (\frac{1}{D_M})]\ (For\ D\ factor)$$

where:

I_M	is the measured current (A)
Q_M	is the measured Q factor.
D_M	is the measured D factor.

10.2.4. TR Test

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_{PV} + A_{SV} + A_N}$$

where:

- A_T is the total accuracy (%)
- A_R is the basic relative accuracy (%)
- A_C is the calibration accuracy (%)
- A_{PV} is the correction for primary voltage level (%)
- A_{SV} is the correction for secondary voltage level (%)
- A_N is the correction for the turns ratio (%)

where:

$$A_R = 0.1\ \%$$

$$A_C = 0.1\ \% + (0.00001\ \% * F_M)$$

$$A_{PV} = 0.1\ \% + (\frac{0.01\ \%}{V_{PM}})$$

$$A_{SV} = 0.1\ \% + (\frac{0.01\ \%}{V_{SM}})$$

$$A_N = 0.1\ \% + (\frac{0.1\ \%}{N_M})$$

where:

- F_M is the test frequency (Hz)
- V_{PM} is the measured primary voltage (V)
- V_{SM} is the measured secondary voltage (V)
- N_M is the measured turns ratio (Primary/Secondary)

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10.2.5. TRL Test

The accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_{LSP} + A_{LSS}$$

where:

A_T is the total accuracy (%)

A_{LSP} is the accuracy of the primary inductance (%)

A_{LSS} is the accuracy of the secondary inductance (%)

To calculate the accuracies of the primary and secondary inductances, use the formula for LS accuracy given in 10.2.2.

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10.2.6. MAGI Test

The accuracy of the applied test voltage is 1%.

The measurement accuracy of MAGI is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_I}$$

where:

A_T is the total accuracy (%)

A_R is the basic relative accuracy (%)

A_C is the calibration accuracy (%)

A_I is the correction for current level (%)

where:

$$A_R = 0.10\ \%$$

$$A_C = 0.08\ \% + (0.001\ \% * F_M)$$

$$A_I = 0.03\ \% + (\frac{0.01\ \%}{I_M}) + (2.0\ \% * I_M)$$

where:

F_M is the test frequency (Hz)

I_M is the measured current (A)

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10.2.7. MAGX Test (External Source)

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_I + A_{OFF} + A_{ESI} + A_{SRCE}}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_I	is the correction for current level (%)
A_{OFF}	is the error in the compensation measurement (%)
A_{ESI}	is the error in the source interface current (%)
A_{SRCE}	is the correction for external source type (%)

where:

$$A_R = 0.10\ \%$$

$$A_C = 0.08\ \% + (0.001\ \% * F_M)$$

$$A_I = 0.03\ \% + (\frac{0.01\ \%}{I_M}) + (2.0\ \% * I_M)$$

$$A_{OFF} = [0.23\ \% + (0.0003\ \% * F_M)] * \frac{1}{I_M}$$

$$A_{ESI} = \quad 0.5\ \%$$

$$A_{SRCE} = 0.5\%\ (For\ manual\ or\ line\ supply)$$

$$A_{SRCE} = 0.0\%\ (For\ analog, amplifier\ or\ AT\ output\ tx)$$

where:

F_M	is the test frequency (Hz)
I_M	is the measured current (A)

During a **MAGX** test, the AT7600 automatically applies the test voltage to the device under test (DUT) and verifies that the voltage has stabilized before recording measurements.

The stabilization time varies depending on the source type and the characteristics of the DUT. In general, particularly when using source types *Programmable* or *AT*

Output Transformer—the AT7600 records measurements very quickly (typically in less than 0.5 seconds), which is advantageous in a production test environment.

If measurements are taken after a longer period under power, slight variations may occur due to self-heating effects in the DUT. This effect may be observed when comparing results obtained with different source types or slower measurement systems.

10.2.8. VOC Test

The accuracy of the applied test voltage is 1%.

The measurement accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)

where:

$$A_R = 0.10\ \%$$

$$A_C = 0.08\ \% + (0.001\ \% * F_M)$$

$$A_V = 0.03\ \% + (\frac{0.01\ \%}{V_M})$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)

10.2.9. VOCX Test (External Source)

The accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + A_C + A_V + A_{SRCE}$$

where:

A_T is the total accuracy (%)

A_R is the basic relative accuracy (%)

A_C is the calibration accuracy (%)

A_V is the correction for voltage level (%)

A_{SRCE} is the correction for external source type (%)

where:

$$A_R = 0.10\ \%$$

$$A_C = 0.08\ \% + (0.001\ \% * F_M)$$

$$A_V = 0.03\ \% + (\frac{0.01\ \%}{V_M})$$

$$A_{SRCE} = 0.5\ \%\ (For\ manual\ or\ line\ supply)$$

$$A_{SRCE} = 0.0\ \%\ (For\ analog, amplifier\ or\ AT\ output\ tx)$$

where:

F_M is the test frequency (Hz)

V_M is the measured voltage (V)

During a VOCX test, the AT7600 automatically applies the test voltage to the device under test (DUT) and verifies that the voltage has stabilized before recording measurements.

The stabilization time depends on both the source type used and the characteristics of the DUT. In general, particularly with source types *Programmable* and *AT Output Transformer* - the AT7600 records measurements very quickly (typically in less than 0.5 seconds), which is advantageous in a production test environment.

If measurements are taken after a longer period under power, slight variations may occur due to self-heating effects in the DUT. This effect may become apparent when comparing results obtained with different source types or slower measurement systems.

10.2.10. LVOC Test

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)

where:

$$A_R = 0.10\ \%$$

$$A_C = 0.08\ \% + (0.00001\ \% * F_M)$$

$$A_V = 0.03\ \% + (\frac{0.01\ \%}{V_M})$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)

10.2.11. IR Test

The accuracy of the test voltage is 3% +/-50V.

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_I + A_Z}$$

where:

A_T is the total accuracy (%)
A_R is the basic relative accuracy (%)
A_C is the calibration accuracy (%)
A_I is the correction for current level (%)
A_Z is the correction for impedance (%)

where:

$$A_R = 1.00\ \%$$

$$A_C = 0.08\ \%$$

$$A_I = 3.20\ \% + (\frac{0.000002\ \%}{I_M})$$

$$A_Z = 0.5\ \% + (0.001\ \% * Z_M)$$

where:

I_M is the measured current (A)
Z_M is the measured IR value (MΩ)

10.2.12. HPDC Test

The accuracy of the test voltage is 3% +/-50V.

The accuracy of the measured current is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_I}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_I	is the correction for current level (%)

where:

$$A_R = 3.20\ \%$$

$$A_C = 0.08\ \%$$

$$A_I = \frac{0.0001\ \%}{I_M}$$

where:

I_M is the measured current (A)

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10.2.13. HPAC Test

The accuracy of the test voltage is 3% +/-50V.

The AC HI POT transformer system on the AT7600 has a VA rating of 250 VA.

The accuracy of the measured current is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_I}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_I	is the correction for current level (%)

where:

$$A_R = 3.00\ \%$$

$$A_C = 0.08\ \% + 0.001\ \% * Fm$$

$$A_I = \frac{0.001\ \%}{I_M}$$

where:

I_M	is the measured current (A)
F_M	is the test frequency (Hz)

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10.2.14. LSB AND LPB Tests

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I + A_Q}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)
A_Q	is the correction for Q factor (%)

where:

$$A_R = 0.05\ \%$$

$$A_C = 0.08\ \% + (0.00001\ \% * F_M)$$

$$A_V = 0.08\ \% + (\frac{0.02\ \%}{V_M})$$

$$A_I = 0.08\ \% + \left(\frac{0.0001\ \%}{I_M}\right) + [0.03\ \% * (\frac{I_B}{I_M})]$$

$$A_Q = 0.08\ \% + (\frac{0.2\ \%}{Q_M})$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)
I_B	is the bias current (A)
Q_M	is the measured Q factor.

10.2.15. WATT and STRW Tests

The accuracy of the applied test voltage is 2%. The measurement accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I + A_{PF}}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)
A_{PF}	is the correction for power factor (%)

where:

$$A_R = 0.30\ \%\ for\ WATT\ or\ 1.00\ \%\ for\ STRW$$

$$A_C = 0.80\ \% + (\frac{0.001\ \%}{Fm})$$

$$A_V = 0.05\ \% + (\frac{0.01\ \%}{V_M})$$

$$A_I = 0.05\ \% + (\frac{0.01\ \%}{I_M}) + (1.0\ \% * Im)$$

$$A_{PF} = 1.0\ \% * (\frac{\sqrt{(1 - PF^2)}}{PF})$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)
PF	is the power factor of the load.

and:

$$PF = \frac{W}{VA}$$

where:

W	is the measured power (W)
VA	is the product of test voltage and magnetizing current.

10.2.16. WATX and STRX Tests (External Source)

The measurement accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_{MAGX} + A_{VOCX} + A_{PF}$$

where:

A_T is the total accuracy (%)

A_{MAGX} is the accuracy of the MAGX current measurement (%)

A_{VOCX} is the accuracy of the VOCX voltage measurement (%)

A_{PF} is the correction for power factor (%)

The accuracies of the MAGX and VOCX measurements are computed from the formulae in 10.2.7 and 10.2.9.

$$A_{PF} = [1.0\% + (0.001\ \% * F_{M)}] * \frac{\sqrt{1 - PF^2}}{PF}$$

where:

F_M is the test frequency (Hz)

PF is the power factor of the load.

and:

$$PF = \frac{W}{VA}$$

where:

W is the measured power (W)

VA is the product of MAGX and VOCX results.

When performing either of these tests, the AT7600 automatically applies the test voltage to the part under test and waits until the voltage has stabilized before recording measurements.

The stabilization time will vary depending on the source type and the characteristics of the part under test.

In general, and especially when using the Programmable or AT Output Transformer source types, the AT7600 records measurements very quickly, typically in less than

0.5 seconds. This rapid response is highly desirable in a production test environment.

If measurements were taken after a longer period under power, slight variations may occur due to self-heating effects within the part under test. These differences may become noticeable when comparing results obtained with different source types or slower measurement systems.

10.2.17. SURG Test

The measurement accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + A_C + A_V$$

where:

A_T is the total accuracy (%)

A_R is the basic relative accuracy (%)

A_C is the calibration accuracy (%)

A_V is the correction for voltage level (%)

where:

$$A_R = 3.00\ \%$$

$$A_C = 3.00\ \%$$

$$A_V = 2.0\ \% + \left(\frac{250\ \%}{V_P}\right) + (0.001\ \% * V_P)$$

where:

V_P is the programmed peak voltage (V)

10.2.17.1. Maximum Programmable SURG Voltage

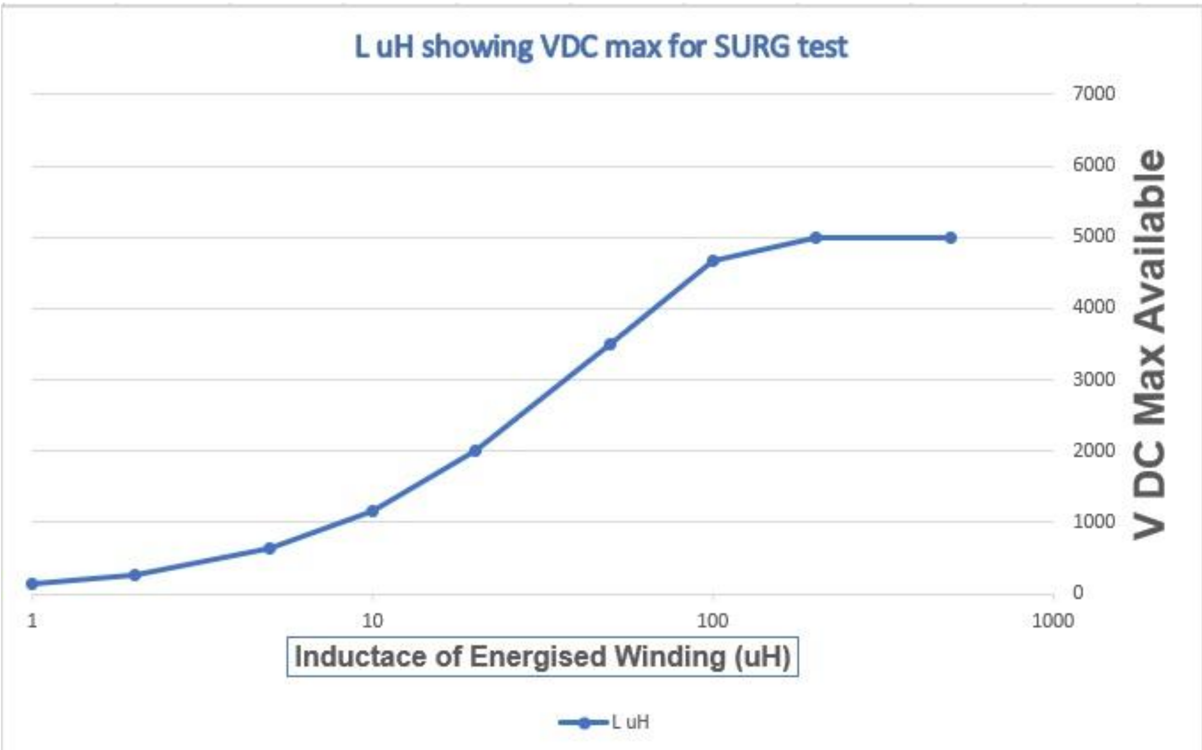
- For UUTs with Ls => 125uH, the unit maximum is achievable, namely 5000V DC
- For UUTs with Ls<=125uH, the maximum voltage achievable is defined by

Vout = (7000 * Luut) / (Luut + 50)

where Luut = UUT Series Inductance in uH

This reduction is because there is a 50uH inductor in the AT7600 to protect the unit in the case that the SURGE is discharged into a dead short.

The above limitation can be seen expressed on the below graph.



10.2.18. L2, C2 and R2 Tests

The accuracy is dependent on the accuracy of the two inductance, capacitance or resistance measurements made, and is given by:

$$A_T = A_X + A_Y$$

where:

A_T is the total accuracy (%)

A_X is the accuracy of the X measurement (%)

A_Y is the accuracy of the Y measurement (%)

Refer to the accuracy specifications for the LS, C and R tests to determine the accuracy of the X and Y measurements (10.2.2 and 10.2.1) and simply add them together.

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10.2.19. GBAL Test

The measurement accuracy is based on the chosen test conditions, and is given by

$$A_T = A_R + 0.87(A_C + A_{VI} + A_{VO})$$

where:

A_T	is the total accuracy (dB)
A_R	is the basic relative accuracy.
A_C	is the calibration accuracy.
A_{VI}	is the correction for the input voltage level.
A_{VO}	is the correction for the output voltage level.

where:

$$A_R = 0.5\ dB$$

$$A_C = 0.1 + (0.000001 * F_M)\ \text{dB}$$

$$A_{VI} = \frac{0.01\ dB}{V_{MI}}$$

$$A_{VO} = \frac{0.01 dB}{V_{MO}}$$

where:

F_M	is the test frequency (Hz)
V_{MI}	is the measured input voltage (V)
V_{MO}	is the measured output voltage (V)

10.2.20. LBAL and ILOS Tests

The measurement accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + 0.87(A_C + A_{VI} + A_{VO})}$$

where:

A_T	is the total accuracy (dB)
A_R	is the basic relative accuracy.
A_C	is the calibration accuracy.
A_{VI}	is the correction for the input voltage level.
A_{VO}	is the correction for the output voltage level.

where:

$$A_R = 0.5\ dB$$

$$A_C = 0.1 + (0.000001 * F_M)\ dB$$

$$A_{VI} = \frac{0.01\ dB}{V_{MI}}$$

$$A_{VO} = \frac{0.01\ dB}{V_{MO}}$$

where:

F_M	is the test frequency (Hz)
V_{MI}	is the measured input voltage (V)
V_{MO}	is the measured output voltage (V)

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10.2.21. RESP Tests

The measurement accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + 1.74(A_C + A_{VI} + A_{VO})$$

where:

A_T	is the total accuracy (dB)
A_R	is the basic relative accuracy (dB)
A_C	is the calibration accuracy.
A_{VI}	is the correction for the input voltage level.
A_{VO}	is the correction for the output voltage level.

where:

$$A_R = 1.0\ dB$$

$$A_C = 0.1 + (0.000001 * F_M)\ dB$$

$$A_{VI} = \frac{0.01\ dB}{V_{MI}}$$

$$A_{VO} = \frac{0.01\ dB}{V_{MO}}$$

where:

F_M	is the test frequency (Hz)
V_{MI}	is the measured input voltage (V)
V_{MO}	is the measured output voltage (V)

10.2.22. RLOS Test

The measurement accuracy is based on the chosen test conditions, and is given by:

$$A_T = 0.174\,\frac{(Z_R * Z)}{({Z_R}^2 - Z^2)} * A_Z$$

where:

A_T is the total accuracy (dB)

A_Z is the total accuracy of the Z test (%)

$$Z = \frac{V_M}{I_M}$$

$$Z_R = \sqrt{{Z_{real}}^2 + {Z_{imag}}^2}$$

and:

V_M is the measured voltage (V)

I_M is the measured current (A)

Z_{real} is the real part of the reference impedance (Ω)

Z_{imag} is the imaginary part of the reference impedance (Ω)

10.2.23. Z and ZB Tests

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I}$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)

where:

$$A_R = 0.20\ \%$$

$$A_C = 0.08\ \% + (0.00001\ \% * F_M)$$

$$A_V = 0.08\ \% + (\frac{0.02\ \%}{V_M})$$

$$A_I = 0.08\ \% + \left(\frac{0.0001\ \%}{I_M}\right) + [0.03\ \% * \left(\frac{I_B}{I_M}\right)]$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)
I_B	is the bias current (A)

10.2.24. ANGL Test

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I}$$

where:

A_T	is the total accuracy (°)
A_R	is the basic relative accuracy (°)
A_C	is the calibration accuracy (°)
A_V	is the correction for voltage level (°)
A_I	is the correction for current level (°)

where:

$$A_R = 0.05\ deg.$$

$$A_C = 0.03 + (0.0000025 * F_M)\ deg.$$

$$A_V = 0.03 + \frac{0.01}{V_M}$$

$$A_I = 0.03 + \frac{0.000003}{I_M}$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)

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10.2.25. PHAS Test

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_N}$$

where:

A_T	is the total accuracy (°)
A_R	is the basic relative accuracy (°)
A_C	is the calibration accuracy (°)
A_V	is the correction for voltage level (°)
A_N	is the correction for turns ratio (°)

where:

$$A_R = 0.05\ deg$$

$$A_C = 0.3\ deg + (0.000005 * F_M)\ deg$$

$$A_V = 0.05 * \left(\frac{1}{V_P} + \frac{TR}{V_P}\right) deg$$

$$A_N = 0.05 * \left(\left|V_P - \frac{V_P}{TR}\right|\right) deg$$

where:

F_M	is the test frequency (Hz)
V_P	is the measured primary voltage (V)
TR	is the turns ratio between the primary and secondary.

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10.2.26. ILK Test

The accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + A_C + A_I$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_I	is the correction for current level (%)

where:

$$A_R = 0.5\ \%$$

$$A_C = 0.1\ \% + (0.001\ \% * F_M)$$

$$A_I = 0.1\ \% + (\frac{0.00001\ \%}{I_M})$$

where:

F_M	is the test frequency (Hz)
I_M	is the measured current (A)

10.2.27. LSBX and LPBX Tests

The accuracy is based on the chosen test conditions, and is given by:

$$A_T = A_R + A_C + A_V + A_I + A_Q$$

where:

A_T	is the total accuracy (%)
A_R	is the basic relative accuracy (%)
A_C	is the calibration accuracy (%)
A_V	is the correction for voltage level (%)
A_I	is the correction for current level (%)
A_Q	is the correction for Q factor (%)

where:

$$A_R = 0.05\ \%$$

$$A_C = 0.08\ \% + (0.00001\ \% * F_M)$$

$$A_V = 0.08\ \% + (\frac{0.0\ 2\%}{V_M})$$

$$A_I = 0.08\ \% + \left(\frac{0.0001\ \%}{I_M}\right) + (0.03\ \% * \left(\frac{I_B}{I_M}\right))$$

$$A_Q = 0.08\ \% + (\frac{2.0\ \%}{Q_M})$$

where:

F_M	is the test frequency (Hz)
V_M	is the measured voltage (V)
I_M	is the measured current (A)
I_B	is the bias current (A) from DC1000
Q_M	is the measured Q factor.

10.2.28. ZBX Tests

The accuracy is based on the chosen test conditions, and is given by:

$$\boldsymbol{A_T = A_R + A_C + A_V + A_I}$$

where:

A_T is the total accuracy (%)

A_R is the basic relative accuracy (%)

A_C is the calibration accuracy (%)

A_V is the correction for voltage level (%)

A_I is the correction for current level (%)

where:

$$A_R = 0.20\ \%$$

$$A_C = 0.08\ \% + (0.00001\ \% * F_M)$$

$$A_V = 0.08\ \% + (\frac{0.02\ \%}{V_M})$$

$$A_I = 0.08\ \% + \left(\frac{0.0001\ \%}{I_M}\right) + (0.03\ \% * \left(\frac{I_B}{I_M}\right))$$

where:

F_M is the test frequency (Hz)

V_M is the measured voltage (V)

I_M is the measured current (A) from DC1000

I_B is the bias current (A)

10.2.29. PWRF Test

The measurement accuracy is based on the chosen test conditions and power factor, and is given by:

At = Ar + Ac + Av + Ai + Apf

where:

At	is the total accuracy (%)
Ar	is the basic relative accuracy (%)
Ac	is the calibration accuracy (%)
Av	is the correction for voltage level (%)
Ai	is the correction for current level (%)
Apf	is the correction for power factor (%)

where:

Ar = 0.50 %

Ac = 0.24 % + (0.003 % * F)

Av = 0.08 % + (0.02 % / V)

Ai = 0.08 % + (0.02 % / I) + (3.00 % * I)

Apf = 1.00 % * ((SQRT (1-PF^2)) / PF)

where:

F	is the test frequency (Hz)
V	is the measured voltage (V)
I	is the measured current (A)
PF	is the power factor of the load.

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10.3. Interface Specifications

This section defines the electrical and communication interface specifications of the AT7600, including available ports, connections, and interlocks.

10.3.1. Server Port

RS232 interface for connection to a PC server running the Voltech AT Server software.

25-pin Male D-type Connector

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	Ground (Earth)	6	No Connection
2	i/p RX	7	0V
3	o/p TX	8	No Connection
4	i/p CTS	…	-
5	o/p RTS	25	No Connection

Recommendation:

As RS232 is now a legacy communications protocol, customers using RS232 on the AT7600 will typically connect via a USB-to-RS232 converter. Since the AT7600 generates high voltages and operates in environments where high voltage and EMC noise are present, the use of an optically isolated **USB-to-RS232 converter is recommended.**

Voltech recommends the **StarTech Model ICUSB232IS converter**, a 1-Port Industrial USB to RS232 Serial Adapter with 5 kV isolation and 15 kV ESD protection.

For more information, refer to ***www.startech.com***

10.3.2. Auxiliary Port

RS232 interface for connection to a PC running the Voltech AT Editor software

9-pin Male D-type Connector

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	No Connection	6	No Connection
2	o/p TX	7	i/p CTS
3	i/p RX	8	o/p RTS
4	No Connection	9	No Connection
5	0V	-	-

Recommendation:

As RS232 is now a legacy communications protocol, customers using RS232 on the AT7600 will typically connect via a USB-to-RS232 converter. Since the AT7600 generates high voltages and operates in environments where high voltage and EMC noise are present, the use of an optically isolated **USB-to-RS232 converter is recommended.**

Voltech recommends the **StarTech Model ICUSB232IS converter**, a 1-Port Industrial USB to RS232 Serial Adapter with 5 kV isolation and 15 kV ESD protection.

For more information, refer to ***www.startech.com***

10.3.3. Remote Port

The Remote Port provides a TTL-compatible interface for connection to various peripherals, such as a foot switch, remote controller, or monitor output. It can also be integrated into robotic or automated systems to trigger test runs and monitor pass/fail status remotely.

The remote port mirrors selected user I/O signals via a 9-way D-type connector, as detailed below.

Inputs

- **RUN and STOP**: Mirror the actions of the corresponding front panel buttons, allowing external control of test initiation and termination.

Outputs

- **BUSY**: Active while a test is being executed.
- **PASS or FAIL**: Provide a logic-level indication of the test result upon completion.
- **BEEP**: Mirrors the unit's internal buzzer output as a digital signal.

9-pin Male D-type Connector

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	o/p BEEP	6	o/p !BUSY / Bin0
2	o/p !PASS / Bin1	7	0V
3	i/p !RUN	8	0V
4	o/p !FAIL / BinStrb	9	i/p !STOP
5	+5V	-	-

Signals with a name starting with "!" are active Lo.

!RUN Input (Pin 3)

The !RUN input is an active Lo input with an internal pull-up resistor. In the execution of programs, it is equivalent to pressing the RUN key on the front panel.

To use this with a footswitch, wire the switch between this input and 0V.

!STOP Input (Pin 9)

The !STOP input is an active Lo input with an internal pull-up resistor. The active-going edge of this input halts all AT7600 activity, turning off all signal sources.

To use this with an ‘emergency stop’ switch, wire the switch between this input and 0V.

BUSY / PASS / FAIL Status Outputs (Pins 2, 4 and 6)

The status outputs are standard 5 Volt logic signals.

In the standard set-up, the three status outputs are active Lo signals which signal Busy, Pass and Fail. They could, for example, be connected as status inputs to a robot controller, a bin selector, or indicator large lamps to show the status.

All the outputs are fitted with 1kΩ protection resistors, and therefore they cannot directly drive external high current loads such as indicators, or bin-select relays.

Note: The BUSY will remain active after a test program has been completed, but while SERVER comms are being used to send results data back to a PC. This can potentially be a few seconds on a slow PC over RS232.

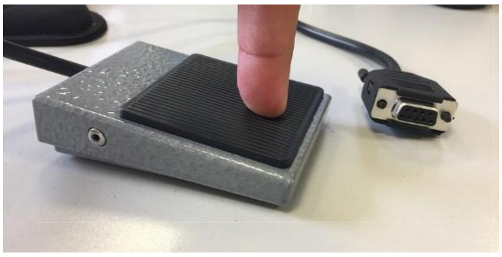
Beep Output (Pin 1)

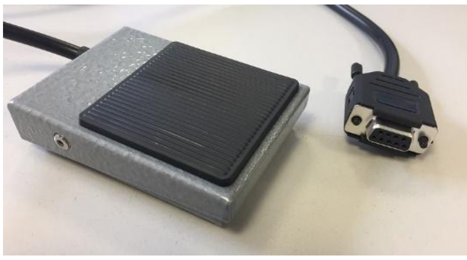
This is an active Hi output which mirrors the internal beeper.

Example – Using Footswitch with Remote Port

A footswitch can be used to trigger a program RUN from the remote port.

This gives a simple foot pedal to trigger RUN on the AT7600.





Voltech no longer supplies the remote-control assembly directly. However, all parts are **commercially available** from standard component suppliers. Recommended parts are listed below:

Item	Description	Suppliers / Part Numbers
Footswitch	Momentary, non-latching type	RS Components (RS# 316-901) or HERGA 6289-CC (Farnell 422940 / Newark 06WX5562)
9-way Female Plug	D-type connector suitable for the Remote Port	ITT Cannon ZDE9S (Newark 42M2693 / Farnell 1348016)
9-way Back Shell	Cable hood suitable for the above connector	ITT Cannon DE77762-9 (Newark 25M8922 / Farnell 1215629)

Wiring

Footswitch	9 way
Black	Pin 3
Brown	Pin 8
Green / Yellow	Case of header for earth

Recommended Isolated IC for Remote Signal Switching

Recommendation	Description
COTO C338S	Dual-channel version of the above device for multiple signal isolation requirements.
COTO C238S	Single-channel, optically isolated MOSFET relay suitable for interfacing with Remote Port drive signals.

These relays provide excellent isolation while remaining compatible with the logic-level drive signals of the Remote Port. Each device is capable of switching up to **80 mA at 600 V** on the switched side.

Manufacturer: COTO Technology

Datasheet: https://cototechnology.com/product/c238s_c338s_series_mosfetrelay/

10.3.4. Peripheral Interface

This interface is intended **solely for connection to approved Voltech accessories**. Do **not** attempt to connect any other equipment or make custom wiring modifications to this interface, as this may result in **damage to the instrument**.

15-pin Female D-type Connector

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	o/p CC	9	o/p LP_HI
2	o/p LP_LO	10	No Connection
3	o/p +12V	11	i/p AUXTRIP\
4	o/p ENAUX	12	No Connection
5	o/p AUX_RELAY	13	0V (AUX)
6	0V (HP)	14	o/p HP_OUT
7	No Connection	15	No Connection
8	i/p AUX_IN		

HP_OUT Pin 14

Dangerous voltages up to 400 V may be present on the HP_OUT pin whenever any connected safety device indicates a safe condition.

General Signal Pins

Except for the HP_OUT pin, other signals on this interface are digital TTL-level inputs or outputs, or direct connections to the instrument's internal power supply rails and signal generator sources.

10.3.5. Safety Interlock

There are three active circuits on the Safety Interlock connector:

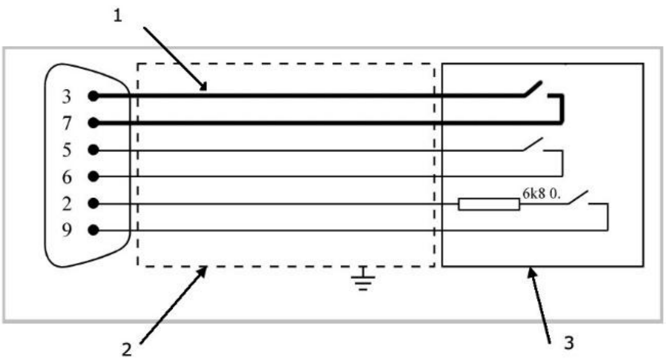
- Two digital control circuits
- One high-voltage analog circuit

The **AT7600** is capable of generating voltages that should be regarded as lethal. Please refer to Section 6 of this manual for important safety information before making any connections.

All three interlock circuits must be correctly connected before the AT7600 will allow any test operation.

9-pin Female D-type Connector

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	No Connection	6	0V
2	+12V	7	i/p HVIP
3	o/p HVOP	8	No Connection
4	No Connection	9	i/p LB1
5	i/p !LB0	-	-



HVOP and HVIP (Pins 3 and 7)

The HVOP is an analog voltage output that can reach levels of up to 400 V.
The HVIP is the corresponding analog voltage input.

All high-voltage test signals used by the AT7600 are derived from this input.

In the safe condition, HVOP is linked back to HVIP (pins 3 and 7 shorted).

LB0 and LB1 (Pins 5 and 9)

These are the two digital control signals associated with the Safety Interlock circuit.

When in the safe condition:

- !LB0 is linked to 0 V (pin 5).
- LB1 is driven to a voltage between +4.5 V and +5 V through a 6.8 kΩ, 0.4 W series resistor.

For correct operation in the safe condition:

- Pin 5 should be shorted to Pin 6.
- Pin 9 should be shorted to Pin 2 via a 6.8 kΩ, 0.4 W resistor.

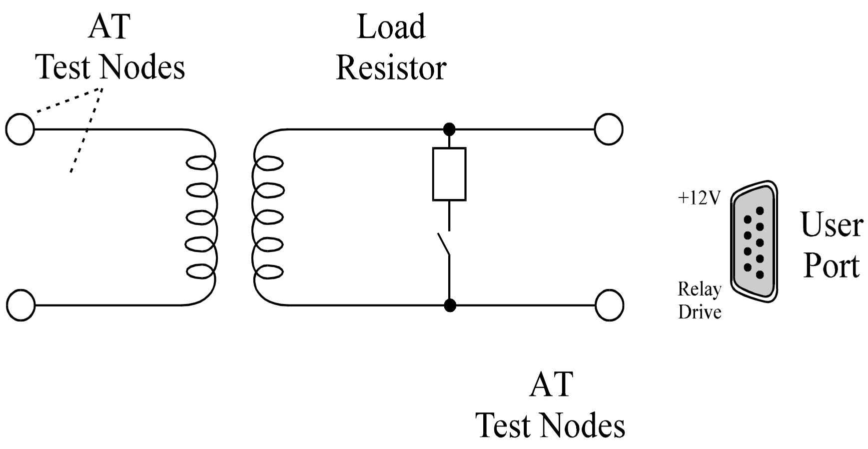
Refer to Section 6.2.2 of this manual for further details.

This configuration provides a triple-redundant system to ensure user safety.

10.3.6. User Port

The User Port is located on the rear panel of the AT7600 and provides six open-collector relay drive outputs.

The relay drives are switched on and off by the OUT test, inserted into your test program sequence. This will enable you, for example, to switch a dummy load on to the secondary winding of the transformer under test, so that subsequent tests are performed on the loaded transformer.



The OUT test switches the control lines to the programmed levels in the following sequence:

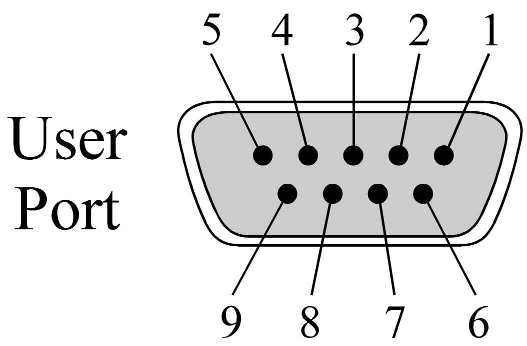
1. Open any relays changing to OFF
2. Wait 20 ms
3. Close any relays switching to ON
4. Wait 20 ms
5. Proceed to the next test

HIGH VOLTAGE WARNING

When designing relays into your fixture, remember that the AT7600 can generate extremely high voltages. It is the user's responsibility to ensure that both the relays and their associated wiring are rated to safely withstand the maximum voltages specified in the test program. It is particularly important to ensure that there is no possibility of flashover between any high-voltage test signal and a relay coil driven from the User Port. Such a flashover may cause severe internal damage to the instrument's circuitry.

If there is any uncertainty, contact Application Support for guidance on suitable relay types for your application.

9-pin Female D-type Connector



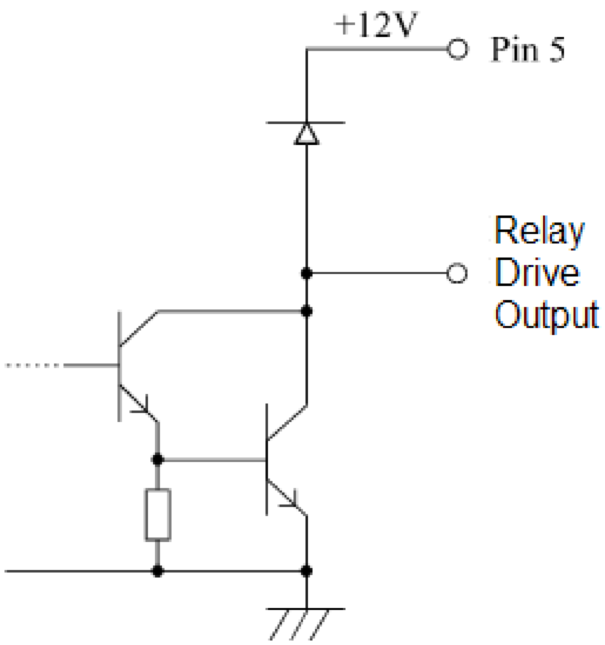
PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	o/p User Relay 0 Drive	6	o/p User Relay 1 Drive
2	o/p User Relay 2 Drive	7	o/p User Relay 3 Drive
3	O/p User Relay 4 Drive	8	o/p User Relay 5 Drive
4	Not Used	9	Not Used
5	o/p +12V	-	-

User Relay Drive Outputs (pins 1, 2, 3, 6, 7, 8)

All the User Relay Drive Outputs have the following equivalent circuit:

Specification: Relay coil resistance: > 150Ω

Maximum output current: 80 mA per output



10.3.7. Ethernet Port

The Ethernet port is a standard RJ45 8P8C connector that provides a standard 10/100 Ethernet interface.

10.3.8. Front and Rear USB “A” Ports

Standard USB 2.0 type ‘A’ interfaces used to connect the AT7600 to a printer.

Also supports USB Keyboard or USB Barcode reader meeting the HID-USB protocol.

See website for details: https://www.voltech.com/applications/barcode-scanner-usb-hid/

10.3.9. USB “B” Port

A standard USB 2.0 type ‘B’ interface used to connect the AT7600 to a PC running the Voltech AT Editor software.

10.4. Environmental Conditions

Line Input

- IEC60320 3-pin C14 socket
- Operating Voltage: 100 to 127VAC and 200 to 240VAC (Auto Changing)
- Operating Frequency: 45 to 65 Hz
- Input Power: 150 VA Maximum
- Fuse 2 AT

Environment

- EN61010-1, Pollution Degree 2, Installation Category II:
- FOR INDOOR USE ONLY.
- This ensures the safety of the instrument and the user when normal precautions are followed.

Dielectric Strength

- 1.5 KV AC 50Hz for 1 minute, line input to earth

Storage Temperature

- -40°C to +70°C

Operating Temperature

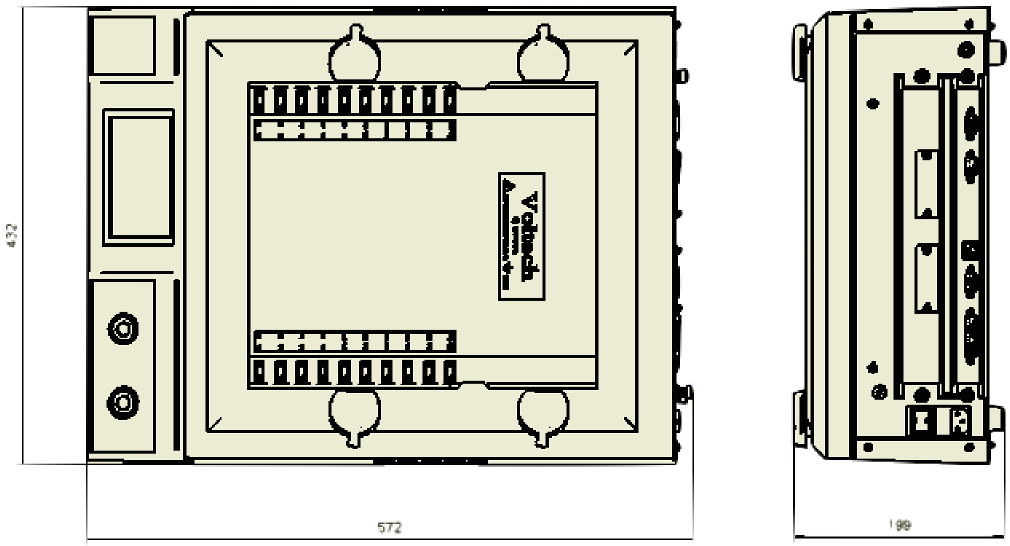
- +5°C to +40°C

As with any measuring equipment, the unit must be powered on for at least 30 minutes to become thermally stable, and SELF TEST run to confirm unit integrity.

Humidity

- 10% to 80% RH non-condensing

10.5. Mechanical Specifications



Weight: Approximately 19kg
Width: 432mm
Height: 199mm
Depth: 572mm

The fixture bay on the top surface of the AT7600 accepts Voltech fixture plates.

The maximum static weight over a 100cm2 area in the centre of a fixture is 5.0Kg

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10.6. EMC Compliance

10.6.1 Declaration of Conformity

DECLARATION OF CONFORMITY

Manufacturers Name:	**Voltech Instruments**
Manufacturers Address:	**Voltech Instruments, Ltd.**
	LHU Building (Former St. Mary's College)
	Shear Brow, Blackburn
	Lancashire
	BB1 8DX
	United Kingdom

declares that the product

Product Name:	**Wound Component Tester**
Model Number:	**AT7600**

conforms to the following product specifications

Safety:	**IEC 61010-1:2010 (3rd Edition)**
	Compliance with National Differences, US,EN,CA,JP,CH.
EMC:	**IEC 61326-1:2012, Class A, Table 1**

Supplementary Information:

The product herewith complies with the requirements of the EMC Directive 2004/108/EC

And

the Low Voltage Directive 2006/95/EC

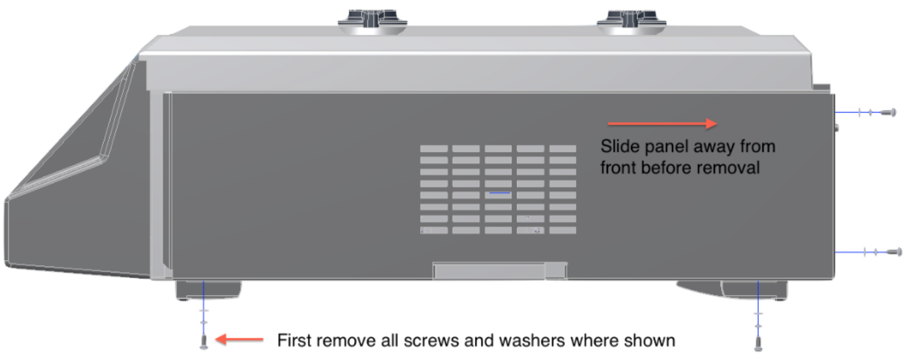
Signed for on behalf of Voltech Instruments

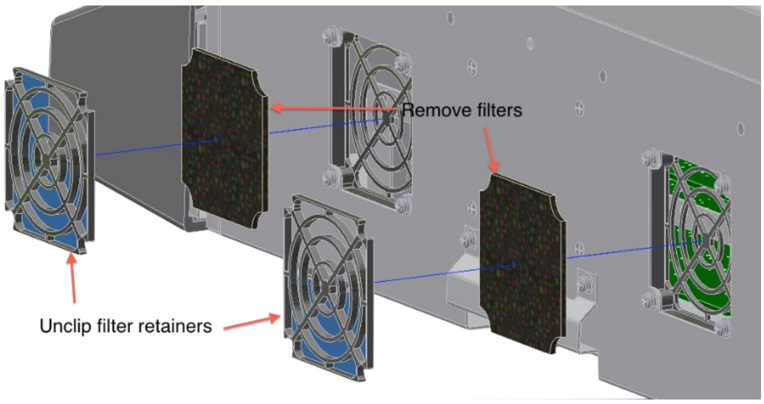
Dr John Ford, Managing Director

08 January 2026

Chapter 11: Maintenance

This chapter outlines the routine maintenance necessary to ensure the safe and reliable operation of the AT7600, covering the inspection and care of air filters, test probes, power cords, and cleaning procedures.





11.1 Air Filters

Guidance on removing and cleaning the air filters.

11.2 Test Probes

Instructions for checking and maintaining test probes.

11.3 Power Cords

Information on inspecting and replacing power cords.

11.4 Cleaning

Recommendations for safe external cleaning of the instrument.

11.1. Air Filters

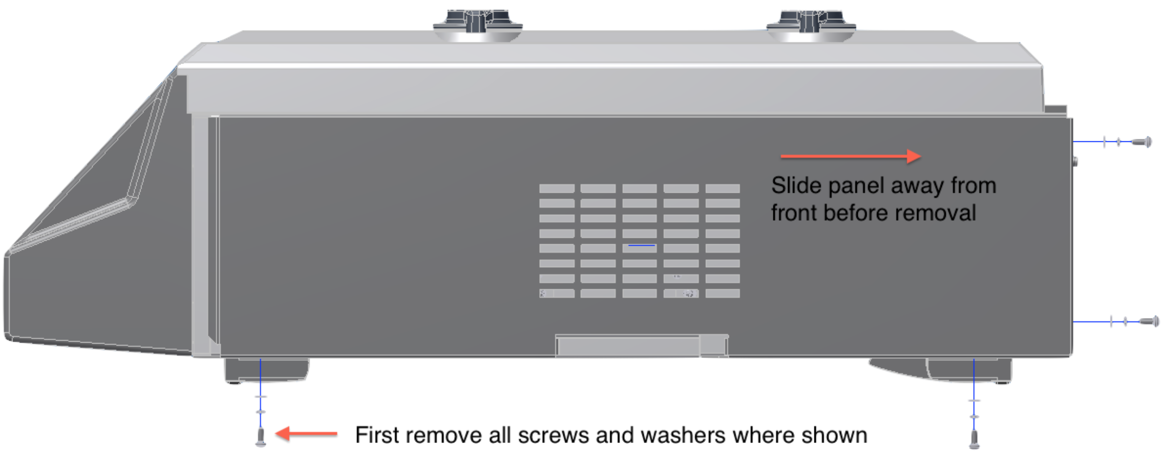
The AT7600 contains two air filters that clean the air drawn in by the cooling fans. These filters are routinely cleaned during service and calibration. When serviced annually, this is normally sufficient to maintain proper airflow through the instrument.

If the AT7600 is operated in a dusty environment, the filters may become clogged, reducing airflow and causing the unit to overheat.

If this occurs, a warning message will appear on the display, indicating that the filters require cleaning.

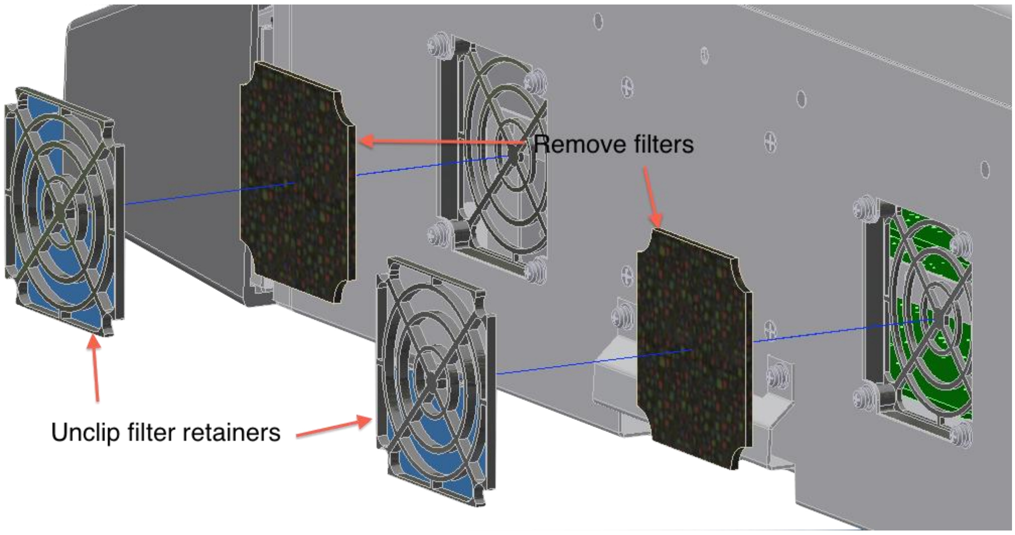
To access the filters, first remove the right-hand side panel as shown below.

11.1.1 Removing the Right-hand Side Panel



Next unclip the filter retainers by pulling using fingers or a screwdriver to release the filters as shown.

11.1.2 Removing the Air Filters



The filters can be cleaned with water or suction using a vacuum cleaner.

11.2. Test Probes

If any test probe becomes damaged, it can be removed and replaced using needle-nose pliers. Grasp the probe firmly and pull it straight upward to remove it from the fixture plate.

The standard 3 mm test probes are supplied by Ingun (UK) Ltd, part number GK S113 204 300 R 1502.

Over time, the test pins on the bottom of the fixture may become tarnished or accumulate dirt and grease from the manufacturing environment.

For cleaning, Voltech recommends using **Chemtronics Pow-R-Wash VZ:**

Website Link: https://www.chemtronics.com/pow-r-wash-vz

11.3. Power Cords

Regularly check the power cord for any signs of wear and replace it if necessary.

11.4. Cleaning

Clean only using a damp cloth.

Do not use any cleaning chemicals as damage may occur to surfaces.

Do not allow water to run inside.

Ensure surfaces are thoroughly dry before use.

Chapter 12: Warranty & Service

This section outlines Voltech's warranty coverage, service and calibration options, and available accessories to help maintain long-term accuracy and reliability of your AT7600.

12.1 Warranty Information

Standard warranty terms and conditions

12.2 Service and Calibration

Recommended calibration intervals and return procedures.

12.3 Accessories

Approved accessories and optional components.

Voltech

12.1. Warranty Information

12.1.1 Post-Sale Warranty Agreement

The product is warranted free from material defects in workmanship and/or materials at the time of delivery to the Customer and that for a period of **two years (24 months)** from such time Voltech will repair or replace any Product which does not comply with this warranty PROVIDED ALWAYS THAT the Company's liability under this warranty shall be limited to the repair or replacement of affected Products and is conditional upon the Customer: -

1. Notifying the Company promptly of any such material defect and in any event within such period of two years.

2. Returning to the Company the affected Products properly and adequately packed, carriage or post-paid, within fourteen days of such notification

3. Having ensured that the Products have not been tampered with, repaired, modified, or altered in any way; and

4. Ensuring that the Products are protected from harm or otherwise properly cared for and are retained in the possession of the Purchaser.

In the event of a failure as above Voltech will:

1. At its discretion, repair or replace the faulty unit free-of-charge for a unit returned to an authorized service centre

2. Pay all return shipment charges from the Voltech service centre to the customer.

3. Re-calibrate the unit before dispatch. A certificate of calibration will be issued as a matter of course.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from unauthorized modification or misuse, or operation outside specification of instrument. No other warranty is expressed or implied.

Whilst every care has been taken in compiling the information in this publication Voltech Instruments cannot accept legal liability for any inaccuracies contained herein. Voltech Instruments has an intensive program of design and development which may well alter product specification and reserve the right to alter specification without notice and whenever necessary to ensure optimum performance from its product range.

It shall be deemed to exclude all other warranties and conditions whether express or implied and whether arising by common law statute or otherwise.

Voltech reserve the right to waive this benefit in any event where it is clear upon inspection that the cause of the failure is due to customer misuse.

Voltech will be the sole arbiter in these circumstances.

Because software is inherently complex and may not be completely free of errors, you are advised to verify your work. In no event, will Voltech be liable for direct, indirect, special, incidental, or consequential damages arising out of the use of or inability to use software or documentation, even if advised of the possibility of such damage. Voltech is not responsible for any lost profits or revenue, loss of use of software, loss of data, cost of substitute software, claims by third parties, or for other similar costs. In no case, shall Voltech liability exceed the amount of the license fee. *(Should this be purchase price*)

Current Full terms of business can be viewed on Voltech's website (www.voltech.com) by selecting "Terms of Business' at the bottom of the home page.

12.2. Service and Calibration

To confirm the accuracy of your product, a calibration check should be carried out every 12 months.

Calibration adjustment is carried out using OEM equipment and software systems. Adjustment can only be performed by an authorized Voltech service centre.

For details of calibration facilities and any other service request, please contact your supplier. Voltech strongly recommends that you discuss your service requirements with your supplier before service is needed.

Extended warranty and full-service agreements may be available.

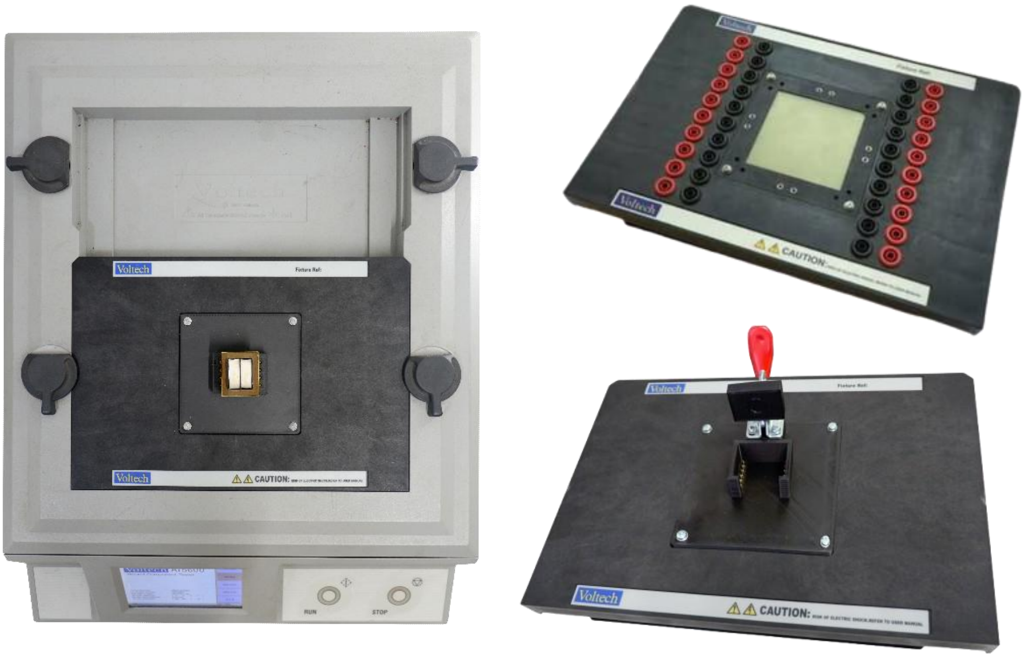
12.3. Accessories

If you require additional cables, fixtures, or fuses beyond those supplied with your AT7600, please contact Voltech.

ACCESSORY	PART NUMBER
USB CABLE	-
Editor RS232 Cable	77-015
Server Port RS232 Cable	77-016
AC Interface Fixture	98-072
Fixture Kit (Custom Fixture Base Assembly)	-
DC1000A DC Bias Unit	100-114
Safety Interlock Y Splitter Cable	250-031
Footswitch	-
Light Curtain Interface Cable	-
Air Filters (Pair)	-
Spring Probes	-
Power Cord	Varies by region (contact Voltech Support for details)

Chapter 13: Test Fixtures

This chapter explains the Voltech fixture system, connection methods, and compensation procedures used to ensure accurate and repeatable testing. It also introduces the **Custom Fixture Design Service** for building fixtures built to your components specifications.



13.1 Introduction

Overview of fixture purpose and function.

13.2 The Voltech Fixture System

Description of the standard fixture setup.

13.3 The Voltech 40 Socket Fixture

Features and usage of the 40-way fixture.

13.4 Voltech Custom Fixture

Custom fixtures for precise, repeatable testing of SMD and through-hole components.

13.5 Making Fixture Connections – Kelvin Connections

Correct connection techniques for accurate measurements.

13.6 Compensation

Procedure for removing fixture and lead effects.

13.7 General Notes

13.1. Introduction

This chapter introduces the fixture system designed for use with the AT Series testers. Each custom fixture kit includes detailed instructions for building your own fixture, and the full Fixture System User Manual (Part No. **98-028**) is available from the Voltech website.

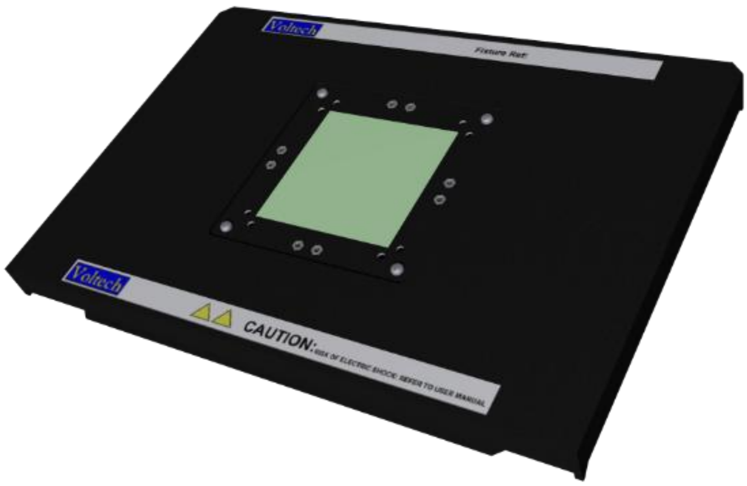
The AT7600 performs a comprehensive range of tests on many types of wound components. To achieve maximum performance, dedicated test fixtures should be constructed for each part type.

Fixtures are built around a precision connection board that interfaces directly with the tester's node pins, allowing fast, repeatable, and reliable component loading, ideal for high-speed automated testing.

Well-constructed test fixtures offer several key benefits:

- Minimize operator fatigue
- Ensure optimum repeatability
- Prevent unnecessary rejects
- Increase test throughput

13.2. Voltech Fixture System



13.2.1. Fixture System Description

The Voltech AT Series fixture system provides flexibility and convenience when designing fixtures for different component types. All fixtures are mounted on standard fixture boards, available either as a blank fixture plate or as a fixture kit containing all required mechanical parts.

Fixtures are designed to accommodate wound components with the following characteristics.

Size:

- A footprint of up to 63.5 mm square
- A height of up to 63.5 mm
- A connection matrix up to 60 mm square
- A maximum static weight of 5.0Kg

Connection Types:

- Surface mount
- Pin connection
- Blade connection
- Flying leads

Pitches:

- 1.27 mm
- 1.96 mm (0.156")
- 2.00 mm
- 2.50 mm
- 2.54 mm (0.1")
- 3.81 mm (0.15")

Although a 1.27 mm pin pitch is available, it is expected that component connections will be on multiples of this pitch. There should not be two connections spaced only 1.27 mm apart.

13.2.2. Compatible Connection Types

The fixture system supports a range of connection types to suit different component terminations and testing requirements.

Compatible connection options include:

- Kelvin clips
- Kelvin blades (Automech type)
- 4 mm sockets
- ATE pins – Rotary Point, Castellated, Point, Cup, and Crown types

A full list of suitable ATE pin types is provided in the Fixture System User Manual (Part No. 98-028), available from the Voltech website.

13.3. Voltech 40-Socket Fixture

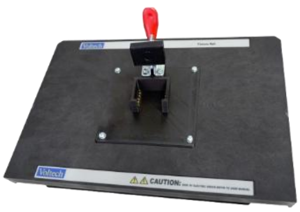
A fixture board fitted with 40 - 4mm sockets, 20 red (power) and 20 black (sense). The sockets are wired to the 40 contacts which align with the tester's 40 nodes.

This fixture may be used for convenient wiring to existing fixtures or as a means of connecting flying leads and clips for use in developing test programs or testing parts in a design laboratory.

13.4. Voltech Custom Fixture

Voltech also offers purpose-built custom fixtures designed to provide precise and repeatable electrical connections between the AT-Series testers and a wide range of wound components. These fixtures eliminate the variability of flying leads and ensure accurate, production-ready testing performance.

Kelvin Pin Fixture - for through-hole, dual in line transformers



SMD Fixture - for surface-mount components

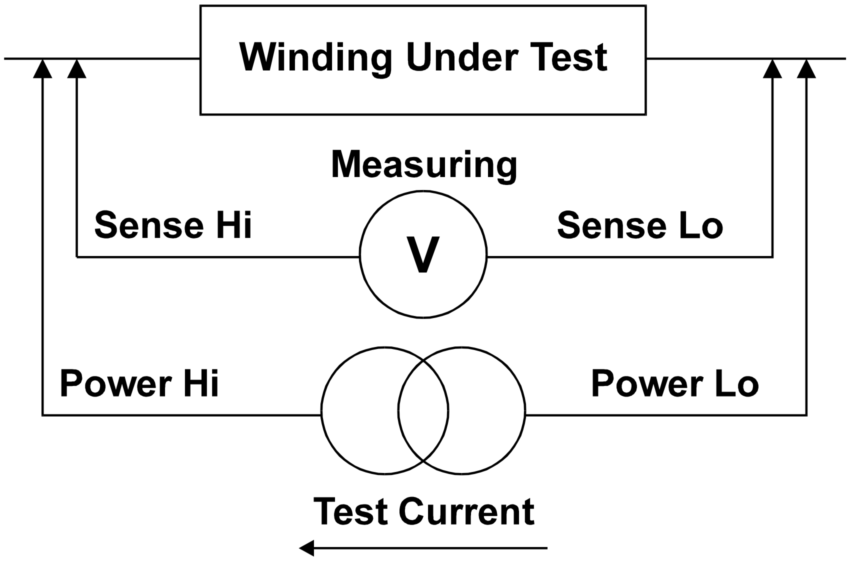
For more details on Voltech Custom Fixtures and to design your own fixture online, visit our Custom Fixture Designer on the Voltech website:
https://www.voltech.com/products/voltech-custom-built-fixtures/

13.5. Making Fixture Connections – Kelvin Connections

In testing many transformer parameters, such as winding resistance or inductance, it is necessary to measure electrical impedance.

The normal method of measuring impedance is to pass a test current through the unknown component, and to measure the resulting voltage produced across it. Dividing the voltage by the current gives the required value of impedance.

In making such measurements, great care must be taken not to include the impedance of the measuring leads in the result. A connection system that avoids such problems is shown below; it uses four wires and is often referred to as a Kelvin connection.



In this arrangement, the test current passes through the two 'power' leads, and the voltage is measured using the two 'sense' leads.

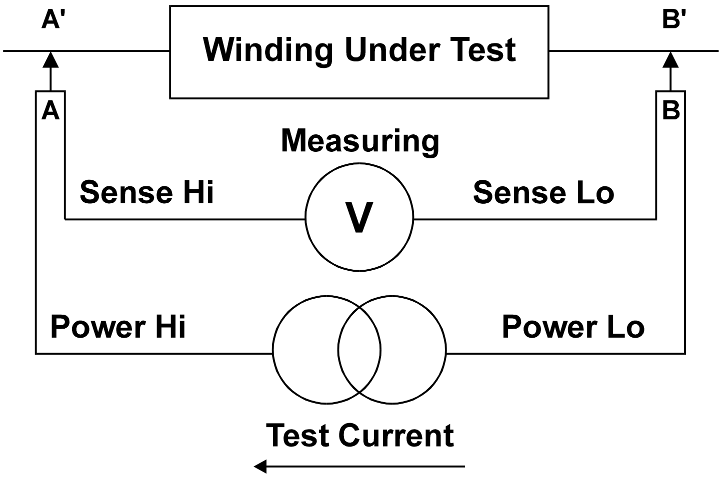
Provided that the sense leads are connected as close as possible to the body of the device under test, any additional voltage drop produced by the test current flowing through the impedance of the power leads is not measured.

The Kelvin connection therefore provides the most accurate means of sensing the voltage, and hence the impedance of the winding.

Ideally, all impedance measurements would be made using Kelvin connections. However, many terminals do not permit the use of four wires all the way to the body of the component under test.

In such cases, separate power and sense leads are used up to the base of the terminal and the length of 'common' lead (from the junction of the power and sense leads, through the terminal and the component lead to the body of the component) should be kept to a minimum.

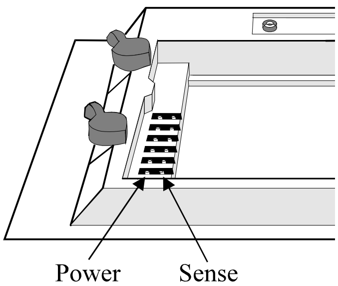
The 'common' lead length is shown as AA' and BB' in the diagram below.



The AT series testers provide all the connections required to take advantage of Kelvin measurements.

A test node is a pair of connections consisting of one power and one sense terminal.

The following diagram indicates how to identify the node terminal function.



POWER terminals are all on the outside of the fixture area.

SENSE terminals are all on the inside of the fixture area.

IMPORTANT

Kelvin four terminal connections are generally advised to be used in all test fixtures but they are essential for impedance measurements less then 1Ω.

13.6. Compensation

Compensation of the test fixture is equivalent to short-circuit and open-circuit correction on a component analyser or LCR meter.

It eliminates errors due to stray parasitic effects which are usually a combination of parallel capacitance between adjacent wires, sockets, or pins, and series resistance and inductance along the lengths of wires.

In addition to the open and short circuit correction, the AT7600 has been enhanced to provide load correction feature, like high end LCR Meters, which allow you to perform load correction using a transfer function that determines the relationship between a standard reference value (pre-measured known value) and the standard's actual measurement. Load correction removes errors that cannot be compensated out using just open and short circuit correction.

Not all test programs require compensation, and for some programs containing only high-power tests, compensation is not possible.

It is best to try compensating when developing test programs with the Editor software. If compensation of the fixture changes the test results, then it should be applied whenever the program is run in a production situation.

When a program is first loaded on an AT7600, compensation must be performed, and the results are then stored for future use.

Compensation offsets are deliberately NOT stored in the program, as these offsets are characteristic of the total environment (program, fixture, and tester) as so would become confusing and ambiguous for users with several units and/or several fixtures.

For optimum accuracy, compensation measurements should be made.

- Whenever the test fixture is changed
- At the beginning of each day or work period
- Whenever a new test program is loaded into the AT for execution

13.6.1. Compensation Summary – Available Tests

TEST		COMPENSATION AVAILABLE?		
Description	**Mnemonic**	**S/C**	**O/C**	**Load (User choice)**
Continuity	CTY	**Yes**	No	**n/a**
DC Resistance	R	**Yes**	No	**Yes**
DC Resistance Match	R2	**Yes**	No	**Yes**
Inductance (Series circuit)	LS	**Yes**	**Yes**	**Yes**
Inductance (Parallel circuit)	LP	**Yes**	**Yes**	**Yes**
Inductance Match	L2	**Yes**	**Yes**	**Yes**
Inductance with Bias (Series)	LSB	**Yes**	**Yes**	**Yes**
Inductance with Bias (Parallel)	LPB	**Yes**	**Yes**	**Yes**
Impedance with Bias	ZB	**Yes**	**Yes**	**Yes**
Inductance with Bias Series (DC1000A)	LSBX	**Yes**	**Yes**	**Yes**
Inductance with Bias Parallel (DC1000A)	LPBX	**Yes**	**Yes**	**Yes**
Impedance with Bias (DC1000A)	ZBX	**Yes**	**Yes**	**Yes**
Quality Factor	QL	**Yes**	**Yes**	**Yes**
Dissipation Factor	D	**Yes**	**Yes**	**Yes**
Equivalent Series Resistance	RLS	**Yes**	**Yes**	**Yes**
Equivalent Parallel Resistance	RLP	**Yes**	**Yes**	**Yes**
Impedance	Z	**Yes**	**Yes**	**Yes**
Impedance Phase Angle	ANGL	**Yes**	**Yes**	**Yes**
Leakage Inductance	LL	**Yes**	No	**Yes**
Inter-winding Capacitance	C	**Yes**	**Yes**	**Yes**
Inter-winding Capacitance Match	C2	**Yes**	**Yes**	**Yes**
Turns Ratio and Phasing by Voltage	TR	**Yes**	No	**Yes**
Turns Ratio and Phasing by Inductance	TRL	**Yes**	**Yes**	**Yes**
Low open Circuit Voltage	LVOC	**Yes**	**Yes**	**Yes**
Inter-winding Phase	PHAS	**Yes**	**Yes**	**Yes**
Insertion Loss	ILOS	**Yes**	**Yes**	**Yes**
Return Loss	RLOS	**Yes**	**Yes**	**Yes**
Longitude Balance	LBAL	**Yes**	**Yes**	**Yes**
General Longitude Balance	GBAL	**Yes**	**Yes**	**Yes**
Frequency Response	RESP	**Yes**	**Yes**	**Yes**
Magnetizing Current	MAGI	No	**Yes**	**Yes**
Open Circuit Voltage	VOC	No	**Yes**	**Yes**
Wattage	WATT	No	**Yes**	**Yes**
Stress Wattage	STRW	No	**Yes**	**Yes**
Magnetizing Current (AC Interface)	MAGX	No	No	**Yes**
Open Circuit Voltage (AC Interface)	VOCX	No	No	**Yes**
Wattage (AC Interface)	WATX	No	No	**Yes**
Stress Wattage (AC Interface)	STRX	No	No	**Yes**
Leakage Current	ILK	No	**Yes**	**Yes**
Insulation Resistance	IR	No	**Yes**	**Yes**
Hi-Pot (DC)	HPDC	No	**Yes**	**Yes**
Hi-Pot (AC)	HPAC	No	**Yes**	**Yes**
Surge Stress	SURG	No	No	**Yes**
Output to User Port	OUT	N/a	N/a	N/a
Power Factor	PWRF	No	**No**	**Yes**
Wait	WAIT	No	**No**	N/a

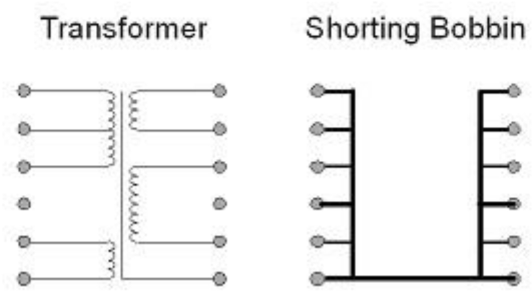
13.6.2. Equipment Required

Short Circuit Compensation

A shorting bobbin is a required for short circuit compensation.

The aim here is to place a short across every winding defined in your test program.

This is normally a transformer bobbin with each winding replaced with a short circuit. To make a shorting bobbin, solder short pieces of wire across the relevant pins of either a) a blank bobbin or b) a completed transformer



For simplicity, and flexibility you can short all pins, even if some are not used. This will give you a S/C bobbin that can be used for ANY transformer based on the same bobbin.

Open Circuit Compensation

For Open Circuit compensation, an empty bobbin should be used.

The aim here is to connect each Source and Measure pair on each of the 20 nodes that are used in your test program.

This allows the unit to measure the parasitic effect of the fixture and leads up to the point of contact with the transformer. This also allows any contact resistance in the connection of the pins/leads to transformer to be removed from your measurements.

If using a fixture with Kelvin blades, this ensures that source and measure sides of each blade pair are connected.

Load Compensation

A 'Standard Reference Component' is measured by a calibrated instrument. The value measured, Nominal Value, is then entered into the test program in the Load Compensation box. The results returned by the AT are then adjusted to compensate any stray parasitic from the system. i.e., Standard Reference Component.

1. Nominal Value: Obtain the standard reference component pre-measured known value. The measured value = 100nH (Enter this value into the Test Program for Load Compensation)

2. When the AT7600 performs a Load Compensation, it measures say 120 nH. The ratio of Nominal Value / AT Measured Results is stored in the AT7600's memory as the Load Compensation Ratio. Example, this case 100nH / 120 nH = 0.833.

3. Then, when the program is run,

   The Displayed Result = Load Compensation Ratio * measured value

   In our case, 100nH = 0.833 * 120 nH

After you have selected short circuit, open circuit, or load compensation and pressed the Run Button on the front panel, the tester will automatically perform all the compensation measurements and retain the results in internal memory.

The compensation factors will then be applied to each transformer as it is tested.

13.6.3. Compensation Failures and Pass / Fail Limits for Compensation

During short or open compensation, the unit will run through your programmed test sequence and measure the fixture (and compensation bobbin if used) using the programmed conditions.

The maximum or minimum limit of AT7600 SC/OC Compensation depends on the test type being compensated.

1) For R, R2, CTY Tests

Short Compensation Maximum limit is 500 mOhms

Open Compensation This group does not have OC Compensation

2) Impedance Style Tests such as LS, RLS, QL, Z etc

The maximum and minimum limits vary and depend on the frequency of the test being compensated.

Short Compensation Max limit = (2* pi *F * 2E-6) + 0.500

Open Compensation Min limit = 1/ (2* pi * F * 5E-9)

OC Compensation does not include the 0.500 'R' value since the internal parasitic capacitance of the components such as relays of the OC fixture is much larger than the insulation DC R value.

Both limits include the internal impedance and leakage of the AT7600 itself and the customer fixture being used.

The "Kelvin Pre-Check" feature can also be used to confirm that each kelvin pair is closed as extra assurance before the compensation is run.

13.7. General Notes

The following general notes should be considered when constructing or modifying fixtures.

13.7.1. Beware of High Voltages

The AT7600 can apply DC voltages up to 7000 V DC and AC voltages up to 5000 V AC during a test. This must be kept in mind when constructing test fixtures.

If possible, always design the fixture with the nodes that experience the same high voltages grouped together. An example of this is the common situation of performing Hi-pot tests between the primary windings as a group, and the secondary windings as a group.

The best layout for the test pins in this case (assuming this is not prohibited for other reasons) is to have all the primary windings connected to test nodes on one side of the fixture board (say the left-hand side using nodes 1, 3, 5, 7, etc.), and to have all the secondary windings connected to test nodes on the opposite side (for example, nodes 2, 4 and 6).

If, in addition, you need to test the isolation between two secondary windings, use the low-numbered nodes (say 2, 4 and 6) for one winding and a well separated group of high-numbered nodes (say 14, 16 and 18) for the other.

For PCB mounting transformers, clearly the spacing between the pins is determined by the transformer itself. If necessary, place pieces of high-voltage insulation between each Kelvin blade and its nearest neighbours, to prevent any high voltage flashover.

When separate terminals are used for transformers with flying leads, you should ensure that there is a generous separation between individual terminals to allow for the high voltages in your program.

Consider both the exposed (high voltage) metal parts of the terminal itself, and the free ends of the transformer lead, which may be carelessly inserted and may bend around to touch an adjacent terminal. Ensure that there is a separation of at least 3 mm per kV between any sharp points in an air gap, assuming that the air is dry. Increase the separation still further for conditions of high humidity.

All leads between the terminals, or crocodile clips, and the contact pins on the AT7600 fixture plate should be covered with insulation capable of withstanding the test voltages you are using in your programs. They should be kept as short as possible, and the leads from one power-sense pair should not touch any bare metal associated with another power-sense pair.

Terminals or interconnections, which have exposed (high voltage) metal in contact with the surface of the fixture board, should be avoided where possible, as there may be creepage along the surface.

If such a terminal is necessary, you must ensure that there are no sharp points or corners on the metal pieces, that the surface between them is scrupulously clean, and that a separation of at least 3 mm per kV is used.

13.7.2. Kelvin Connections

Always use Kelvin connections. In addition, when measuring extremely low transformer impedances, make sure that the Kelvin connections are continued through the terminal to the transformer leads.

13.7.3. Mechanical Problems

Always use terminals, sockets or probes that are mechanically robust. Poor mechanical connections can affect the measurements, and hence your throughput and quality of product.

In use, clean the fixtures and connectors regularly, to avoid any build-up of dirt and transformer varnish. Dirty fixtures give poor contacts and poor insulation resistance between contacts and could reduce the quality of your product.

Use a separate fixture for each type of wound component, as this can improve the testing throughput. Design the fixture so that the connections to the component under test can be made quickly and easily. One example is to use guides to ensure that the component cannot be put on to the fixture the wrong way around.

It is most important that when removing insulation from single core wire that the conductor does not get marked or damaged when stripping as this will fracture in time when in use.

13.7.4. Cleaning Test Pins

The test pins on the bottom of the test fixture can also tarnish with age and accrue dirt and grease from the manufacturing environment.
Voltech recommends Chemtronics Pow-R-Wash VZ for cleaning the test pins:

Website link: https://www.chemtronics.com/pow-r-wash-vz

Voltech

Summary Reference Tables

1. AT7600 Features

Features	ATi	AT3600	AT7600
20-way switching matrix	✓	✓	✓
PC test editor and results server	✓	✓	✓
Test fixture system	✓	✓	✓
Small signal tests (e.g., inductance, capacitance, turns ratio)	✓	✓	✓
Telecoms. tests (e.g., return loss, longitudinal balance)	✓	✓	✓
Insulation resistance	500V	7000V	7000V
Hi-pot (AC)		5000V	5000V
Hi-pot (DC)		7000V	7000V
Surge testing		5000V	5000V
Magnetizing current and open circuit voltage		270V	270V
Watts, Stress Watts		✓	✓
Leakage Current		✓	✓
Hi-pot Ramp (AC)		5000V	5000V
Hi-pot Ramp (DC)		7000V	7000V
Ethernet (For networked communications)			✓
USB (For simple program editing and printing)			✓
Measurements optimized for accuracy and speed			✓
Fast stabilization of magnetizing current			✓
Audit Testing			✓
Diagnostic Testing			✓
Load Compensation			✓

2. AT7600 Available Tests

2.1. AT7600 Low Voltage Tests

Test	Description	Main Application	Winding Tested	Reason for Test
CTY	Continuity	All transformers		Properly installed fixture
R	DC Resistance	All transformers	All windings	Properly installed fixture. Correct wire used. Integrity of terminations
LS	Inductance (Series circuit)	Most transformers but usually not line frequency transformers	One winding usually the primary	Correct primary turns. Right grade of core material. Core correctly assembled
LP	Inductance (Parallel circuit)	Most transformers but usually not line frequency transformers	One winding usually the primary	Correct primary turns. Right grade of core material. Core correctly assembled
QL	Quality Factor	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
RLS	Equivalent Series Resistance	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
RLP	Equivalent Parallel Resistance	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
D	Dissipation Factor	Most transformers but usually not line frequency transformers	One winding usually the primary	Right grade of core material Core correctly assembled Check for shorted turns
LL	Leakage Inductance	SMPS transformers Communication Transformers Others as applicable	Selected windings	Check windings have been installed in the correct position relative to the core
C	Interwinding Capacitance	High frequency transformers. Isolating transformers		Check winding positioning Check insulation thickness between windings
TR	Turns Ratio and Phasing	Most transformers, but usually not line frequency transformers	All windings	Check windings have corrected turns and phasing

Test	Description	Main Application	Winding Tested	Reason for Test
TRL	Turns Ratio by Inductance	As with Turns Ratio but used where there is poor flux linkage between windings.	All windings	Check windings have correct turns and phasing
LVOC	Low Voltage Open Circuit	All transformers	All other windings	Correct secondary turns. Correct phasing
LSB	Inductance with Bias Current (Series Circuit)	Transformers for use in applications where passing significant (DC) bias current is part of the normal operation	One winding	Correct number of turns. Right grade of core material Core correctly assembled
LPB	Inductance with Bias Current (Parallel Circuit)	Transformers for use in applications where passing significant (DC) bias current is part of the normal operation	One winding	Correct number of turns. Right grade of core material Core correctly assembled
R2	DC Resistance Match	SMPS, audio & telecom	All windings	Checks matching between windings
L2	Inductance Match	SMPS, audio & telecom transformers	All windings	Checks matching between windings
C2	Capacitance Match	SMPS, audio & telecom transformers	All Windings	Checks correct winding position on bobbin
GBAL	General Longitudinal Balance	Audio & telecom transformers	Selected Windings	Checks common mode rejection ratio
LBAL	Longitudinal Balance	Audio & telecom transformers	Selected Windings	Checks common mode rejection ratio
ILOS	Insertion Loss	Audio & telecom transformers	Selected Windings	Checks losses within the transformer
RESP	Frequency Response	Audio & telecom transformers	Selected Windings	Checks losses over a range of frequencies
RLOS	Return Loss	Audio & telecom transformers	Selected Windings	Checks losses returned by a transformer
Z	Impedance	Audio & telecom transformers	Selected Windings	Checks impedance at a given frequency
ZB	Impedance + bias	Audio & telecom transformers	Selected Windings	Checks impedance at a given frequency
ANGL	Impedance Phase Angle	Audio & telecom transformers	Selected Windings	Finds phase shift between Voltage and Current on a winding.
PHAS	Interwinding Phase Test	Audio & telecom transformers	Selected Windings	Measures phase shift between a pair of windings

2.2. AT7600 High Voltage Tests

Test	Description	Main Application	Winding Tested	Reason for Test
HPDC	Hi-Pot (DC)	All transformers especially those used for safety insulation	Between selected windings usually primary to secondary, screens and core	High voltage safety insulation
HPAC	Hi-Pot (AC)	All transformers especially those used for safety insulation	Between selected windings usually primary to secondary, screens and core	High voltage safety insulation
SURG	Surge Stress Test	All transformers, especially those using fine wire	Selected windings	To identify shorted turns
IR	Insulation Resistance	All transformers	Between selected windings	Winding isolation check where safety is not involved
ILK	Leakage Current Test	Medical applications	Between Primary and Secondary Windings	Checks for a common mode current due to capacitance
MAGI	Magnetizing Current	Usually, line frequency transformers	One winding, usually the primary	Correct primary turns. Correct core material properly assembled
VOC	Open Circuit Voltage	Usually, line frequency transformers	All other windings	Correct secondary turns. Correct phasing
WATT	Wattage	50/60Hz Iron core transformers	One winding	Correct core material. Properly assembled
PWRF	Power Factor	Usually, line frequency transformers or Current Transformers	One winding, usually the primary	Power losses over whole transformer.
STRW	Stress Wattage	Line frequency & High Frequency Transformers	One Winding (Usually the primary)	Checks inter-turn insulation, magnetic material, and joints

2.3. AT7600 + DC1000A Tests

Test	Description	Main Application	Winding Tested	Reason for Test
LSBX	Inductance with External Bias (Series Circuit)	Wound components that usually carry a significant DC Bias current in normal operation.	Selected Windings	Checks number of turns, right grade of correctly assembled core material, where bias current is greater than LSB test can manage.
LPBX	Inductance with External Bias (Parallel Circuit)	Wound components that usually carry a significant DC Bias current in normal operation.	Select Windings	Checks number of turns, right grade of correctly assembled core material, where bias current is greater than LPB test can manage.
ZBX	Impedance with External Bias	Audio & Telecom	Selected Windings	Checks impedance at a given frequency, while applying a greater bias current than is possible with ZB test.

2.4. AT7600 + AC Interface Tests

Test	Description	Main Application	Winding Tested	Reason for Test
MAGX	MAGI (External Source)	Usually, line frequency transformers	One winding, usually the primary	Correct primary turns. Correct core material properly assembled
VOCX	VOCX (External Source)	Usually, line frequency transformers	All other windings	Correct secondary turns. Correct phasing
WATX	WATT (External Source)	50/60Hz Iron core transformers	One winding	Correct core material. Properly assembled
STRX	STRW (External Source)	Line frequency & High Frequency Transformers	One Winding (Usually the primary)	Checks integrity of inter-turn insulation, the magnetic material, and joints

2.5. Other Functionality Options

Test	Description	Main Application	Winding Tested	Reason for Test
OUT	Output to User Port	Switching relays using the 6-way USER OUT port.	n/a	Allows the AT to perform external switching as part of the test program.
WAIT	Wait test	Introduce fixed duration or indefinite pause in program.	n/a	Allows time for core demagnetization or for user to manually fit load resistors or change wiring etc

3. AT7600 Tests Specifications Summary

3.1. AT7600 Low Voltage Test Specifications

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
CTY	Continuity	10 kOhm	to	50 kOhm	-		-	-		-	n/a
R	DC Resistance	500 uOhm	to	50 kOhm	-		-	-		-	0.10%
LS	Inductance (series)	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
LP	Inductance (parallel)	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
QL	Quality Factor	0.001	to	1000	1 mV	to	5 V	20 Hz	to	3 MHz	0.50%
RLS	Equivalent Series Resistance	10 mOhm	to	10 Mohm	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
RLP	Equivalent Parallel Resistance	10 mOhm	to	10 Mohm	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
D	Dissipation Factor	0.001	to	1000	1 mV	to	5 V	20 Hz	to	3 MHz	0.50%
LL	Leakage Inductance	1 nH	to	1 kH	1 mA 1 mV	to	100 mA 5 V	20 Hz	to	3 MHz	0.10%
C	Interwinding Capacitance	100 fF	to	1 mF	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
TR	Turns Ratio +Phase	1:100 k	to	100 k:1	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
TRL	Turns Ratio by Inductance	30 - 1	to	1 - 30	1 mV	to	5 V	20 Hz	to	3 MHz	0.10%
LVOC	Low Voltage Open Circuit	1 mV	to	650V (3)	1mV	to	5 V	20 Hz	to	3 MHz	0.10%

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
*LSB	Inductance with DC Bias (Series)	1 nH	to	1 MH	1 mV 1 mA	to	5 V 1 A	20 Hz	to	3 MHz	0.05%
*LPB	Inductance with DC Bias (Parallel)	1 nH	to	1 MH	1 mV 1 mA	to	5 V 1 A	20 Hz	to	3 MHz	0.05%
R2	DC Resistance Match	1-1000	to	1000-1	-		-	-		-	0.20%
L2	Inductance Match	1-10000	to	10000-1	1 mV	to	5 V	20 Hz	to	3MHz	0.10%
C2	Inter-winding Capacitance Match	1-1000	to	1000-1	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
GBAL	General Balance	0 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
LBAL	Longitudinal Balance	0 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
ILOS	Insertion Loss	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	0.5dB
RESP	Frequency Response	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	1.0dB
RLOS	Return Loss	-100 dB	to	100 dB	1 mV	to	5 V	20 Hz	to	3 MHz	
Z	Impedance	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
*ZB	Impedance + Bias	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%
ANGL	Impedance Phase	-360˚	to	360˚	1 mV	to	5 V	20 Hz	to	3 MHz	0.05˚
PHAS	Inter-winding Phase	-360˚	to	360˚	1 mV	to	5 V	20 Hz	to	3 MHz	0.05˚

NOTES:

- *LSB & LPB the AC Test Signal Range is **20uA to 100mA***
- *The AT7600's constant current generator has a maximum voltage limit of **10V** for bias testing (**ZB, LSB, and LPB** tests). Exceeding this limit may result in an overvoltage error (xxx1).*

3.2. AT7600 High Voltage Test Specifications

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
HPAC	AC Hi-Pot	1 uA	to	30 mA (4)	100 V	to	5 kV	50 Hz	to	1 kHz	3.00%
HPDC	DC Hi-Pot	1 uA	to	3 mA	100 V	to	7 kV	-		-	3.20%
SURG	Surge Stress	1 mVs	to	1 kVs	100 V	to	5 kV	-		-	3.00%
IR	Insulation Resistance	100 kOhm	to	100 GOhm	100 V	to	7 kV	-		-	1.00%
ILK	Leakage Current	1 uA	to	10 mA	1 V	to	270 V	20 Hz	to	1 kHz	0.50%
MAGI	Magnetizing Current	1 mA	to	2 A (3)	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.10%
VOC	Open Circuit Voltage	100 mV	to	650 V (3)	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.10%
WATT	Wattage	1 mW	to	40 W	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.30%
STRW	Stress Wattage	1 mW	to	40 W	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	1.00%
PWRF	Power Factor	0	to	1	1 V	to	270 V 40 W	20 Hz	to	1.5 kHz	0.5%

3.3. AT7600 + DC1000A Test Specifications

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
LSBX	Series Inductance + DC1000A Bias	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
LPBX	Parallel Inductance + DC1000A Bias	1 nH	to	1 MH	1 mV	to	5 V	20 Hz	to	3 MHz	0.05%
ZBX	Impedance +DC1000A Bias	1 mOhm	to	1 MOhm	1 mV	to	5 V	20 Hz	to	3 MHz	0.20%

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3.4. AT7600 + AC Interface Test Specifications

Test	Name	Measurement Range			Test Signal			Test Frequency			A_R (1)
MAGX	Magnetizing Current (Ext Source)	50 mA	to	10 A (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	0.10%
VOCX	Open Circuit Voltage (Ext Source)	100 mV	to	650 V (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	0.10%
WATX	Wattage (Ext. Source)	100 mW	to	6 kW (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	1.00%
STRX	Stress Wattage (Ext. Source)	100 mW	to	6 kW (6)	1 V	to	600 V	20 Hz	to	5 kHz (2)	1.00 %

Specification Table Notes

1. **AR** = basic relative accuracy (for the full specification, refer to later sections).
2. Depends on external source type.
3. 650 Vrms for AC measurements, or 900 V for DC measurements. Maximum 40 W for VOC, MAGI, WATT, and STRW tests.
4. Peak value.
5. DC bias current accuracy is ±10% of the requested value.
6. 40 W when using ACIF with step-up/step-down transformer.
    - 6 kW maximum when using ACIF with an external AC power amplifier (Note: amplifier choice may result in a lower maximum power).

4. Compensation Summary – Available Tests

TEST		COMPENSATION AVAILABLE?		
Description	Mnemonic	S/C	O/C	Load (User choice)
Continuity	**CTY**	**Yes**	No	**n/a**
DC Resistance	**R**	**Yes**	No	**Yes**
DC Resistance Match	**R2**	**Yes**	No	**Yes**
Inductance (Series circuit)	**LS**	**Yes**	**Yes**	**Yes**
Inductance (Parallel circuit)	**LP**	**Yes**	**Yes**	**Yes**
Inductance Match	**L2**	**Yes**	**Yes**	**Yes**
Inductance with Bias (Series)	**LSB**	**Yes**	**Yes**	**Yes**
Inductance with Bias (Parallel)	**LPB**	**Yes**	**Yes**	**Yes**
Impedance with Bias	**ZB**	**Yes**	**Yes**	**Yes**
Inductance with Bias Series (DC1000A)	**LSBX**	**Yes**	**Yes**	**Yes**
Inductance with Bias Parallel (DC1000A)	**LPBX**	**Yes**	**Yes**	**Yes**
Impedance with Bias (DC1000A)	**ZBX**	**Yes**	**Yes**	**Yes**
Quality Factor	**QL**	**Yes**	**Yes**	**Yes**
Dissipation Factor	**D**	**Yes**	**Yes**	**Yes**
Equivalent Series Resistance	**RLS**	**Yes**	**Yes**	**Yes**
Equivalent Parallel Resistance	**RLP**	**Yes**	**Yes**	**Yes**
Impedance	**Z**	**Yes**	**Yes**	**Yes**
Impedance Phase Angle	**ANGL**	**Yes**	**Yes**	**Yes**
Leakage Inductance	**LL**	**Yes**	No	**Yes**
Inter-winding Capacitance	**C**	**Yes**	**Yes**	**Yes**
Inter-winding Capacitance Match	**C2**	**Yes**	**Yes**	**Yes**
Turns Ratio and Phasing by Voltage	**TR**	**Yes**	No	**Yes**
Turns Ratio and Phasing by Inductance	**TRL**	**Yes**	**Yes**	**Yes**
Low open Circuit Voltage	**LVOC**	**Yes**	**Yes**	**Yes**
Inter-winding Phase	**PHAS**	**Yes**	**Yes**	**Yes**
Insertion Loss	**ILOS**	**Yes**	**Yes**	**Yes**
Return Loss	**RLOS**	**Yes**	**Yes**	**Yes**
Longitude Balance	**LBAL**	**Yes**	**Yes**	**Yes**
General Longitude Balance	**GBAL**	**Yes**	**Yes**	**Yes**
Frequency Response	**RESP**	**Yes**	**Yes**	**Yes**
Magnetizing Current	**MAGI**	No	**Yes**	**Yes**
Open Circuit Voltage	**VOC**	No	**Yes**	**Yes**
Wattage	**WATT**	No	**Yes**	**Yes**
Stress Wattage	**STRW**	No	**Yes**	**Yes**
Magnetizing Current (AC Interface)	**MAGX**	No	No	**Yes**
Open Circuit Voltage (AC Interface)	**VOCX**	No	No	**Yes**
Wattage (AC Interface)	**WATX**	No	No	**Yes**
Stress Wattage (AC Interface)	**STRX**	No	No	**Yes**

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TEST		COMPENSATION AVAILABLE?		
Description	Mnemonic	S/C	O/C	Load (User choice)
Leakage Current	**ILK**	No	**Yes**	**Yes**
Insulation Resistance	**IR**	No	**Yes**	**Yes**
Hi-Pot (DC)	**HPDC**	No	**Yes**	**Yes**
Hi-Pot (AC)	**HPAC**	No	**Yes**	**Yes**
Surge Stress	**SURG**	No	No	**Yes**
Output to User Port	**OUT**	N/a	N/a	N/a
Power Factor	**PWRF**	No	**No**	**Yes**
Wait	**WAIT**	No	**No**	N/a

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5. Status Error Codes

HEX CODE	DESCRIPTION
0000	Test passed with no errors.
xxx1	Voltage over-range occurred.
xxx2	Current over-range occurred.
xxx4	Ramp-up process has been aborted; too much load.
xxx8	Error reported by the DC bias unit or that the DC bias unit did not respond to a command.
xx2x	The test signal could not be trimmed to required value; incorrect test parameters for the load.
xx4x	An error occurred after ramp-down; current did not decay away in time.
x1xx	Current limit fail (Hi-pot tests only); test current exceeded pre-programmed limit.
x2xx	The measured voltage did not go away in time; something on the fixture is staying charged.
#4xx	The test has been interrupted (see table below).
Where # = reason for the interrupt.	
1	The safety interlock was broken during the test
2	Power more than limit requested. Power is above 40 W. If this power level is exceeded, we abort the test
3	A Hi-pot current trip has terminated the test, i.e., a flashover (spark) has occurred, or the current has exceeded the AT's current capabilities (can occur on HPAC, HPDC, and IR).
4	A STOP input has terminated the test from the STOP input of the remote port or the STOP button on the front panel
5	An 8KV overvoltage has been detected and terminated the test.
6	Class D overload. A hardware trip to protect the unit if >4A has been detected for greater than a few microseconds.
7	An over-temperature interrupt has terminated the test; unit has become too hot.
8	An auxiliary fault interrupt has terminated the test; this can be created by an accessory attached to the peripheral port.
9	Unit rebooted during the test sequence.

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AT7600 User Manual Change Log

Voltech Instruments is committed to continuous improvement of its products and documentation. As a result, product specifications, features, or information within this manual may be updated over time. Any modifications that affect the content of this manual will be reflected in this section.

Version	Date	Description of Changes
1.0	01/08/2026	Initial publication of the AT7600 User Manual. Establishes baseline for future updates.

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AT7600 WOUND COMPONENT TESTER

AT7600 User Manual

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