AirBORNe®

# Aviator Transport Incubator

## Service Manual

International BIOMEDICAL

# *Aviator*
# *Infant Transport Incubator System with Optional PulseOx*
# *Service Manual*


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# LANGUAGE DISCLAIMER

(EN)

**WARNING:**

This service manual is available in English only.

- If a customer's service provider requires a language other than English, it is the customer's responsibility to provide translation services.
- Do not attempt to service the equipment unless this service manual has been consulted and is understood.
- Failure to heed this warning may result in injury to the service provider, operator, or patient from electric shock, mechanical hazards, or other hazards.

(CS)

**VÝSTRAHA**

Tento provozní návod existuje pouze v anglickém jazyce.

- V případě, že externí služba zákazníkům potřebuje návod v jiném jazyce, je zajištění překladu do odpovídajícího jazyka úkolem zákazníka.
- Nesnažte se o údržbu tohoto zařízení, aniž byste si přečetli tento provozní návod a pochopili jeho obsah.
- V případě nedodržování této výstrahy může dojít k poranění pracovníka prodejního servisu, obslužného personálu nebo pacientů vlivem elektrického proudu, respektive vlivem mechanických či jiných rizik.

(DA)

**ADVARSEL**

Denne servicemanual findes kun på engelsk.

- Hvis en kundes tekniker har brug for et andet sprog end engelsk, er det kundens ansvar at sørge for oversættelse.
- Forsøg ikke at servicere udstyret uden at læse og forstå denne servicemanual.
- Manglende overholdelse af denne advarsel kan medføre skade på grund af elektrisk stød, mekanisk eller anden fare for teknikeren, operatøren eller patienten.

(NL)

**WAARSCHUWING**

Deze onderhoudshandleiding is enkel in het Engels verkrijgbaar.

- Als het onderhoudspersoneel een andere taal vereist, dan is de klant verantwoordelijk voor de vertaling ervan.
- Probeer de apparatuur niet te onderhouden alvorens deze onderhoudshandleiding werd geraadpleegd en begrepen is.
- Indien deze waarschuwing niet wordt opgevolgd, zou het onderhoudspersoneel, de operator of een patiënt gewond kunnen raken als gevolg van een elektrische schok, mechanische of andere gevaren.

# LANGUAGE DISCLAIMER

(BG)

**ПРЕДУПРЕЖДЕНИЕ**

Това упътване за работа е налично само на английски език.

- Ако доставчикът на услугата на клиента изиска друг език, задължение на клиента е да осигури превод.
- Не използвайте оборудването, преди да сте се консултирали и разбрали упътването за работа.
- Неспазването на това предупреждение може да доведе до нараняване на доставчика на услугата, оператора или пациента в резултат на токов удар, механична или друга опасност.

(ZH-CN)

警告

本维修手册仅提供英文版本。

- 如果客户的维修服务人员需要非英文版本，则客户需自行提供翻译服务。
- 未详细阅读和完全理解本维修手册之前，不得进行维修。
- 忽略本警告可能对维修服务人员、操作人员或患者造成电击、机械伤害或其他形式的伤害。

(ZH-HK)

警告

本服務手冊僅提供英文版本。

- 倘若客戶的服務供應商需要英文以外之服務手冊，客戶有責任提供翻譯服務。
- 除非已參閱本服務手冊及明白其內容，否則切勿嘗試維修設備。
- 不遵從本警告或會令服務供應商、網絡供應商或病人受到觸電、機械性或其他的危險。

(ZH-TW)

警告

本維修手冊僅有英文版。

- 若客戶的維修廠商需要英文版以外的語言，應由客戶自行提供翻譯服務。
- 請勿試圖維修本設備，除非 您已查閱並瞭解本維修手冊。
- 若未留意本警告，可能導致維修廠商、操作員或病患因觸電、機械或其他危險而受傷。

(HR)

**UPOZORENJE**

Ovaj servisni priručnik dostupan je na engleskom jeziku.

- Ako davatelj usluge klijenta treba neki drugi jezik, klijent je dužan osigurati prijevod.
- Ne pokušavajte servisirati opremu ako niste u potpunosti pročitali i razumjeli ovaj servisni priručnik.
- Zanemarite li ovo upozorenje, može doći do ozljede davatelja usluge, operatera ili pacijenta uslijed strujnog udara, mehaničkih ili drugih rizika.

# LANGUAGE DISCLAIMER

**HOIATUS**

See teenindusjuhend on saadaval ainult inglise keeles

(ET)

- Kui klienditeeninduse osutaja nõuab juhendit inglise keelest erinevas keeles, vastutab klient tõlketeenuse osutamise eest.
- Ärge üritage seadmeid teenindada enne eelnevalt käesoleva teenindusjuhendiga tutvumist ja sellest aru saamist.
- Käesoleva hoiatuse eiramine võib põhjustada teenuseosutaja, operaatori või patsiendi vigastamist elektrilöögi, mehaanilise või muu ohu tagajärjel.

**VAROITUS**

Tämä huolto-ohje on saatavilla vain englanniksi.

(FI)

- Jos asiakkaan huoltohenkilöstö vaatii muuta kuin englanninkielistä materiaalia, tarvittavan käännöksen hankkiminen on asiakkaan vastuulla.
- Älä yritä korjata laitteistoa ennen kuin olet varmasti lukenut ja ymmärtänyt tämän huolto-ohjeen.
- Mikäli tätä varoitusta ei noudateta, seurauksena voi olla huoltohenkilöstön, laitteiston käyttäjän tai potilaan vahingoittuminen sähköiskun, mekaanisen vian tai muun vaaratilanteen vuoksi.

**ATTENTION**

Ce manuel d'installation et de maintenance est disponible uniquement en anglais.

(FR)

- Si le technicien d'un client a besoin de ce manuel dans une langue autre que l'anglais, il incombe au client de le faire traduire.
- Ne pas tenter d'intervenir sur les équipements tant que ce manuel d'installation et de maintenance n'a pas été consulté et compris.
- Le non-respect de cet avertissement peut entraîner chez le technicien, l'opérateur ou le patient des blessures dues à des dangers électriques, mécaniques ou autres.

**WARNUNG**

Diese Serviceanleitung existiert nur in englischer Sprache.

(DE)

- Falls ein fremder Kundendienst eine andere Sprache benötigt, ist es Aufgabe des Kunden für eine entsprechende Übersetzung zu sorgen.
- Versuchen Sie nicht diese Anlage zu warten, ohne diese Serviceanleitung gelesen und verstanden zu haben.
- Wird diese Warnung nicht beachtet, so kann es zu Verletzungen des Kundendiensttechnikers, des Bedieners oder des Patienten durch Stromschläge, mechanische oder sonstige Gefahren kommen.

# LANGUAGE DISCLAIMER

(EL)

**ΠΡΟΕΙΔΟΠΟΙΗΣΗ**

Το παρόν εγχειρίδιο σέρβις διατίθεται μόνο στα αγγλικά.

- Εάν ο τεχνικός σέρβις ενός πελάτη απαιτεί το παρόν εγχειρίδιο σε γλώσσα εκτός των αγγλικών, αποτελεί ευθύνη του πελάτη να παρέχει τις υπηρεσίες μετάφρασης.
- Μην επιχειρήσετε την εκτέλεση εργασιών σέρβις στον εξοπλισμό αν δεν έχετε συμβουλευτεί και κατανοήσει το παρόν εγχειρίδιο σέρβις.
- Αν δεν προσέξετε την προειδοποίηση αυτή, ενδέχεται να προκληθεί τραυματισμός στον τεχνικό σέρβις, στο χειριστή ή στον ασθενή από ηλεκτροπληξία, μηχανικούς ή άλλους κινδύνους.

(HU)

**FIGYELMEZTETÉS**

Ezen karbantartási kézikönyv kizárólag angol nyelven érhető el.

- Ha a vevő szolgáltatója angoltól eltérő nyelvre tart igényt, akkor a vevő felelőssége a fordítás elkészíttetése.
- Ne próbálja elkezdeni használni a berendezést, amíg a karbantartási kézikönyvben leírtakat nem értelmezték.
- Ezen figyelmeztetés figyelmen kívül hagyása a szolgáltató, működtető vagy a beteg áramütés, mechanikai vagy egyéb veszélyhelyzet miatti sérülését eredményezheti.

(IS)

**AÐVÖRUN**

Þessi þjónustuhandbók er aðeins fáanleg á ensku.

- Ef að þjónustuveitandi viðskiptamanns þarfnast annas tungumáls en ensku, er það skylda viðskiptamanns að skaffa tungumálaþjónustu.
- Reynið ekki að afgreiða tækið nema að þessi þjónustuhandbók hefur verið skoðuð og skilin.
- Brot á sinna þessari aðvörun getur leitt til meiðsla á þjónustuveitanda, stjórnanda eða sjúklings frá raflosti, vélrænu eða öðrum áhættum.

(IT)

**AVVERTENZA**

Il presente manuale di manutenzione è disponibile soltanto in lingua inglese.

- Se un addetto alla manutenzione richiede il manuale in una lingua diversa, il cliente è tenuto a provvedere direttamente alla traduzione.
- Procedere alla manutenzione dell'apparecchiatura solo dopo aver consultato il presente manuale ed averne compreso il contenuto.
- Il mancato rispetto della presente avvertenza potrebbe causare lesioni all'addetto alla manutenzione, all'operatore o ai pazienti provocate da scosse elettriche, urti meccanici o altri rischi.

(JA)

**警告**

このサービスマニュアルには英語版しかありません。

- サービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
- このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないでください。
- この警告に従わない場合、サービスを担当される方、操作員あるいは患者 さんが、感電や機械的又はその他の危険により負傷する可能性があります。

# LANGUAGE DISCLAIMER

(KO)

경고

본 서비스 매뉴얼은 영어로만 이용하실 수 있습니다.

- 고객의 서비스 제공자가 영어 이외의 언어를 요구할 경우, 번역 서비스를 제공하는 것은 고객의 책임입니다.
- 본 서비스 매뉴얼을 참조하여 숙지하지 않은 이상 해당 장비를 수리하려고 시도하지 마십시오.
- 본 경고 사항에 유의하지 않으면 전기 쇼크, 기계적 위험, 또는 기타 위험으로 인해 서비스 제공자, 사용자 또는 환자에게 부상을 입힐 수 있습니다.

(LV)

**BRĪDINĀJUMS**

Šī apkopes rokasgrāmata ir pieejama tikai angļu valodā.

- Ja klienta apkopes sniedzējam nepieciešama informācija citā valodā, klienta pienākums ir nodrošināt tulkojumu.
- Neveiciet aprīkojuma apkopi bez apkopes rokasgrāmatas izlasīšanas un saprašanas.
- Šī brīdinājuma neievērošanas rezultātā var rasties elektriskās strāvas trieciena, mehānisku vai citu faktoru izraisītu traumu risks apkopes sniedzējam, operatoram vai pacientam.

(LT)

**ĮSPĖJIMAS**

Šis eksploatavimo vadovas yra tik anglų kalba.

- Jei kliento paslaugų tiekėjas reikalauja vadovo kita kalba – ne anglų, suteikti vertimo paslaugas privalo klientas.
- Nemėginkite atlikti įrangos techninės priežiūros, jei neperskaitėte ar nesupratote šio eksploatavimo vadovo.
- Jei nepaisysite šio įspėjimo, galimi paslaugų tiekėjo, operatoriaus ar paciento sužalojimai dėl elektros šoko, mechaninių ar kitų pavojų.

(NO)

**ADVARSEL**

Denne servicehåndboken finnes bare på engelsk.

- Hvis kundens serviceleverandør har bruk for et annet språk, er det kundens ansvar å sørge for oversettelse.
- Ikke forsøk å reparere utstyret uten at denne servicehåndboken er lest og forstått.
- Manglende hensyn til denne advarselen kan føre til at serviceleverandøren, operatøren eller pasienten skades på grunn av elektrisk støt, mekaniske eller andre farer.

(PL)

**OSTRZEŻENIE**

Niniejszy podręcznik serwisowy dostępny jest jedynie w języku angielskim.

- Jeśli serwisant klienta wymaga języka innego niż angielski, zapewnienie usługi tłumaczenia jest obowiązkiem klienta.
- Nie próbować serwisować urządzenia bez zapoznania się z niniejszym podręcznikiem serwisowym i zrozumienia go.
- Niezastosowanie się do tego ostrzeżenia może doprowadzić do obrażeń serwisanta, operatora lub pacjenta w wyniku porażenia prądem elektrycznym, zagrożenia mechanicznego bądź innego.

# LANGUAGE DISCLAIMER

(PT-BR)

**AVISO**

Este manual de assistência técnica encontra-se disponível unicamente em inglês.

- Se outro serviço de assistência técnica solicitar a tradução deste manual, caberá ao cliente fornecer os serviços de tradução.
- Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica.
- A não observância deste aviso pode ocasionar ferimentos no técnico, operador ou paciente decorrentes de choques elétricos, mecânicos ou outros.

(PT-PT)

**ATENÇÃO**

Este manual de assistência técnica só se encontra disponível em inglês.

- Se qualquer outro serviço de assistência técnica solicitar este manual noutro idioma, é da responsabilidade do cliente fornecer os serviços de tradução.
- Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica.
- O não cumprimento deste aviso pode colocar em perigo a segurança do técnico, do operador ou do paciente devido a choques eléctricos, mecânicos ou outros.

(RO)

**ATENȚIE**

Acest manual de service este disponibil doar în limba engleză.

- Dacă un furnizor de servicii pentru clienți necesită o altă limbă decât cea engleză, este de datoria clientului să furnizeze o traducere.
- Nu încercați să reparați echipamentul decât ulterior consultării şi înțelegerii acestui manual de service.
- Ignorarea acestui avertisment ar putea duce la rănirea depanatorului, operatorului sau pacientului în urma pericolelor de electrocutare, mecanice sau de altă natură.

(RU)

**ОСТОРОЖНО!**

Данное руководство по техническому обслуживанию представлено только на английском языке.

- Если сервисному персоналу клиента необходимо руководство не на английском, а на каком-то другом языке, клиенту следует самостоятельно обеспечить перевод.
- Перед техническим обслуживанием оборудования обязательно обратитесь к данному руководству и поймите изложенные в нем сведения.
- Несоблюдение требований данного предупреждения может привести к тому, что специалист по техобслуживанию, оператор или пациент получит удар электрическим током, механическую травму или другое повреждение.

(SR)

**UPOZORENJE**

Ovo servisno uputstvo je dostupno samo na engleskom jeziku.

- Ako klijentov serviser zahteva neki drugi jezik, klijent je dužan da obezbedi prevodilačke usluge.
- Ne pokušavajte da opravite uređaj ako niste pročitali i razumeli ovo servisno uputstvo.
- Zanemarivanje ovog upozorenja može dovesti do povređivanja servisera, rukovaoca ili pacijenta usled strujnog udara ili mehaničkih i drugih opasnosti.

# LANGUAGE DISCLAIMER

**UPOZORNENIE**

Tento návod na obsluhu je k dispozícii len v angličtine.

(SK)

- Ak zákazníkov poskytovateľ služieb vyžaduje iný jazyk ako angličtinu, poskytnutie prekladateľských služieb je zodpovednosťou zákazníka.
- Nepokúšajte sa o obsluhu zariadenia, kým si neprečítate návod na obluhu a neporozumiete mu.
- Zanedbanie tohto upozornenia môže spôsobiť zranenie poskytovateľa služieb, obsluhujúcej osoby alebo pacienta elektrickým prúdom, mechanické alebo iné ohrozenie.

**ATENCION**

Este manual de servicio sólo existe en inglés.

(ES)

- Si el encargado de mantenimiento de un cliente necesita un idioma que no sea el inglés, el cliente deberá encargarse de la traducción del manual.
- No se deberá dar servicio técnico al equipo, sin haber consultado y comprendido este manual de servicio.
- La no observancia del presente aviso puede dar lugar a que el proveedor de servicios, el operador o el paciente sufran lesiones provocadas por causas eléctricas, mecánicas o de otra naturaleza.

**VARNING**

Den här servicehandboken finns bara tillgänglig på engelska.

(SV)

- Om en kunds servicetekniker har behov av ett annat språk än engelska, ansvarar kunden för att tillhandahålla översättningstjänster.
- Försök inte utföra service på utrustningen om du inte har läst och förstår den här servicehandboken.
- Om du inte tar hänsyn till den här varningen kan det resultera i skador på serviceteknikern, operatören eller patienten till följd av elektriska stötar, mekaniska faror eller andra faror.

**OPOZORILO**

Ta servisni priročnik je na voljo samo v angleškem jeziku.·

(SL)

- Če ponudnik storitve stranke potrebuje priročnik v drugem jeziku, mora stranka zagotoviti prevod.·
- Ne poskušajte servisirati opreme, če tega priročnika niste v celoti prebrali in razumeli.·
- Če tega opozorila ne upoštevate, se lahko zaradi električnega udara, mehanskih ali drugih nevarnosti poškoduje ponudnik storitev, operater ali bolnik.

**DİKKAT**

Bu servis kılavuzunun sadece ingilizcesi mevcuttur.

(TR)

- Eğer müşteri teknisyeni bu kılavuzu ingilizce dışında bir başka lisandan talep ederse, bunu tercüme ettirmek müşteriye düşer.
- Servis kılavuzunu okuyup anlamadan ekipmanlara müdahale etmeyiniz.
- Bu uyarıya uyulmaması, elektrik, mekanik veya diğer tehlikelerden dolayı teknisyen, operatör veya hastanın yaralanmasına yol açabilir.

# SECTION 1: GENERAL INFORMATION

## INTRODUCTION

**INDICATIONS FOR USE -**

The transport incubator is intended for use by personnel trained in neonatal care to facilitate the movements of neonates by air or ambulance. The transport incubator circulates warmed air at an operator selected and controlled temperature when transporting neonatal infants to hospitals prepared for neonatal infant care.

The International Biomedical Aviator Infant Transport Incubator with optional PulseOx (referred to herein as the incubator) provides a thermally regulated environment to support an infant's temperature requirements and has the capability to monitor vital information during transport. The pulse oximeter and oxygen monitor measure pulse rate, oxygen saturation, and oxygen concentration and allow the user to configure high and low alarm settings. The incubator circulates warmed air throughout the infant chamber to maintain the temperature at a user-selected setpoint. Chamber doors and hand ports provide quick and easy access to the infant. Positioning straps are provided to limit infant movement within the infant chamber. Two "E" cylinders for air and oxygen can be installed on the transport incubator. There are no known contraindications associated with the incubator.

***NOTE:*** *The Pulse oximetry and oxygen monitoring is only available if the PulseOx version of the incubator was purchased.*

This service manual is designed to introduce the user to key features of the incubator, including safety issues, instructions for use, equipment maintenance and contact information. The manual should be read and understood by all users before using the transport incubator.

## CLASSIFICATION

According to the standard EN60601-1 of the International Electrotechnical Commission, Medical electrical equipment, Part 1: General requirements for safety, the infant transport incubator is classified as follows:

- Class I / Internally Powered, according to the type of protection against electric shock
- Type B, according to the degree of protection against electric shock (i.e. the patient may not be electrically isolated from earth)
- Ordinary, according to the degree of protection against harmful ingress of water

- Equipment is not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitric oxide.
- Continuous operation for the mode of operation

The pulse oximeter cables and sensors are classified as type BF, per the EN60601-1 electrical standard.

The skin temperature probe is classified as type BF, per EN60601-1 electrical standard (systems with optional PulseOx).

The skin temperature probe is classified as type B, per EN60601-1 electrical standard (systems without optional PulseOx).

## SAFETY SUMMARY

The incubator is designed to be used by trained clinical users and/or biomedical engineers and operated in a manner consistent with the instructions contained in this manual. Refer to any additional training, procedures, requirements, or documentation beyond those identified here for operation and policies required within the institution. All personnel operating the incubator must be familiar with the warnings and operating procedures contained in this manual. International Biomedical is not to be held responsible if the incubator is used in a manner inconsistent with the instructions herein.

## IMPORTANT SAFETY CONSIDERATIONS

The incubator has been tested and found to comply with limits for electromagnetic interference and susceptibility as defined by EN60601-1-2. However, this equipment can radiate radio frequency (RF) energy and may cause harmful interference to other devices. The incubator may also be affected by interference from other devices. If RF interference is suspected, relocate or shield the incubator to reduce or eliminate the effects.

Within certain governmental jurisdictions, all interconnected accessory equipment must be labeled by an approved testing laboratory. After interconnection with accessory equipment, risk (leakage) current and grounding requirements must be maintained.

# SECTION 1: GENERAL INFORMATION

Safety concerns or additional pertinent information will be displayed using warnings, cautions, and notes, having the following significance:

**WARNING:** **Maintenance or operating procedure, technique, etc., which may result in personal injury or loss of life if not carefully followed.**

**CAUTION:** Maintenance or operating procedure, technique, etc., which may result in patient harm or damage to equipment if not carefully followed.

***NOTE:*** *Maintenance or operating procedure, technique, etc., which is considered essential to emphasize.*

The principal **WARNING** and **CAUTION** notices to be observed in use of this incubator are brought together here for emphasis

**WARNINGS**

- OBSERVE BEST PRACTICE: The instructions in this manual in no way supersede established medical procedures or staff preference concerning patient care.
- ENSURE UNIT IS PROPERLY GROUNDED: To ensure grounding reliability, only connect the power cord to a properly grounded, 3-wire hospital grade outlet of the proper voltage and frequency. DO NOT USE EXTENSION CORDS. If the integrity of the connection is in doubt, the incubator should be operated from its internal battery.
- EXPLOSION HAZARD: Do not use the examination light, the pulse oximeter, or oxygen monitor in the presence of flammable anesthetics or other flammable gases.
- USE OF OXYGEN INCREASES FIRE DANGER: Spark-producing auxiliary equipment should not be placed in or near the transport incubator.
- Avoid direct sunlight or radiant heat, which can cause a dangerous increase in chamber air temperature.
- Avoid eye exposure. Direct light exposure may cause eye damage. Infants must wear eye protection.
- The use of oxygen may increase the noise level within the infant chamber.
- Air and oxygen tanks are pressurized and must be properly secured.

- The transport incubator is Type B equipment and the baby may not be electrically isolated from earth. Care must be taken that additional equipment connected to the baby is electrically safe. To ensure patient electrical isolation, connect only to other equipment with electronically isolated circuits.
- Do not change the lamp and touch the patient simultaneously.
- When the infant tray is removed, do not touch exposed circuitry and patient simultaneously.
- This incubator was calibrated with the infant chamber originally supplied. If this chamber is exchanged for an infant chamber of a different configuration or size, the temperature calibration will be affected. Consult International Biomedical before returning the incubator to service.
- The incubator should be turned off and AC or DC power disconnected when cleaning.
- When the incubator is attached to a Ferno 146 Collapsible Cart, the two highest positions should not be used as they can cause a tip hazard.
- Do not use the pulse oximeter or oximetry sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The pulse oximeter may affect the MRI image and the MRI unit may affect the accuracy of the oximetry results.
- If using pulse oximetry during full body irradiation, keep the sensor out of the irradiation field. If the sensor is exposed to irradiation, the reading might be inaccurate or the unit might read zero for the duration of the active irradiation period.
- The pulse oximeter should NOT be used as an apnea monitor.
- If an alarm condition (other than exceptions listed herein) occurs while the MUTE button is activated, only visual alarm indicators will be activated.
- Pulse rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect arrhythmias. The pulse oximeter should not be used as a replacement or substitute for ECG based arrhythmia analysis.
- Connecting equipment to the outlets on this device creates a medical electrical system and the user is responsible for continued compliance with the requirements of IEC 60601-1.
- Do not modify this equipment without proper authorization from International Biomedical.

- An Infant Transport Incubator should be used by appropriately trained personnel and under the direction of qualified medical staff familiar with currently known risks and benefits of Infant Transport Incubator use.
- When this incubator is operated on battery in low ambient temperatures, the thermal cover must be used.
- Skin temperature probe is not a rectal probe. The skin temperature sensor is not to be used as a rectal probe.
- Do not use liquids in or around the transport incubator.

**CAUTIONS**

- U. S. Federal and Canadian law restricts this device to sale by or on the order of a physician or other licensed medical practitioner. Outside Canada and the U. S., check with local laws for applicable restrictions.
- Use of sharp objects on Front Display Panel will cause permanent damage and will void warranty.
- Do not touch, press, or rub the display panels with abrasive cleaning compounds, instruments, brushes, rough-surface materials, or bring them into contact with anything that could scratch the panel.
- Use an oxygen analyzer when oxygen is delivered to the infant.
- The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.
- The infant tray grounding tabs are sharp; use care when cleaning air flow system.
- Do not move the incubator by pushing on the infant chamber. The infant chamber is not designed to sustain the forces to push the incubator. Stress fractures in the infant chamber can occur.
- DO NOT leave the 12 volt cord attached to the DC connector of the incubator.
- Do not overtighten the infant chamber screws. Do not strip the aluminum into which these screws are threaded.
- Do not drip cleaning solution through the holes where the swell latches fit into the air flow assembly.

- The incubator MUST be plugged into AC power and the battery recharged after any battery usage. The battery will sustain damage if drained of power and not placed on recharge soon.
- CLEANING AND CARE: Do not autoclave, pressure sterilize, or gas sterilize the incubator, cables, or sensors. Use cleaning solutions sparingly as excessive solution can flow into the incubator and cause damage to internal components. Do not soak or immerse the incubator or sensors in any liquid. Do not use petroleum-based, alcohol, acetone, or other harsh solvents. See cleaning instructions of reusable sensors and cables in directions for their use.
- Check alarm limits each time the system is used to ensure that they are appropriate for the patient being monitored.
- If a sensor or cable is damaged in any way, discontinue use immediately.
- The Maxtec MAX-250E oxygen sensor is a sealed device containing a mild acid electrolyte, lead (Pb), and lead acetate. Lead and lead acetate are hazardous waste constituents and should be disposed of properly, or returned to Maxtec or International Biomedical for proper disposal or recovery.
- Pulse oximeter probes and cables are designed for use with specific monitors. Only use Masimo sensors and patient cables for Masimo pulse oximetry model. Only use Nellcor sensors and patient cables for Nellcor pulse oximetry model. Verify the compatibility of the monitor, sensor, and cable before use, otherwise patient injury can result.
- Only use International Biomedical cable and Maxtec sensor for oxygen monitoring.
- Calibrate the oxygen sensor daily when in use or if environmental conditions change significantly (i.e., Temperature, Humidity or Barometric Pressure).
- Dropping or severely jarring the oxygen sensor after calibration may shift the calibration point enough to require recalibration.
- Oxygen sensor and pulse oximetry cables must be contained within cart or otherwise secured when not in use.

# SYMBOLS

The following symbols appear in the incubator documentation and labels. These internationally recognized symbols are defined by the International Electrotechnical Commission and International Organization of Standardization, IEC 417A, IEC 878, and ISO 7000.

| | |
|---|---|
| | Keep away from rain |
| | On (power: connection to the mains) |
| | Off (Standby) |
| (Blue Background) | Attention, consult accompanying documents |
| | Alternating Current |
| | Direct Current |
| | Protective earth (ground) |
| | Type B equipment (EN60601-1) |
| | Type BF equipment (EN60601-1) |
| | Recycle or dispose of properly, contains sealed lead batteries |

| SYMBOL | MANUAL REFERENCE | EXPLANATION |
|---|---|---|
| | ALARM | Designates location of alarms on front panel |
| °C | HIGH TEMP | High temperature alarm indicator |
| SYS | SYS FAIL | System failure alarm indicator |
| | AIR FLO | Air flow blockage alarm indicator |
| SENS | SENS FAIL | Primary temperature sensor malfunction alarm indicator |
| | PWR FAIL | Incubator not connected to AC nor DC, and battery power is below 10.1 volts |
| | MUTE | Mute button silences audible alarms for approximately 1 minute |
| °C | BABY TEMP | Baby probe temperature mode |
| | BAT CHG | Battery charging indicator |
| | AC OP | Incubator connected to AC power |
| | DC OP | Incubator connected to DC power |
| | BAT OP | Incubator operating on internal battery due to no external power connected |
| | LOW BAT | Low battery indicator |

# UNPACKING AND ASSEMBLY OF INCUBATOR

The Aviator Incubator (see Figure 2 - 1) ships in 2 separate boxes. Upon arrival, inspect all boxes for any damage.

1. First open the largest box (approximately 56 × 26 × 16, marked 222-7358) and remove the incubator main module (Item A in Figure 2 - 1). Place the incubator on a table or cart.

**Figure 2 - 1 Aviator, Assembled**

2. Find the infant positioning straps, usually shipped in the main module box. Loop the straps through the slits in the side of the infant bed and Velcro into place. There will be four pieces of straps, making two complete belts. See Figure 2 - 2.

**Figure 2 - 2 Positioning Strap Mounting, Chamber and Lamp Mounting**

3. Open the final box (approximately 34 × 21 × 17, marked part # 222-7312) and remove the inner, clear Plexiglas infant chamber out of the box and place on the top of the main module, in the chamber gasket. The large opening on the side of the chamber should be placed facing the front, with the cut out for the head door on the left.

4. Take the outer, clear Plexiglas infant chamber out of the box and place over the inner chamber. The large door should be facing the front of the incubator, with the head door on the left.

5. Secure both chambers to the incubator by inserting the four push/pull pins located at both ends on the top of the main module (see Figure 2 - 2). Adjust the chambers until the pins are easily inserted.

6. Locate the lamp. The mounting base for the lamp is located on the top right back corner of the main module, just behind the infant chamber. See Figure 2 - 2.

7. Please contact International Biomedical at (512) 873-0033 if any questions or problems are encountered while assembling the unit.

# SECTION 3: OPERATING INSTRUCTIONS

This section contains operating procedures for the incubator. The incubator should be operated with external power whenever possible. The incubator's battery should be fully charged prior to use by connecting the unit to an AC power supply for at least 8 hours. When not in use, the incubator should be plugged into an AC power source in order to recharge the battery. It is not recommended for the incubator to be on and heating when not in use as this will shorten the life of system components.

**WARNING:** **Avoid direct sunlight or radiant heat which can cause a dangerous increase in chamber air temperature.**

## FRONT PANEL DISPLAY FEATURES

The incubator controls are located on a front display panel. Figure 3 - 1 shows a drawing of the membrane panel and highlights important features. A description of each of the features follows.

**CAUTION:** Use of sharp objects on Front Display Panel will cause permanent damage and will void warranty.

**CAUTION:** Do not touch, press, or rub the display panels with abrasive cleaning compounds, instruments, brushes, rough-surface materials, or bring them into contact with anything that could scratch the panel.

**Figure 3 - 1 Front Display Panel**

1. System Fail Alarm Indicator (***SYS FAIL***)
2. Sensor Fail Alarm Indicator (***SENS FAIL***)
3. Air Temperature Setpoint >37° C Indicator
4. Air Flow Alarm Indicator (***AIR FLO***)
5. High Temperature Indicator (***HIGH TEMP***)
6. AC Fail Indicator
7. Power Fail Indicator (***PWR FAIL***)
8. Main Display Screen
9. Air Temperature Display Indicator
10. Set Air Temperature Indicator
11. Baby Temperature Display Indicator
12. Battery Life Display Indicator
13. Baby Temp. Display Button (***BABY TEMP***)
14. Set Air Temperature Down Button
15. Set Air Temperature Button
16. Set Air Temperature Up Button
17. Mute Button and Indicator (***MUTE***)

* 18. Oxygen Saturation Display Screen
* 19. Pulse Rate Display Screen
* 20. Oxygen Display Screen
* 21. Oxygen Sensor Cal. Indicator
* 22. Pulse Strength Indicator
* 23. Oxygen Setpoint Low Indicator
* 24. PulseOx SET Button
* 25. PulseOx Up / Down Arrows

26. Battery Life Display Button
27. Low Battery Indicator (*LOW BAT*)
28. Batt. Charging Indicator (*BAT CHG*)
29. AC Power Indicator (*AC OP*)
30. DC Power Indicator (*DC OP*)
31. Battery Power Indicator (*BAT OP*)
32. Power Button

* ***NOTE:*** *Items 18 - 25 are features exclusive to the PulseOx version of the incubator.*

# SECTION 3: OPERATING INSTRUCTIONS

**1: System Fail Alarm Indicator (SYS FAIL)**

Yellow LED indicator that illuminates when the displayed temperature exceeds 39.0° C

**2: Sensor Fail Alarm Indicator (SENS FAIL)**

Yellow LED indicator that illuminates when the temperature being sensed by the primary temperature sensor is outside the normal temperature range of the incubator (10 - 45° C)

**3: Air Temperature Setpoint > 37° C Indicator**

Yellow LED that illuminates when the chamber air temperature setpoint is set above 37° C

**4: Air Flow Alarm Indicator (AIR FLO)**

Yellow LED indicator that illuminates when the air flow is blocked

**5: High Temperature Alarm Indicator (HIGH TEMP)**

Yellow LED indicator that illuminates when the displayed temperature exceeds 38.5° C

**6: AC Fail Indicator**

Yellow LED indicator that illuminates when the incubator is unplugged from an AC power source

**7: Power Fail Indicator (PWR FAIL)**

Yellow LED indicator that illuminates when the incubator is unplugged from AC and DC power and the internal battery voltage falls below 10.1 volts

**8: Main Display Screen**

Seven segment digital display that displays chamber air temperature, baby temperature, battery life status, and HI or LO temperature alarms

**9: Air Temperature Display Indicator**

Indicator is illuminated when the Main Display Screen displays the current air temperature in the infant chamber.

**10: Set Air Temperature Indicator**

Indicator is illuminated when the user is adjusting the infant chamber air temperature set point.

**11: Baby Temperature Display Indicator**

Indicator is illuminated when the ***BABY TEMP*** button is pressed and held.

**12: Battery Life Display Indicator**

Indicator is illuminated when the Battery Life Display button is pressed and held.

**13: Baby Temperature Button (BABY TEMP)**

When button is pressed, the Main Display Screen will display the temperature measured by the baby temperature probe.

**14: Set Air Temperature Down Button**

Button will decrease the setpoint temperature in 0.1° C increments.

**15: Set Air Temperature Button**

When button is pressed, the infant chamber air temperature can be adjusted.

**16: Set Air Temperature Up Button**

Button will increase the setpoint temperature in 0.1° C increments.

**17: Mute Button (MUTE)**

Button is used to silence audible alarms for approximately one minute. The warning LED to the left of the Mute Button will be illuminated for the duration of the mute cycle.

***NOTE:*** *The LED is only available with the PulseOx version of the incubator.*

**18: Oxygen Saturation Display Screen (Optional Feature)**

Screen displays functional oxygen saturation (units: percent).

**19: Pulse Rate Display Screen (Optional Feature)**

Screen displays pulse rate (units: beats per minute).

**20: Oxygen Display Screen (Optional Feature)**

Screen displays the oxygen concentration (units: percent).

**21: Oxygen Sensor Cal. Indicator (Optional Feature)**

Indicator is illuminated when the user is calibrating the oxygen sensor.

**22: Pulse Strength Indicator (Optional Feature)**

Bar graph will illuminate at the rate shown on the Pulse Rate Display Screen with a calculated intensity.

**23: Oxygen Setpoint Low Indicator (Optional Feature)**

Indicator is illuminated when the oxygen concentration lower alarm limit is set to a value below 21%.

**24: PulseOx SET Button (Optional Feature)**

Button used to enter modes to set pulse oximetry and oxygen monitor alarm limits and to calibrate the oxygen sensor

**25: PulseOx Up and Down Arrows (Optional Feature)**

Buttons used to set pulse oximetry and oxygen monitoring variables

**26: Battery Life Display Button**

Button used to display the status of the battery on the Main Display Screen

**27: Low Battery Indicator (LOW BAT)**

Yellow LED indicator that illuminates when the battery voltage is less than 11 volts

**28: Battery Charging Indicator (BAT CHG)**

Green LED indicator that illuminates when the battery is actively being charged

**29: AC Power Indicator (AC OP)**

Green LED indicator that illuminates when the incubator is on and connected to external AC power

**30: DC Power Indicator (DC OP)**

Green LED indicator that illuminates when the incubator is on and connected to external DC power

**31: Battery Power Indicator (BAT OP)**

Green LED indicator that illuminates when the incubator is on and no external power is applied, indicating the unit is operating off of internal battery power

**32: Power Button**

Button is used to turn the incubator on and off. When turned on, it enables the temperature display, pulse oximetry and oxygen monitor displays, alarms, and infant chamber air temperature control.

## REAR PANEL FEATURES

The rear panel of the incubator is where power cords connect and where circuit breakers are located. Figure 3 - 2 shows a drawing of the rear panel and highlights important features. A description of each of the features follows.

**Figure 3 - 2 Rear Panel**

1. Battery Circuit Breaker
2. External Circuit Breaker
3. Accessory Circuit Breakers (× 4)
4. Accessory Connectors (× 6)
5. Potential Equalization Stud
6. DC Power Cord Connector
7. Voltage Selector
8. AC Power Cord Connector

**1: Battery Circuit Breaker**

This 10 Amp circuit breaker is connected to the battery circuit.

**2: External Circuit Breaker**

This 10 Amp circuit breaker is connected to the external DC input circuit.

**3: Accessory Circuit Breakers**

These 3 Amp circuit breakers are connected to the Accessory Connectors.

**4: Accessory Connectors**

Accessory equipment that needs to be powered from the incubator can be connected to these connection points. Power will only be supplied when the incubator is connected to an AC power source. When on DC or Battery power, these outlets will not provide power.

**5: Potential Equalization Stud**

This stud is used for potential equalization.

**6: DC Power Cord Connector**

When operating on DC power, the DC power cord connects to this connection point.

**7: Voltage Selector**

The Aviator is capable of being run off of 110 V or 220 V AC. This selector must be switched to the correct voltage being supplied to the incubator.

**8: AC Power Cord Connectors**

Connection point for the AC power cord

# SENSOR PANEL FEATURES

The sensor panel of the incubator is where the pulse oximeter sensor, oxygen monitor sensor, and temperature probe connect. It is located to the right of the Front Panel Display on the front of the incubator. Figure 3 - 3 shows a drawing of the sensor panel and highlights important features. A description of each of the features follows.

**Figure 3 - 3 Sensor Panel**

**Pulse Oximeter Sensor Connector (Optional Feature)**

The $SpO_2$ and pulse rate sensor used with the Masimo or Nellcor pulse-oximeter connects to this connection point. Refer to **SECTION 4** for details on the pulse oximeter system.

**Oxygen Sensor Connector (Optional Feature)**

The oxygen sensor used with the Oxygen Monitor connects to this connection point. Refer to **SECTION 5** for details on the oxygen monitor system.

**Baby Temperature Cable Connector**

The Baby Temperature Cable connects to this connection point.

# POWER FEATURES

The incubator can be operated in one of three power modes: external AC power, external DC power, or internal battery power.

### *AC Power Mode*

AC power can be supplied using either 120 V or 230 V external AC power, depending on the incubator configuration. When operating in AC power mode, the ***AC OP*** indicator (Figure 3 - 1, item 29) will be illuminated. AC power has priority over all other power sources, external or internal. AC power should be used for warming the incubator in preparation for transport and also to recharge the battery.

**WARNING:** **ENSURE UNIT IS PROPERLY GROUNDED: To ensure grounding reliability, only connect the power cord to properly grounded, 3-wire hospital grade outlet of the proper voltage and frequency. DO NOT USE EXTENSION CORDS. If the integrity of the available external power sources is in doubt, the incubator should be operated from its internal battery.**

### *DC Power Mode*

DC power can be supplied using a 12 V power source. When operating in DC power mode, the ***DC OP*** indicator (Figure 3 - 1, item 30) will be illuminated. External DC power is supplied through a 3 conductor circular connector located on the back of the incubator (Figure 3 - 2, item 6). DC power has priority over internal battery power. While operating in DC power mode, the battery will not be charged.

### *Battery Power Mode*

Battery power will automatically be selected when neither AC power nor DC power are available. When operating on internal battery, the ***BAT OP*** indicator (Figure 3 - 1, item 31) will be illuminated. Connecting AC or DC power will supersede battery power operation. The battery charger operates continually when the incubator is connected to an AC power source. When charging, the green ***BAT CHG*** indicator (Figure 3 - 1, item 28) will be illuminated. The rate at which the battery charges decreases when the incubator is powered on. A significantly low AC line voltage will also decrease the rate of battery charge. It takes approximately 8 hours to fully charge a completely discharged standard 26 ampere-hour battery when the incubator is supplied AC power and is powered down. If the incubator is on and warming up, the battery charge time is two to three times longer. The incubator will maintain an infant chamber temperature of 37° C for three hours on a fully charged battery with an ambient temperature of 20° C.

***NOTE:*** *When not in use, the incubator should be plugged into an AC source to recharge the battery. See SECTION 6 on BATTERY CARE.*

To determine how much battery life is left, the Battery Life Display Button (Figure 3 - 1, item 26) can be pressed to display the status of the battery on the Main Display Screen (Figure 3 - 1, item 8). In this mode, the Battery Life Display Indicator (Figure 3 - 1, item 12) will be illuminated. When operating on AC power, the Main Display Screen will indicate the state of charge of the battery as an estimated percentage (to the nearest 20%). A fully charged battery will display 100% and a battery which has almost reached its safe discharge level will display 0%. When the incubator is operating from battery power or external DC power, the Main Display Screen will indicate the battery voltage (to the nearest 0.3 volt). Regardless of the power source, error code E03 will be reported if the battery voltage is outside of the 9.0 volt to 14.5 volt range. To continue normal operation, the battery voltage must be above 10 $\pm$ 0.3 volts.

For general operation, the use of external AC or DC power is *HIGHLY RECOMMENDED*. The internal battery should be used only when the incubator has no other energy source available.

***Power Interruption / Failure***

If external AC or DC power is lost while the incubator is powered on, the incubator will automatically switch over to battery power with no interruption in incubator performance or degradation of pulse oximeter and/or oxygen monitor accuracy. In the event of total power loss, all user-programmed settings (e.g. temperature setpoint, alarm limits) will default to the most recently programmed values.

# POWERING UP THE INCUBATOR

To turn the incubator on, press the Power Button (Figure 3 - 1, item 32) on the lower right hand corner of the Front Display Panel. When the incubator is turned on, all functional LEDs on the display panel will illuminate and the audible alarm will sound. This Power-up Indicator Test will last approximately two seconds after which the Main Display Screen will display the infant chamber air temperature set point. The PulseOx Display screen will alternately display the HI/LO alarm settings for 16 seconds. To interrupt the PulseOx display, press the PulseOx settings button. After the initial start-up, the PulseOx display will be in the “Off” status. After 5 seconds, if no buttons have been pressed, the display will change and show the actual measured infant chamber air temperature. The incubator will immediately attempt to regulate the infant chamber air temperature to the last set point stored in memory (refer to SECTION 3, SETTING THE INFANT CHAMBER AIR TEMPERATURE, for instructions on setting the temperature).

One of three power source indicators will be illuminated, indicating which source is currently powering the incubator.

- AC power indicator (Figure 3 - 1, item 29)
- External DC power indicator (Figure 3 - 1, item 30)
- Internal battery power indicator (Figure 3 - 1, item 31)

## POWERING OFF THE INCUBATOR

To turn the incubator off, press the Power Button (Figure 3 - 1, item 32) on the lower right hand corner of the Front Display Panel. The Power Button provides the means of electrically isolating the incubator circuits from supply mains simultaneously on all poles.

## DISPLAY MODES

The incubator has the ability to display both infant chamber air temperature and infant temperature. When the incubator is initially powered on, the Main Display Screen (Figure 3 - 1, item 8) displays the setpoint temperature for a few seconds and then defaults to displaying the current air temperature in the infant chamber. In this mode, the Air Temperature Display Indicator (Figure 3 - 1, item 9) is illuminated. To display the infant temperature, the ***BABY TEMP*** button (Figure 3 - 1, item 13) can be pressed. In this mode, the Baby Temperature Display Indicator (Figure 3 - 1, item 11) illuminates and the infant temperature is displayed on the Main Display Screen. When the button is released, the display reverts back to infant chamber air temperature.

## TEMPERATURE CONTROL

The infant chamber air temperature can be controlled from the front display panel on the incubator. When the Set Air Temperature Button (Figure 3 - 1, item 15) is pressed, the user can use the up and down arrows (Figure 3 - 1, items 14 & 16) to adjust the temperature setpoint (in 0.1° C increments). When in this mode, the Set Air Temperature Indicator (Figure 3 - 1, item 10) will be illuminated. To maximize heating efficiency, the incubator should be connected to AC power while heating to desired setpoint. Running the incubator on its internal battery will drastically increase the required time to reach the desired temperature setpoint. The baby temperature cannot be controlled but can be displayed on the Main Display Screen by pressing the ***BABY TEMP*** button (Figure 3 - 1, item 13).

## SETTING THE INFANT CHAMBER AIR TEMPERATURE

To adjust the infant chamber air temperature set point:

1. Turn on the incubator using the Power Button (Figure 3 - 1, item 32).
2. After the Power-up Indicator Test is complete, press the Set Temperature Button (Figure 3 - 1, item 15).
3. Use the Set Temperature Up and Down Arrow Buttons (Figure 3 - 1, items 14 and 16) to adjust the temperature setting to the desired value. The temperature can be adjusted from 17.0° C to 38.9° C in 0.1° C increments.
4. When the desired value is set, either press the Set Temperature Button again or wait 5 seconds, after which time the Main Display Screen will return to displaying the measured infant chamber air temperature.

## PULSE OXIMETER AND OXYGEN MONITOR CONTROL (OPTIONAL FEATURE)

The incubator is calibrated to display functional oxygen saturation (Figure 3 - 1, item 18), pulse rate (Figure 3 - 1, item 19) and oxygen concentration (Figure 3 - 1, item 20). In addition to these numerical displays, the pulse rate is also displayed on a pulse strength bar graph (Figure 3 - 1, item 22). The PulseOx SET button (Figure 3 - 1, item 24) and up and down arrows (Figure 3 - 1, item 25) can be used to turn the pulse oximeter and/or oxygen monitor on and off. These buttons can also be used to set high and low alarm limits for each variable. When these buttons are used to reach the oxygen sensor calibration mode, the Oxygen Sensor Cal. Indicator (Figure 3 - 1, item 21) will be illuminated. Refer to SECTION 4 and SECTION 5 for more information on using the pulse oximeter and oxygen monitor features of this incubator.

# ALARMS / INDICATORS

The incubator utilizes a visual and audible alarm system. Audible alarms can be silenced for approximately one minute using the ***MUTE*** button (Figure 3 - 1, item 17). The audible alarm will sound at 65 dB at a distance of 3 m from the operator interface of the incubator.

**WARNING:** **If an alarm condition (other than the exceptions listed herein) occurs while the MUTE button is activated, only visual indicators will be activated.**

## Standard System Alarms

| Alarm | Priority |
|---|---|
| System Fail Alarm | LOW |
| Sensor Fail Alarm | LOW |
| Air Temperature Setpoint >37°C | LOW |
| Air Flow Alarm Indicator | LOW |
| High Temperature Indicator | LOW |
| AC Fail Indicator | LOW |
| Power Fail Indicator | LOW |

## $SpO_2$ Alarms (Optional Feature)

| | |
|---|---|
| $SpO_2$ % HIGH | LOW |
| $SpO_2$ % LOW | MEDIUM |
| PULSE RATE HIGH | LOW |
| PULSE RATE LOW | LOW |
| $O_2$ % HIGH | LOW |
| $O_2$ % LOW | LOW |
| $SpO_2$ DATA PERIOD | LOW |

Alarms are indicated by a continuous beep to alert operator to inspect the device to determine the cause of the alarm.

The $SpO_2$ % LOW is indicated by a series of 3 beeps followed by a slight pause, and then repeated. This is to alert the operator to the specific alarm and its Medium Priority.

### *Power Alarms*

When the incubator becomes disconnected from AC power, the AC Fail indicator (Figure 3 - 1, item 6) illuminates and an audible alarm will sound. When the incubator becomes disconnected from both AC and DC power and the internal battery voltage falls below 10.1 volts, the ***PWR FAIL*** indicator (Figure 3 - 1, item 7) illuminates and a continuous audible alarm sounds. Power to maintain the temperature in the infant chamber, and the accuracy of the $O_2$ and the $SpO_2$ monitors (if equipped) is no longer available and all power to the incubator (other than to power the ***PWR FAIL*** indicator and the audible alarm) is disabled. The indicator illuminates as long as the incubator remains on. Pressing the ***MUTE*** button will not silence the audible alarm. The Power Button should be pressed to turn the incubator off, silencing the audible alarm, and the incubator should be connected to AC power to allow the battery to recharge.

In units with the Optional $SpO_2$ feature, the Power Fail alarm is a Medium Priority Technical Alarm.

### *Temperature Alarms*

When the measured air temperature is more than 1° C from the user-configured set point, an intermittent audible alarm will sound every minute and the Main Display Screen will flash ***HI*** or ***LO*** every 5 seconds until the incubator temperature is back to within 1° C of the set point.

When the measured air temperature exceeds 38.5° C, the ***HIGH TEMP*** alarm indicator (Figure 3 - 1, item 5) illuminates and an intermittent audible alarm turns on. The incubator is still fully operational and the operator, at his/her discretion, may ignore this alarm.

When the measured air temperature exceeds 39.0° C, the ***HIGH TEMP*** alarm indicator, the ***SYS FAIL*** alarm indicator (Figure 3 - 1, item 1), and a continuous audible alarm turn on. The incubator's heater is disabled and the incubator must cool to below 39° C before the heater is re-enabled.

When the measured air temperature exceeds 39.2° C, the ***SYS FAIL*** alarm indicator and a continuous audible alarm turn on. The incubator's heater is disabled until the infant chamber temperature is lowered, at which point the incubator must be turned off and then on again to reset the alarm.

The ***SENS FAIL*** indicator (Figure 3 - 1, item 2), coupled with a continuous audible alarm, indicates the temperature being sensed by the primary temperature sensor is well outside the normal temperature range of the incubator (10 - 45° C). The activation of this alarm may indicate a problem with the temperature sensor or the control circuitry, in which case, the incubator needs to be serviced by qualified personnel.

If the primary temperature sensor is shorted or indicates an extremely high temperature, the ***SENS FAIL***, ***HIGH TEMP***, and ***SYS FAIL*** indicators and alarms will all be activated and the incubator's heater will be disabled.

If the primary temperature sensor is open or indicates an extremely low temperature, the ***SENS FAIL*** and ***SYS FAIL*** alarms will be activated, and the heater will be disabled.

If the user specifies a chamber set point temperature greater than 37° C, the Air Temperature Setpoint > 37° C Indicator (Figure 3 - 1, item 3) will illuminate.

***Pulse Oximeter and Oxygen Monitor Alarms (Optional Feature)***

Below each of the pulse oximeter and oxygen monitor screens are two green LEDs, labeled HI and LO. When any of the three displayed values (oxygen saturation, pulse rate, or oxygen concentration) exceed the user-programmed high alarm limit, the corresponding HI LED illuminates and an audible alarm will sound. When any of the three displayed values goes below the user-programmed low alarm limit, the corresponding LO LED illuminates and an audible alarm will sound.

When calibrating the oxygen monitor, if the low oxygen alarm limit is programmed below 21%, the Oxygen Setpoint Low Indicator (Figure 3 - 1, item 23) is illuminated.

***Other Alarms***

When the airflow through the infant chamber is reduced due to an obstruction, such as a blanket, the ***AIR FLO*** alarm indicator (Figure 3 - 1, item 4) illuminates and a continuous audible alarm turns on. Due to reduced airflow, the incubator's heater's temperature will exceed a preset threshold and will be disabled. After the airflow obstruction is removed and the heating element is allowed to cool, the heater system will return to normal operation.

***NOTE:*** *A blanket should always be used inside the infant chamber between the infant and the mattress.*

When the battery voltage drops below 11 volts, the ***LOW BAT*** indicator (Figure 3 - 1, item 27) illuminates and an intermittent audible alarm turns on. The battery will be able to supply the heater requirements for only a few minutes after this alarm occurs. The ***LOW BAT*** alarm cannot be reset. The incubator must be connected to AC power to allow the battery to recharge when this alarm occurs.

***NOTE:*** *When this alarm activates, the incubator has approximately fifteen (15) minutes of operational power remaining. This estimate is for a good battery and an ambient temperature of 20° C.*

## EXTERNAL LIGHTING

The incubator is equipped with an external examination light. This light can be activated only when the incubator is turned on.

The light is intended to be used as an external light source. Do not place the light into the inner infant chamber.

**WARNING: Do not change the lamp and touch the patient simultaneously.**

**WARNING: EXPLOSION HAZARD: Do not use the examination light, the pulse oximeter, or oxygen monitor in the presence of flammable anesthetics or other flammable gases.**

**WARNING: Avoid eye exposure. Direct light exposure may cause eye damage. Infants must wear eye protection.**

## SKIN TEMPERATURE PROBE

The Measurement Specialties 409B Reusable Skin Temperature Probe is to be used to monitor the surface temperature of the infant. Select appropriate site for monitoring according to currently accepted medical practices.

**WARNING: The skin temperature sensor is not a rectal probe. The skin temperature sensor is not to be used as a rectal probe.**

# SECTION 4: PULSE OXIMETRY (OPTIONAL FEATURE)

This section contains information regarding the pulse oximetry feature of the incubator. Principles of operation, set-up instructions, and sensor options are detailed.

## PULSE OXIMETER PRINCIPLES OF OPERATION

Pulse oximetry is based on several key principles:

- the absorption of red and infrared light (spectrophotometry) by oxyhemoglobin and deoxyhemoglobin
- the change in volume of arterial blood in tissue (and hence, light absorption by blood) due to changes in pulse (plethysmography)
- the fluctuating absorbance of venous blood during arteriovenous shunting contributes to noise during the pulse

Because oxyhemoglobin and deoxyhemoglobin differ in light absorption, the amount of red and infrared light absorbed by the blood is related to hemoglobin oxygen saturation. The pulse oximeters supported by the incubator, Masimo SET® and Nellcor OxiMax, decompose the red and infrared pulsatile absorbance signals into an arterial signal plus a noise component and calculate the ratio of arterial signals. The ratio of the two arterial pulse-added absorbance signals is used to find the oxygen saturation in an empirically derived equation in the pulse oximeter software.

Different pulse oximetry sensors can be used with the system. The user should consult the sensor's instructions for use to ensure the appropriate sensor is being used. In addition, only Masimo sensors should be used with the Masimo pulse oximeter and only Nellcor sensors should be used with the Nellcor pulse oximeter. Sensor accuracy data, found in SECTION 11 (SPECIFICATIONS), are based on human blood studies in which the values obtained for healthy adult volunteers in induced hypoxia states during motion and non-motion conditions were compared to a laboratory co-oximeter.

Erroneous $SpO_2$ readings may be caused by several reasons including, but not limited to, the following:

- Interfering substances such as Carboxyhemoglobin and Methemoglobin (i.e. an increase in $SpO_2$ approximately equal to the amount of carboxyhemoglobin present)
- Dyes, or any substance containing dyes, that change usual blood pigmentation

- Severe anemia
- Excessive patient movement
- Venous pulsations
- Placement of a sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line
- Use during defibrillation (temporary)

**WARNING:** **Do not use the pulse oximeter or oximetry sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The pulse oximeter may affect the MRI image and the MRI unit may affect the accuracy of the oximetry results.**

**WARNING:** **The pulse oximeter should NOT be used as an apnea monitor.**

***NOTE:*** *The pulse oximeter should be considered an early warning device. As a trend towards patient hypoxemia is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.*

Pulse rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect arrhythmias. The pulse oximeter should not be used as a replacement or substitute for ECG-based arrhythmia analysis.

***NOTE:*** *Loss of pulse signal can occur for many reasons including, but not limited to, when the patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia; there is arterial occlusion proximal to the sensor; or the patient is in cardiac arrest or is in shock.*

# SECTION 4: PULSE OXIMETRY (OPTIONAL FEATURE)

## PULSE OXIMETER SET-UP INSTRUCTIONS

The following steps will instruct the user how to initially set up the pulse oximeter and program low and high alarm settings for $SpO_2$ and pulse rate. Additionally, when using the Masimo pulse oximeter, the user can also set the algorithm mode, set the averaging mode, and view the oxygen perfusion index.

**CAUTION:** Check alarm limits each time the system is used to ensure that they are appropriate for the patient being monitored.

**INITIAL SET-UP**

1. Turn the incubator power on using the Power Button (Figure 3 - 1, item 32).
2. Connect the pulse oximeter cable to the connector on the side of the incubator (Figure 3 - 3, item 2). Connect pulse oximeter sensor to the cable and to a suitable site on the patient being monitored.
3. To turn on the pulse oximeter displays, press the SET button (Figure 3 - 1, item 24) one time and then either the up or down arrow button (Figure 3 - 1, item 25) until the %SPO2 screen displays “On”. If the screen shows “---”, there is no value available.
4. When the pulse oximeter is disabled, the %SPO2 and PULSE screens will display “OFF”. All alarms related to the pulse oximeter will also be disabled.

**SETTING HIGH AND LOW %$SpO_2$ ALARMS**

***NOTE:*** *The pulse oximeter display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

1. Press the SET button (Figure 3 - 1, item 24) three times (or until the %SPO2 HI LED illuminates) to set the high $SpO_2$ alarm.
2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to set the high alarm to the desired setting.
   a. Must be at least 1% higher than the $SpO_2$ low alarm setting.
   b. Can be set from 85 - 100%.
3. Press the SET button four times (or until the %SPO2 LO LED illuminates) to set the low $SpO_2$ alarm.
4. Use the up or down arrow buttons to set the low alarm to the desired setting.
   a. Must be at least 1% lower than the $SpO_2$ high alarm setting.
   b. Can be set from 0 - 84%.

### SETTING HIGH AND LOW PULSE RATE ALARMS

***NOTE:*** *The pulse oximeter display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

1. Press the SET button (Figure 3 - 1, item 24) five times (or until the PULSE HI LED illuminates) to set the high Pulse alarm.
2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to set the high alarm to the desired setting.
   a. Must be at least 1 bpm higher than the Pulse low alarm setting.
   b. Can be set from 85 - 241 bpm.
3. Press the SET button six times (or until the PULSE LO LED illuminates) to set the low Pulse alarm.
4. Use the up or down arrow buttons to set the low alarm to the desired setting.
   a. Must be at least 1 bpm lower than the Pulse high alarm setting.
   b. Can be set from 25 - 84 bpm.

### SETTING THE ALGORITHM MODE (MASIMO ONLY)

***NOTE:*** *The pulse oximeter display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

Different algorithm modes can be used depending on the importance of $SpO_2$ sensitivity vs. probe-off detection. The system will power up in A1 Normal Mode as a default. When setting the Algorithm Mode, the setting will be displayed on the %SPO2 screen.

1. Press the SET button (Figure 3 - 1, item 24) 10 times (or until HI and LO %SPO2 LEDs are both illuminated) to set the Algorithm Mode.
2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to choose one of the following modes:
   a. A1 = Normal Mode
      i. Provides the best combination of sensitivity and probe-off detection performance.
      ii. This mode is recommended for the majority of patients.

b. A2 = Maximum Mode

i. Interprets and displays data for very weak signals.

ii. This mode is recommended for the sickest patients or during procedures when clinician and patient contact is continuous.

c. A3 = APOD Mode

i. Least sensitive in picking up a reading on patients with low perfusion but provides the best detection for probe-off conditions.

ii. This mode is recommended for use on patients that are at particular risk of the sensor becoming detached (e.g. pediatric, combative, etc.)

**SETTING THE AVERAGING MODE (MASIMO ONLY)**

***NOTE:*** *The pulse oximeter display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

The Averaging Mode is used to determine how many values will be used to calculate the $SpO_2$ and pulse rate readings. A lower averaging rate uses fewer values to calculate the readings, resulting in more unstable readings, but will more quickly alert the user to potentially alarming patient conditions. The system will power up with C2 Middle Averaging Rate as a default. When setting the Averaging Mode, the setting will be displayed on the %SPO2 screen.

1. Press the SET button (Figure 3 - 1, item 24) 11 times (or until the HI and LO PULSE LEDs are both illuminated) to set the Averaging Mode.

2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to choose one of the following averaging rates:

a. C1 = Low Averaging Rate

i. $SpO_2$ averaging rate is set to 2 - 4 seconds.

b. C2 = Middle Averaging Rate

i. $SpO_2$ averaging rate is set to 8 seconds.

c. C3 = High Averaging Rate

i. $SpO_2$ averaging rate is set to 16 seconds.

### SETTING THE PERFUSION INDEX (MASIMO ONLY)

The Perfusion Index value represents a ratio between the pulse signal and noise. It helps clinicians determine if the pulse oximetry sensor is placed on an optimal monitoring site. The Perfusion Index value has a range of 0.0 - 20.0 (i.e. the higher the value, the better the perfusion).

1. Press and hold the down arrow button (Figure 3 - 1, item 25).
2. The perfusion index will be displayed on the %SPO2 screen. A display of "---" indicates no value is available.
3. Release the down arrow button to switch back to Normal Operation Mode.

***NOTE:*** *Calibration and resetting the pulse oximeter algorithm or averaging mode may cause a slight delay in readings.*

***NOTE:*** *Setting alarm set points, calibration, and resetting pulse oximeter algorithm or averaging methods will disable a portion of the pulse oximetry or oxygen monitoring displays (Masimo only).*

## OPERATIONAL ALARMS AND WARNINGS

When the measured oxygen saturation or pulse rate falls out of the user-selected range, either "HI" or "LO" will flash on the appropriate screen every 2 seconds. An audible alarm will also be heard every 2 seconds. Pressing the ***MUTE*** button will silence the audible alarm for approximately 1 minute.

### *Update Period Exceeded*

The PulseOx system updates the data being displayed on the display screens every second. After a period of 5 seconds, if the system has not received an update, the screen will flash "PS". If an update still is unavailable after 15 seconds, "PS" will continue to flash and an audible alarm will sound until the condition is corrected.

### *Low Perfusion (Masimo Only)*

The system displays "LP" when there are very low amplitude arterial pulsations. It has been suggested that at extremely low perfusion levels, pulse oximeters can measure peripheral saturation, which may differ from central arterial saturation[1]. This "localized hypoxemia" may result from the metabolic demands of other tissues extracting oxygen proximal to the monitoring site under conditions of sustained peripheral hypoperfusion. (This may occur even with a pulse rate that correlates with the ECG heart rate.)

***NOTE:*** *If the low perfusion message is frequently displayed, find a better-perfused monitoring site. In the interim, assess the patient and, if indicated, verify oxygenation status through other means.*

### *Low Signal IQ (Masimo Only)*

When the signal quality is very low, the accuracy of the $SpO_2$ measurement may be compromised, and the system displays "LS" on the PULSE Display Screen. When the "LS" message appears, proceed with caution and do the following:

- Assess the patient.
- Check the sensor and ensure proper sensor application. The sensor must be well secured to the site to maintain accurate readings. Also, misalignment of the sensor's emitter and detector can result in smaller signals.
- Determine if an extreme change in the patient's physiology and blood flow at the monitoring site occurred (e.g., an inflated blood pressure cuff, a squeezing motion, sampling of an arterial blood specimen from the hand containing the pulse oximetry sensor, severe hypotension, peripheral vasoconstriction in response to hypothermia, medications, or a spell of Raynaud's syndrome).
- With neonates or infants, check that the peripheral blood flow to the sensor site is not interrupted. Interruption, for example, may occur while lifting or crossing their legs during a diaper change.

[1] Severinghaus JW, Spellman MJ. Pulse Oximeter Failure Thresholds in Hypotension and Vasoconstriction. Anesthesiology 1990; 73:532-537

# SECTION 4: PULSE OXIMETRY (OPTIONAL FEATURE)

## TEST OF OPERATIONAL ALARMS

To ensure the pulse oximeter is generating the proper alarm indications, the following instructions should be followed:

1. After the sensor is attached to the patient, verify the patient alarms are functional by setting the $SpO_2$ and pulse rate high and low alarm limits beyond the patient readings.
   a. An audible alarm should sound.
   b. A “HI” or “LO” visual indicator should flash on the appropriate display screen.
2. Verify the sensor alarms are functional.
   a. Remove the sensor from the patient.
      i. An audible alarm should sound.
      ii. Error code “E6” should flash on the $\%SpO_2$ display screen.
   b. Disconnect the sensor from the incubator.
      i. An audible alarm should sound.
      ii. Error code “E9” should flash on the $\%SpO_2$ display screen.

## PULSE OXIMETRY SENSORS

The incubator has been validated to be used with Masimo LNCS sensors and Nellcor OxiMax sensors. Refer to SECTION 13, PARTS AND ACCESSORIES, for vendor contact information to request sensor technical data. Before using any sensor, carefully read the sensor’s instructions for use. When selecting a sensor, consider the patient’s weight, the adequacy of perfusion, the available sensor sites, and duration of monitoring.

**WARNING:** **If using pulse oximetry during full body irradiation, keep the sensor out of the irradiation field. If the sensor is exposed to irradiation, the reading might be inaccurate or the unit might read zero for the duration of the active irradiation period.**

**CAUTION:** Oxygen sensor and pulse oximetry cables must be contained within cart or otherwise secured when not in use.

# SECTION 4: PULSE OXIMETRY (OPTIONAL FEATURE)

**CAUTION:** Pulse oximeter probes and cables are designed for use with specific monitors. Only use Masimo sensors and patient cables for Masimo pulse oximetry model. Only use Nellcor sensors and patient cables for Nellcor pulse oximetry model. Verify the compatibility of the monitor, sensor, and cable before use, otherwise patient injury can result.

Tissue damage can be caused by incorrect application or use of a pulse oximetry sensor, for example, by wrapping the sensor too tightly. Inspect the sensor site as directed in the sensor instructions for use to ensure skin integrity and correct positioning and adhesion of the sensor.

High ambient light sources such as surgical lights (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, and direct sunlight can interfere with the performance of a $SpO_2$ sensor. To prevent interference from ambient light, ensure that the sensor is properly applied and that the sensor site is covered with opaque material if necessary. Failure to take this precaution in high ambient light conditions may result in inaccurate measurements.

**CAUTION:** If a sensor or cable is damaged in any way discontinue use immediately.

## PULSE OXIMETRY TESTERS / SIMULATORS

To verify the functionality of the pulse oximeter sensors and cables, some commercially available functional testers may be used (refer to the testing device's instructions for use to determine compatibility). The functional testers are designed to interface with the pulse oximeter's expected calibration curves and measure the total error of the pulse oximetry system. However, due to the complex interaction between the pulse oximeter sensor and patient, these testers cannot be used to assess the accuracy of the pulse oximeter sensors. Refer to SECTION 11, SPECIFICATIONS, to review sensor accuracy information or contact the pulse oximeter vendor listed in SECTION 13, PARTS AND ACCESSORIES.

# OXYGEN MONITOR PRINCIPLES OF OPERATION

The oxygen monitor is intended to be used to measure and display the oxygen concentration as a volume fraction percentage (%) in an area to which a Maxtec MAX-250E oxygen sensor is exposed. The readings are proportional to the partial pressure of oxygen ($pO_2$), which is equal to the percentage of oxygen times the absolute pressure of the environment being measured. The oxygen monitor can be influenced by the following:

***Temperature***

In order for oxygen readings to be accurate, the oxygen monitor must be thermally stable when calibrated and when measurements are taken. If temperature conditions change, adequate time must be allowed for the sensor to stabilize and give accurate readings. For best results, calibrate the oxygen monitor at the same temperature at which the monitor will be used.

***Pressure***

The readings from the oxygen monitor are proportional to the oxygen concentration only if pressure is held constant. The oxygen monitor does not compensate for changes in barometric pressure. Because the flow rate of the gas being sampled can affect the pressure at the sensor in that the back pressure may change, the oxygen monitor should be calibrated at the same pressure as the sample gas. Changes in elevation result in calibration error of approximately 1% of reading per 250 feet. In general, calibration of the instrument should be performed when the geographic elevation at which the product is being used changes by more than 500 feet. The oxygen monitor should not be calibrated at a pressure above 2 atmospheres as this is beyond the sensor's intended use.

***Humidity***

Condensation due to high humidity can adversely affect the oxygen monitor. The sensor should be calibrated and used in environments < 95% relative humidity and placed upstream of any humidifier (if used in a breathing circuit) to reduce the risk of water condensation.

**CAUTION:** Only use International Biomedical cable and Maxtec sensor for oxygen monitoring.

**CAUTION:** Use the oxygen monitor when oxygen is delivered to the infant.

# OXYGEN MONITOR SET-UP INSTRUCTIONS

The following steps will instruct the user how to initially set up the oxygen monitor, program low and high alarm settings, and how to calibrate the oxygen sensor.

**CAUTION:** Check alarm limits each time the system is used to ensure that they are appropriate for the patient being monitored.

**INITIAL SET-UP**

1. Turn the incubator power on using the Power Button (Figure 3 - 1, item 32).
2. Connect the oxygen sensor cable to the connector on the side of the incubator (Figure 3 - 3, item 1).
3. Connect the oxygen sensor to the cable and place in area to be monitored.
   a. Place the oxygen sensor inside the infant chamber to monitor ambient oxygen concentration within the chamber.
   b. Connect the oxygen sensor to a 15 mm adapter on a patient breathing circuit to use in conjunction with a ventilator.
4. To turn on the Oxygen display, press the SET button (Figure 3 - 1, item 24) two times and then either the up or down arrow buttons (Figure 3 - 1, item 25) until the OXYGEN screen displays “On”. If the screen shows “---”, there is no value available.
5. When the Oxygen Monitor is disabled, the OXYGEN screen will display “OFF”. All alarms related to the Oxygen Monitor will also be disabled.

**SETTING HIGH AND LOW OXYGEN ALARMS**

***NOTE:*** *The Oxygen Monitor display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

1. Press the SET button (Figure 3 - 1, item 24) seven times (or until the OXYGEN HI LED illuminates) to set the high oxygen alarm.
2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to set the high alarm to the desired setting.
   a. Must be at least 1% higher than the low oxygen alarm setting.
   b. Can be set from 31 - 100%.

3. Press the SET button eight times (or until the OXYGEN LO LED illuminates) to set the low Oxygen alarm.

4. Use the up or down arrow buttons to set the low alarm to the desired setting.

   a. Must be at least 1% lower than the high oxygen alarm setting.

   b. Can be set from 18 - 30%.

5. If the low oxygen alarm is set below 21.0%, the yellow “<21%” warning LED (Figure 3 - 1, item 23) will be illuminated.

**OXYGEN MONITOR CALIBRATION**

***NOTE:*** *The Oxygen Monitor display will convert back to Normal Operation Mode after 5 seconds if no buttons are pressed.*

1. Press the SET button (Figure 3 - 1, item 24) nine times (or until the CAL LED illuminates, Figure 3 - 1, item 21) to calibrate the oxygen monitor.

2. Use the up or down arrow buttons (Figure 3 - 1, item 25) to change the oxygen percentage to the concentration of oxygen the sensor is exposed to during the calibration (use 20.9% if exposed to room air). Expose the sensor to the calibration gas for several minutes to ensure the sensor reading has stabilized.

   a. Can be set from 15.0 - 100%.

      ***NOTE:*** *If using a calibration gas other than room air, procure and dispose of gas according to hospital policy.*

3. Once the calibration setting is set to the desired level, press both the up and down arrow buttons simultaneously. “CAL” will be displayed on the OXYGEN screen to confirm that calibration is complete.

   ***NOTE:*** *Calibrate the oxygen sensor daily when in use or if environmental conditions change significantly (i.e. Temperature, Humidity, or Barometric Pressure).*

For oxygen readings to be accurate, the oxygen monitor must be thermally stable when calibrated and when measurements are taken. Calibration should also be done at the same pressure as when in use due to the fact that the flow rate of sample gas can change the back pressure at the sensing point, changing the oxygen reading. Never calibrate at a pressure above 2 atmospheres as this is beyond the sensor's intended use. The sensor should be calibrated and used in environments < 95% relative humidity and placed upstream of any humidifier to reduce the risk of water condensation which can affect the oxygen sensor.

**CAUTION:** Dropping or severely jarring the oxygen sensor after calibration may shift the calibration point enough to require recalibration.

## OPERATIONAL ALARMS AND WARNINGS

When the measured oxygen concentration falls out of the user-selected range, either "HI" or "LO" will flash on the OXYGEN screen every 2 seconds. An audible alarm will also be heard every 2 seconds. Pressing the ***MUTE*** button will silence the audible alarm for approximately one minute.

## TEST OF OPERATIONAL ALARMS

To ensure the oxygen monitor is generating the proper alarm indications, the following instructions should be followed:

1. After the oxygen sensor is placed in the area to be monitored, verify the out-of-range alarms are functional by setting the oxygen high and low alarm limits beyond the oxygen readings of the area.
   a. An audible alarm should sound.
   b. A "HI" or "LO" visual indicator should flash on the OXYGEN display screen.
2. Verify the sensor alarm is functional by disconnecting the oxygen sensor from the cable attached to the incubator.
   a. An audible alarm should sound.
   b. Error code "E7" should flash on the OXYGEN display screen.

# SECTION 5: OXYGEN MONITOR (OPTIONAL FEATURE)

## OXYGEN SENSOR

The Maxtec MAX-250E oxygen sensor is similar in operation as a conventional galvanic cell (lead anode / KOH electrolyte) oxygen sensor. However, the chemistry of the MAX-250E sensor is unique. By implementing a weak acid electrolyte, MAX-250 sensors offer superior performance over the conventional oxygen sensor. The weak acid electrolyte is unaffected by $CO_2$, CO, and $NO_x$. This results in a sensor with a superior technical advantage over KOH-type sensors in applications where these gases are present.

Use only Maxtec Max-250E oxygen sensors and International Biomedical supplied cables with the incubator. Max-250E oxygen sensors offer quick response, stability, and life greater than 9000 hours.

**CAUTION:** The Maxtec MAX-250E oxygen sensor is a sealed device containing a mild acid electrolyte, lead (Pb), and lead acetate. Lead and lead acetate are hazardous waste constituents and should be disposed of properly, or returned to Maxtec or International Biomedical for proper disposal or recovery.

**CAUTION:** Oxygen sensor and pulse oximetry cables must be contained within cart or otherwise secured when not in use.

**CAUTION:** Only use International Biomedical cable and Maxtec sensor for oxygen monitoring.

# SECTION 6: PREVENTATIVE MAINTENANCE

To ensure proper operation, standby readiness, and malfunction reporting, International Biomedical recommends following a preventative maintenance program. The daily preventative maintenance procedures can be performed by a knowledgeable incubator transport person. Monthly maintenance procedures should be performed by an appropriately trained biomedical maintenance person. No other preventative maintenance is required.

***NOTE:*** *Perform preventative maintenance procedures on all Accessory Equipment as recommended in the manual for each piece of equipment.*

## DAILY MAINTENANCE

The following maintenance procedures should be performed on a daily basis by a knowledgeable incubator transport person.

**OPERATIONAL CHECK**

1. Check the AC power cord and ensure that there are no cuts or severe bends in the cord, that all three prongs on the plug are in good condition, and that the cord is securely fastened in place. Replace the cord as needed.

2. Ensure the incubator is plugged in to an appropriate AC power source. Verify the ***BAT CHG*** indicator (Figure 3 - 1, item 28) on the front panel is illuminated and that all other indicators are off when the incubator power is off.

3. With the incubator connected to AC power, press the power button (Figure 3 - 1, item 32) to turn the incubator on. The incubator will perform a test of all indicators, LEDs, and the audible alarm. Ensure all the indicators and LEDs illuminate, and that the audible alarm can be heard. Verify the ***AC OP*** indicator (Figure 3 - 1, item 29) remains illuminated after completion of the test.

4. Place a hand inside the right side of the infant chamber and verify air flow. The fan should be able to be heard at the left side of the incubator.

5. A few minutes after turning the incubator on, the air temperature inside the infant chamber should begin to increase and will be displayed on the Main Display Screen. Verify.

6. Turn on the external light and ensure it operates under AC power. Turn off the light.

7. Disconnect the AC power connection from the incubator and observe that the ***BAT OP*** indicator (Figure 3 - 1, item 31) is illuminated and that the Main Display Screen still displays the infant chamber air temperature.

8. Turn on the external light and ensure it operates under Battery power. Turn off the light.

9. Turn off the incubator.

10. If external 12 volt DC power is to be used, check the 12 volt DC power cord and ensure that it has no cuts or severe bends and that the connectors have not been damaged.

11. Connect the incubator to a DC power source. Turn on the incubator and verify the ***DC OP*** indicator (Figure 3 - 1, item 30) is illuminated and that the Main Display Screen still displays the infant chamber air temperature.

12 Turn on the external light and ensure it operates under DC power. Turn off the light.

13. Disconnect the DC power connection and reconnect AC power to the incubator and turn the incubator off.

**CAUTION:** DO NOT leave the 12 volt cord attached to the DC connector of the incubator when not operating in DC power mode.

14. Inspect the mattress and positioning straps for damage. Repair or replace as needed.

**WARNING:** **The transport incubator is Type B equipment and the baby may not be electrically isolated from earth. Care must be taken that additional equipment connected to the baby is electrically safe. To ensure patient electrical isolation, connect only to other equipment with electronically isolated circuits.**

**AIR / OXYGEN SYSTEM**

1. If gas tanks are included in the incubator assembly, ensure they are properly secured.

2. With the air and oxygen tank regulators connected to appropriate external devices, open the valves on the air and oxygen tanks and ensure that each tank is fully pressurized and ready for use.

3. Ensure that none of the hoses connecting the tanks to external devices are leaking or kinked.

### INFANT CHAMBER CHECK

**CAUTION:** Do not move the incubator by pushing on the infant chamber. The infant chamber is not designed to sustain the forces to push the incubator. Stress fractures in the infant chamber can occur.

1. Ensure that the infant chamber is free from cracks.
2. Ensure that the gasket between the chambers and airflow tray is in place. Check that the grommets in the tubing through-holes on the infant chamber are also in place.
3. Ensure that the infant chamber is secured to the incubator with the two latches on both ends of the infant chamber.

   **CAUTION:** Do not overtighten the infant chamber screws. Do not strip the aluminum into which these screws are threaded.

4. Ensure that the infant chamber is clean and ready for transport, as determined by the transport team leader.

   **WARNING:** **This incubator was calibrated with the infant chamber originally supplied. If this chamber is exchanged for an infant chamber of a different configuration or size, the temperature calibration will be affected. Consult International Biomedical before returning the incubator to service.**

### CART AND ACCESSORIES

1. Inspect the casters for wear or damage. Inspect for worn or damaged rubber and tightness of retaining nuts. Replace damaged casters immediately.
2. Ensure the incubator is securely fastened to the cart.
3. Test operation of other accessories as indicated by manufacturer's recommendations.

   **CAUTION:** When the incubator is attached to a rigid cart with an internal power strip, the power cord must be contained within cart or secured on the end of cart with cord holders when not in use.

### SENSORS AND CABLES (OPTIONAL EQUIPMENT)

1. Inspect the oxygen sensor and the pulse oximeter sensor for damage. Replace, if necessary.
2. Inspect the oxygen sensor cable and pulse oximeter cable for wear or damage. Replace, if necessary.

### CLEANING OF INCUBATOR AND CHAMBER

**WARNING:** **The incubator should be turned off and AC or DC power disconnected when cleaning.**

**CAUTION:** CLEANING AND CARE: Do not autoclave, pressure sterilize, or gas sterilize the incubator, cables, or sensors. Use cleaning solutions sparingly as excessive solution can flow into the incubator and cause damage to internal components. Do not soak or immerse the incubator or sensors in any liquid. Do not use petroleum-based, alcohol, acetone, or other harsh solvents. See cleaning instructions of reusable sensors and cables in directions for their use.

Wash the chamber, infant mattress, and top surface of the airflow tray with mild soap or detergent and water solution.

**CAUTION:** Do not drip cleaning solution through the holes where the swell latches fit into the air flow assembly.

Household ammonia diluted in water in the concentrations recommended for hospital cleaning may also be used. These solutions may be applied with a soft absorbent cloth, followed by rinsing with clean water. Wipe away residue with soft chamois or cellulose sponge material.

**CAUTION:** The infant tray grounding tabs are sharp; use care when cleaning the air flow system.

### CLEANING OF CABLES (OPTIONAL EQUIPMENT)

Clean the oxygen sensor cable and the pulse oximeter patient cable by wiping with a 70% isopropyl alcohol pad (or equivalent) and allow the cables to dry before reusing.

### CLEANING OF PULSE OXIMETRY SENSOR (OPTIONAL EQUIPMENT)

The provided sensors are disposable and should only be reused on the same patient if the adhesive still adheres to the skin and the detector window is clear. Otherwise, properly dispose of the sensor (see SECTION 6, PRODUCT DISPOSAL / RECYCLING, for disposal methods). For reusable sensors, see the manufacturer's cleaning instructions.

### CLEANING OF OXYGEN SENSOR (OPTIONAL EQUIPMENT)

When cleaning or disinfecting the oxygen sensor, take appropriate care to prevent any solution from entering the sensor end or the connector end. The oxygen sensor may be cleaned using a mild detergent and moist cloth and disinfected using standard topical disinfectants.

# MONTHLY MAINTENANCE

The following procedures should be performed monthly by a biomedical maintenance person. These checks should be in addition to the daily maintenance checks.

### OPERATIONAL CHECK

1. Connect the incubator to an AC power source and turn the incubator power button on.
2. Adjust the setpoint to 38.9° C and observe the incubator as the temperature rises to perform the following checks.
3. As the temperature reaches 38.5 ± 0.1° C, the ***HIGH TEMP*** indicator should illuminate.
4. Adjust the setpoint to 37° C and allow the temperature to stabilize at that setting.

### KEYBOARD / LED CHECK (OPTIONAL FEATURE)

1. Turn the incubator on, press the PulseOx SET button.
2. Press the Up Arrow button and see the display in the Pulse and %$SpO_2$ change from “OFF” to “On”.
3. Press the Down Arrow button and see the display in the Pulse and %$SpO_2$ change from “On” to “OFF”.
4. Check that the %$SpO_2$ and Pulse HI and LO LEDs are on. Continue to press the SET button and check that the LEDs correspond to the marked display.

### ALARM MUTE CHECK (OPTIONAL FEATURE)

1. Turn on the Oxygen Monitor and unplug the oxygen sensor.
2. Listen for the alarm. After hearing the alarm, press the ***MUTE*** button.
3. Verify the mute on LED lights up and the alarm silences.
4. Wait approximately 1 minute and verify the alarm sounds again.
5. Turn off the Oxygen Monitor and plug the sensor back in.

### TANK INSPECTION

1. Inspect the air and oxygen tanks for the date of the last hydrostatic test. Each tank must be hydrostatically tested periodically according to the manufacturer’s recommendation. The date of the last test is stamped on the top of the tank in month and year (mmyy).
2. Inspect the recharge record of each tank and, if the record indicates there have been a maximum number of pressure cycles as per DOT (Department of Transportation) specifications, the tank should be destroyed and another tank used.

3. Inspect tanks for abrasion, cuts, or other damage.

4. The tanks should be replaced according to the manufacturer's recommendation.

**INFANT CHAMBER INSPECTION & CLEANING**

1. Carefully inspect the infant chamber for cracks and crazing of the Plexiglas.

2. Check all screws and knobs for tightness.

   **CAUTION:** Do not overtighten the infant chamber screws!

3. Wash chamber with mild soap or detergent and water solution to clean the Plexiglas. Household ammonia in water in the concentrations recommended for hospital cleaning is also excellent. These solutions may be applied with a soft absorbent cloth, followed by rinsing with clean water. Wipe away residue with soft chamois or cellulose sponge material.

   **CAUTION:** Any type of alcohol or solvents should never be used for cleaning the infant chamber, as these solvents tend to soften the surface and often cause crazing. Cleansing materials containing abrasives or strong solvents as found in some window cleaning preparations should never be used to clean the inner and outer infant chamber.

**BATTERY TEST**

The incubator is equipped with a 12 volt 26 ampere-hour battery. Under normal operating conditions in an ambient temperature of 20° C, a new fully charged battery should operate the incubator for over three hours. Battery replacement is recommended yearly, or if operating time is less than 1 ¼ hours.

The battery is specified for only a finite number of complete discharges. The test of the battery will completely discharge it. The test can be performed as follows:

1. Ensure the battery is fully charged by connecting the incubator to AC power for 12 hours with the power switch off.

2. Place the incubator in a room with a temperature of approximately 20 - 23° C. Turn on the incubator power switch and adjust the setpoint on the front panel to 37° C. Let the incubator stabilize to its operational temperature with AC power.

3. After the incubator has reached operating temperature, allow an additional twenty minutes for stabilization.

4. After stabilization, disconnect the AC power and note the time. The incubator will automatically switch to battery operation.

5. Note the time at which the low battery alarm activates.

6. The difference between the noted times in steps 4 and 5 is the operational time. If this time is less than 1 ¼ hour, the battery should be replaced.

**AIR FLOW SYSTEM INSPECTION & CLEANING**

1. Remove the inner and outer infant chambers from the incubator and CAREFULLY set them aside.

2. Remove the infant mattress. Lift the swell latches on the infant tray and remove the infant tray. Ensure the swell latches are securely attached to the infant tray. Clean the infant mattress and infant tray with a hospital approved cleaning solution.

   **WARNING:** **Do not remove the infant tray and touch exposed circuitry and patient simultaneously.**

   ***NOTE:*** *The infant tray material is Kydex 100 and the support plate material is conductive clear chromate aluminum.*

3. Lift the two swell latches on impeller cover and remove it. Clean the cover with a hospital approved cleaning solution.

   **CAUTION:** Entry of fluids into fan motor, thermistors, or warming unit will significantly reduce service life. Clean this area by wiping with a cloth dampened with an appropriate cleaning solution and wipe dry.

4. Clean the airflow system with a hospital approved cleaning solution.

   **WARNING:** **The infant tray grounding tabs are sharp, use care when cleaning the air flow system.**

5. Dry and reassemble the air flow, infant tray system.

   **CAUTION:** Do not drip any cleaning solution through the holes where the swell latches fit into the air flow assembly.

**HARDWARE**

1. Ensure that all screws on the incubator are properly tightened.

   **CAUTION:** Do not strip the aluminum into which the screws are threaded.

## BATTERY CARE

The incubator contains a sealed lead battery (P/N 888-0071). If the incubator is not to be used for an extended period of time, disconnect and remove the battery. After use or complete discharge, immediately recharge the battery. If not regularly used or maintained on charge, the battery should be recharged on a monthly basis to prevent battery degradation. The battery is warranted for a period of ninety days. The life of the battery is dependent on the number and depth of discharge cycles. At the end of the battery's life, it must be recycled or disposed of properly.

**CAUTION:** The incubator MUST be plugged into AC power and the battery recharged after any battery usage. The battery will sustain damage if drained of power and not recharged.

Accessory equipment may also contain batteries which must be properly cared for. Consult the accessory equipment user's manuals for instructions.

## PRODUCT DISPOSAL / RECYCLING

The incubator should be returned to International Biomedical for recycling when it reaches the end of its life (7 to 10 years). The incubator's battery can be taken to any battery recycling facility when it reaches the end of its life (approximately 200 discharge cycles, dependent on depth of discharge).

The pulse oximetry sensors are single-use sensors and should be disposed of in a manner consistent with local laws.

# GENERAL TROUBLESHOOTING

The following list describes the most common issues that arise through use of the incubator and the suggested corrective actions. If further assistance is needed, contact International Biomedical.

**WARNING:** **OBSERVE BEST PRACTICE: The instructions in this manual in no way supersede established medical procedures or staff preference concerning patient care.**

**Why is the AC fail alarm sounding when the unit is unplugged?**

This is normal. The alarm indicates that the unit is no longer connected to AC power. Press the ***MUTE*** button to clear it.

**Why is the Air Flow alarm sounding?**

When a certain air flow rate is not met, the alarm sounds. Check for an obstruction, such as a blanket, in the airflow pathway. Check the chamber for cracks, missing grommets, or missing gaskets. Verify that the fan impeller is spinning. Verify that all swell latches are present and tightly secured.

**Why don't the buttons do anything when I press them?**

Ensure the incubator is turned on. If problem still persists, the membrane panel has been damaged and the overlay needs to be replaced. Contact International Biomedical for assistance.

**Why won't the light turn on?**

Ensure the incubator is turned on; the light gets its power from the incubator and will not work unless the incubator is on. If the light still doesn't work with the incubator on, it needs to be replaced (e.g. an LED may be bad, there may be a short in the circuitry). Contact International Biomedical for assistance.

# MAIN DISPLAY ERROR CODES

Table 7 - 1 shows the failure codes that may be seen on the Main Display Screen. If further assistance is needed, contact International Biomedical.

**Table 7 - 1 Main Display Screen Failure Codes**

| Error Code | Failure | Corrective Action |
|---|---|---|
| E01 | Set Point Output Voltage Error | The display board needs to be replaced. Contact International Biomedical for assistance. |
| E02 | Temperature Out of Range: baby temp. probe is disconnected, damaged, or out of sensor's useable range | Reconnect temperature probe to incubator. If error persists, replace temperature probe. |
| E03 | Battery Voltage Out of Range: battery is drained or overcharged | Charge battery by plugging into AC power for a minimum of 8 hours. If problem persists, battery must be replaced. |
| E04 | Display Range Limit Exceeded: value to be shown is outside of the display's limits | Verify temperature using secondary method. If temperature seems reasonable, the temperature sensor is faulty and must be replaced. Contact International Biomedical for assistance |
| E07 | EEPROM Write Failure: temperature set point not saved | Turn the incubator off and then on again. Repeat temperature set procedure. If error still occurs, the display board must be serviced. Contact International Biomedical for assistance. |
| E08 | EEPROM Value Out of Range: temperature set point out of range | |
| E09 | EEPROM Corrupt | |

# PULSE OXIMETER AND OXYGEN MONITOR FAILURE CODES (OPTIONAL FEATURE)

Table 7 - 2 shows the failure codes that may be seen when using the Masimo Pulse Oximeter. Failure codes will be displayed in the %$SpO_2$, PULSE, or OXYGEN display screens, as designated in the table. In some cases, a power down may reset the error; however, the pulse oximeter and/or oxygen monitor should be used with extreme caution. If further assistance is needed, contact International Biomedical.

**Table 7 - 2 Masimo Pulse Oximetry and Oxygen Monitoring Failure Codes**

| %$SpO_2$ Display | Pulse Display | Oxygen Display | Failure | Corrective Action |
|---|---|---|---|---|
| - | PS (flashing) | - | Pulse Search | Ensure proper sensor application. Reposition sensor, if necessary. |
| - | LP (flashing) | - | Low Perfusion | Move sensor to better perfused site. |
| - | LS (flashing) | - | Low Signal IQ | Ensure proper sensor application. Move sensor to a better perfused site. |
| - | - | E1 | $O_2$ Cal. Data Lost | Recalibrate the oxygen sensor per SECTION 5. |
| - | - | E7 | Oxygen Value Out of Range | Confirm sensor cable is attached. Recalibrate oxygen sensor. If error persists, replace cable. |
| E2 | E2 | - | Alarm Setpoint Data Lost | Set the alarm limits per SECTION 4 and/or SECTION 5. |
| E4 | - | - | Too Much Light | Remove or reduce lighting. Cover sensor from light. Reposition sensor. |
| E5 | - | - | Signal Interference | Remove outside interference. |
| E6 | - | - | Sensor Off Patient | Reattach sensor to patient. |
| E7 | multiple | - | Bad Sensor | Replace sensor. Refer to the instructions for the sensor being used. |
| E8 | - | - | | |
| E9 | - | - | No Sensor Connected (or the signal has been lost for more than 4 seconds) | Confirm a sensor is attached to the incubator and the patient being monitored. |
| E10 | - | - | Display board failure | Do not continue to use incubator. Send unit to service department for repair. Contact International Biomedical for more information. |
| E32 | - | - | | |
| E33 | - | - | | |
| E34 | - | - | | |
| E35 | - | - | | |
| E36 | - | - | | |
| E37 | - | - | | |
| E38 | - | - | | |
| E39 | - | - | | |
| E40 | - | - | | |
| E63 | multiple | - | | |

Table 7 - 3 and Table 7 - 4 show the failure codes that may be seen when using the Nellcor Pulse Oximeter. In Table 7 - 3, the error code listed will be displayed on the PULSE display screen. Additional error codes may be displayed on the %SPO2 display screen, but are unnecessary to describe here. If further assistance is needed, contact International Biomedical.

**Table 7 - 3 Nellcor Pulse Oximetry Board and Software Failure Codes**

| PULSE Display | Error Description | Corrective Action |
|---|---|---|
| 1 or 2 | Malfunction (typically, a failed hardware test) | Cycle the PulseOx system off and then on again. If error persists, the PulseOx system is damaged and needs to be replaced. |
| 4 | Software Error | Wait for 15 seconds to see if the software resets itself. If no signal is received after 15 seconds, the PulseOx system needs to be serviced. Contact International Biomedical. |
| 5 | Communications Error | Wait for 15 seconds to see if communications reset. If no signal is received, the PulseOx system needs to be serviced. Contact International Biomedical. |
| 6 | Defective Sensor Detected | Ensure the sensor is properly connected. Disconnect and reconnect the sensor. If the error occurs again, replace the sensor and/or cable. If the error persists, the PulseOx system needs to be serviced. Contact International Biomedical. |

**Table 7 - 4 Nellcor Pulse Oximetry Sensor Failure Codes**

| Sensor Status | %SPO2 Display | PULSE Display | Corrective Action |
|---|---|---|---|
| Sensor Disconnected | E9 | 1 | Ensure sensor is connected to the incubator. Reconnect, if necessary. |
| Sensor Off | E6 | 1 | Reattach sensor to patient. |
| Light Pulse Search | - | PS | Ensure proper sensor application. Reposition sensor, if necessary. |
| Blink Pulse Search | - | PS | |
| Light Interference | E5 | 1 | |
| Blink Interference | E5 | 1 | |

# SECTION 8: INTERNAL COMPONENT ACCESS

This section contains procedures for accessing and removing components from the incubator chassis.

**WARNING:** **SERVICE ONLY BY QUALIFIED PERSONNEL: The incubator should be serviced only by qualified personnel in the Electronics Maintenance or Biomedical Engineering Department within the hospital or by International Biomedical personnel.**

**WARNING:** **HIGH VOLTAGES: Dangerous voltages may be contained on circuitry internal to the unit. Maintenance should be performed by qualified personnel only.**

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

***NOTE:*** *Servicing the transport incubator requires special equipment and tools. Do not attempt to service the transport incubator without proper equipment.*

## ELECTRONICS COMPARTMENT ACCESS

This section details the procedure to be followed to gain access to the electronics compartment of the incubator.

1. Turn the incubator power button off and unplug the AC power cord.
2. Remove the inner and outer infant chambers.
3. Remove the four latches that secure the infant chamber (two screws per latch).
4. Remove the two or four screws that secure the lamp assembly and gently pull the assembly to expose the connector. Disconnect it and remove the lamp assembly.
5. Carefully lift the front edge of the airflow tray assembly just enough to gain sufficient access to disconnect the two electrical cables and the ground cable. Disconnect both electrical cables and the ground cable.
6. The airflow tray assembly can now be completely removed.

## BATTERY REMOVAL

This section details the procedure to be followed to remove and replace the battery. The procedure detailed to gain access to the electronics compartment must be followed before beginning this procedure. Due to the weight of the battery and limited working area, exercise caution when inserting / removing battery to avoid damage to circuit boards or cables.

1. Loosen the four quarter turn fasteners securing the battery and remove the battery clamping bracket.
2. Remove the negative lead from the battery terminal. If necessary, the battery may be carefully lifted or tilted to allow better access to the terminal.
3. Remove the positive lead from the battery terminal. If necessary, the battery may be carefully lifted or tilted to allow better access to the terminal.
4. The battery can now be carefully removed.

**CAUTION:** Replace battery only with International Biomedical part number 888-0071.

## CONTROL BOARD REMOVAL

This section details the procedure to be followed to remove the control board assembly. The procedure detailed to gain access to the electronics compartment must be followed before beginning this procedure.

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Disconnect the two remaining cables from connectors J1 and J3.
2. From underneath, remove the three screws securing the aluminum heatsink and spacer to the floor of the electronics compartment. When reassembling, clean the bottom of the aluminum extrusion and spacer and apply a thin coating of a suitable heatsink compound to all mating surfaces.
3. Remove the six screws securing the printed circuit board to the six standoffs.
4. The control board can now be lifted out of the frame.

# DISPLAY BOARD REMOVAL

This section details the procedure to be followed to remove the display board assembly. The procedure detailed in the previous section to gain access to the electronics compartment must be followed before beginning these procedures.

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Disconnect the ribbon cable from the display board.
2. Disconnect the skin temp cable from the display board.
3. Remove the two screws that secure the display board and front panel to the incubator chassis.
4. Pull the PC board towards the rear of the chassis. The display board and the front panel will come out together as a unit.
5. Disconnect the membrane keypad connector from the display board.
6. Remove the five screws and nylon washers securing the PC board to the front panel standoffs.
7. The display board may now be removed from the front panel.

# PULSEOX DISPLAY BOARD REMOVAL

This section details the procedure to be followed to remove the PulseOx display board assembly. The PulseOx daughter board will be still attached (see Pulse Oximeter Board Removal procedure for details on removing the daughter board). The procedure detailed in the previous section to gain access to the electronics compartment must be followed before beginning this procedure.

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Disconnect the ribbon cable from the display board (***J1***).
2. Disconnect the skin temp cable from the display board (***J3***).
3. Disconnect the oxygen sensor cable from the display board (***J11***).
4. Remove the PulseOx Input cable from the side panel.

   **NOTE:** The $SpO_2$ flex cable is secured to the PulseOx daughter board and needs to be removed with the display PCB assembly.

5. Remove the two screws that secure the display board and front panel to the incubator chassis.

6. Pull the PC board towards the rear of the chassis and up. The display board, daughter board, and the front panel will come out together as a unit.

7. Disconnect the membrane keypad connector from the display board (***J4***).

8. Remove the four visible screws and nylon spacers securing the PC board to the front panel standoffs (one in each corner and one in the middle).

9. Remove the PulseOx daughter board in order to access the last Display PCB screw.

    a. For Masimo, remove 3 screws and the jumper connected to ***J13***.

    b. For Nellcor, remove 2 screws and the jumper connected to ***J14***.

10. The display board may now be removed from the front panel.

# PULSE OXIMETER BOARD REMOVAL

This section details the procedure to be followed to remove the PulseOx daughter board assembly. The electronics compartment access procedure must be followed before beginning this procedure.

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Disconnect the PulseOx flex cable from the PulseOx daughter board.

    a. For Masimo, connector ***J3*** on PulseOx board

    b. For Nellcor, connector ***J4*** on PulseOx board

2. Disconnect the cable from the side panel of the incubator to the PulseOx daughter board (***J1***).

3. Remove the PulseOx daughter board from the standoffs on the display board.

    a. For Masimo PulseOx board, there are 3 standoffs.

    b. For Nellcor PulseOx board, there are 2 standoffs.

# SECTION 9: CALIBRATION PROCEDURES

The following calibration procedures should be performed only by a person who is experienced in electronics and has the proper test equipment. The entire system can be calibrated using the System Calibration Procedure. Individual board calibration procedures (i.e. Control Board Calibration and Display Board Calibration) should be performed after a board has been repaired. In order to perform any of the calibration procedures, the circuitry must be accessed (refer to SECTION 8 for instructions on accessing the electronics compartment).

## CALIBRATION TEST EQUIPMENT REQUIRED

- Four Digit Digital Voltmeter
- Variable DC voltage power supply 10 - 20 volts at 10 amperes
- Oscilloscope
- Resistor decade box ± 1% accuracy
- 3 Clip lead jumpers (preferably one red and two black)
- 10 kΩ resistor
- Airborne temperature test circuit P/N 387-1190 (Available from International Biomedical)
- Airborne sensor simulator P/N 387-1191 (Available from International Biomedical)
- Calibrated digital temperature measuring device 0.1° C accuracy

## SYSTEM CALIBRATION PROCEDURE

The following procedure should be used to calibrate the system after repairs or during routine maintenance.

1. Locate the **J2** connector on the control board and connect the sensor simulator connector. If not using a sensor simulator, leave airflow tray connected to **J2**. Ensure **JP1** on the control board is set to route the Secondary Thermistor to the display board's "measured temperature" input (jumper **JP1** should be on positions 1 and 3). Connect the incubator to an appropriate AC power source. Check the voltage at the positive battery terminal. It should be approximately 13.7 ± 0.2 volts with a fully charged battery.

2. Check the voltage at **TP1** on control board. It should be 13.7 ± 0.1 volts with a fully charged battery. Adjust **R1** if necessary. The **BAT CHG** indicator should be on.

3. Turn the power button on and observe for a couple of seconds; all LEDs should be illuminated, all seven-segmented LED elements turned on, and the audible alarm on. The **BAT CHG** and **AC OP** indicators should stay on.

4. Remove the sensor simulator. **SENS FAIL** and **SYS FAIL** alarms should activate. Reconnect the sensor simulator to **J2** on the control board.

5. Set the thermostat switch on the sensor simulator to OPEN (up position). The **AIR FLO** indicator should be on and alarm should sound continuously. Set the thermostat switch to CLOSED (down position).

6. Turn the incubator power off. Remove the fan impeller from underneath the mattress tray, turn the unit on, adjust the temperature setpoint to 37.0° C, and verify that the **AIR FLO** alarm activates under twelve minutes. The **AIR FLO** alarm may sound for a few minutes. Replace the fan impeller.

7. With the incubator turned on, disconnect the power cord. An audible alarm indicating loss of AC power should sound, which can be silenced by pressing the **MUTE** button. Turn the incubator power off and disconnect the negative battery cable. Set the external power supply to 12 volts and connect the external power supply output to the battery cables, observing proper polarity.

8. Turn the incubator power on. Connect the digital multimeter leads to the battery cables. Slowly reduce the supply voltage. The **LOW BAT** warning LED should illuminate at 10.8 ± 0.3 volts and the audible alarm should sound at approximately 8 second intervals. The **PWR FAIL** indicator should turn on at 10.1 ± 0.1 volts and the incubator power should turn off. The audible alarm should sound continuously. If these alarms turn on at incorrect voltages, see the Control Board Calibration procedure.

9. Turn the incubator power off and disconnect the external supply. Reconnect the negative battery cable to the battery. Connect one end of the red clip lead to **TP7** of the control board and run the other end outside the incubator. Similarly, connect one black clip lead to **TP1** and one black clip lead to **TP2** of display board. Disconnect the sensor simulator from **J2** on the control board and connect the airflow tray cable to **J2** on the control board. Connect heater and ground wires also. Install the inner and outer infant chambers.

10. Using the calibrated temperature measuring device, monitor the temperature in the center of the chamber 10 cm above the center of the mattress.

11. Reconnect the incubator to an appropriate source of AC power and turn the unit ON. Adjust the setpoint temperature to 37.0° C. Operate the unit until the temperature inside the infant chamber stabilizes (approximately 30 minutes).

12. If the temperature indicated by the monitoring instrument is not 37.0 ± 0.5° C, adjust **R3** on the control board until 37.0° C is achieved. This adjusts for the temperature offset between 10 cm above the center of the mattress and the location of the control temperature sensor.

13. Wait 10 minutes and repeat the previous step if necessary.

14. Adjust **R9** until the incubator displayed temperature matches the measured temperature of the measuring device, ± 0.5° C. Operate the incubator long enough to allow the displayed temperature to stabilize and adjust **R9** again as needed.

15. Wait 10 minutes and repeat the previous step, if necessary.

16. Use the two black clip leads to connect the 10 kΩ resistor between **TP1** and **TP2** on the display board, while the setpoint temperature is set at 37.0° C. (This effectively sets the temperature to 39.9° C). Verify that the **HIGH TEMP** alarm activates at 38.5 ± 0.1° C as indicated by the front panel display. The alarm should sound at approximately 8 second intervals. Adjust **R8** on the control board as necessary.

17. As the temperature in the chamber continues to rise, verify that the **SYS FAIL** alarm activates at 39.0 ± 0.2° C and that the heater is disabled (incubator cools gradually). Adjust **R7** on the control board as necessary. If this adjustment seems to have no effect, check that the secondary **SYS FAIL** isn't activating at too low a temperature (see step 18).

18. With the other black clip lead, ground **TP7** on the control board by clipping on to the chassis. The **SYS FAIL** alarm should turn off. Verify the **SYS FAIL** alarm reactivates at 39.2 ± 0.1° C, and that the heater is again disabled. Adjust **R15** on the control board as necessary. This **SYS FAIL** alarm should continue to be active even though the incubator cools below 39.2° C - the incubator must be turned off, then back on, to cancel it.

19. Remove all clip leads. Allow time for the unit to re-establish equilibrium.

20. Disconnect the power cord. The **BAT OP** indicator should illuminate. The **MUTE** button will cancel the **AC FAIL** alarm. Operate the unit from battery power for five minutes and verify that the temperature maintained is the same as with AC operation.

21. Connect an external source of 12V DC power to the external 12V DC connector. The **DC OP** indicator should illuminate. Verify temperature is maintained while powered from external DC for five minutes. Disconnect the external power supply and turn the unit off.

# CONTROL BOARD CALIBRATION PROCEDURE

The following procedure should be used to calibrate the control board with it installed in the transport incubator, after any repairs, prior to system calibration.

***NOTE:*** *TP11 and TP13 are ground references.*

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Disconnect the AC power cord from any AC power source. Connect the temperature sensor test circuit to **J2** of the control board. Ensure **JP1** on the control board is set to route the Secondary Thermistor to the Display Board's "measured temperature" input (jumper **JP1** should be on positions 1 and 3). Connect the decade box to the temperature sensor test circuit. Set the temperature sensor test circuit switches as follows:

   a. Set the secondary sensor switch to DECADE BOX position.

   b. Set the primary sensor switch to 1400 Ω position.

   c. Set the decade box to 1454 Ω (37.0° C).

2. Reconnect the AC power cord to an appropriate AC power source. To set the battery charging voltage, turn off the incubator power switch and check the voltage at ***TP1***. With a fully charged battery, ***TP1*** should be 13.9 ± 0.05 volts. Adjust ***R1*** as necessary.

   a. To check the maximum charging current, measure the voltage from ***TP14*** to ***Z4*** pin 7. The voltage should be approximately 50 ± 10 millivolts.

      ***NOTE:*** *This maximum current is supplied to a discharged battery. The charging circuit automatically reduces this current for a charged battery. Be sure to check the current using a depleted battery, or with a 1.3 Ω, 100 W resistor in place of the battery.*

   b. Turn the incubator power switch to on and allow 10 minutes for the voltage references to stabilize.

c. To check the two independent voltage references, measure the voltage at ***TP4*** and ***TP10***. The voltage should be 5.00 ± 0.005 volts. If necessary, adjust ***R4*** and ***R10*** respectively.

d. To check the calibration of the setpoint temperature circuit, adjust the setpoint temperature to 37.0° C. With a properly calibrated display board, the voltage at ***TP2*** should be 3.399 ± 0.005 volts. Adjust ***R2*** on control board as necessary.

e. To check the calibration of the secondary temperature sensor, measure the voltage at ***TP9***. It should be 3.421 ± 0.005 volts. Adjust ***R9*** as necessary.

f. To check the ***SYS FAIL*** alarm, set the decade box to 1326 Ω. The ***SYS FAIL*** alarm should activate at 39.2° C (when switching from 1325 Ω to 1326 ± 100 Ω). Adjust ***R15*** as necessary. Achieving the exact temperature and ohm values is not critical now as this alarm will be readjusted more precisely during the system calibration.

g. Ensure ***JP1*** on the control board is set to route the Primary Thermistor to the Display Board's "measured temperature" input (jumper ***JP1*** should be on positions 1 and 2). Set the temperature sensor test circuit switches as follows:

   i. Primary sensor switch to DECADE BOX

   ii. Secondary sensor switch to 1400 Ω

   iii. Set the decade box to 1454 Ω (≈ 37.0° C).

h. To check the primary sensor calibration, measure the voltage at ***TP3***. It should be 3.399 ± 0.005 volts. Adjust ***R3*** as necessary.

i. Set the decade box to 1356 ± 100 Ω. The ***HIGH TEMP*** alarm should activate at 38.5° C when switching from 1356 to 1355 ± 100 Ω. Adjust ***R8*** as necessary. Achieving the exact temperature and ohm values is not critical now, as this alarm will be readjusted more precisely during the system calibration.

3. Set the decade box to 1329 ± 100 Ω (the HIGH TEMP alarm will be on). The ***SYS FAIL*** alarm should activate while switching at 39.0° C (when switching from 1329 to 1328 ± 100 Ω. Adjust ***R7*** as necessary. Achieving the exact temperature and ohm values is not critical now, as this alarm will be readjusted more precisely during the system calibration.

4. Turn off the incubator and unplug the AC cord. Remove the negative lead from the battery post. Connect the variable DC supply in place of the battery.

5. Adjust the voltage of the DC supply to 18.3 ± 0.05 volts. Connect a jumper across ***R59***. (***R59*** is located 1.5 inches below variable resistor ***R7***.) Set the decade box to 1576 Ω. Turn the incubator power switch on. Observe the waveform at ***TP12*** with an oscilloscope. The duty cycle of the square wave should be 60 ± 5%. Adjust ***R12*** as necessary. Verify that the period is between 14 ms and 16 ms. Disconnect the jumper on ***R59***.

6. Decrease the voltage output of the DC supply to 10.5 volts. The low battery alarm should activate.

7. Slowly decrease the applied voltage until the display turns off and the ***PWR FAIL*** indicator illuminates. This should occur at 10.1 ± 0.3 volts. If it does not, perform one of the following procedures:

   a. If the shutdown occurs <u>below</u> 10.1 volts do the following:

      i. Increase the applied voltage to 12.0 volts.

      ii. Cycle the power switch to off, then to on.

      iii. Adjust the applied voltage to 10.1 volts.

      iv. Slowly adjust ***R6*** clockwise until the display just shuts down.

   b. If the shutdown occurs <u>above</u> 10.1 volts, do the following:

      i. Increase the applied voltage to 12.0 volts.

      ii. Cycle the power switch to off, then to on.

      iii. Adjust ***R6*** fully counter clockwise.

      iv. Adjust the applied voltage to 10.1 volts.

      v. Slowly adjust ***R6*** clockwise until the display just shuts down.

      vi. Turn off power and remove the DC supply and reconnect the battery.

      vii. Return ***JP1*** to its original position (pins 1 and 3).

      viii. Remove all test apparatus and reassemble unit. Proceed to the System Calibration.

8. Perform the System Calibration procedure.

# DISPLAY BOARD CALIBRATION PROCEDURE

The following procedure should be used to calibrate the display board. It should be performed once installed in the incubator, after any repairs, and prior to system calibration.

**CAUTION:** The incubator electronics contain static sensitive components that can be damaged by improper handling. Use approved grounding techniques for work areas and service personnel.

1. Turn the power switch on and observe for a couple of seconds; all LEDs should be illuminated, all seven-segmented LED elements turned on, and the audible alarm is on.
2. Verify ***TP3*** (relative to ***TP13***) is 5.0 ± 0.1 volts.
3. Adjust ***R36*** for a voltage of 1.809 ± 0.005 volts from ***TP4*** to ***TP13***.
4. Attach decade resistor box across the ground and input lugs of the skin temperature connector. Set decade resistor box to 1.355 Ω. Adjust ***R30*** for a reading of 3.399 ± 0.005 volts from ***TP5*** to ***TP11***. The display should show a reading of 37.0 ± 0.1° C when the ***BABY TEMP*** button is pushed.
5. Turn off the power. Remove all test apparatus.
6. Perform the System Calibration procedure.

# SECTION 10: CIRCUIT DESCRIPTION

The theory of operation of the incubator's electronic circuits is described. The individual schematics for the control board and display board should be referred to when reading the theory of operation.

## CONTROL BOARD

This section describes the theory of operation of the incubator's control board.

### TEMPERATURE REGULATION

The air inside the incubator is heated and its temperature is sensed by the components of the air flow tray. The air flow tray contains the circulating fan, the temperature sensors, the heater, and the heater switching transistor. The heater power is controlled with pulse width modulation. There are two separate thermistors in the airflow tray. The first or primary thermistor is used to measure and control the incubator's temperature. The second or secondary thermistor is used for display control and an independent indicator of high temperature.

On the incubator control board are three identical temperature sensor circuits (***Z3B***, ***Z9B***, ***Z10B***, and their associated components). Two of these circuits (***Z3B*** and ***Z10B***) convert the two thermistors' nonlinear resistance values into a voltage proportional to the temperature of the thermistors. The third bridge circuit (***Z9B***) converts the voltage output of the setpoint circuit on the display board into a voltage proportional to the temperature setting.

The difference between the measured temperature and the setpoint temperature is amplified by ***Z10A*** producing an error voltage. ***Z7B*** compares this error voltage to a triangular wave produced by a 555 timer oscillator circuit, ***Z5***, ***R60***, and ***C9***. This comparison produces a square wave, the duty cycle of which is proportional to the error voltage. This square wave is then used to drive the base of the heater switching transistor. Diode ***CR12*** limits the maximum value of the error voltage seen by comparator ***Z7B***. The transistor amplifier formed by ***Q4***, ***R54***, ***R55***, ***R56***, ***R57***, and ***C16***, causes this maximum value limit to decrease approximately as the square of the applied heater voltage. This results in a relatively constant maximum heater power even though the heater voltage may vary. The applied heater voltage will vary due to changing AC line conditions, varying states of charge of the internal battery, or variations in the external DC voltage.

Potentiometer ***R12*** adjusts the DC level of the triangular wave, which controls the relationship between error voltage and duty cycle. This allows ***R12*** to control maximum heater power. The diodes ***CR13*** and ***CR17*** allow the DC level of the triangular wave to be increased when the incubator is powered by AC power. When AC power is used, the applied heater voltage is larger than when battery power or external DC power is used. The higher DC level of the triangular wave results in lower duty cycle applied to the heater for a given error voltage.

**FAILSAFE TEMPERATURE LIMIT**

The secondary thermistor and its independent circuitry provide a fail-safe heater disable function. The secondary thermistor circuit is completely independent of the control loop. It has a completely separate voltage reference (***Z2***) and amplifier (***Z3B***). A comparator (***Z3A***) is adjusted by means of ***R15*** to activate when a voltage corresponding to a temperature of 39.2° C is reached. This turns off ***Q3***, which opens the relay ***K3***, and interrupts power to the heater. The ***SYS FAIL*** indicator will activate and the audible alarm will sound.

**ALARMS**

Four comparators monitor the voltage derived from the primary thermistor. Comparator ***Z11A*** activates if the voltage is greater than 5 volts, indicating a shorted thermistor. Comparator ***Z11D*** activates if the voltage is less than 0.9 volts indicating an open thermistor. Activation of either of these two comparators will turn on the ***SENS FAIL*** indicator, sound the audible alarm, and disable the heater by turning ***Q3*** off.

Comparator ***Z11B*** activates when a voltage corresponding to a temperature of 39° C is reached. This turns on the ***SYS FAIL*** indicator, sounds the audible alarm, and disables the heater.

Comparator ***Z11C*** activates when a voltage corresponding to a temperature of 38.5° C is reached. This turns on the ***HIGH TEMP*** indicator and enables ***Z13***, a 555 timer, which sounds an intermittent audible alarm. The 555 timer ***Z13*** is configured as an asymmetrical square wave oscillator. It establishes the repetition rate and duration of the intermittent audible alarm.

Comparator ***Z7A*** monitors the voltage level of the power source. If this voltage drops below 10.8 volts, battery operation is assumed and the ***LOW BAT*** alarm is turned on. ***Z13*** is also enabled causing the intermittent audible alarm to sound.

## POWER FAIL ALARM

The ***PWR FAIL*** alarm activates when the battery voltage drops below 10 volts, causing ***Z1*** to turn off ***Q1***, which supplies the battery voltage. This removes all power from the control circuitry. The drain of ***Q1*** will go low which will turn ***Q2*** on. Transistor ***Q2*** then supplies power from the battery to sound the alarm and turn on the ***PWR FAIL*** indicator. Although the battery has insufficient power to operate the unit, it does have plenty of power to operate the alarm indicators. The unloaded battery voltage will rebound and exceed the 10 volt level, but because ***Q1*** is off, ***Z1*** is turned off and cannot turn ***Q1*** back on. This is a latched condition and can be changed only by cycling the power switch, or by application of an external power source.

Without the application of external power, turning the power switch off will charge a capacitor (***C3***) on the display board through ***R72***. Then when the power switch is turned on, this capacitor is switched to pin 8 of ***Z1***. This provides sufficient power to ***Z1*** to allow it to turn on ***Q1***, if the battery voltage is sufficient. When ***Q1*** turns on, power is then supplied to ***Z1*** through ***CR9***.

## VOLTAGE REFERENCE

Operational amplifier ***Z9A*** amplifies the 0.2 volts reference generated by ***Z8***. Potentiometer ***R4*** adjusts the gain to provide 5 volts at pin 1 of ***Z9***, ***TP4***. This establishes the voltage reference for the control loop amplifier circuits and all alarm circuits except the fail-safe circuit. The voltage reference for the fail-safe circuit is generated by ***Z2*** and adjusted by means of ***R10*** to be 5 volts at ***TP10***.

## LAMP DRIVE CIRCUIT

Lamp power is regulated by maintaining a constant current through the lamp. A voltage reference within ***Z8*** provides 0.2 volts at pin 1 which is connected to pins 8 and 3. The amplifier drives the base of ***Q7*** to a voltage that causes the voltage at ***Z8*** pin 2 to be 0.2 volts. The constant voltage across the resistance of ***R38*** generates a constant current in the emitter of ***Q7*** and the emitter and collector currents are approximately equal. Therefore, the collector or lamp current is constant and regulated at 0.42 amps. The constant current drive provides the soft start effect when the lamp is turned on.

## BATTERY CHARGER

The battery charger is powered any time the incubator is plugged into a source of AC power. The charger maintains a constant output voltage of 13.9 volts in the trickle charge mode or limits the charge current to 5 amps in the current mode. A fully charged battery has a voltage between 13.5 volts and 13.8 volts. The voltage regulator for the battery charger consists of ***Q5***, ***Z6***, and its associated components. A 200 millivolt reference within ***Z6*** establishes the voltage at the noninverting input of ***Z6***. The amplifier output drives ***Q5*** at the level necessary to cause the voltage at the inverting input of ***Z6*** to be equal to the reference voltage. By adjusting the potentiometer ***R1***, the ratio of the voltage divider string ***R32***, ***R1***, and ***R34*** can be varied to set the voltage at ***TP1*** to equal 13.9 volts.

The battery charging is interrupted when the heater is on to prevent excessive current draw on the transformer. This is accomplished by means of ***R35*** and ***CR15***. When the heater on signal at ***TP12*** goes high, the heater is turned on and causes a current through ***R35***. The current increases the voltage at the inverting input of ***Z6*** to exceed the 200 millivolt reference level, causing ***Z6*** to turn off ***Q5***. During the portion of the duty cycle when the heater signal at ***TP12*** output is low, the heater is turned off and battery charging resumes. Battery charging will be totally interrupted if the duty cycle of the heater reaches 100%. With average line voltages the maximum duty cycle is limited to less than 65%. When the battery is depleted, maintaining a voltage of 13.9 volts at ***TP1*** would force a charging current high enough to damage the battery. Therefore, a current limiting circuit is provided. This circuit is formed by ***Q6***, ***Z4***, and associated components. Zener diode ***CR14*** establishes a reference voltage and the potentiometer ***R14*** is adjusted to provide a reference of negative 50 millivolts at ***TP14*** with respect to the AC rectified voltage. The resistor ***R28*** is connected to the AC rectified voltage and supplies the battery charging current. As long as the voltage across ***R28*** is less than 50 millivolts or the charging current is less than 5 amps, ***Z4*** keeps ***Q6*** turned off. When the voltage across ***R28*** exceeds 50 millivolts, ***Z4*** causes the drain current of ***Q6*** to be increased until the voltage drop across ***R27*** matches the voltage drop across ***R28***. The drain current of ***Q6*** flows through ***R34*** producing an additional voltage to the inverting input of ***Z6***. The output of ***Z6*** responds by lowering the voltage to ***Q5*** and the battery charging current. The control loop responds to current rather than voltage and regulates to maintain a constant current of 5 amps. The current regulation is maintained until the battery terminal voltage rises sufficiently to cause ***TP1*** to rise above 13.9 volts and voltage regulation resumes.

# SECTION 10: CIRCUIT DESCRIPTION

### POWER SOURCE SELECTION

Relays ***K1*** and ***K2*** are arranged by means of their contact and drive coil connections to select the proper power source. AC power is the preferred source and is selected when the only external power applied is AC. It is also selected when both external DC and AC are applied. External DC is selected only when it is applied exclusively. When no external source of power is applied, the relays select the internal battery.

## DISPLAY BOARD

This section details the functions provided by the circuitry on the display board. Microcontroller ***U4*** is the chief component of the incubator display portion of the board. When powered on, dedicated firmware processes key inputs received from the membrane switch panel; continuously monitors the incubator air temperature, skin temperature, and battery voltage inputs; selects and updates the seven-segment digits, display mode LEDs, and temperature setpoint; and provides nonvolatile memory to restore system settings when power is cycled.

Meanwhile, microcontroller ***U19*** is the chief component of the pulse oximeter and oxygen monitor. When powered on, dedicated firmware processes key inputs received from the membrane switch panel and continuously monitors the oxygen content and serial communications from the pulse oximetry board. It continuously selects and updates the seven-segment digits for %$SpO_2$, Pulse, and Oxygen concentration, as well as the pulse bar graph and the pulse-oximeter / oxygen display mode LEDs. It provides early warning for too low of a low oxygen alarm setpoint and drives the alarm output. It also provides nonvolatile memory to restore system settings when power is cycled.

### MEASURED TEMPERATURE DISPLAY

The seven-segment display LEDs (***DS1***, ***DS2***, and ***DS3***) and the display mode LEDs (***D53***, ***D54***, ***D55***, and ***D56***) are updated at 200 Hz and are driven by current source array ***U11***. This refresh rate is established by the microcontroller, which activates the common cathodes for each display component using open collector Darlington array ***U10***.

# SECTION 10: CIRCUIT DESCRIPTION

## MAIN INCUBATOR ALARM AND POWER INDICATORS

Of the twelve remaining alarm and indicator LEDs for the incubator, nine are driven by ***U8*** and ***U9***, which are open collector Darlington arrays. Two indicators (***BAT CHG*** and ***PWR FAIL***) are driven directly since they must operate when the incubator power is turned off. One indicator (>37° C) is driven by the microcontroller through open collector Darlington array ***U10***. The audible alarm is turned on as determined by logic on the control board. The audible alarm can be silenced for approximately 60 seconds by pressing the ***MUTE*** button. This charges ***C13*** raising the voltage above the reference voltage generated by ***R25*** and ***R27***. The comparator ***U14-B*** compares these voltages and turns off ***Q3***, which turns off the audible alarm until the ***C13*** discharges through ***R26***. It also turns off an input to U10, which in turn turns on an input to U10, thus causing the alarm muted LED to come on. The ***MUTE*** button is overridden by a ***PWR FAIL*** alarm turning on ***Q5***.

## TEMPERATURE SETPOINT

The temperature setpoint is entered from the membrane keypad as described in the Operator's Manual. The microcontroller firmware then converts this setpoint to a voltage output, which is written to the serial digital-to-analog converter ***U6***. This voltage in turn controls the current across fixed resistor ***R16*** (inserted between ***TP1*** and ***TP2***) and thereby emulates the passive resistor model of an ordinary thumbwheel switch. The equivalent resistance is input to a temperature sensor circuit on the control board. The microcontroller ***U4*** also monitors the voltage out of ***U6*** directly to guard against any failure in the temperature setpoint circuit.

## SETPOINT ALARM

This alarm activates when the incubator temperature is more than 1° from the setpoint. The display will flash HI or LO every 5 seconds. An audio alarm sounds every minute until the incubator temperature is within 1° of the setpoint.

## PULSE, $SpO_2$, AND OXYGEN DISPLAYS (OPTIONAL FEATURES)

The seven-segment display LEDs (***DS20*** - ***DS28***), the pulse-oximeter / oxygen display mode LEDs (***D38*** - ***D44***), and the pulse bar graph LEDs (***D45 - D49***) are updated at 120 Hz by the microprocessor on the display daughter card. The oxygen low setpoint below 21% warning LEDs (***D35 - D36***) is also driven by the microprocessor on the display daughter card.

### SATURATION, PULSE, OXYGEN, AND PULSE GRAPH DISPLAYS (OPTIONAL FEATURES)

The seven-segment display LEDs (***DS20*** - ***DS28***), the display mode LEDs (***D38*** - ***D44***), and the horizontal bar graph of the pulse amplitude (***D45*** - ***D49***) (all located on the main display board) are updated at 120 Hz and are driven by current source array ***U21***. This refresh rate is established by the microcontroller, which activates the common cathodes for each display component using open collector Darlington array ***U12*** and ***U20***, with some of the selection done via the 3 to 8 line decoder ***U23***.

### ALARM AND POWER INDICATORS (OPTIONAL FEATURES)

The low oxygen limit below 21% warning LED and the alarm are driven by ***U12***. The alarm is the same one as is used by the incubator so the mute circuitry will shut down all audible alarms.

### ALARM SETPOINTS (OPTIONAL FEATURE)

The high and low alarm levels are entered from the membrane keypad as described in the Operator's Manual. The microcontroller firmware then compares the setpoints to the serially communicated inputs from the pulse oximetry board and the serial data from the analog to digital converter, which is in turn connected to an instrumentation amplifier with a gain of 1 on the oxygen reading level. These setpoints are stored in the EPROM included in the microprocessor ***U19***.

### SETPOINT ALARM (OPTIONAL FEATURE)

This alarm activates when any reading is greater than its respective high setpoints or lower than its low setpoint. The display will flash HI or LO in the appropriate display at a rate as determined by the alarm severity. An audio alarm sounds every second three times for a high priority alarm, two times for a medium priority alarm, and once for a low priority alarm until the incubator alarming condition is removed or the incubator is turned off.

### OTHER ALARM AND WARNING CONDITIONS

All alarm conditions including error codes are detailed in the operator's manual and in SECTION 7 of this Service manual.

# GENERAL MECHANICAL SPECIFICATIONS

| | **Height** inches (cm) | **Width** inches (cm) | **Depth** inches (cm) | **Weight** lbs. (kg) |
|---|---|---|---|---|
| Incubator without Infant Chamber | 7.8 (19.9) | 53 (134.6) | 22.2 (56) | 84 (38) |
| Infant Chamber | 11.25 (28.6) | 29 (73.7) | 16.5 (41.9) | 20 (9.1) |

| | | |
|---|---|---|
| Mattress Tray Dimensions | 11 ¼ × 25 ¼ × 2 ⅜ in | 28.7 × 64.1 × 6 cm |
| Infant Chamber Vertical Clearance | 8 ¾ in | 22.3 cm |
| Front Access Door with 2 Hand Ports | 9 × 21 in | 22.7 × 53.2 cm |

***NOTE:*** *Dimensions and weights are approximate. Height dimensions are given such that, when added, the approximate total height is given.*

## Mounting Provisions

Four mounting holes (intended for M6 or ¼" hardware) on the bottom of the incubator are intended to be utilized to mount the incubator to an interface that will securely fix the incubator system in a hospital setting or emergency vehicle as appropriate. It is the customer's responsibility to ensure that any safety requirements have been addressed on the installation. Unless otherwise specified, maximum additional equipment weight limited to 10 lbs.

**Figure 11 - 1**

## ELECTRICAL SPECIFICATIONS

| | |
|---|---|
| AC Power | 120 VAC 50 - 400 Hz 6 Amps |
| | 230 VAC 50 - 400 Hz 6 Amps |
| Accessories | 3 Amps |
| External DC Power | 12 volts 10 Amps |
| Internal Battery | One 12 volt 26 AH Sealed Lead/Acid type |
| Battery Life | Approx. 200 cycles |
| Nominal Battery Recharge (90%) Time | 8 Hr. on AC, Unit Off |
| Nominal Battery Operation Time | 3 Hr. Chamber at 37° C Ambient 20° C |

## OPERATIONAL SPECIFICATIONS

| | |
|---|---|
| Temperature Setpoint | 17° C to 38.9° C, 0.1° C increments |
| Digital Display Resolution | 0.1° C |
| Digital Display Accuracy | ± 1° C in range 10° to 45° C |
| Warmup time[2] | 20 minutes ± 20%, large chamber |
| Carbon dioxide concentration[3] | < 0.5% |
| Maximum Infant Weight | 16 lb (7.3 kg) |
| Display update period | 1 second |

[2] As determined by EN60601-2-20, clause 201.12.1.107. Time to rise 11° C, when control temperature is set 12° C above ambient.

[3] As determined by EN60601-2-20, clause 201.12.4.2.101. Measured 15 cm from 4% $CO_2$ mixture administered at rate of 750 ml/min, 10 cm above center of mattress.

### GUIDANCE AND MANUFACTURER'S DECLARATION - EMISSIONS

The Transport Incubator is intended for use in the electromagnetic environment specified below. The customer or user of the Transport Incubator should ensure that it is used in such an environment.

| EMISSIONS TEST | COMPLIANCE | ELECTROMAGNETIC ENVIRONMENT - GUIDANCE |
|---|---|---|
| RF Emissions CISPR 11 | Group 1 | The Transport Incubator uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment. |
| Conducted Emissions CISPR 11 | Class B | The Transport Incubator is suitable for use in all establishments, including domestic, and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes. |
| Harmonics IEC 61000-3-2 | Class A | |
| Flicker IEC 61000-3-3 | Complies | |

### GUIDANCE AND MANUFACTURER'S DECLARATION - IMMUNITY

The Transport Incubator is intended for use in the electromagnetic environment specified below. The customer or user of the Transport Incubator should ensure that it is used in such an environment.

| IMMUNITY TEST | IEC 60601 TEST LEVEL | COMPLIANCE LEVEL | ELECTROMAGNETIC ENVIRONMENT - GUIDANCE |
|---|---|---|---|
| ESD<br>IEC 61000-4-2 | ± 6 kV Contact<br>± 8 kV Air | ± 6 kV Contact<br>± 8 kV Air | Floors should be wood, concrete, or ceramic tile. If floors are synthetic, the r/h should be at least 30%. |
| EFT<br>IEC 61000-4-4 | ± 2 kV Mains<br>± 1 kV I/Os | ± 2 kV Mains<br>± 1 kV I/Os | Mains power quality should be that of a typical commercial or hospital environment. |
| Surge<br>IEC 61000-4-5 | ± 1 kV Differential<br>± 2 kV Common | ± 1 kV Differential<br>± 2 kV Common | Mains power quality should be that of a typical commercial or hospital environment. |
| Voltage Dips/Dropout<br>IEC 61000-4-11 | > 95% Dip for 0.5 Cycle<br><br>60% Dip for 5 Cycles<br><br>30% Dip for 25 Cycles<br><br>> 95% Dip for 5 Seconds | > 95% Dip for 0.5 Cycle<br><br>60% Dip for 5 Cycles<br><br>30% Dip for 25 Cycles<br><br>During the 5 Second event, the Transport Incubator switches to internal battery power. | Mains power quality should be that of a typical commercial or hospital environment. If the user of the Transport Incubator requires continued operation during power mains interruption, it is recommended that the Transport Incubator be powered from an uninterruptible power supply or internal battery. |
| Power Frequency 50/60 Hz Magnetic Field<br>IEC 61000-4-8 | 3 A/m | 30 A/m | Power Frequency magnetic fields should be that of a typical commercial or hospital environment. |

### GUIDANCE AND MANUFACTURER'S DECLARATION - IMMUNITY

The Transport Incubator is intended for use in the electromagnetic environment specified below. The customer or user of the Transport Incubator should ensure that it is used in such an environment.

| IMMUNITY TEST | IEC 60601 TEST LEVEL | COMPLIANCE LEVEL | ELECTROMAGNETIC ENVIRONMENT - GUIDANCE |
|---|---|---|---|
| Conducted RF<br>IEC 61000-4-6<br><br>Radiated RF<br>IEC 61000-4-3 | 3 Vrms<br>150 kHz to 80 MHz<br>(AC/DC)<br><br>3 V/m<br>80 MHz to 2.5 GHz | (V1) Vrms<br><br>(E1) V/m | Portable and mobile communications equipment should be separated from the Transport Incubator by no less than the distances calculated/listed below:<br><br>D=(3.5/V1)(Sqrt P)<br><br>D=(3.5/E1)(Sqrt P)<br>80 to 800 MHz<br><br>D=(7/E1)(Sqrt P)<br>800 MHz to 2.5 GHz<br><br>Where P is the max power in watts and D is the recommended separation distance in meters.<br><br>Field strengths from fixed transmitters, as determined by an electromagnetic site survey, should be less than the compliance levels (V1 and E1).<br><br>Interference may occur in the vicinity of equipment containing a transmitter. |

Equipment and Systems that are NOT Life-Supporting

**RECOMMENDED SEPARATION DISTANCES BETWEEN PORTABLE AND MOBILE RF COMMUNICATIONS EQUIPMENT AND THE TRANSPORT INCUBATOR**

The Transport Incubator is intended for use in the electromagnetic environment in which radiated disturbances are controlled. The customer or user of the Transport Incubator can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF Communications Equipment and the Transport Incubator as recommended below, according to the maximum output power of the communications equipment.

| MAX OUTPUT POWER (WATTS) | SEPARATION (m) 150 kHz to 80 MHz D=(3.5/V1)(Sqrt P) | SEPARATION (m) 80 to 800 MHz D=(3.5/E1)(Sqrt P) | SEPARATION (m) 800 MHz to 2.5 GHz D=(7/E1)(Sqrt P) |
|---|---|---|---|
| 0.01 | 0.12 | 0.12 | 0.23 |
| 0.1 | 0.37 | 0.37 | 0.74 |
| 1 | 1.17 | 1.17 | 2.33 |
| 10 | 3.69 | 3.69 | 7.38 |
| 100 | 11.67 | 11.67 | 23.33 |

Equipment and Systems that are NOT Life-Supporting

# PULSE OXIMETER SPECIFICATIONS (OPTIONAL FEATURE)

***Range***

Oxygen Saturation ---------- 1% - 100%

Pulse Rate ---------- 25-240 bpm

Perfusion Index (Masimo Only) ---------- 0.02% to 20%

***Resolution***

Oxygen Saturation ---------- 1%

Pulse Rate ---------- 1 bpm

***Sensor Peak Wavelengths***

*Peak wavelength information may be useful to clinicians, such as those performing photodynamic therapy.*

Masimo ---------- 660 nm (red light), 905 nm (infrared light)

Nellcor---------- 660 nm (red light), 900 nm (infrared light)

***Sensor Maximum Power Output***

Masimo ---------- less than 15 mW (at 50 mA pulsed)

Nellcor---------- less than 15 mW

***Masimo Sensor Accuracy[4]***

During No Motion Conditions[5]

| | | |
|---|---|---|
| Oxygen Saturation - Neonates | 70 - 100% | ± 3% |
| | 0 - 69% | unspecified |
| Oxygen Saturation - Pediatrics | 70 - 100% | ± 2% |
| | 0 - 69% | unspecified |
| Pulse Rate - Neonates / Pediatrics | 25 - 240 bpm | ± 3 bpm |

During Motion Conditions[6,7]

| | | |
|---|---|---|
| Oxygen Saturation - Neonates / Pediatrics | 70 - 100% | ± 3% |
| | 0 - 69% | unspecified |
| Pulse Rate - Neonates / Pediatrics | 25 - 240 bpm | ± 5 bpm |

Low Perfusion (where 0.02% Pulse Amplitude and % Transmission > 5%)[8]

| | |
|---|---|
| Oxygen Saturation - Neonates / Pediatrics | ± 2% |
| Pulse Rate - Neonates / Pediatrics | ± 3 bpm |

[4] Masimo sensors have been validated for pulse rate accuracy for the range of 25 - 240 bpm in bench top testing against a Biotek Index 2 simulator. This variation equals plus or minus one standard deviation, which encompasses 68% of the population.

[5] Masimo SET technology with LNCS sensors have been validated for no motion accuracy in human blood studies on healthy adult male and female volunteers with light to dark skin pigmentation in induced hypoxia studies in the range of 70-100% $SpO_2$ against a laboratory co-oximeter and ECG monitor. This variation equals plus or minus one standard deviation, which encompasses 68% of the population. The saturation accuracy of the neonatal sensors was validated on adult male and female volunteers with light to dark skin pigmentation and 1% was added to account for the properties of fetal hemoglobin.

[6] Masimo SET technology with LNCS sensors has been validated for motion accuracy in human blood studies on healthy adult male and female volunteers with light to dark skin pigmentation in induced hypoxia studies while performing rubbing and tapping motions, at 2 to 4 Hz at an amplitude of 1 to 2 cm and a non-repetitive motion between 1 to 5 Hz at an amplitude of 2 to 3 cm in induced hypoxia studies in the range of 70-100% $SpO_2$ against a laboratory co-oximeter and ECG monitor. This variation equals plus or minus one standard deviation, which encompasses 68% of the population.

[7] The Masimo SET Technology with LNCS Neo sensors has been validated for neonatal motion accuracy in human blood studies on healthy adult volunteers in induced hypoxia studies while performing rubbing and tapping motions, at 2 to 4 Hz at an amplitude of 1 to 2 cm and a non-repetitive motion between 1 to 5 Hz at an amplitude of 2 to 3 cm in induced hypoxia studies in the range of 70-100% $SpO_2$ against a laboratory CO-oximeter and ECG monitor. 1% has been added to the saturation accuracy to account for the effects of fetal hemoglobin. This variation equals plus or minus one standard deviation, which encompasses 68% of the population.

[8] Masimo SET technology has been validated for low perfusion accuracy in bench top testing against a Biotek Index 2 simulator and Masimo's simulator with signal strengths of greater than 0.02% and a % transmission of greater than 5% for saturations ranging from 70 to 100%. This variation equals plus or minus one standard deviation, which encompasses 68% of the population.

***Nellcor Sensor Accuracy[9,10]***

Oxygen Saturation (70-100% range) ---------- ± 2% (OxiMax adhesive sensors)

Oxygen Saturation (60-80% range) ---------- ± 3% (MAX sensors)

Pulse Rate ---------- 20 - 240 bpm ± 3 bpm

***Interfering Substances***

Carboxyhemoglobin may erroneously increase readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes, or any substance containing dyes, that change usual arterial pigmentation may cause erroneous readings.

# OXYGEN MONITOR SPECIFICATIONS (OPTIONAL FEATURE)

Measurement Range ---------- 10.0% to 100%

Resolution ---------- 0.1%

Response Time ---------- < 16 seconds for 90% response

< 25 seconds for 97% response

Accuracy ---------- ± 4.0% over measurement range

Stability ---------- Less than 2% drift over 8 hours at constant temperature and pressure

Required Sample Flow ---------- Minimal 3cc/minute, 100cc/minute typical

Operating Temperature ---------- 5° to 40° C (31 - 104°F)

**INTERFERING SUBSTANCES**

| Interferent | Volume % Dry | Interference in Oxygen Reading |
|---|---|---|
| Nitrous Oxide | 75% | < 2% |
| Carbon Dioxide | 10% | < 2% |
| Halothane | 5% | < 2% |
| Enflurane | 5% | < 2% |
| Isoflurane | 5% | < 2% |
| Helium | 70% | < 2% |
| Sevoflurane | 6% | < 2% |
| Desflurane | 15% | < 2% |

[9] The NELL-1 PulseOximeter board has been validated, in part, by studies conducted on healthy adult male and female volunteers, spanning a range of skin pigmentations and ranging in age from 18-50 years old, under controlled laboratory conditions over the saturation range of 70% to 100%. $SpO_2$ was compared to $SaO_2$ measured to blood CO-oximetry, and pulse rate was compared to EKG heart rate. Clinical functionality has been demonstrated on a population of hospitalized neonate and infant patients (MAX sensors: 1-23 days old, weight from 750-4100 grams, Softcare sensors: 24-40 weeks old, weight from 710-5000 grams).

[10] The NELL-1 PulseOximeter board has been validated for low perfusion accuracy using signals supplied by a patient simulator. $SpO_2$ and pulse rate values were varied across the monitoring range over a range of weak signal conditions and compared to the known true saturation and pulse rate of the input signals.

# OPERATING, STORAGE, AND TRANSPORT ENVIRONMENT

The infant transport incubator requires the following environmental conditions for transport and storage:

Temperature ---------- -15° C to 40° C
Humidity ---------- 10% to 95% non-condensing
Pressure ---------- 50 kPa to 106 kPa

The requirements of the International Standard, EN60601-2-20:2009 are met. The environment, if not further specified in the standard, is:

Temperature ---------- 21° C to 25° C
Humidity ---------- 45% to 75% non-condensing
Pressure ---------- 86 kPa to 106 kPa

# SECTION 12: WARRANTY

Unless otherwise specified, International Biomedical warrants all products of its manufacture at the time of shipment to be free from defects of material and workmanship for a period of twelve months from the date of shipment when owned by the original purchaser. Any product which is believed to be defective, if returned within twelve months after date of shipment by the Company with freight prepaid and found by the Company's inspection to be defective within the terms of this warranty, will be repaired or replaced free of charge and shipped, freight prepaid, to any point in the United States. If inspection by the Company of any such product does not disclose any defect within the terms of this warranty, the Company's regular charges for repairs or replacement and freight shall apply. All consumable and disposable products are guaranteed to be free from defects upon shipment only. The warranty period for batteries is limited to 90 days from date of shipment.

This warranty specifically excludes and replaces all other express and implied warranties. The Company shall have no liability under any warranty in any amount greater than the Company receives for the sale of the product involved. The use and manner of use of the Company's products shall be the responsibility of the purchaser and the purchaser covenants and agrees to indemnify and save harmless the Company in respect to any loss and damage that may arise through the use by the purchaser, or others, of any of the Company's products.

This warranty is rendered void and International Biomedical cannot be held liable for conditions resultant therefrom if:

1. Damage to the unit is incurred as a result of mishandling.
2. The customer fails to maintain the unit in a proper manner.
3. The customer uses any parts, accessories, or fittings not specified or sold by International Biomedical.
4. Sale or Service is performed by a non-certified service / dealer agency or any other unauthorized agency.

All shipping claims must be made within 30 days from date of shipment from International Biomedical; otherwise factory will not be liable for claims of missing items. Any item ordered in error and returned to the factory for credit, will be subject to a minimum restocking charge of 15%. Requests for returning items must be made within 30 days of factory shipment date.

International Biomedical will accept no returned goods without a Returned Goods Authorization number (RGA) obtained from Customer Service Department.

# EUROPEAN REGULATORY AFFAIRS REPRESENTATIVE

The authorized regulatory affairs representative in Europe for the incubator is:

Emergo Europe
Westervoortsedijk 60
6827 AT
Arnhem, The Netherlands

# PARTS AND ACCESSORIES

Power Cords (vary depending on customer requirements)

| | |
|---|---|
| 216-0350 | Strap, Infant Positioning - (Reorder PN 731-2950, Case of 20) |
| 700-3409 | 409B Skin Temperature Probe, Reusable |
| 711-1860 | Cable, Oxygen Sensor to Side Panel |
| 711-0022 | Cable Assy, Patient, 10', Masimo LNCS |
| 711-1920 | Cable Assy Patient, 10 Foot, Nellcor OxiMax |
| 731-0004 | Phototherapy Eye Shields, Small |
| 731-9592 | Cover, Thermal, Incubator - Large, Head and Foot Door |

For general incubator assistance or for parts and accessories, contact:

International Biomedical
8206 Cross Park Drive
Austin, TX 78754

512-873-0033

www.int-bio.com

For information on Masimo pulse oximeter sensors and cables, contact:

Masimo Corporation
52 Discovery
Irvine, CA 92618

949-297-7000

www.masimo.com

For information on Nellcor pulse oximeter sensors and cables, contact:

Covidien
6135 Gunbarrel Avenue
Boulder, CO 80301

800-635-5267 or 303-530-2300

www.nellcor.com

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| REVISION HISTORY | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |
| A | NDR 2891 | 06/10/16 | TE |

ORIGINAL

| | |
|---|---|
| NEXT ASSY | USED ON |
| APPLICATION | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

| DECIMALS | ANGLES |
|---|---|
| .X ±.1 | ±1/2° |
| .XX ±.02 | |
| .XXX ±.010 | |

DO NOT SCALE DRAWING

| APPROVALS | | DATE |
|---|---|---|
| DRAWN | teh | 052716 |
| CHECKED | TE | 060316 |
| ENGR | TE | 06/10/16 |

international BIOMEDICAL
8206 CROSS PARK DR. AUSTIN, TX 78754

TITLE SYS WIRING DIAG, MASIMO PULSEOX, AVIATOR/185A+

| SIZE | CAGE CODE | DWG NO. | REV |
|---|---|---|---|
| B | | 002-0012 | A |

SCALE NTS | SHEET 1 OF 1

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REVISION HISTORY

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| A | NDR 2891 | 06/10/16 | TE |

ORIGINAL

| NEXT ASSY | USED ON |
|---|---|
| APPLICATION | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS .X ±.1 .XX ±.02 .XXX ±.010
ANGLES ±1/2°
DO NOT SCALE DRAWING

| APPROVALS | | DATE |
|---|---|---|
| DRAWN | teh | 052716 |
| CHECKED | TE | 060316 |
| ENGR | TE | 06/10/16 |

international BIOMEDICAL®
8206 CROSS PARK DR. AUSTIN, TX 78754

TITLE SYS WIRING DIAG, NELLCOR PULSEOX, AVIATOR/185A+

| SIZE | CAGE CODE | DWG NO. | REV |
|---|---|---|---|
| B | | 002-0015 | A |

SCALE NTS | SHEET 1 OF 1

REVISION RECORD
LTR | ECO NO: | DATE: | APPD:
A | NDR 1448 | 11/15/02 | RLD
B | 10756 | 01/28/03 | RLD
C | 10896 | 03/30/05 | RLD
D | 11018 | 08/14/06 | GM
E | 11040 | 01/02/07 | GM
F | 11435 | 03/01/10 | MS
G | 12371 | 01/02/13 | SM
H | 12467 | 07/23/13 | SM
J | 13271 | 08/19/16 | AL
ORIGINAL
UNSHOWN POWER CONNECTIONS
REF | POWER | GROUND
DES | PIN | SIGNAL | PIN | SIGNAL
Z3 | 8 | +12V | 4 | GND
Z4 | 7 | AC_RECT | 4 | GND
Z7 | 8 | +12V | 4 | GND
Z9 | 8 | +12V | 4 | GND
Z10 | 8 | +12V | 4 | GND
Z11 | 11 | +12V | 4 | GND
Z12 | 14 | +12V | 7 | GND
Z14 | 14 | +12V | 7 | GND
Z15 | 7 | AC_RECT | 4 | GND
COMPANY: INTERNATIONAL BIOMEDICAL
TITLE: SCHEMATIC, UPDATED INCUBATOR CONTROL BOARD
DRAWN:
CHECKED:
QUALITY CONTROL:
RELEASED:
DATED:
CODE:
SIZE: B
DRAWING NO: 001-5181
REV: J
SCALE:
SHEET: 1 OF 1
EXT_DC_IN
AC_RECT_IN
BATT_IN
ACTIVE PWR OUT
GND
LAMP PWR
DC_PWR_OUT
EXT_DC_OP_MODE
AC_OP_MODE
PWR_FAIL
DC_PWR_IN
FAN PWR
DISPLAY +12V
VOLTAGE_SWITCH
BATT CHARGE
LAMP_RTN
SECONDARY THERMISTOR
PRIMARY THERMISTOR
SET_PT
SET_PT
PRIMARY THERMISTOR
REF VOLT
BATT_CHG_DISABLE
HTR_CNTRL
FAN & THERMAL_SW RTN
AC_FAIL
HTR_PWR
THERMAL_SW
AIR_FLOW_ALARM
SONALERT
SYS_FAIL
SENSOR_FAIL
HI_TEMP_ALARM
LOW_BATT
OVER TEMP SHUTDOWN
SHORTED
OPEN
39 DEG C ALARM
INTERMITTENT AUDIBLE ALARM

ORIGINAL
REVISION RECORD
REV ECO NO APPROVED DATE
C NDR 1744 RR 07/15/08
D 11300-1 RR 01/15/09
E 11328 RR 04/03/09
F 11398 KKM 06/22/09
G 11421 RR 08/26/09
H 12206 TAM 08/14/12
J 13225 TE 05/02/16
J4-2 is common for Power Button
J4-10 is common for Mute Button
J4-3 is common for all other buttons
TO CONTROL BOARD
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, PULSEOX INCUBATOR DISPLAY
CONFIGURATION
001-5193-01
PAGES
1-6
357-4703
INCUBATORS
NEXT ASSY
USED ON
CODE:
SIZE:
A
DRAWING NO:
001-5193
REV:
J
SCALE: NONE
SHEET: 1 OF 6

POWER ON CIRCUIT
ALARM & MUTE
POWER UP TEST
SONALERT
001-5193-01
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, PULSEOX INCUBATOR DISPLAY
CODE:
SIZE:
A
DRAWING NO:
001-5193
REV:
J
SCALE: NONE
SHEET: 2 OF 6

PULSE-OX CONTROLLER
Jumper JP1 on the 1-2 position selects Nellcor pulse oximeter
Jumper JP1 on the 2-3 position selects Masimo pulse oximeter
SPO2
PULSE
OXYGEN
PULSE STRENGTH BAR GRAPH
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, PULSEOX INCUBATOR DISPLAY
CODE:
SIZE:
A
DRAWING NO:
001-5193
REV:
J
SCALE: NONE
SHEET: 3 OF 6
001-5193-01

TO NELLCOR NELL-1
PULSE OXIMETRY BOARD
TO MASIMO MS-2013
PULSE OXIMETRY BOARD
OXYGEN PREAMP
TO OXYGEN
SENSOR
MAX-250E
PROGRAMMING INTERFACE
GAIN = 42.15
001-5193-01
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, PULSEOX INCUBATOR DISPLAY
CODE:
SIZE:
A
DRAWING NO:
001-5193
REV:
J
SCALE: NONE
SHEET: 4 OF 6

## POWER / GROUND / BYPASS CAPS

| REF | DEVICE | POWER PINS | SOURCE | GROUND PINS | C-Bypass |
|---|---|---|---|---|---|
| U1 | 74HC14 | 14 | U15 | 7 | C7 |
| U2 | 74HC74A | 14 | U15 | 7 | C8 |
| U3 | 74HC244 | 20 | U15 | 10 | C9 |
| U4 | PIC16F877 | 7, 28 | U16 | 6, 29 | C18, C19 |
| U5 | CD4013B | 14 | SEE NOTE | 7 | C20 |
| U6 | LTC1453 | 8 | U16 | 5 | C63 |
| U8 | DS2003 | NONE | NONE | 8 | NONE |
| U9 | DS2003 | NONE | NONE | 8 | NONE |
| U10 | DS2003 | NONE | NONE | 8 | NONE |
| U11 | UDN2985A | 9 | J1-29 | 10 | NONE |
| U13 | LM10CL | 7 | U18 | 4 | C73 |
| U14 | ICL7621BCPA | 8 | U16 | 4 | C22 |
| U19 | PIC16F877A | 7, 28 | U16 | 6, 29 | C27, C28 |
| U20 | DS2003 | NONE | NONE | 8 | NONE |
| U12 | DS2003 | NONE | NONE | 8 | NONE |
| U17 | CC1R5-1212 | 1 | J1-29 | 3 | C45 |
| U21 | UDN2985A | 9 | J1-29 | 10 | NONE |
| U7 | LM2936Z-3.3 | 2 | U18 | 2 ISO | C41 |
| U27 | HPCL-261N | 8 | U18 | 5 ISO | C43 |
| U23 | 74HC238 | 16 | U16 | 8 | C47 |
| U24 | ADS7816 | 8 | U18 | 4 ISO | C40 |
| U25 | AD623 | 7 | U18 | 4 -5V_ISO | C44,C61 |
| U26 | LM4040A | Z-CATHODE | U18 | 2 ISO | J1-13,15,17 |
| U28 | HPCL-261N | 8 | U18 | 5 ISO | C39 |
| U29 | HPCL-261N | 8 | U16 | 5 | C21 |
| U18 | LM340T-5.0 | 8 | U4-7 | 5 | C21 |
| U17 | 74HC238 | 8 | U16 | 5 | C14 |
| U31 | AD7816 | 8 | U18 | 4 ISO | C71 |
| U32 | HPCL-261N | 8 | U18 | 5 ISO | C72 |
| U33 | HPCL-261N | 8 | U16 | 5 | C75 |
| U34 | ADR02 | 2 | U22 | 4 ISO | C74 |

U5 draws from from the 12V supply of the control board (originating from J1-29) through a reverse blocking diode (D11)

All circuits are referenced to ground through J1-21,23,25 EXCEPT components powered by U22 which creates an isolated ground.

001-5193-01

COMPANY: INTERNATIONAL BIOMEDICAL

TITLE: SCHEMATIC, PULSEOX INCUBATOR DISPLAY

| CODE: | SIZE: | DRAWING NO: | REV: |
|---|---|---|---|
| | A | 001-5193 | J |

SCALE: NONE SHEET: 5 OF 6

+12V_ISO
U34
V_IN
V_OUT
ADR02
TRIM
GND
R109
C70
.1uF
TP3
GND_ISO
+5V
R108
340
U33
3-C6
ST_DT
SHIELD
GND
HCPL-063L-060E
R110
220
+5V_ISO
R107
9.10K
Q18
MMBT2222A
C69
.1uF
GND_ISO
+5V
3-C6
ST_CK
R106
220
R102
9.10K
Q17
MMBT2222A
C67
.1uF
+5V
3-C6
ST_CS
R105
220
R101
9.10K
Q16
MMBT2222A
C68
.1uF
GND
U32
CLK1
CH_SEL1
SHIELD
HCPL-063L-060E
GND_ISO
+5V_ISO
R104
340
R103
340
U31
ADS7816
DCLOCK
DOUT
CS/SHDN
REF
IN+
IN-
GND_ISO
SKIN TEMPERATURE
TP5
R37
15.0K
R30
2.0K
R29
1.50K
J3
R31
5.11K
TP4
U13
LM10CWM
R34
432K
R35
49.9K
R33
10.0K
R36
10K
R32
10.0K
GND_ISO
001-5193-01
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, PULSEOX INCUBATOR DISPLAY
CODE:
SIZE:
A
DRAWING NO:
001-5193
REV:
J
SCALE: NONE
SHEET: 6 OF 6

## POWER

| REF | DEVICE | POWER PINS | SOURCE | GROUND PINS | GROUND |
|---|---|---|---|---|---|
| U1 | 74HC14 | 14 | U15 | 7 | J1-21,23,25,27 |
| U2 | 74HC74A | 14 | U15 | 7 | J1-21,23,25,27 |
| U3 | 74HC244 | 20 | U15 | 10 | J1-21,23,25,27 |
| U4 | PIC16F877 | 11, 32 | U16 | 12, 31 | J1-21,23,25,27 |
| U5 | CD4013B | 14 | SEE NOTE | 7 | J1-21,23,25,27 |
| U6 | LTC1453 | 8 | U16 | 5 | J1-21,23,25,27 |
| U8 | DS2003 | NONE | NONE | 8 | J1-21,23,25,27 |
| U9 | DS2003 | NONE | NONE | 8 | J1-21,23,25,27 |
| U10 | DS2003 | NONE | NONE | 8 | J1-21,23,25,27 |
| U11 | UDN2985A | 9 | J1-29 | 10 | J1-21,23,25,27 |
| U13 | LM10CL | 7 | U16 | 4 | J1-21,23,25,27 |
| U14 | ICL7621BCPA | 8 | U12 | 4 | J1-21,23,25,27 |

U5 draws from from the 12V supply of the control board (originating from J1-29) through a reverse blocking diode (D11)

J1-21,23,25,27 acts as a power ground for the UID.

U12, U15 and U16 are referenced to power ground (J1-21,23,25,27)

| CONFIGURATION | PAGES |
|---|---|
| 001-5192-01 | 1-2 |
| 357-4702 | |
| USED ON | NEXT ASSY |

COMPANY: INTERNATIONAL BIOMEDICAL

TITLE: SCHEMATIC, UPGRADED INCUBATOR DISPLAY

| CODE: | SIZE: | DRAWING NO: | REV: |
|---|---|---|---|
| | A | 001-5192 | F |

SCALE: NONE SHEET: 1OF 2

001-5192-01
COMPANY:
INTERNATIONAL BIOMEDICAL
TITLE:
SCHEMATIC, UPGRADED INCUBATOR DISPLAY
CODE:
SIZE:
A
DRAWING NO:
001-5192
REV:
F
SCALE: NONE
SHEET: 2OF 2
BATTERY_VOLTAGE_IN
ACTIVE_POWER_IN
POWER_BUTTON
12_VOLT_POWER
DC_POWER_OUT
DC_POWER_IN
ACTIVE_POWER_IN
BATTERY_VOLTAGE_IN
TEST_BUZZER
POWER_FAIL
SONALERT
SKIN_TEMP
BATTERY_DISCHARGE
BATTERY_CHARGE
MUTE_BUTTON
POWER_ON_TEST
DARLINGTON_SINK_2
DARLINGTON_SINK_1
AC_FAIL_IN
AC_OPERATION_MODE
AC_FAIL
C20 is a bypass capacitor for U5.
U15
78L05ACZ
U12
LM340T-5.0
74HC74AN
74HC244N
CD4013BCN
U14-A
ICL7621BCPA
U14-B
ICL7621BCPA
U13
LM10CLN
SONALERT
BZ1
SBM616P
K1
DS2Y-SL2-DC5V
Q2
VP0300M
Q4
VN0610L
Q1
VN0610L
Q3
VN0610L
Q5
VN0610L
Q6
VN0610L
Q7
PN2222A
Q8
PN2222A
X1 MOUNTING_HOLE
X2 MOUNTING_HOLE
X3 MOUNTING_HOLE
X4 MOUNTING_HOLE
X5 MOUNTING_HOLE
X6 MOUNTING_HOLE
X7 MOUNTING_HOLE

### TEMPERATURE SENSOR RESISTANCE VALUES

| Temperature (° C) | Resistance (ohms) |
|---|---|
| 15 | 3539 |
| 16 | 3378 |
| 17 | 3226 |
| 18 | 3081 |
| 19 | 2944 |
| 20 | 2814 |
| 21 | 2690 |
| 22 | 2572 |
| 23 | 2460 |
| 24 | 2354 |
| 25 | 2252 |
| 26 | 2156 |
| 27 | 2064 |
| 28 | 1977 |
| 29 | 1894 |
| 30 | 1815 |
| 31 | 1739 |
| 32 | 1667 |
| 33 | 1599 |
| 34 | 1533 |
| 35 | 1471 |
| 36 | 1412 |
| 37 | 1355 |
| 38 | 1301 |
| 39 | 1249 |
| 40 | 1200 |
| 41 | 1152 |
| 42 | 1107 |
| 43 | 1064 |
| 44 | 1023 |

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND IS LOANED IN CONFIDENCE SUBJECT TO RETURN UPON DEMAND ON THE EXPRESS CONDITION THAT IT WILL NOT BE USED IN ANY WAY NOT AUTHORIZED IN WRITING BY INTERNATIONAL BIOMEDICAL.

| REVISION HISTORY | | | |
|---|---|---|---|
| REV | DESCRIPTION | DATE | APPROVED |
| A | RELEASED PER NDR-1799 | 4/15/09 | TE |

ORIGINAL

SYMBOL KEY

CHECK VALVE

SHUT–OFF VALVE

FLOW CONTROL VALVE WITH VARIABLE OUTPUT

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | AVIATOR |
| NEXT ASSY | USED ON |
| APPLICATION | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

| DECIMALS | ANGLES |
|---|---|
| .X ±.1 | ±1/2° |
| .XX ±.03 | |
| .XXX ±.010 | |

DO NOT SCALE DRAWING

| APPROVALS | | DATE |
|---|---|---|
| DRAWN | TE | 120808 |
| CHECKED | TE | 4/15/09 |
| ENGR | TE | 4/15/09 |

International Biomedical

8508 CROSS PARK DR. AUSTIN, TX 78754

TITLE SCHEMATIC, PNEUMATIC AVIATOR

| SIZE | CAGE CODE | DWG NO. | REV |
|---|---|---|---|
| B | | 002-4020 | A |

SCALE NONE | SHEET 1 OF 1